Oregon State University

College of Earth, Ocean, and Atmospheric Sciences
Oregon State University
104 CEOAS Admin Bldg.
Corvallis, Oregon 97331-5503

P 541-737-3504
F 541-737-2064
ceoas.oregonstate.edu

May 30, 2019

Via Electronic Filing

Ms. Kimberly D. Bose, Secretary
Federal Energy Regulatory Commission
888 First Street, N.E.
Washington, D.C. 20426

Subject: Submittal of the Final License Application for the PacWave South Project (FERC Project No. 14616)

Dear Secretary Bose,

Oregon State University (OSU) is pleased to submit the Final License Application (FLA) and Applicant Prepared Environmental Assessment (APEA) for the PacWave South Project (formerly known as Pacific Marine Energy Center South Energy Test Site) (FERC Project No. 14616), a grid-connected wave energy test facility located approximately six nautical miles off the coast of Newport, Oregon. With this application, OSU is seeking a 25-year Federal Energy Regulatory Commission (FERC) original license authorizing construction and operation of the Project, with an installed capacity not to exceed 20 megawatts.

The FLA has been prepared through the Commission's Alternative Licensing Process and pursuant 18 C.F.R. § 4.41. The FLA consists of four volumes. Volumes I, II, and III of the application contain public information. Volume IV of the application includes the detailed drawings of the Project works, which is classified as Critical Energy Infrastructure Information (CEII) because it contains specific engineering and detailed design information about a proposed critical infrastructure that meets the definition of CEII under 18 C.F.R. § 388.113 and, thus, Volume IV of the application is not being distributed to the public. OSU is filing Volume IV with the Commission under the e-Filing guidelines for filing CEII. OSU requests that the CEII designation commence as of the date of filing and last for the maximum five-year period. Because these facilities are expected to remain in operation going forward for at least the term of the license, OSU requests that the Commission continue to re-designate this information as CEII indefinitely, or for the maximum duration permitted by law.

In conjunction with the electronic filing of the FLA, OSU is providing the Commission with three courtesy copies of the application (to the Office of Energy Projects, Office of General Counsel-

Energy Projects, and Portland Regional Office), as well as compact disks that contain the associated Exhibit G drawings and data. These will follow in separate transmittals to the Commission.

Concurrent with this filing, OSU will send the FERC weblink of the FLA to its distribution list from the Collaborative Work Group process, including resource agencies, Indian tribes, local governments, and non-governmental organizations. Other interested parties can also access the filing at FERC's online e-Library at http://www.ferc.gov/docs-filing/elibrary.asp, by searching FERC Project No. 14616. The FLA can also be reviewed during normal business hours at the Newport Public Library, 35 NW Nye St., Newport, OR 97365. In support of the relicensing process, OSU will publish public notice of the filing of the FLA twice in the Newport News Times.

Comments received on the Draft License Application (DLA) are presented in Appendix L of the APEA along with OSU's responses to those comments. Comments on the DLA have been addressed in this FLA as appropriate.

Should you have any questions regarding this filing, please contact Dan Hellin at (541) 737-5452.

Sincerely,

Michael Green
Vice President for Finance and Administration
Oregon State University
640 Kerr Administration Building
1500 SW Jefferson Avenue
Corvallis, OR 97331

cc: Service List for P-14616

CERTIFICATE OF SERVICE

I hereby certify that I have this day served the *Final License Application for the Pac Wave South Project, (FERC Project No. 14616)* by Oregon State University, upon each person designated on the official service list below compiled by the Secretary in this proceeding.

DATED at Seattle, Washington this 31st day of May, 2019.

Judy Shore

Judy Shore, Practice Assistant
for Cherise M. Gaffney
STOEL RIVES LLP
600 University St., Suite 3600
Seattle, WA 98101
Telephone: (206) 386-7622 (Cherise)
Telephone: (206) 386-7571 (Judy)
Facsimile: (206) 386-7500
cherise.gaffney@stoel.com

Service List for P-14616-000 Oregon State University

Party	Primary Person or Counsel of Record to be Served	Other Contact to be Served
Oregon State University	Cherise Gaffney Stoel Rives LLP 600 University St Suite 3600 Seattle, WASHINGTON 98101 UNITED STATES cherise.gaffney@stoel.com	

VOLUME I

PACWAVE SOUTH

LICENSE APPLICATION

FERC PROJECT NO. 14616

APPLICANT:

OREGON STATE UNIVERSITY
CORVALLIS, OR

MAY 2019

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VOLUME I LICENSE APPLICATION

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ACRONYMS AND ABBREVIATIONS

AC	Alternating current
ALP	Alternative Licensing Process
APEA	Applicant Prepared Environmental Assessment
BPA	Bonneville Power Administration
BOEM	Bureau of Ocean Energy Management
CLPUD	Central Lincoln People's Utility District
CEII	Critical Energy Infrastructure Information
CWG	Collaborative Workgroup
dB	Decibels
DP	Dynamic positioning
DPV	Dynamic Positioning Vessels
DOE	U.S. Department of Energy
EMF	Electromagnetic field
EPA	Environmental Protection Agency
ESA	Endangered Species Act
FERC	Federal Energy Regulatory Commission
FINE	Fishermen Involved in Natural Energy
ft	Feet
FWS	U.S. Fish and Wildlife Service
HDD	Horizontal directional drilling
kW	Kilowatts
kW/m	Kilowatts per meter
m	Meter
MBTA	Migratory Bird Treaty Act
MLLW	Mean lower low water
mm	Millimeters
MW	Megawatt
NDBC	National Data Buoy Center
NMFS	National Marine Fisheries Service
OAR	Oregon Administrative Rules
O&M	Operations and maintenance
OCS	Outer Continental Shelf
ODFW	Oregon Department of Fish and Wildlife
ODOE	Oregon Department of Energy
ODOT	Oregon Department of Transportation
OPRD	Oregon Parks and Recreation Department
OSU	Oregon State University
OWC	Oscillating water columns
OWET	Oregon Wave Energy Trust

PAD	Pre-Application Document
PMEC-NETS	Pacific Marine Energy Center North Energy Test Site
PMEC-SETS	Pacific Marine Energy Center South Energy Test Site
ROV	Remotely operated vehicle
SCADA	Supervisory control and data acquisition
UCMF	Utility Connection and Monitoring Facility
USACE	U.S. Army Corps of Engineers
USCG	U.S. Coast Guard
WEC	Wave energy converter

EXECUTIVE SUMMARY

Oregon State University (OSU) is filing this license application with the Federal Energy Regulatory Commission (FERC) to authorize the construction and operation of the proposed PacWave South (Project; formerly known as Pacific Marine Energy Center South Energy Test Site [PMEC-SETS]), a grid-connected wave energy test facility. The Project would be located in the Pacific Ocean, approximately 6 nautical miles off the coast of Newport, Oregon on the Outer Continental Shelf (OCS) and would occupy an area of approximately 2 square nautical miles (1,695 acres). The Project would support up to 20 commercial-scale wave energy converters (WECs) and transfer power to a grid connection point with the Central Lincoln People's Utility District (CLPUD) in Lincoln County, Oregon. With this application, OSU is seeking a 25-year FERC license authorizing construction and operation of the PacWave South Project with an installed capacity not to exceed 20 megawatts (MW) at any time under the FERC license term.

As a grid-connected test facility, PacWave South would provide developers of WECs the opportunity to:

- Optimize WECs and arrays to increase their energy capture, improve their survivability and reliability, and decrease their levelized cost of energy;
- Refine deployment, recovery, operations, and maintenance procedures;
- Collect interconnection and grid synchronization data; and
- Gather information about potential environmental effects, and economic and social benefits.

As such, the primary purpose of the proposed Project is to serve as a facility to allow clients to test full-scale WECs, with generation and transmittal of power to the grid being a secondary Project purpose. The Project has also been designed to specifically support the mission, vision, and goals of the U.S. Department of Energy's (DOE) Office of Energy Efficiency and Renewable Energy Water Power Technologies Office to improve performance, lower costs, and accelerate deployment of innovative technologies for clean, domestic power generation from resources such as hydropower, waves, and tidal technologies. Testing conducted at PacWave South would advance the development of WEC technologies, and thus further the nation's efforts to reduce its greenhouse gas emissions, diversify its energy supply, provide cost-competitive electricity to key coastal regions, and stimulate revitalization of key sectors of the economy.

Licensing consultation on Project design and assessment of potential impacts has been conducted under FERC's Alternative Licensing Process (ALP), which OSU requested approval to use when formal licensing consultation was initiated with the filing of the Pre-Application Document (PAD) in April 2014. The ALP was selected as the preferred FERC licensing approach by the parties engaged in early consultation as being the most appropriate approach for the proposed Project by providing a consultation process that enabled federal and state agencies, and stakeholders to work cooperatively toward the ultimate OSU proposal. The FLA has been prepared in accordance with 18 CFR §4.41.

Pre-formal consultation with agencies began in the fall of 2012 to share information and to prepare for the formal licensing consultation process. In January 2013, OSU formed an advisory team comprised of federal and state agencies involved in the PacWave South authorization process, as well as non-governmental organizations representing stakeholder interests, to collectively explore the Project and identify key regulatory and environmental considerations. This advisory group is called the Collaborative Workgroup (CWG).

The Project site was selected in consultation with a group of local fishermen, Fishermen Involved in Natural Energy (FINE), which identified a 6 square nautical mile area off the coast of Newport that the members felt would be a suitable and acceptable area within which to locate PacWave South based on their extensive knowledge of the local marine environment. Based on the area identified by FINE, OSU submitted a research lease application to the Bureau of Ocean Energy Management (BOEM). OSU subsequently conducted site-specific surveys and gathered information from agencies and stakeholders to characterize the physical and biological conditions of the area and used this information to select a 2 square nautical mile test site described in this application.

The power generated at PacWave South would vary depending on the WEC types and testing conditions; preliminary estimates range from 150 kilowatts (kW) to 2 MW per WEC. As a result, the energy capacity of PacWave South would vary over the life of the Project. OSU expects that the capacity and number of WECs at PacWave South would be lower in the initial operations term and increase gradually as the industry advances. WEC-testing data and power generated by the Project would also support Oregon's goal to develop wave energy as a source of future renewable energy. The State of Oregon Biennial Energy Plan 2015-17 highlights that "Oregon is at the crossroads of a developing marine energy industry, with a powerful wave climate and an environment suited for testing WEC technologies. Oregon is becoming the place to deploy WECs from concept to full-scale deployment and learn how well they work in the marine environment" (Oregon Department of Energy (ODOE) 2015). Regionally, the Northwest Power and Conservation Council (2016) predicts the electricity demand in the Pacific Northwest to increase between 0.5 to 1.0 percent per year, between 2015 and 2035. Testing conducted at PacWave South would advance the development of WEC technologies and further the nation's efforts to reduce its greenhouse gas emissions, diversify its energy supply, provide cost-competitive electricity to key coastal regions, and stimulate revitalization of key sectors of the economy.

INITIAL STATEMENT

Before the Federal Energy Regulatory Commission
Application for License for Major Unconstructed Project

(1) Oregon State University (OSU) *applies to the Federal Energy Regulatory Commission for an* original license *for* PacWave South , FERC Project Number P-14616, *as described in the attached exhibits.*

(2) *The location of the proposed project is:*

State or Territory:	Oregon
County:	Lincoln
Township or nearby township:	Seal Rock
Stream or other body of water:	Pacific Ocean

(3) *The exact name, business address, and telephone number of the applicant are:*

Oregon State University
Michael Green
Vice President for Finance and Administration
Oregon State University
640 Kerr Administration Building
1500 SW Jefferson Avenue
Corvallis, OR 97331
541-737-9725

(4) *The applicant is* a public university in the state of Oregon*, and* is not *claiming preference under section 7(a) of the Federal Power Act. See 16 U.S.C. 796.*

(5)(i) *The statutory or regulatory requirements of the state(s) in which the project would be located and that affect the project as proposed with respect to bed and banks and to the appropriation, diversion, and use of water for power purposes, and with respect to the right to engage in the business of developing, transmitting, and distributing power and in any other business necessary to accomplish the purposes of the license under the Federal Power Act, are: [provide citation and brief identification of the nature of each requirement; if the applicant is a municipality, the applicant must submit copies of applicable state or local laws or a municipal charter or, if such laws or documents are not clear, any other appropriate legal authority, evidencing that the municipality is competent under such laws to engage in the business of developing, transmitting, utilizing, or distributing power.]:*

Permit, Certification, or Approval	Statute or Regulation	Grantor/Reviewer
Ocean Shores Permit; Motor Vehicle on the Ocean Shore	Oregon Administrative Rules (OAR) 736-020, 736-022	Parks and Recreation Department
Dredge and Fill Section 401 Water Quality Certification	Clean Water Act Section 401 (33 U.S.C. 1341) and OAR 340-048	Department of Environmental Quality
Joint Permit Application ("Fill-Removal Permit")	OAR 141-85	Department of State Lands
Easements for Fiber Optic and Other Cables on State-Owned Submerged and Submersible Land Within the Territorial Sea	OAR 141-083-0800	Department of State Lands
Part 4 – Uses of the Sea Floor (2000)	ORS Chapter 196	Department of Land Conservation and Development
Coastal Zone Certification	Coastal Zone Management Act	Department of Land Conservation and Development

(ii) The steps which the applicant has taken, or plans to take, to comply with each of the laws cited above are: [provide brief description for each requirement]

OSU has taken a number of steps to comply with the required non-FERC permits and use authorizations and is in the process of consulting with those agencies that have jurisdiction for the identified permits, certifications, and approvals. In particular, OSU has developed project plans and proposed protection, mitigation and enhancement measures in consultation with state agencies with the goal of meeting the standards and requirements of the approvals listed above. OSU intends to submit the above-listed applications later in 2019.

SECTION 4.32 – GENERAL INFORMATION

1.0 PROPRIETARY RIGHTS

For a preliminary permit or license, identify every person, citizen, association of citizens, domestic corporation, municipality, or state that has or intends to obtain and will maintain any proprietary right necessary to construct, operate, or maintain the project.

OSU is the only applicant for the FERC license and will be the sole entity that has and will maintain proprietary rights to construct, operate, and maintain the Project.

2.0 PROJECT LOCATION

For a preliminary permit or a license, identify (providing names and mailing addresses):

2.1 County

Every county in which any part of the project, and any Federal facilities that would be used by the project, would be located.

Lincoln County, Oregon
225 West Olive Street
Newport, Oregon 97365

2.2 City

Every city, town, or similar local political subdivision:

In which any part of the project, and any federal facilities that would be used by the project, would be located:

The Project is not located within any designated cities, towns, subdivisions or Indian Tribe reservations. The nearest cities, towns, subdivisions, or population centers to the Project with a population of 5,000 or less are the unincorporated communities of Seal Rock, Bayshore, Forfar, and Holiday Beach. No federal facilities will be used by the Project.

Or that has a population of 5,000 or more people and is located within 15 miles of the project dam;

Newport, Oregon
169 SW Coast Highway
Newport, Oregon 97365

2.3 Special purpose political subdivisions

Every irrigation district, drainage district, or similar special purpose political subdivision:

> *(A) In which any part of the project, and any Federal facilities that would be used by the project, would be located; or*

The Project is not located within any special purpose political subdivisions.

> *(B) That owns, operates, maintains, or uses any project facilities or any Federal facilities that would be used by the project;*

The Project would transfer power to a grid connection point with the CLPUD, but CLPUD would not own or operate any of the Project facilities, with the possible exception of CLPUD owning the proposed power line from the electrical meters at the utility connection and monitoring facility (UCMF) to the grid connection on Highway 101, in which case OSU would negotiate the right to undertake any action required by FERC.

2.4 Other interested political subdivisions

Every other political subdivision in the general area of the project that there is reason to believe would likely be interested in, or affected by, the application.

None identified.

2.5 Affected tribes

All Indian tribes that may be affected by the project.

> Confederated Tribes of Siletz Indians
> Chairwoman Delores Pigsley
> 201 SE Swan Avenue
> P.O. Box 549
> Siletz, Oregon 97380

> Confederated Tribes of the Siletz Indians
> Tracy Bailey, Energy Manager
> 201 S.E. Swan Avenue
> P.O. Box 549
> Siletz, OR 97380

Confederated Tribes of Siletz Indians
1322 N. Larchwood
Salem, OR 97303

Confederated Tribes of Grand Ronde
Chairwoman Cheryle Kennedy
9615 Grand Ronde Road
Grand Ronde, OR 97347

Confederated Tribes of Grand Ronde
Eirik Thorsgard, Cultural Protection Program Manager
8720 Grand Ronde Road
Grand Ronde, OR 97347

Confederated Tribes of Grand Ronde
Michael Karnosh
8720 Grand Ronde Road
Grand Ronde, OR 97347

Confederated Tribes of Grand Ronde
Briece Edwards, Tribal Archeologists
8720 Grand Ronde Road
Grand Ronde, OR 97347

3.0 NOTIFICATION OF INTERESTED PARTIES

For a license (other than a license under section 15 of the Federal Power Act) state that the applicant has made, either at the time of or before filing the application, a good faith effort to give notification by certified mail of the filing of the application to:

3.1 Property owners

Every property owner of record of any interest in the property within the bounds of the project, or in the case of the project without a specific boundary, each such owner of property which would underlie or be adjacent to any project works including any impoundments.

OSU is filing for an original license and will notify the necessary parties by certified mail in accordance with this requirement.

Oregon Parks and Recreation Department
725 Summer Street N.E., Suite C
Salem, Oregon 97301

Oregon Department of Transportation
355 Capitol Street NW, MS 11
Salem, Oregon 97301

Adjacent Property Owners:

Lyle and Debra Beard
4999 NW Pacific Coast Highway
Waldport, OR 97394

Christopher and Anna Biszantz
PO Box 872
Waldport, OR 97394

Alvin and Bonita Boldt
PO Box 358
Seal Rock, OR 97376

Gary and Angela Bridges
5554 NW Pacific Coast Highway
Seal Rock, OR 97376

Warren and Silvia Cate
10456 Lake Drive SE
Salem, OR 97306

Timothy and Barbara Couch
PO Box 389
Seal Rock, OR 97376

Frank and Norma Jean Fisher
PO Box 1953
Sisters, OR 97759

David and Melissa Hamman
1335 NW Sarkisian Drive
Seal Rock, OR 97376

Richard and Mary Hill
PO Box 1087
Waldport, OR 97394

William and Marilyn Hoffman
PO Box 307
Waldport, OR 97394

Pauline Ivers and Phillip Bertholl
PO Box 2412
Waldport, OR 97394

Mark and Susan Johns
P.O. Box 1083
Waldport, OR 97394

Jeanne Kreisberg
1270 NW Camrose Drive
Seal Rock, OR 97376

Wesley and Ruth Lenox
4342 NE 36th Avenue
Portland, OR 97211

Joshua McDowall
1303 NW Powe Drive
Seal Rock, OR 97376

Rick Myers
165 SE 10th Avenue
Canby, OR 97013

National University of Natural Medicine
Attn: Gerald Bores
049 SW Porter Street
Portland, OR 97201

Carl and Charlene Russell
1255 NW Camrose Drive
Seal Rock, OR 97376

RRB Enterprise LLC
4997 River Road S
Salem, OR 97302

David and Nancy Stone
5566 NW Pacific Coast Highway
Seal Rock, OR 97376

Emerson and Sharon Tiedeman
1201 Dollar Street
West Linn, OR 97068

Mark and Jessica Treon
PO Box 1515
Waldport, OR 97394

Connie Waldron
PO Box 839
Waldport, OR 97394

University of Western States
Attn: Lisa Lopez
2900 NE 132nd Avenue
Portland, OR 97230

Robert Wonson
1194 NW Camrose Drive
Seal Rock, OR 97376

William and Sheila Woodward
100 E Lakeshore Drive
Allyn, WA 98524

3.2 Interested government agencies

The entities identified in section 2, as well as any other Federal, state, municipal or other local *government agencies that there is reason to believe would likely be interested in or affected by such application.*

Bureau of Ocean Energy Management
Pacific OCS Region
770 Paseo Camarillo
Camarillo, CA 93010

Federal Energy Regulatory Commission
Portland Regional Office
805 SW Broadway
Fox Tower - Suite 550
Portland, OR 97205

National Marine Fisheries Service - West Coast Region
1201 NE Lloyd Blvd., Suite 1100
Portland, OR 97232-1274

U.S. Fish & Wildlife Service – Pacific Region
Attn: FERC Coordinator
911 NE 11th Ave.
Portland, OR 97232

U.S. Fish & Wildlife Service – Pacific Region
2600 SE 98th Ave Suite 100
Portland, OR 97266132

Environmental Protection Agency
Office of Ecosystems
805 SW Broadway, Suite 500
Portland, OR 97205

Environmental Protection Agency
Regional Administrator
U.S. Environmental Protection Agency
805 SW Broadway, Suite 500
Portland, OR 97205-3331

U.S. Army Corps of Engineers
Attn: Commander
Operations Division, Regulatory Branch
PO Box 2946
Portland, OR 97208-2946

U.S. Army Corps of Engineers
Brad Johnson
P.O. Box 2946
Portland, OR 97208-2946

U.S. Army Corps of Engineers, NW Division
Attn: Stephen Bredthauer
Technical Review Program Manager
P. O. Box 2870
Portland, OR 97208-2870

U.S. Department of Energy
Golden Field Office
1617 Cole Boulevard
Golden, CO 80401

U.S. Department of Energy
Steve DeWitt
1000 Independence Ave SW Portals III, Room 514
EE-4WP
Washington, DC 20585

U.S. Coast Guard
13th District, Waterways
Management Branch
915 2nd Avenue, Room 3510
Seattle, WA 98174-9693

U.S. Coast Guard
MSO PORTLAND
6767 N Basin Ave
Portland, OR 97217-3929

Bureau of Reclamation
Klamath Basin Area Office
6600 Washburn Way
Klamath Falls, OR 97603-9365

Bureau of Reclamation
Columbia-Cascades Area Off.
Bureau of Reclamation
1917 Marsh Road
Yakima, WA 98901-2058

Bonneville Power Administration
FERC Contact
PO Box 3621
Portland, OR 97208-3621

Oregon Department of Fish & Wildlife
2040 SE Marine Drive
Newport, OR 97365

Oregon Department of State Lands
775 Summer Street NE, Suite 100
Salem, OR 97301-1279

Oregon Department of Environmental Quality
811 SW 6th Avenue
Portland, OR 97204

Oregon Department of Environmental Quality
Attn: Marilyn Fonseca
Water Quality Division
700 NE Multnomah St, Suite 600
Portland, OR 97232

Oregon Department of Land Conservation & Development
635 Capitol St. NE Ste. 150
Salem, OR 97310-2540

Oregon State Historic Preservation Office, Oregon Parks and Recreation Department
Dr. Dennis Griffin
725 Summer Street NE, Suite C
Salem, OR 97301

Oregon Parks and Recreation Department
Dr. Sam Willis, Coastal Region Archaeologist
12735 NW Pacific Coast Hwy
Seal Rock, OR 97376

Office of the Governor
255 Capitol Street NE, Suite 126
Salem, OR 97301

Governor of Oregon
Oregon Office of the Governor
900 Court Street NE, RM 160
Salem, OR 97301

Oregon Department of Energy
625 Marion St. NE
Salem, OR 97301

Oregon Department of Transportation
Shawn Denny, District 4 Permits
3700 SW Philomath Blvd
Corvallis, OR 97333

Oregon Public Utility Commission
Secretary
Public Utility Commission of Oregon
PO Box 1088
Salem, OR 97308-1088

Oregon State Extension Services
Director
Oregon State University
101 Ballard Hall
Corvallis, OR 97331

City of Newport
169 SW Coast Hwy.
Newport, OR 97365

Port of Toledo
PO Box 428
Toledo, OR 97391

Port of Newport/FINE
Attn: Walter Chuck
600 SE Bay Blvd.
Newport, OR 97365

Surfrider
PO Box 6010
San Clemente, CA 92674-6010

Oregon Shores
PO Box 33
Seal Rock, OR 97376

Oregon Wave Energy Trust
240 N. Broadway, Suite 115
Portland, OR 97227

3.3 Contents of notification

Such notification must contain the name, business address, and telephone number of the applicant and a copy of the Exhibit G contained in the application, and must state that a license application is being filed with the Commission.

The notification referred to above includes the required information.

VERIFICATION

As to any facts alleged in the application or other materials filed, be subscribed and verified under oath in the form set forth (below) by the person filing, an officer thereof, or other person having knowledge of the matters sent forth. If the subscription and verification is by anyone other than the person filing or an officer thereof, it shall include a statement of the reasons therefor.

This Application is executed in the

State of Oregon
County of Benton

by: Michael J. Green
Vice President for Finance and Administration / Chief Financial Officer
Oregon State University
640 Kerr Administration Building
1500 SW Jefferson Avenue
Corvallis, OR 97331

Michael J. Green, being duly sworn, depose(s) and say(s) that the contents of this (application, etc.) are true to the best of his knowledge or belief. The undersigned applicant(s) has (have) signed the (application, etc.) this 7th *day of May, 2019.*

Oregon State University

By: ______________________

Subscribed and sworn to before me, a Notary Public of the State of Oregon this 7th *day of May, 2019.*

____
Notary Public for the State of Oregon

(Notary Public, or other authorized official)

OFFICIAL STAMP
VIKKI MARIE POINTER
NOTARY PUBLIC - OREGON
COMMISSION NO. 976603
MY COMMISSION EXPIRES JULY 15, 2022

EXHIBIT A: PROJECT DESCRIPTION

1.0 PROJECT DESCRIPTION

OSU would construct and operate an offshore wave energy test site composed of four test berths that could collectively support the testing of up to 20 WECs, and associated moorings, anchors, subsea connectors, subsea power and communication cables, and onshore facilities. The PacWave South test site would occupy approximately 2 square nautical miles in federal waters about 6 nautical miles off the coast of Newport, Oregon (Figure A-1).

Water depths at PacWave South range from 65 to 79 meters (m) mean lower low water (MLLW) and OSU expects types of deep water WECs (described in more detail below) to be tested at the site; however, it would not be feasible to test medium to shallow water or shoreline-based WECs at this site. OSU would oversee and manage all activities, and clients deploying WECs at PacWave South would be subject to test center protocols and procedures.

The Project site was selected in consultation with a group of local fishermen, FINE, which identified a 6 square nautical mile area off the coast of Newport that the members felt would be a suitable and acceptable area within which to locate PacWave South based on their extensive knowledge of the local marine environment. Based on the area identified by FINE, OSU submitted a research lease application to the BOEM. OSU subsequently conducted site-specific surveys and gathered information from agencies and stakeholders to characterize the physical and biological conditions of the area and used this information to select a 2 square nautical mile test site. The coordinates for the corners of the 2 square nautical mile Project site are below:

NW:	44° 35' 00.00"N	124° 14' 30.00"W
NE:	44° 35' 02.75"N	124° 13' 06.17"W
SE:	44° 33' 02.75"N	124° 12' 58.51"W
SW:	44° 33' 00.00"N	124° 14' 22.41"W

The Project would transfer power to a grid connection point with the CLPUD in Lincoln County, Oregon. The Project could generate up to 20 MW that would travel through four individually buried subsea cables running from the test site to a terrestrial cable connection point at Driftwood Beach State Recreation Site in Seal Rock, Lincoln County, Oregon and then about 0.5 miles to the east and south to a newly built grid connection point with CLPUD (Figure A-2).

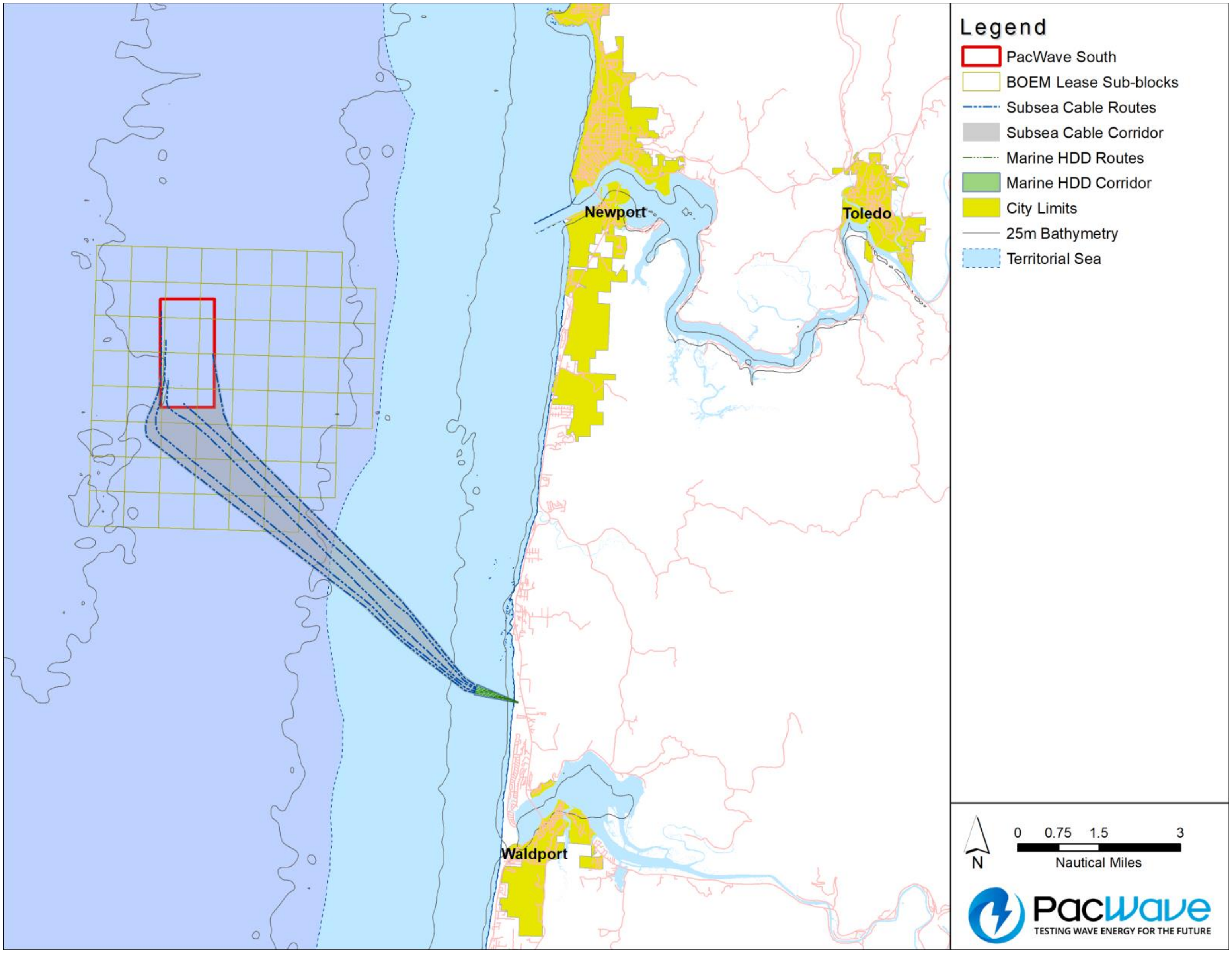

Figure A-1. PacWave South marine project area.

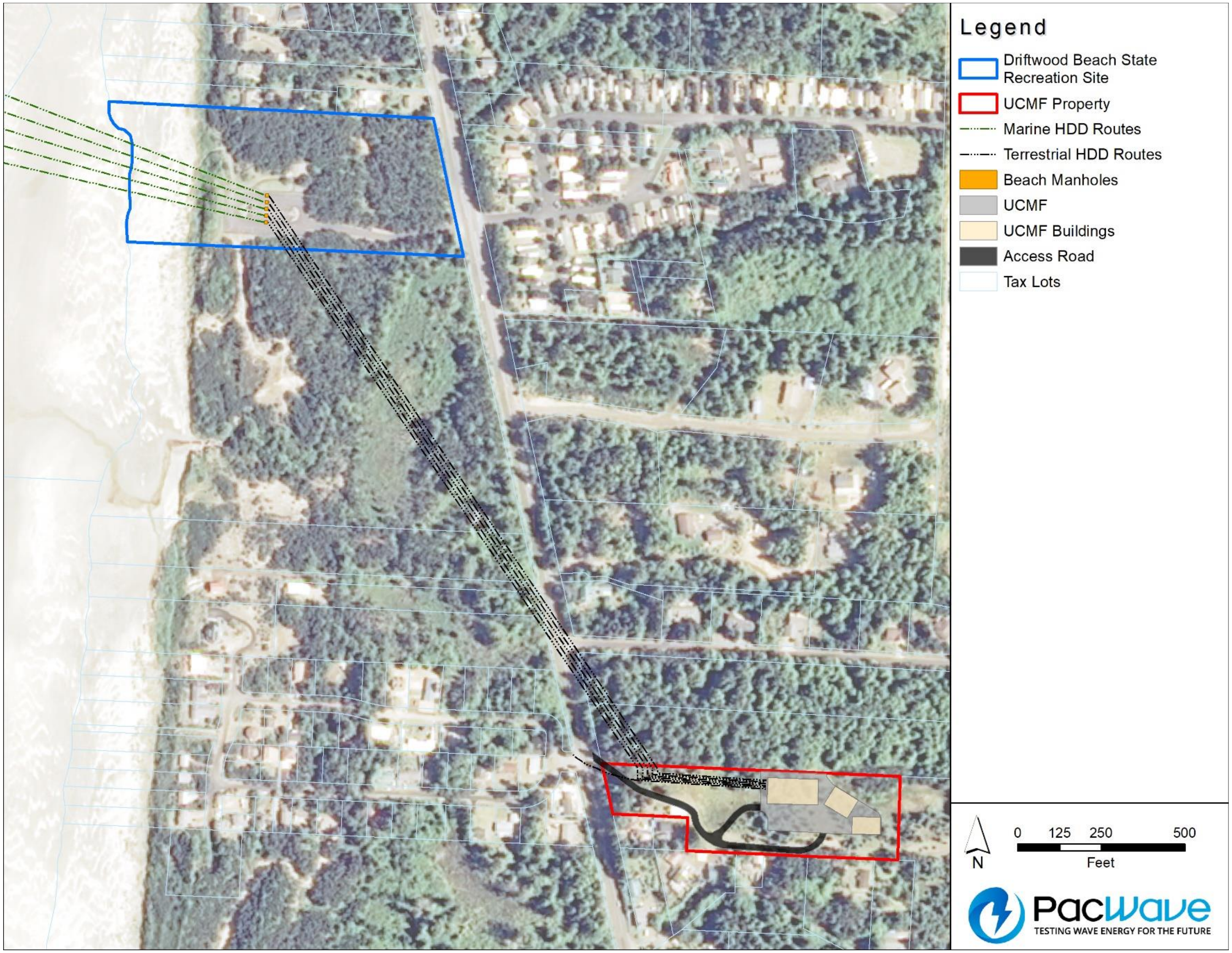

Figure A-2. Terrestrial area of PacWave South.

The 2 square nautical mile WEC deployment area, the subsea cable corridor, the cable landing at Driftwood Beach State Recreation Site, and the onshore facilities are collectively referred to as the Project area in this License Application.

1.1 Description of facilities

The physical composition, dimensions, and general configuration of any dams, spillways, penstocks, powerhouses, tailraces or other structures proposed to be included as part of the project.

Primary Project components include WECs, marker buoys, anchors and mooring systems, support buoys and instrumentation, subsea connectors and hubs, subsea transmission and auxiliary cables, and a utility connection and monitoring facility (UCMF) to transfer power to the grid. The WECs, support buoys, anchors and mooring systems, and subsea connectors and hubs would be located in the test berths. From the subsea connectors, the subsea cables would transmit medium-voltage alternating current (AC) power and data from the PacWave South test berths to shore. Around the 10-m isobath (33 feet [ft]) (i.e., depth contour), each subsea cable would enter a dedicated conduit, installed by horizontal directional drilling (HDD), running to an onshore cable landing point, or “beach manhole”. Each of the five beach manholes would consist of an approximately 10 x 10 x 10 ft buried concrete splice vault. Within the beach manholes, the subsea cables would be connected to terrestrial cables, which would connect to an onshore UCMF. The cable conduits between the beach manholes and the UCMF would be installed by HDD. Cable conduits would also be buried by HDD from the UCMF, across the UCMF property to the grid connection point with the CLPUD overhead distribution line along the highway.

A detailed description of each of the Project facilities is included in the following sections.

1.2 Water surface area, elevation, and storage

The normal maximum water surface area and normal maximum water surface elevation (mean sea level), gross storage capacity of any impoundments to be included as part of the project.

PacWave South would occupy approximately 2 square nautical miles in federal waters of the Pacific Ocean, about 6 nau4tical miles off the coast of Newport, Oregon. PacWave South would not require the impoundment of any surface waters as part of the Project.

Based on site-specific surveys, water depth at the Project site ranges from 65 to 79 m (Goldfinger et al. 2014). Figure A-3 illustrates bathymetry at the offshore test site; bathymetry along the proposed cable route is shown in Figure A-4.

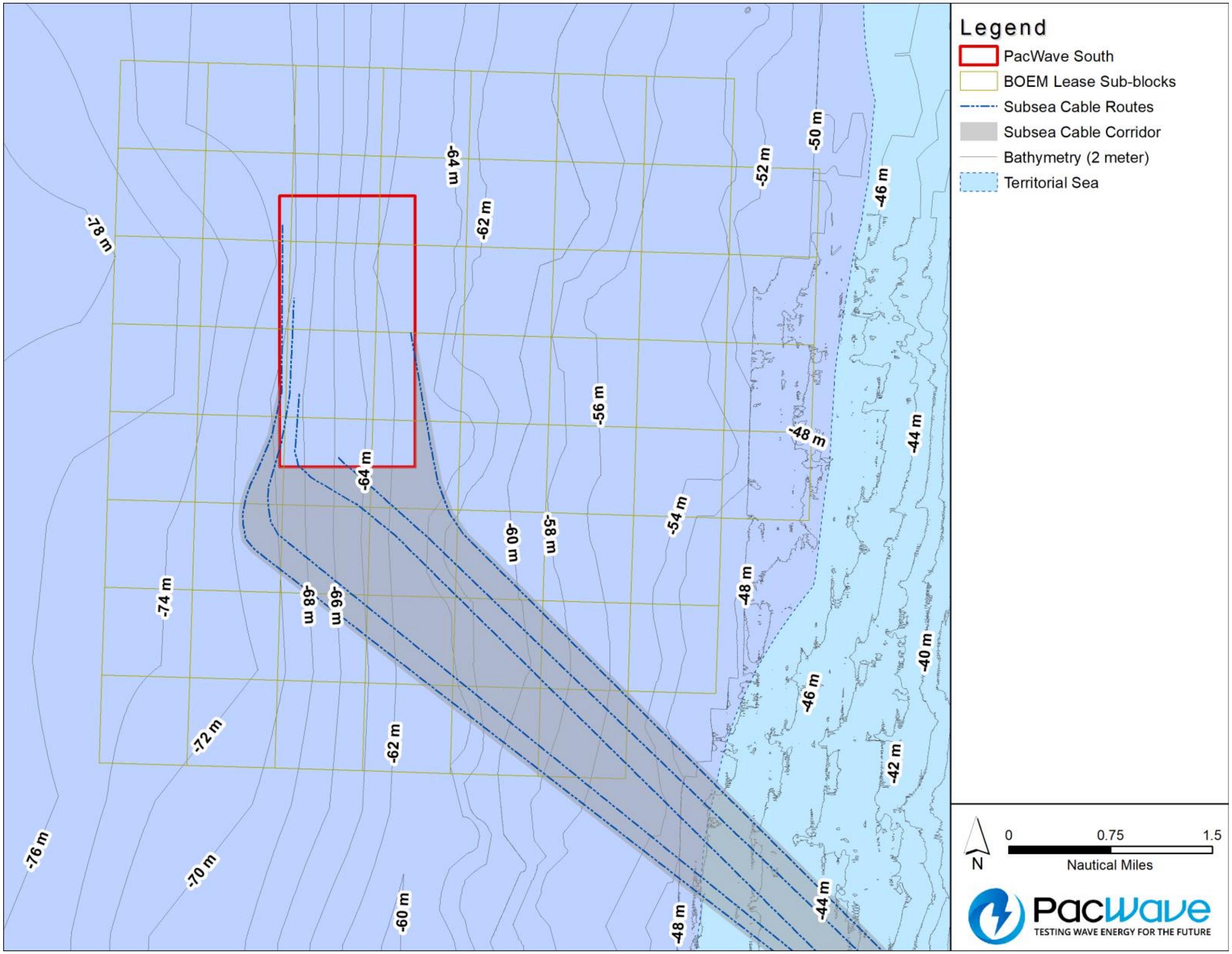

Figure A-3. **PacWave South bathymetry.**

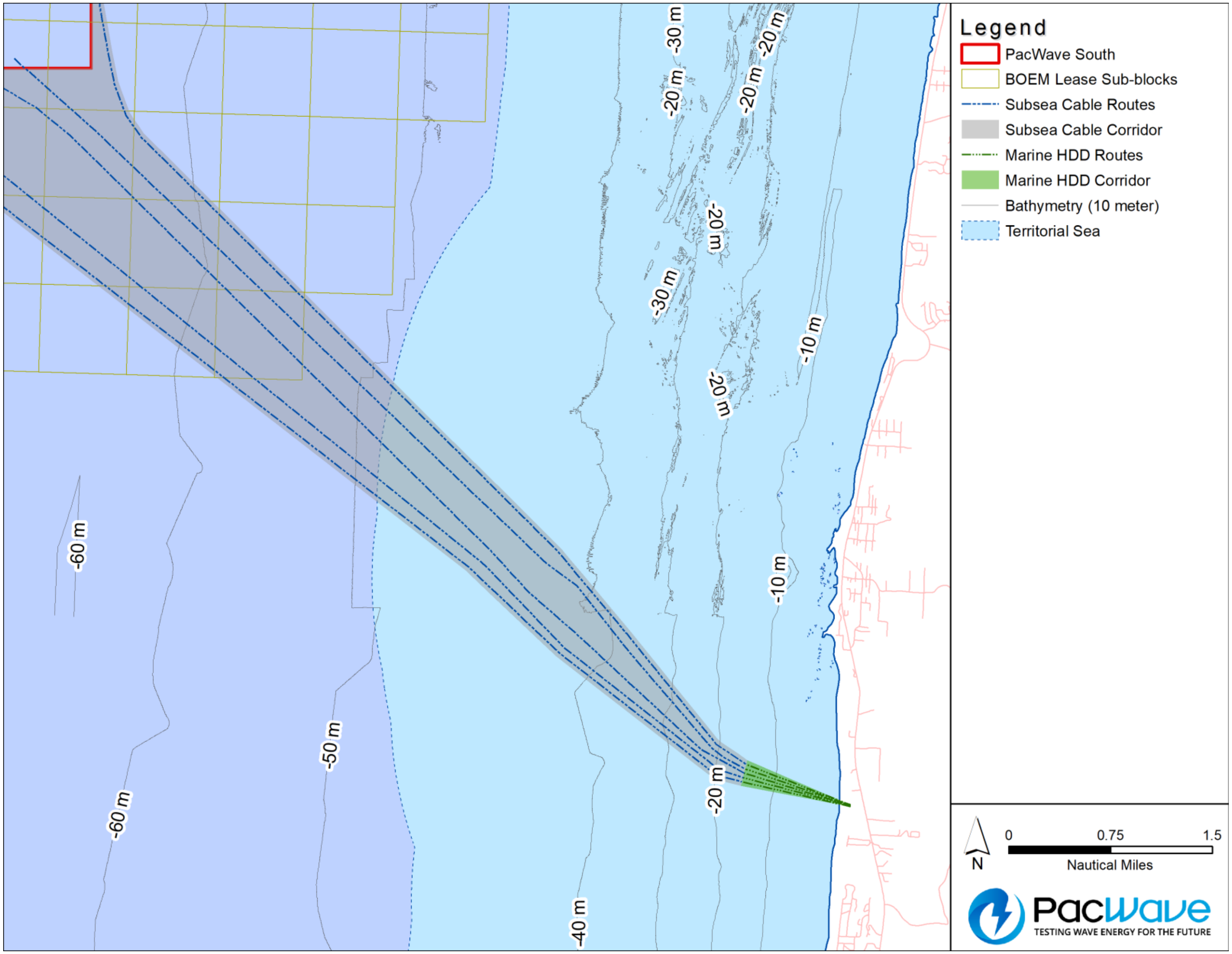

Figure A-4. Cable route bathymetry.

Direct measurements of wave climate information have been collected through in-situ measurements at PacWave North[1] (formerly known as PMEC-NETS) (Cahill 2014), which is considered to be reasonably representative of PacWave South given the relative proximity of the two sites (the sites are 9 miles apart). Cahill (2014) compared wave measurements at PacWave North collected from August to October 2012 and August to October 2013, to the National Data Buoy Center (NDBC) Buoy 46050, located 20 nautical miles west of Newport, to develop a representative, 18 year dataset of wave parameters for PacWave North. Annual average wave heights are approximately 2 m, with the highest annual average exceeding 2.5 m. The annual average wave energy flux fluctuates between approximately 30 kilowatts per meter (kW/m) and 60 kW/m. The average wave power across the entire 18-year period of record was 40 kW/m. Strong seasonal trends were documented from this analysis: during winter, as would be expected, higher wave height, longer wave period, and a greater available wave energy resource occurs. Wave power during December is on average approximately eight times greater than in June, July, and August (Cahill 2014).

1.3 Description of turbines or generators

The number, type and rated capacity of any proposed turbines or generators to be included as part of the project.

The Project will involve testing of WECs (Figure A-5), which transform the kinetic energy of ocean swells into clean, renewable electricity. The WECs are designed to generate electricity by capturing the kinetic energy of ocean waves.

WEC technology is expected to evolve over the duration of the Project's FERC license and various types of WECs would be tested. To accommodate near-term and long-term industry needs, OSU surveyed and interviewed WEC technology developers to ascertain what types of WECs could be reasonably expected to be deployed at PacWave South, based on the location of the test site (e.g., water depth and wave resources) and present state of technology. Based on this research, the following WEC types are expected to be tested (singly or in arrays) at PacWave South (Figure A-5):

[1] PacWave North is an existing wave energy test facility developed by OSU in 2012. The facility, which is north of the proposed PacWave South site, is not grid connected and is not part of the PacWave South license application.

- **Point absorbers:** floating or submerged structures with components at or near the ocean surface that capture energy from the motion of waves, which drives a generator. Point absorbers may be fully or partly submerged.
- **Attenuators:** structures that respond to the curvature of the waves rather than the wave height. These WECs may consist of a series of semi-submerged sections linked by hinged joints. As waves pass along the length of the WEC, the sections move relative to one another. The wave-induced motion of the sections is captured and used to drive a generator.
- **Oscillating water columns** (**OWC**)**:** structures that are partially submerged and hollow, open to the sea below the water line, enclosing a column of air above the water. Waves cause the water under the device to rise and fall, which in turn compresses and decompresses the air column above. This air is forced in and out through a turbine, which usually has the ability to rotate regardless of the direction of the airflow (i.e., a bi-directional turbine).
- **Hybrid:** WEC types that use two or more of the above-listed technology types. For example, some WECs that are the relative size and shape of a point absorber may generate power through movements that resemble an attenuator. Another example is a class of WECs with moving masses that are internal to a hull with no external moving parts exposed to the ocean. An example of this technology is the Vertical Axis Pendulum, which consists of a structural hull that contains all moving parts; inside, a pendulum rotates and converts the kinetic energy of the ocean waves into electrical power.

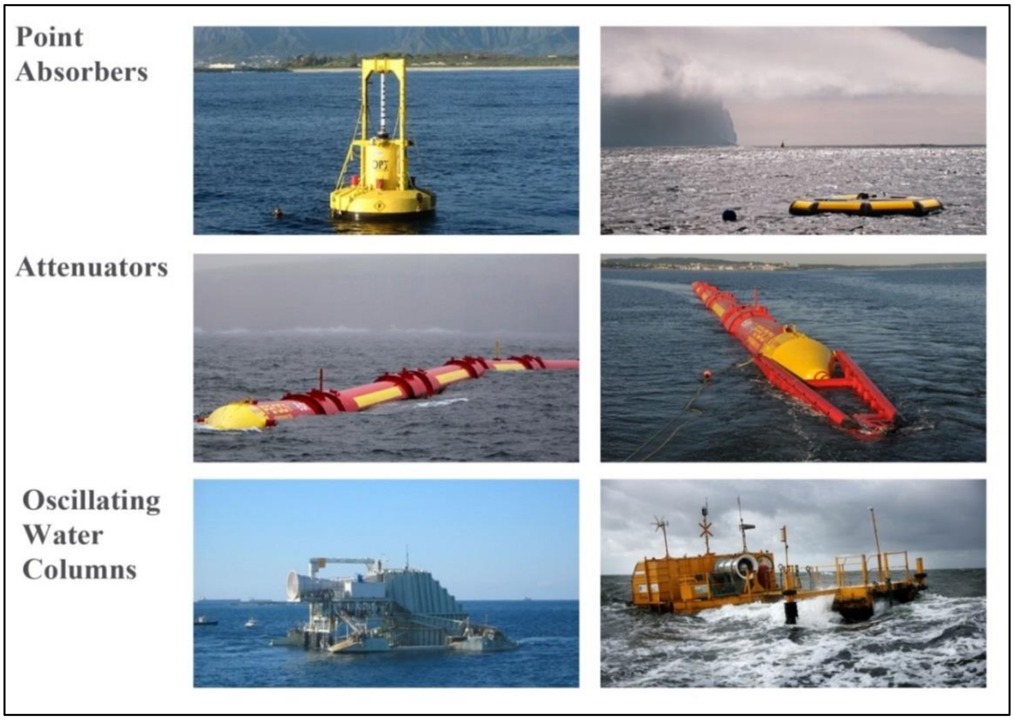

Figure A-5. Examples of different types of WECs.

To allow for the testing of arrays of WECs, PacWave South could accommodate the deployment of up to 20 WECs (total) at one time. However, OSU expects that the number of WECs deployed at PacWave South would vary throughout the license term and that fewer WECs would likely be deployed in the initial years of operation (i.e., the first five years or so). To evaluate the true range of potential effects that the Project might have over a 25-year license term, this license application evaluates both an initial development scenario and a full build out scenario, as follows:

- Initial Development Scenario (Figure A-6) – 6 WECs consisting of:
  - Berth 1 = 1 point absorber;
  - Berth 2 = 1 OWC;
  - Berth 3 = 1 attenuator; and
  - Berth 4 = 3 point absorbers with shared anchors.
- Full Build Out Scenario (Figure A-7) – 20 WECs consisting of:
  - Berth 1 = array of 5 point absorbers;
  - Berth 2 = array of 5 OWCs;
  - Berth 3 = array of 5 point absorbers; and
  - Berth 4 = array of 5 attenuators.

WECs would likely be deployed 50 to 200 m or more apart from each other within a berth[2] (Figures A-8 and A-9). The rated capacity of individual WECs would vary and preliminary estimates range from 150 kW to 2 MW per device. Based on these estimates, the installed capacity for the initial development scenario will not exceed 10 MW, and the installed capacity for the full build out scenario will not exceed 20 MW. Supporting buoys and instrumentation would also be used to gather data on site conditions and support testing operations. This equipment would likely be similar to those previously deployed at OSU's nearby PacWave North.

With this license application, OSU is seeking issuance of a 25-year FERC license authorizing the maximum 20 MW build out described herein. Because the rated capacity of WECs would vary depending on the units installed for testing at the site at any given time, the average power output from PacWave South would also vary under the term of the FERC license. Accordingly, the characterization of power and generation produced by the proposed PacWave South Project would similarly vary with time, including the average capacity factor, availability, and value of installed capacity. The primary purpose of the PacWave South Project is to serve as a test facility designed for developers of WECs who would contract with OSU to use these test

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[2] The referenced distance refers to the separation of the WECs; the moorings may be located closer to each other.

facilities, and generation of power for transmission to the grid would be a secondary purpose focused on testing the integration of power from the test units onto the distribution grid. Therefore, OSU is not able to provide some of the information required by FERC in license applications for traditional hydropower projects where the generation equipment will remain unchanged over the term of the FERC license, and has noted this constraint in sections of this license application where applicable.

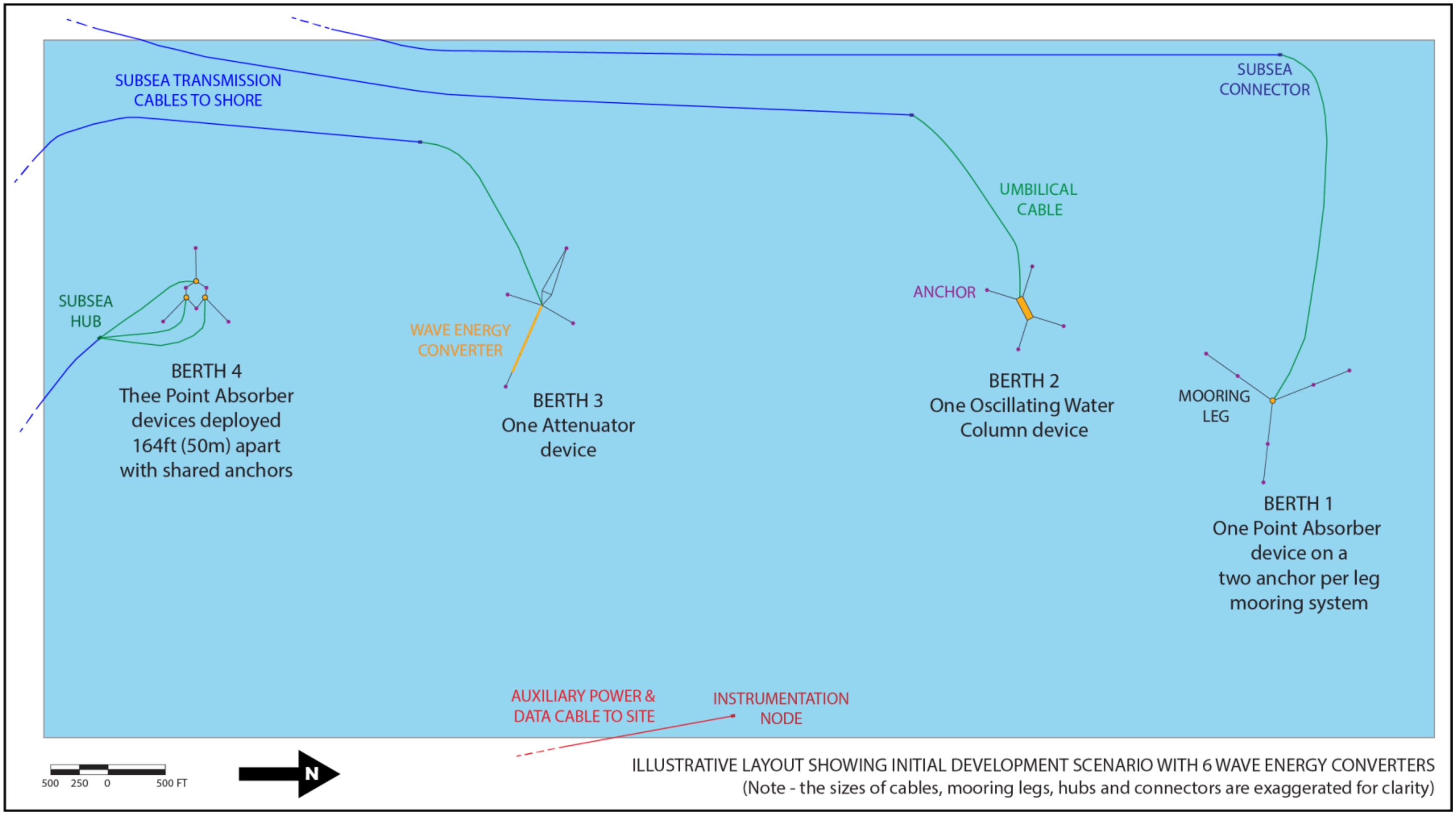


Figure A-6. Illustrative test berth configuration for the initial development scenario. Note, actual deployment would vary.

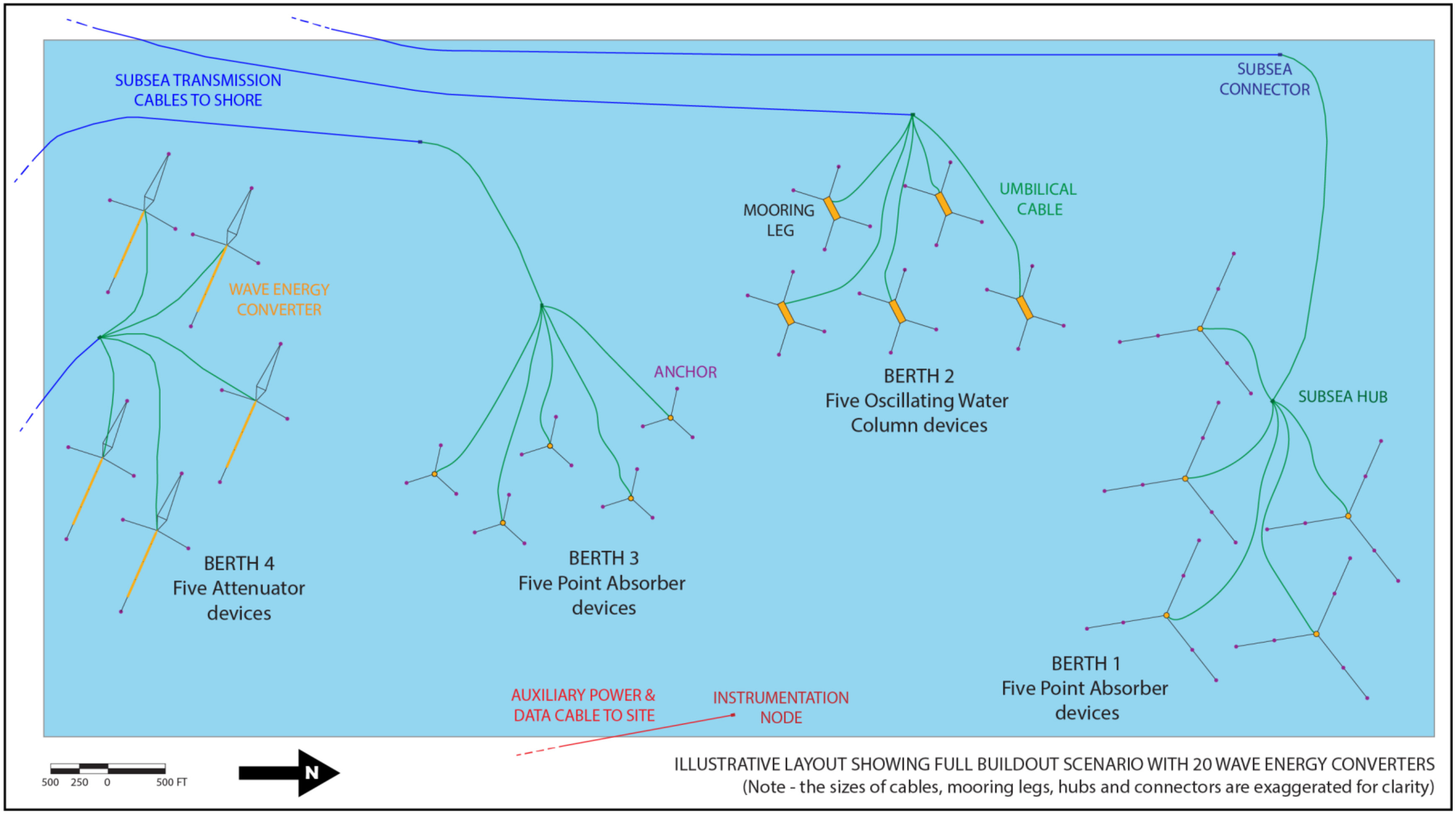
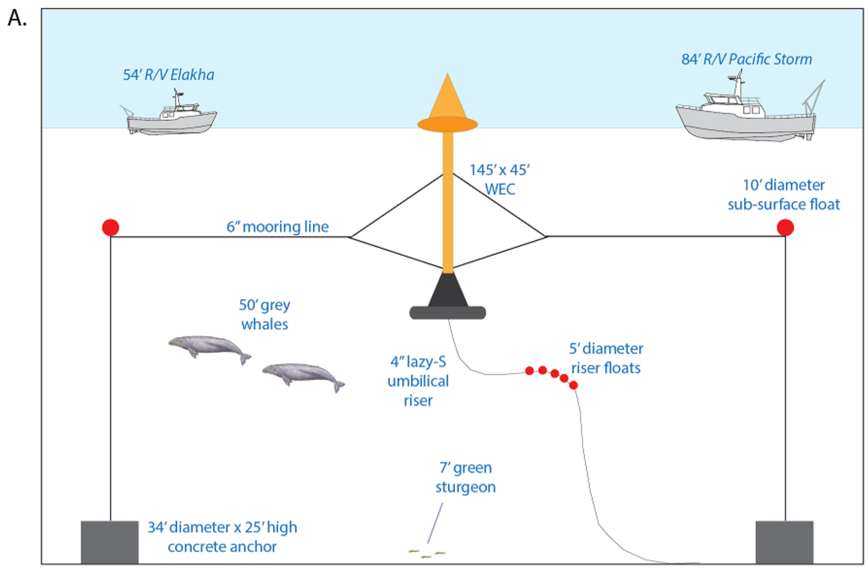


Figure A-7. Illustrative test berth configuration for the full build out scenario. Note, actual deployment would vary.



Illustrations of a common mooring system for a WEC and how such WECs and moorings might fit in a single berth and in all four berths at PacWave South.

NOTE: All elements (WEC, floats, lines, anchors, water depth, spacing, berth size, vessels and marine life) are in proportion.

Only two of the three mooring legs are shown.

Illustration A shows the WEC and mooring system.

Illustration B shows three WECs deployed at the western edge of a single test berth.

Illustration C shows three WECs deployed at the western edge of all four PacWave South berths.

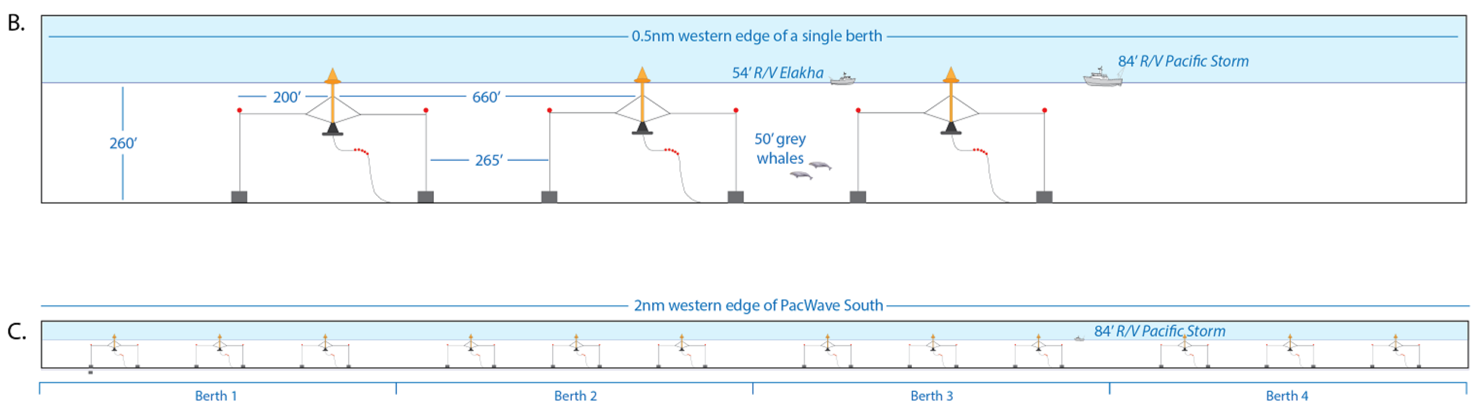


Figure A-8. Scale drawing of WECs at 200 m spacing (660 ft).

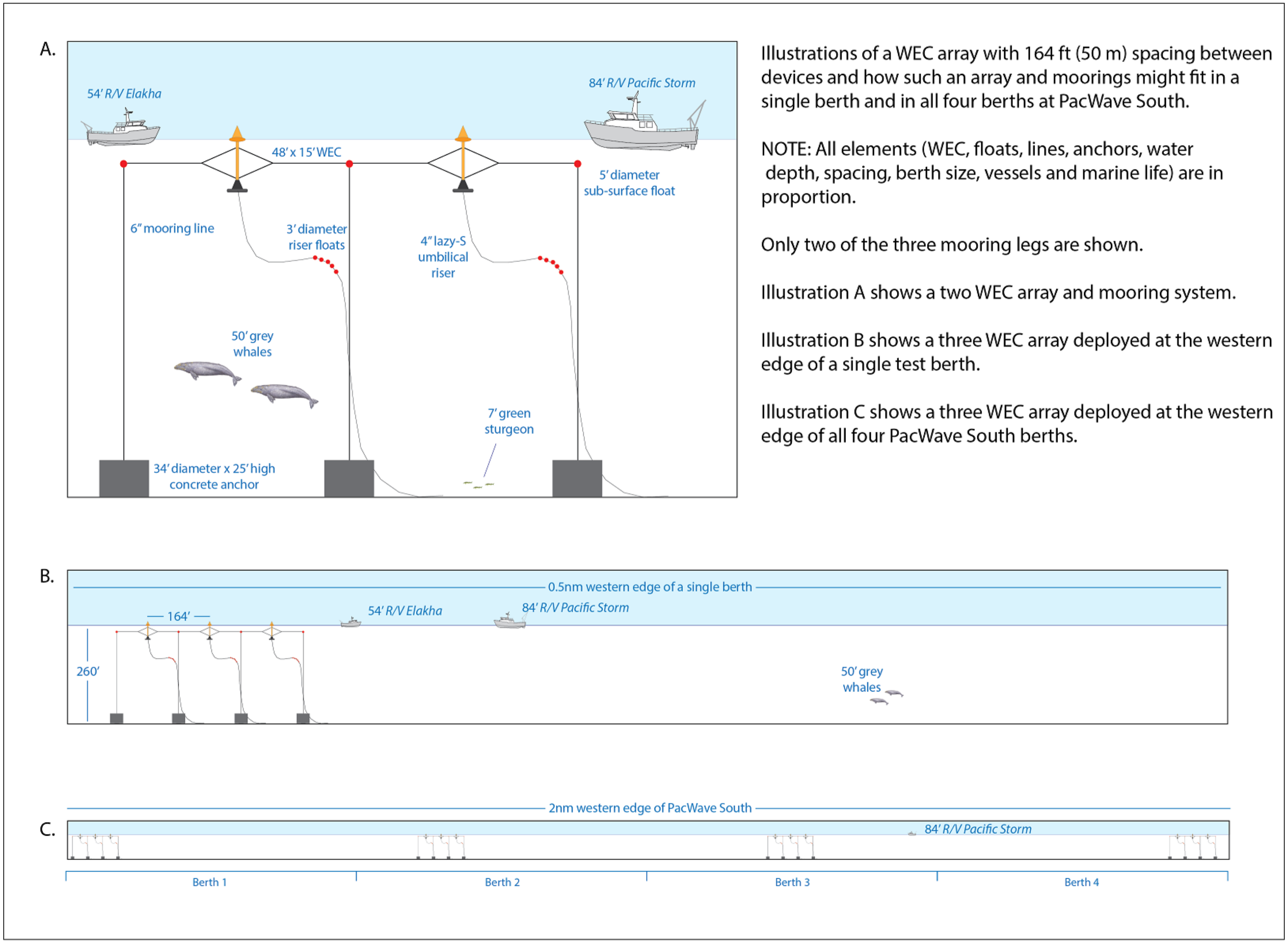


Figure A-9. Scale drawing of WECs at 50 m spacing (164 ft)

1.4 Proposed transmission lines

The number, length, voltage and interconnections of any primary transmission lines proposed to be included a part of the project.

1.4.1 Subsea Connectors

Power generated by WECs would be transferred via umbilical cables (also known as dynamic risers) to a subsea connector attached to the end of a subsea cable and located on the seafloor at each test berth; from there, electricity would be transmitted from the subsea connector via the subsea cable to shore. As the WECs will be on or near the surface, the umbilical cables will run from the WEC to the seafloor and will, therefore, be partially suspended in the water column. The common configuration for such umbilical cables is to attach subsurface floats to create a "lazy-S", which maintains tension but allows enough motion to prevent the umbilical from being damaged by WEC movements. There would be one umbilical cable per WEC. If a client were testing a WEC array, or needed additional power conditioning or conversion support, the umbilicals would all connect to a client-supplied hub, which would then connect to the PacWave South subsea connector at that berth.

The final subsea connector choice will depend on a number of factors including the final cable specification. Subsea connectors are also an area of on-going research and development. However, one option is the GreenLink Inline Termination manufactured by MacArtney Underwater Technology (Figure A-10). The connector has no external moving parts and can be dry, oil, gel or nitrogen filled as required. It is a "drymate" system, which requires the connector to be winched onto a vessel for a WEC to be connected or disconnected.

Figure A-10. Example of subsea connector (MacArtney's GreenLink Inline Termination).

Using a system like this would allow test clients to easily connect their WECs to the subsea cables, monitor device performance, and export power to the grid via the onshore UCMF. Subsea connector systems such as this typically have built-in cathodic protection and are expected to operate for up to 25 years. The subsea connectors would be installed at the same time as the subsea cables to shore.

1.4.2 Subsea cables

Four subsea transmission cables are planned, one for each of the four test berths. In addition, an auxiliary cable would also connect power to the site. The subsea transmission cables would transfer power back to shore and allow for the monitoring and control of WECs via fiber optic elements incorporated into the transmission cables themselves. The cable corridor dimensions and routing are described in further detail below.

The auxiliary cable would increase the monitoring capabilities at PacWave South. An auxiliary cable would allow for extended deployments of instruments or equipment with high data bandwidths or power requirements. The auxiliary cable would run to the test site and terminate into an instrumentation node. This node would allow for monitoring instruments to be connected and deployed as needed.

OSU anticipates that the subsea transmission cables would be three-conductor, AC cables with a rated voltage of 35 kV, like the cable shown in Figure A-11. At present, OSU is considering cables with either 70-square millimeters (mm^2) or 50-mm^2 copper conductors, which are slightly less than 4 inches in diameter and weigh between 7 and 8 pounds per foot. The exact specifications for the subsea cables would be developed during final design. All the cables would use standard industrial shielding and armoring (e.g., galvanized steel wires), as illustrated in Figure A-11. Electric fields from energized AC cable conductors are shielded effectively by metallic sheathing and armoring.

Figure A-11. Example of medium-voltage subsea cable.

Within the Project site, the umbilical cables and a segment (approximately 300 m) of the subsea cables would remain unburied to allow for access during WEC deployment and removal, and maintenance activities (Figure A-12); however, the majority of the subsea cable segment would be buried to a target depth of 1 to 2 m from the offshore test site back to the HDD conduits, to the extent practicable. In areas where burial is not feasible (due to unsuitable seafloor conditions), the cables would be laid on the seafloor and protected by split pipe, concrete mattresses, or other cable protection systems. The subsea cables would enter HDD-installed conduits at approximately the 10 m isobath and continue to shore passing under the beach and dune systems and into the parking lot at Driftwood Beach State Recreation Site (Figure A-12). The industry best practice for minimum spacing between buried subsea cables is 1.5 times the water depth. The eastern edge of the Project site is in approximately 65 m of water, and the HDD conduits would be located in approximately 10 m of water. Accordingly, the minimum spacing between each cable at the edge of the Project site would be at least 100 m (i.e., 65 m x 1.5 = 97.5 m), and the minimum spacing between each cable at the HDD conduits would be approximately 15 m, resulting in a cable corridor that converges from at least 400 m at the offshore test site to a minimum of 60 m at the nearshore HDD conduits. As the seafloor does not shelve evenly, the cable corridor would not widen at a constant rate between the HDD conduits and the Project site (see Figure A-12).

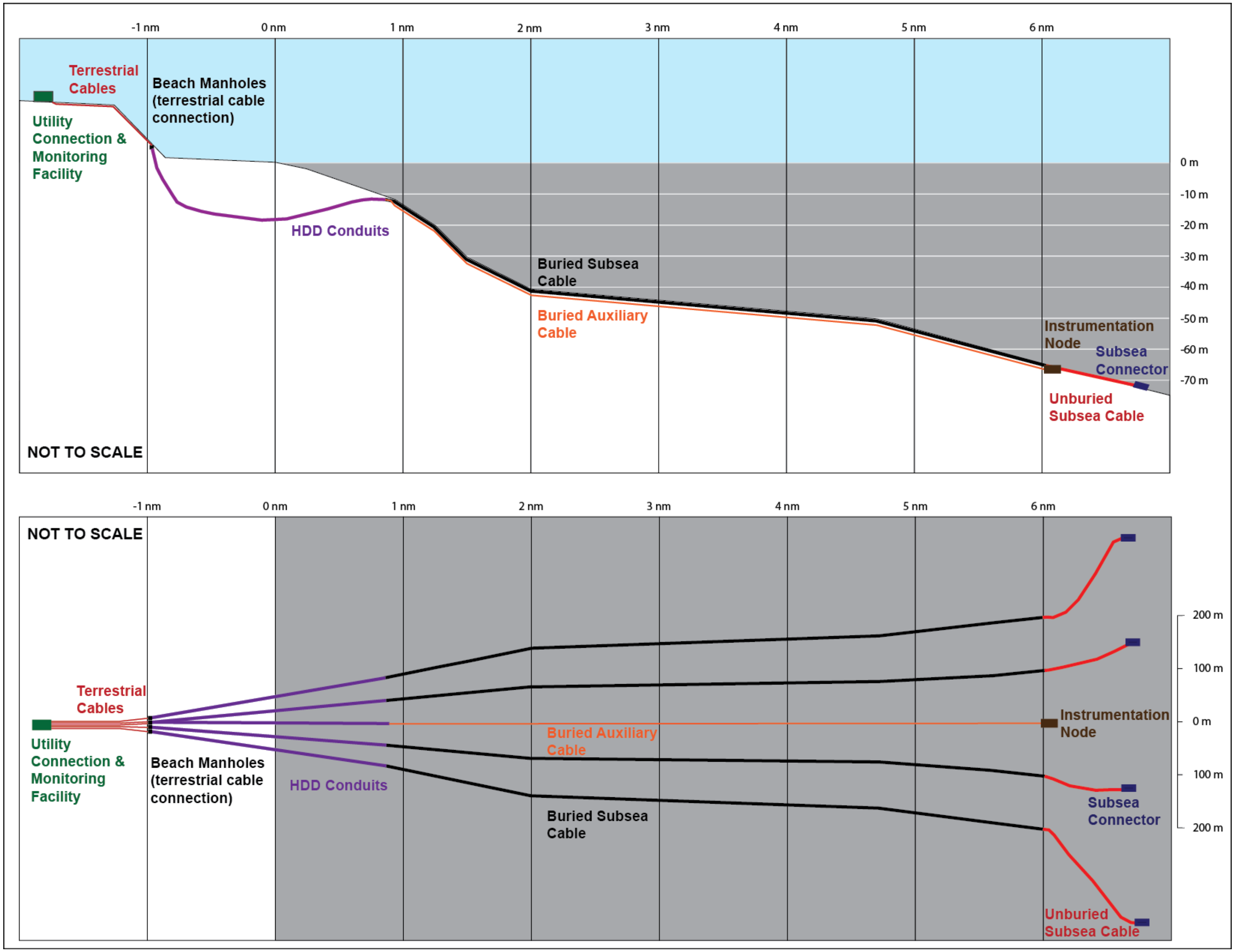


Figure A-12. Subsea cables schematic. Note, these schematics are illustrative and are not to scale.

While a number of cable route corridor alternatives were evaluated, OSU has selected one preferred cable corridor route for the Project. The proposed route runs south of an area of rocky geology that extends along the coast to the north, and the cables would come ashore at Driftwood Beach State Recreation Site in Seal Rock (Figure A-13). The subsea cables would be buried approximately 1 to 2 m below the seafloor to around the 10-m isobath where the cable would enter the HDD conduits, using a jet plow or a similar technique.

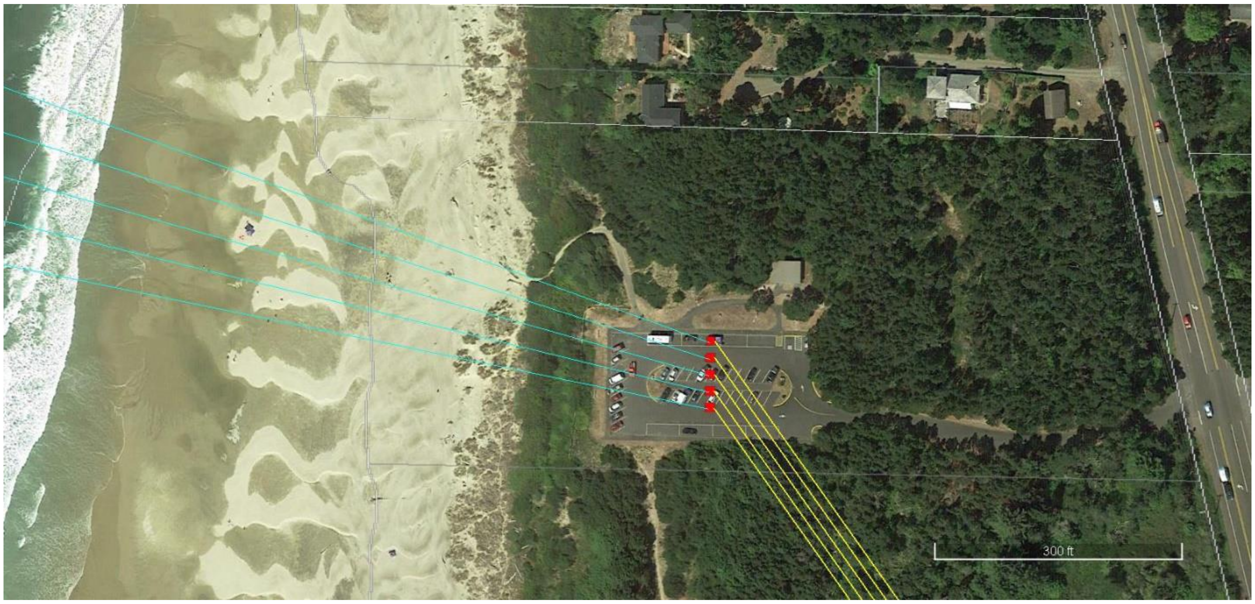


Figure A-13. PacWave South landfall, Driftwood Beach State Recreation Site. Beach manholes are shown in red, the buried HDD conduits to the test site are shown in green, and the underground HDD conduits to the Utility Connection and Monitoring Facility are shown in yellow.

HDD would be used to install five separate conduits (for four subsea transmission cables and one auxiliary cable) from the Driftwood Beach State Recreation Site, beneath the beach and dune system and, out to about the 10-m isobath, a distance of about 0.6 nautical mile (Figure A-12). The four transmission cables and auxiliary cable would each run through separate HDD conduits to individual, onshore cable splice vaults, known as "beach manholes", where the subsea cables would transition to terrestrial cables. It is anticipated that there would be five beach manholes, which would be made of precast concrete. The buried concrete vaults would measure approximately 10 x 10 x 10 ft. Access to each beach manhole would be via a standard manhole cover, similar to those used to access underground utilities (sewer, power, and telephone). The proposed Project subsea cable route would be about 8.3 nautical miles, consisting of about 3.7 nautical miles located on the OCS, 4.0 miles in the Territorial Sea and 0.6 miles of HDD conduit nearshore zone.

1.4.3 Terrestrial cables

From the beach manholes at the Driftwood Beach State Recreation Site, the cables would be installed in up to five HDD bores to the UCMF property. From the beach manholes, the cables would run to the southeast, under the southern portion of the Driftwood Beach State Recreation Site. The HDD cables would then run under small sections of six private properties located on either side of Highway 101, and then to the OSU-owned UCMF parcel east of the highway. From the UCMF, an additional conduit would also be buried by HDD west to, and under, Highway 101 to the grid connection point with the CLPUD overhead distribution line along the road; for this part of the construction, the HDD rig would be set up on the UCMF property. The total distance of the terrestrial cables would be about 0.5 miles (Figure A-2). The specifications of the terrestrial cables are dependent on the final subsea cable design and coordination with CLPUD to ensure compatibility with existing infrastructure. At this stage, OSU anticipates that the terrestrial transmission cables would either be three-conductor cables, such as the Okonite cable (Figure A-14), or single-conductor terrestrial cables such as the Kerite cable (Figure A-15). If three-conductor terrestrial cables are used, then one terrestrial cable would be needed for each subsea cable, plus the auxiliary (i.e., five terrestrial cables total). If single-conductor terrestrial cables are used, three terrestrial cables would be needed for each subsea cable (i.e., 15 terrestrial cables total).

A Uncoated, Okopact (Compact Stranded) Copper Conductors
B Extruded Semiconducting EPR Strand Screen
C Okoguard Insulation (EPR)
D Extruded Semiconducting EPR Insulation Screen
E Phase Identification Tape
F Copper Grounding Conductor
G Uncoated Copper Shield
H Fillers and Binder Tape
J Impervious, Continuous, Corrugated Aluminum C-L-X Sheath
K Jacket-Orange Low Temperature Okoseal

Figure A-14. An example of an Okonite three-conductor terrestrial cable.

Depending on insulation type, the three-conductor cables are typically between 3.2 and 3.7 inches in diameter and weigh between 4.7 and 5.7 pounds per foot. The single conductor cables are between 1.4 and 1.6 inches in diameter and weigh between 0.9 and 1.5 pounds per foot. Due to the number, size, and weight of the cables, using the existing above-ground utility poles would not be feasible, and it would be necessary to bury the cables.

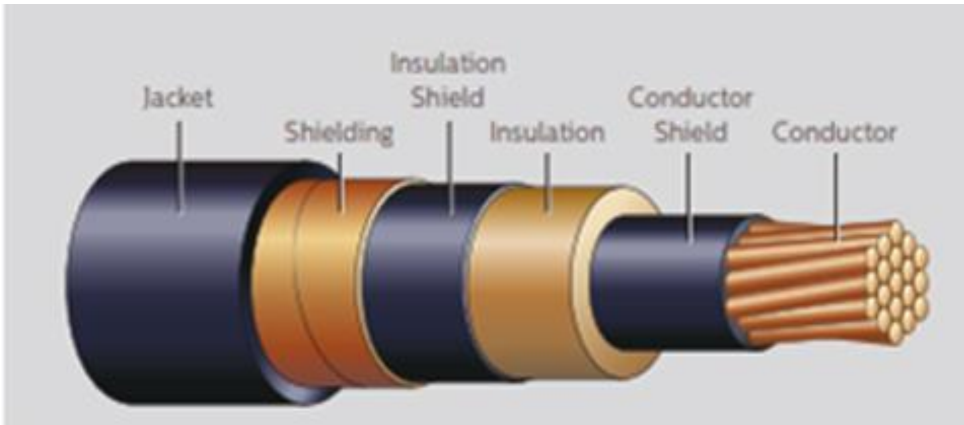


Figure A-15. An example of a Kerite single-conductor terrestrial cable.

1.4.4 Utility connection and monitoring facility

Power monitoring, conditioning, utility equipment and other electrical operations would be performed at the onshore UCMF, located on the OSU-owned property 0.3 miles south of Driftwood Beach State Recreation Site. The current plans for the UCMF include three, single-story buildings (Figure A-2). One building would accommodate the conditioning and monitoring equipment for each of four potential test clients and would be approximately 11,250 ft^2. A second, 4,800 ft^2 building would include the PacWave South switch gear, utility equipment and general storage. The third building would be the Project's data, control, and communications center and would contain monitoring, communications, data storage, and supervisory control and data acquisition (SCADA) systems. The building would also contain operational support infrastructure such as restrooms and a maintenance/supply area. This building would be approximately 4,250 ft^2. The existing gravel lane (NW Wenger Lane) would be paved to accommodate semi-truck access to the UCMF. The improved road would be approximately 20 ft wide and 800 ft long and would run from Highway 101 to the UCMF compound. The UCMF compound would include the three buildings and a parking/laydown area large enough to allow truck access (approximately 80 ft by 200 ft). The entire area of the UCMF compound will be approximately 1.2 acres, and would be fenced and covered by security cameras and necessary lighting to meet building code standards.

The grid connection to CLPUD's distribution system would run from the UCMF to CLPUD's distribution lines on the west side of Highway 101. The proposed power line from the electrical meters at the UCMF to the grid connection on Highway 101 would be owned by OSU or owned and maintained by CLPUD, in which case OSU would negotiate the right to undertake any action required by FERC. All wire, conduit, transformers, meters, and other ancillary equipment needed to support the grid connection would be specified by CLPUD. OSU would be responsible for HDD installation of the conduits along the route, and CLPUD would then pull the wires through the conduits and complete the installation. It is expected that three 4-inch diameter conduits, and a bare copper ground wire would be required.

The CLPUD has existing telemetering capabilities at Bonneville Power Administration's (BPA) Toledo substation, which meet federal interconnection requirements. In addition, the CLPUD has experience installing and operating data and communications systems, including SCADA, ION metering, Distribution Automation, Smart Grid technologies, and other fiber optic communications. This expertise, along with the CLPUD's proven track record of operating a highly reliable system, would facilitate a successful test facility operation at PacWave South. A single line diagram showing each component of power transmission and grid interconnection is provided in Figure A-16.

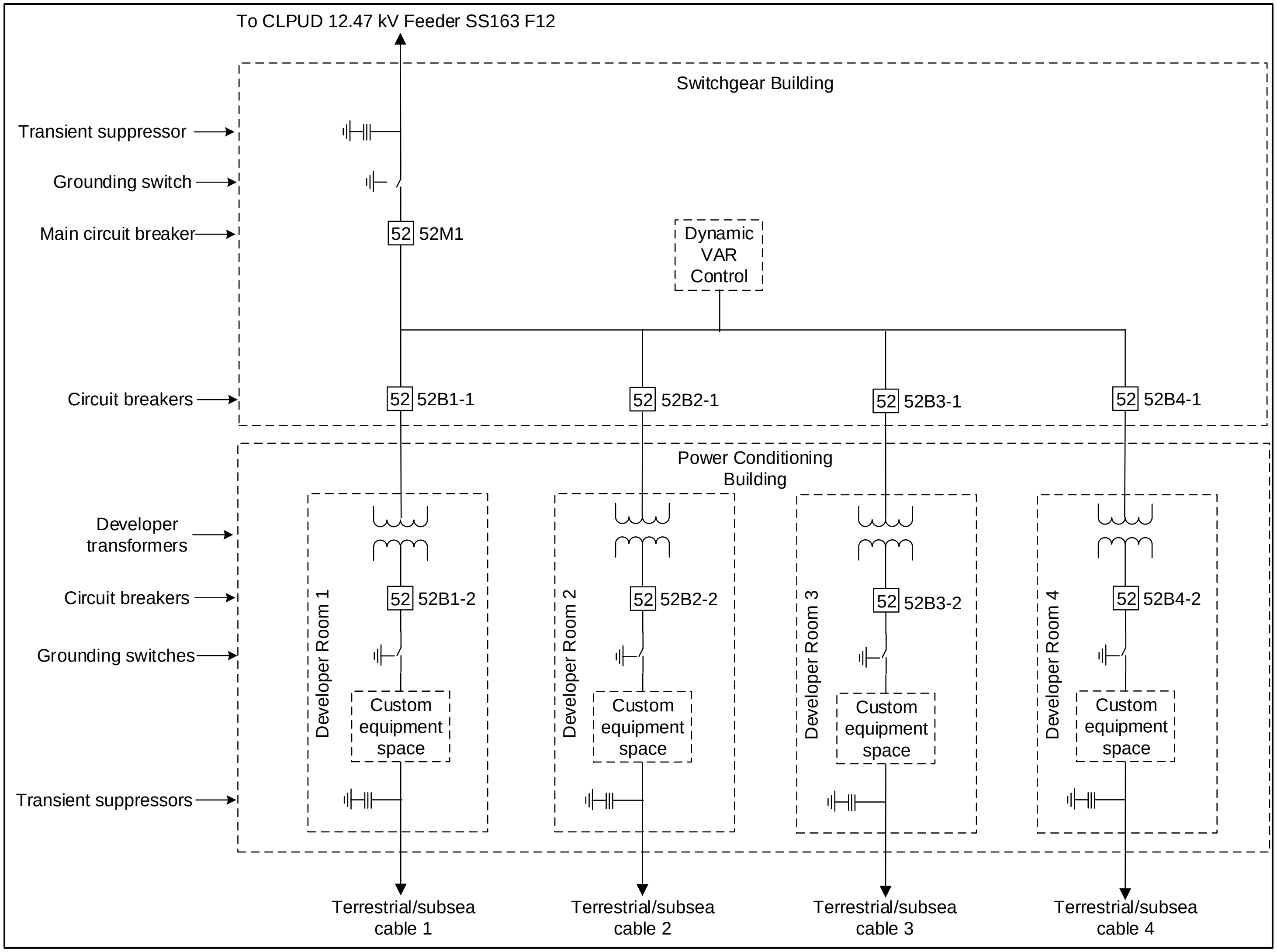


Figure A-16. Single line diagram of PacWave South transmission.

OSU has worked with CLPUD to develop and submit an application for grid interconnection to BPA. The application submittal has placed the PacWave South into the BPA project queue and OSU and BPA have completed a series of grid interconnection studies to help ensure that the proper design requirements are developed during the PacWave South design process. In addition to power transmission and grid-connection, OSU is also exploring power purchase options with the CLPUD. CLPUD has stated that there is sufficient grid capacity to accommodate the project, but OSU would continue to coordinate with both CLPUD and BPA to determine whether grid upgrades would be necessary to achieve the planned 20 MW of generating capacity as the facility approaches maximum capacity. If grid upgrades are determined to be necessary in the future to directly accommodate the generating capacity of the Project, such upgrades may be subject to FERC approval and any required federal and state environmental review. As noted above in Section 1.3, OSU is seeking issuance of a 25-year FERC license with an authorized installed capacity of 20 MW for the proposed PacWave South Project.

1.5 Appurtenant equipment

The description of any additional mechanical, electrical, and transmission equipment appurtenant to the project.

1.5.1 Anchors and mooring systems

The specific anchor types and mooring configurations at PacWave South would vary based on the specific WECs being deployed. However, because the physical and environmental conditions within the Project site are relatively uniform, the general types of anchoring and mooring systems would not vary substantially. Furthermore, the anchors and mooring systems used at PacWave South would be the same as or similar to those commonly used for other applications in the marine environment. An Oregon Wave Energy Trust (OWET)-funded report, titled *Advanced Anchoring and Mooring Studies*, describes common types and features of mooring systems (Sound & Sea Technology 2009).

Results of the OSU survey of WEC technology developers indicate that anchoring systems used at PacWave South would likely include gravity anchors, drag embedment anchors, suction anchors, and plate anchors (Figure A-17). In some cases, a combination of anchor types might be used. The survey results also show that anchors would likely consist of steel, concrete, or a combination of the two.

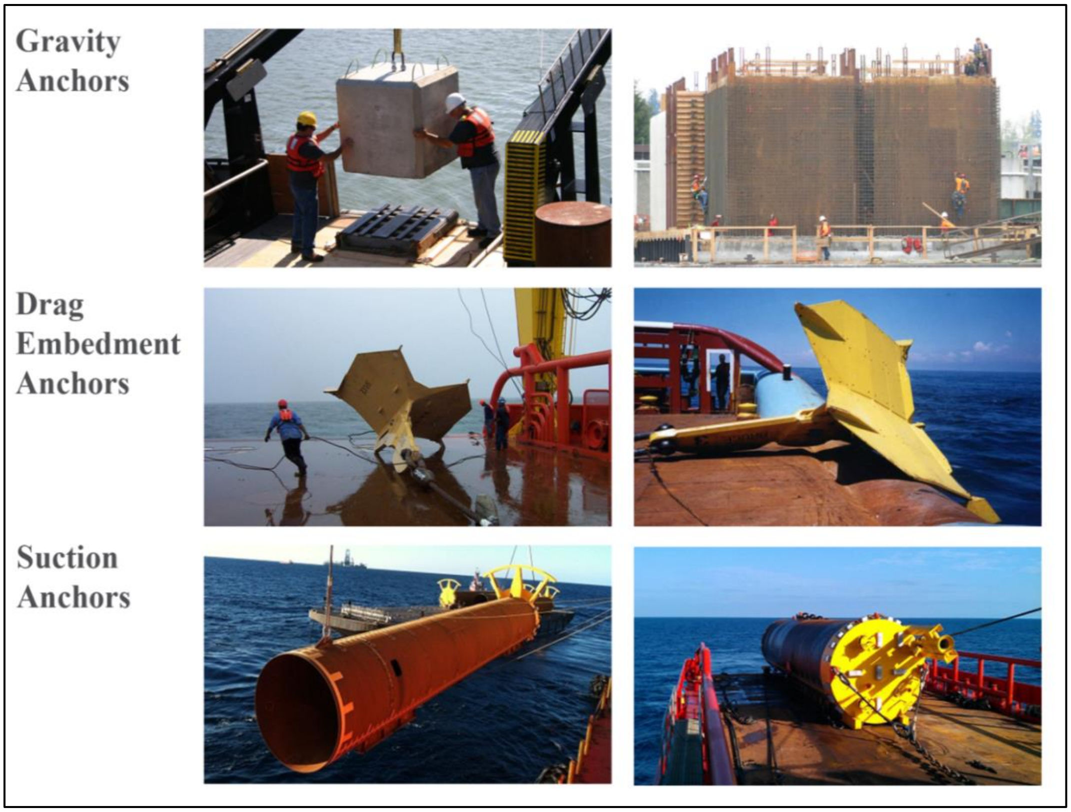


Figure A-17. Examples of different anchor types.

The maximum estimated area covered by the anchors (i.e., the anchor footprint) under the initial and full build out scenarios are provided in Table A-1. The estimates are based on exclusive use of 34-ft diameter cylindrical gravity anchors as these represent the largest anchors that might be expected to be used at PacWave South; however, other types of smaller anchors would likely be used for many of the WECs, and shared anchors may be used for some WECs when feasible. Therefore, the actual seafloor anchor footprint is expected to be considerably smaller than the estimates in Table A-1.

Table A-1. Estimated maximum anchor footprints for initial development and full build-out scenarios by berth.

Scenario	WEC Type	No. WECs	Total No. Anchors	Maximum Seafloor Anchor Footprint (ft^2)*
Initial Development				
Berth 1	Point absorber	1	6	5,448
Berth 2	OWC	1	4	3,632
Berth 3	Attenuator	1	4	3,632
Berth 4	Point absorber with shared anchors	3	7	6,356
Maximum Total Anchor Footprint = 19,068 ft^2 (0.4 acres)				

Scenario	WEC Type	No. WECs	Total No. Anchors	Maximum Seafloor Anchor Footprint (ft^2)*
Full Build Out				
Berth 1	Point absorber	5	30	27,240
Berth 2	OWC	5	20	18,160
Berth 3	Point absorber	5	30	27,240
Berth 4	Attenuator	5	20	18,160
			Maximum Total Anchor Footprint =	90,800 ft^2 (2 acres)

* Based on the total footprint of 34-ft-diameter gravity anchors (908 ft^2 per anchor), representing the largest possible footprint per anchor, assuming no anchor sharing; other anchor types will have a considerably smaller footprint.

The OSU survey of WEC technology developers also asked developers about mooring systems, and analysis of the results shows that most WECs would use single- or three-point mooring systems (25 percent and 28 percent of responses, respectively). Mooring systems are generally classified by their configuration (e.g., single- or multi-leg) and components (i.e., anchors, buoys, and lines). As with anchor types, mooring lines would consist of types commonly used in the marine industry (e.g., chain, steel wire, or synthetic materials). Like the rest of the marine industry, WEC technologies use various combinations of these anchor types and mooring system components. Mooring infrastructure may also include buoys and/or subsurface floats. Although these components can be combined in various ways, there are only a few different component types (i.e., three common types of mooring line and four common types of anchor), as shown in Table A-2.

Table A-2. Mooring systems configurations and components.

CONFIGURATION
A. Single Leg
B. Multi Leg
1. Three-point
2. Four-point
3. Five-point
4. Six-point
i. Catenary
ii. Taut

COMPONENTS		
Anchors (steel/concrete/both)	**Buoys**	**Lines**
A. Gravity/deadweight	A. Steel	A. Chain
B. Drag embedment	B. Composite	B. Wire rope
C. Suction embedment	1. Surface	C. Synthetic
D. Plate embedment	2. Subsurface	

Sample mooring and anchor specifications for different types of WECs are presented in Table A-3.

Table A-3. Illustrative WEC mooring and anchoring configurations.

	Point Absorber	Point Absorber	Attenuator	Oscillating Water Column
Mooring Configuration	Single leg	Multi-leg Catenary	Multi-leg Catenary	Multi-leg Taut
Approx. Water Depth (ft)	250	250	250	250
Line Length per Leg (ft)	~300	~600	~400	~350
Line Material	Chain & wire rope	Chain & synthetic rope	Chain & synthetic rope	Wire & synthetic rope
No. of Legs	1	3	4	4
No. of Anchors Per Leg	1	2	1	1
Anchor Type	Suction	Drag & gravity	Drag	Gravity
Anchor Sizes (ft)	DxH (Qty) 6x8 (1)	LxWxH (Qty) Drag: 12x13x8 (3) Gravity: 8x6x4 (3)	LxWxH (Qty) 16x18x11 (3) 22x24x15 (1)	DxH (Qty) 34x25 (4)
Anchor Material	Steel	Drag: Steel Gravity: Steel & concrete	Steel	Steel & concrete

*Note: D = Diameter; H = Height; L = Length; W = Width; (Qty) = number of anchors.

Anchor deployment and recovery would be infrequent. The OSU industry survey and OWET market analysis indicate that most developers plan to deploy WECs for multi-year test periods (e.g., 3–5 years), so anchors would likely also be deployed for multi-year periods. Furthermore, it is unlikely that anchor systems would be adjusted during a WEC test due to the high costs associated with installing and removing them. Therefore, disturbance due to anchor installation and removal operations within a berth should only occur occasionally (once a year, and perhaps only once every several years). Additionally, these activities rely on specific weather windows, so the timeframes within which anchor deployment and recovery operations could occur are limited. Finally, it is OSU’s intent to reuse anchors wherever possible. If an incoming WEC developer could use an anchor and/or mooring configuration that was already in place from a previous test, then the anchors could be left in place to limit seafloor disturbance.

1.6 Lands of the United States

All lands of the United States, including lands patented subject to the provisions of section 24 of the Act, 16 U.S.C. 818, that are enclosed within the project boundary described in Exhibit G, identified and tabulated by legal subdivisions of a public land survey, by the best available legal description. The tabulation must show the total acreage of the lands of the United States within the project boundary.

No terrestrial lands of the United States will be affected by the Project. Offshore, a portion of the Project will be located on the OCS. There is no public land survey or legal subdivision available. The portion of the Project enclosed within the project boundary on the OCS (approximately 6,152 acres) is depicted in the Exhibit G map.

2.0 LITERATURE CITED

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EXHIBIT B: PROJECT OPERATION AND RESOURCE UTILIZATION

1.0 ALTERNATIVES CONSIDERED

A description of each alternative site considered in selecting of the proposed site.

1.1 Site location

In 2011, OSU initiated an extensive public outreach program as part of the technical evaluation of candidate sites for PacWave South. In coordination with Oregon Sea Grant, OSU conducted outreach in the communities being considered for the Project site to share information about and gather feedback on the Project. In particular, OSU held a series of public forums in Newport, Reedsport, and Coos Bay for members of the public to learn more about the Project and identify issues of concern and interest.

OSU conducted a feasibility study of candidate sites along the Oregon coast in 2011. After identifying candidate sites, industry feedback on requirements for an optimal grid-connected ocean test site was gathered to inform the site evaluation criteria. Applying both the objectives of the test site and needs identified by industry, technical criteria were established and applied to screen candidate locations off the coast of Oregon. Possible sites were initially evaluated using the following screening criteria:

- Proximity to facilities for deployment;
- Proximity to port for service vessels capable of conducting onboard maintenance;
- Proximity to facilities for dockside repair;
- Logistical convenience for staff, developers, and researchers;
- Energy resources;
- Proximity to interconnection points;
- Potential environmental effects;
- Potential effects on human uses; and
- Access to utilities for energy off take.

Based on this screening, OSU narrowed possible tests sites to Warrenton, Newport, Reedsport, and Coos Bay.

Recognizing that community input and support are crucial to a successful project, OSU also initiated an extensive outreach program during the technical evaluation of candidate sites. Results of the outreach process, along with the screening criteria above, were used to narrow the candidate sites to the two communities that demonstrated the most interest in and best matched the criteria for the test site: Reedsport and Newport. Apart from the community interest criteria, Warrenton was not selected as it did not meet the water depth and port facilities requirements, and Coos Bay was not selected because of spatial constraints from other competing ocean projects. In fall 2012, Reedsport and Newport each formed a Community Site Selection Team to develop proposals for PacWave South, including commercial and recreational fishermen and other ocean users, tribal representatives, the CLPUD, Lincoln and Douglas Counties, city and port representatives, and the public. Representatives from a variety of stakeholder groups were directly involved in the preparation and approval of the community proposals for PacWave South.

In developing their proposals, the Community Site Selection Teams considered all aspects of the Project, including technical criteria for the test facility, community resources, economic development, marine traffic, marine debris and salvage aspects, and environmental resources. The community teams submitted their proposals in December 2012, and in January 2013 OSU selected Newport as the location for PacWave South. The decision was based on a combination of community input and preferred site criteria, including physical and environmental characteristics, subsea and terrestrial cable route options, port and industry capabilities, potential impacts on existing ocean users, permitting considerations, stakeholder participation in the proposal process, and support of the local fishing communities. OSU determined that the Reedsport site was not a feasible alternative for a number of reasons, including: (1) it does not have robust project-related marine operations, (2) the limited cable landing options would not have provided sufficient project planning flexibility, and (3) interconnection to the local grid presented technical challenges that would have been difficult and costly to overcome. Since identifying the Project study area off the coast of Newport, OSU has continued to maintain ongoing communication and coordination with the local community and the fishing industry in particular.

1.2 Subsea cable route

Two alternatives for the subsea cable route to the mainland were also considered:

- Airport Route: A cable path through a 100-m wide opening through the nearshore rocky reef that would have landed at the Newport Municipal Airport.
- Ona Beach/ODOT: A cable path through the same 100-m wide opening through the nearshore rocky reef as the Airport Route, but with two alternative cable landing locations. One landing was located near the local Oregon Department of Transportation (ODOT) maintenance yard, and the other was located near Ona Beach. This route was the shortest of the three identified.

These routes were dismissed as not feasible because, unlike the selected route to Driftwood Beach State Recreation Site, they crossed a nearshore rocky reef. This rocky reef is known locally as Seal Rock Reef and measures 12 square miles; it supports an abundance of rocky reef fish species and, consequently, supports the highest fishing effort in the recreational groundfish fishery in Oregon (letter from D.O. McIsaac, Ph.D., Executive Director, Pacific Fishery Management Council to FERC and OSU, July 8, 2014). Also, burying the cables would not be possible for the segments of the Airport and Ona Beach cable routes that cross the rocky reef. Additionally, the Airport Route would be closer to shipping and tow lanes associated with the Yaquina River channel; vessel traffic along these routes increases the risk of damage to cables (e.g., from anchor drag; 3U Technologies 2013).

The selected cable corridor between the PacWave South site and Driftwood passes to the south of Seal Rock Reef. From the offshore HDD breakout point, the five cables will run in a northwesterly direct out toward the test site. The distance between the cables will increase with depth to maintain sufficient separation between the cables to safely allow for installation and repair, if every required. The selected cables routes were developed based on geophysical and geotechnical seafloor and sub-bottom data and aim to achieve maximum burial. The cable routes therefore avoid areas where cable burial may be challenging. At the test site, two cables will enter along the western edge, two will enter from the south and the fifth cable will enter along the easterly boundary. The proposed Project subsea cable route will be about 8.3 nautical miles, consisting of about 3.7 nautical miles located on the OCS, 4.0 nautical miles on the Territorial Sea, and 0.6 nautical miles of HDD conduit in the shoreline zone (Figure B-1).

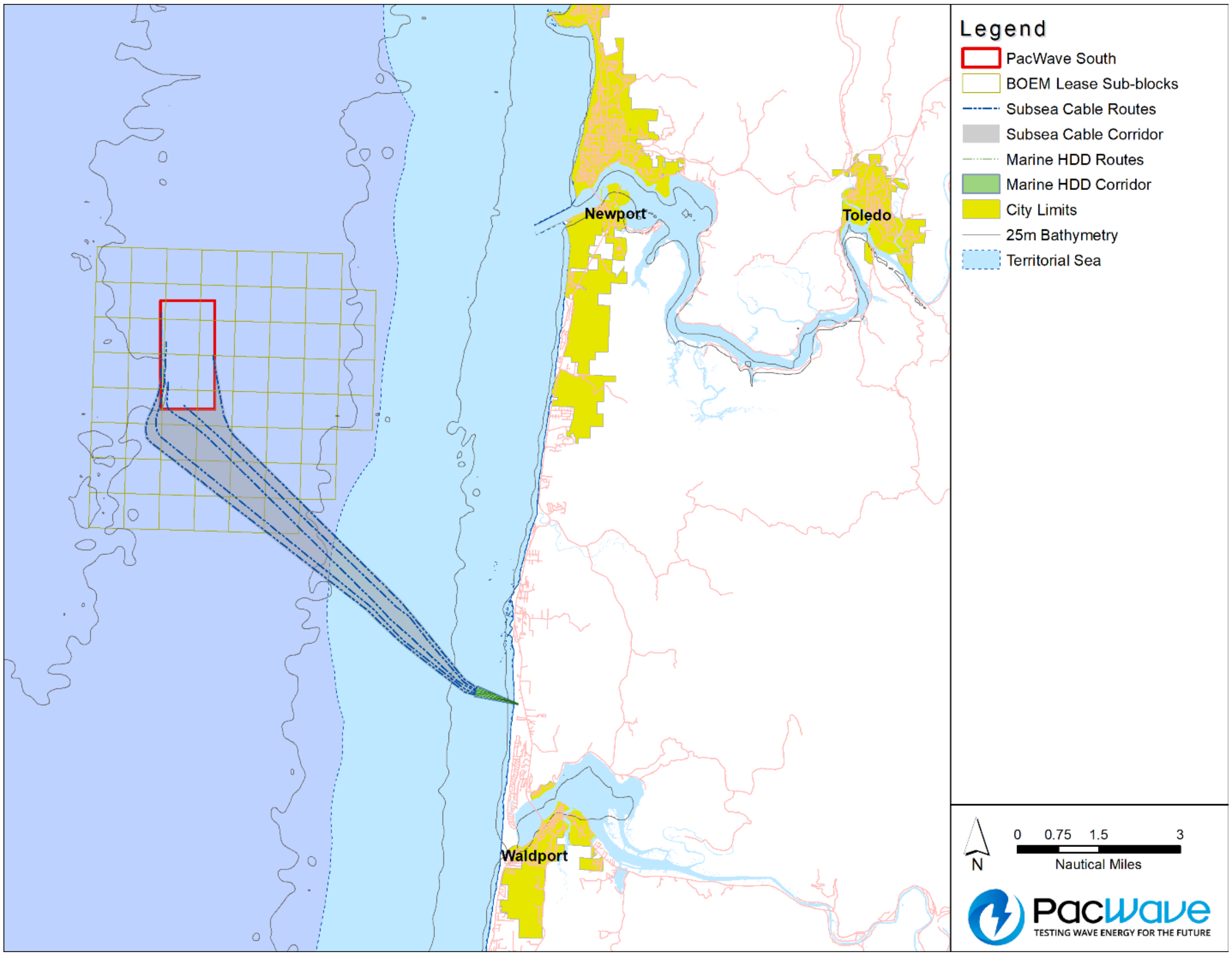

Figure B-1. PacWave South marine project area.

1.3 UCMF location and terrestrial cable route

Various sites in the vicinity of the Driftwood Beach State Recreation Site cable landing site were considered as locations for the UCMF. Initially, OSU considered a location on Legion Road, 1.5 miles from Driftwood. Following input from CLPUD and discussions with additional prospective land owners, the Legion Road site was rejected because OSU could not secure a lease or purchase, and instead found a property much closer (0.3 miles from Driftwood). The Legion Road site was therefore considered, but rejected.

In the DLA, OSU proposed burying the cables by trench excavation and/or short range HDD boring between Driftwood Beach State Recreation Site and the UCMF along Highway 101. With this approach, the five cables would run from the beach manholes at Driftwood for about 0.2 miles along the Driftwood access road out to Highway 101. Here they would pass under the highway and run about 0.3 miles south within the Highway 101 right-of-way, and then turn east and run about 0.2 miles across OSU's property to the UCMF. The total distance of the terrestrial cable route would be about 0.7 miles.

Due to the technical and environmental challenges of the Highway 101 cable route that had been initially proposed, and as large scale HDD drilling equipment is already required to construct the marine shore landing aspects of the Project, as presented above, OSU is now proposing to use a single step, long range HDD bore to install the terrestrial cable conduits directly from the Driftwood Beach State Recreation Site to the UCMF. This approach will result in avoiding or minimizing effects to wetlands, streams, terrestrial habitat, adjacent landowners, and Highway 101 users.

2.0 ALTERNATIVE FACILITY DESIGNS, PROCESSES, AND OPERATIONS CONSIDERED

A description of any alternative facility designs, processes, and operations that were considered.

The planned test site has always consisted of four test berths connected to the shore. As a test site, a variety of WECs will be deployed at PacWave South.

2.1 No-action alternative

The No-Action Alternative was considered in the Applicant Prepared Environmental Assessment (APEA) and provides a benchmark, enabling decision-makers to evaluate the magnitude of environmental effects of the Project. The no-action alternative for this Project is license denial. Under the no-action alternative, the Project would not be built, environmental resources in the Project area would not be affected, and there would not be a grid-connected wave energy test facility to facilitate industry commercialization and fully reap the benefits of this clean, renewable energy resource. The no-action alternative would result in no direct environmental impacts from the Project, but also would not: (1) further the State of Oregon's stated goal of utilizing responsibly sited wave energy to power Oregon; (2) meet the U.S. Department of Energy's identified need for a demonstration center to commercialize this renewable energy sector which, ultimately, can reduce the nation's fossil fuel use; or (3) meet BOEM's goal to grow offshore renewable energy through issuing leases for renewable energy initiatives.

3.0 POWER PLANT OPERATION

A statement as to whether operation of the power plant will be manual or automatic, an estimate of the annual plant factor, and a statement of how the project will be operated during adverse, mean, and high water years.

The WECs would be operated automatically, and would use a connectivity system to easily connect the WECs to the subsea cables, constantly monitor performance of the WECs, and export power to the grid through the onshore UCMF.

Up to six WECs would likely be deployed during the initial development scenario and a maximum of 20 WECs would be deployed for the full build out, with a maximum total capacity of 20 MW. OSU expects that fewer WECs would be deployed at PacWave South during initial operations and this number would increase gradually as the industry advances. However, the number of WECs will fluctuate based on clients' needs.

Because PacWave South does not rely on surface water elevations for production of power, operation would be the same during adverse, mean, and high water years. However, since the purpose of PacWave South is to function as a testing center for WEC-developers to use to field test their equipment during the design and testing phases, the annual plant factor would change depending on the number and types of units installed at PacWave South for testing over the term of the license and thus, cannot be estimated.

4.0 DEPENDABLE CAPACITY AND AVERAGE ANNUAL ENERGY PRODUCTION

An estimate of the dependable capacity and average annual energy production in kilowatt-hours (or mechanical equivalent), supported by the following data.

PacWave South would serve as an integrated test center to evaluate the performance of commercial scale or near-commercial scale WECs. As a secondary benefit, the Project would provide electricity to the Oregon coast region. PacWave South would have a maximum installed capacity of 20 MW. This capacity is based on the OWET sponsored market analysis that forecasted future demand for berthing capacity at PacWave South (OWET 2014).

The power generated at PacWave South would vary depending on the WEC types and testing conditions; preliminary estimates range from 150 kW to 2 MW per WEC. As a result, the energy capacity of PacWave South would vary over the life of the Project. OSU expects that the capacity and number of WECs at PacWave South would be low in the initial operations term and increase gradually as the industry advances. Since the purpose of PacWave South is to function as a testing center for WEC developers to use to field test their equipment during the design and testing phases, the Project's dependable capacity and average annual energy production would change depending on the number and types of units installed at PacWave South for testing over the term of the license and thus, cannot be estimated.

It is important to note, the primary purpose of PacWave South is to serve as an integrated test center to evaluate the performance of commercial scale WECs; energy generation is a secondary benefit. OSU believes that once the Project develops, the capital costs of wave energy would become more competitive with traditional generation.

4.1 Minimum, mean, and maximum recorded flows

The minimum, mean, and maximum recorded flows in cubic feet per second of the stream or other body of water at the power plant intake or point of diversion, with a specification of any adjustment made for evaporation, leakage minimum flow releases (including duration of releases) or other reductions in available flow; monthly flow duration curves indicating the period of record and the gauging stations used in deriving the curves; and a specification of the critical streamflow used to determine the dependable capacity

PacWave South will be located in the Pacific Ocean, and will not require surface water flows for operation.

The high level of wave energy impinging on the Oregon coast is caused by prevailing western winds and the large fetch of the North Pacific Ocean (Boehlert et al. 2008). Wave energy on the coast varies considerably by season, such that the wave energy flux is approximately eight times greater during winter than summer (Bedard 2005). Episodic winter storms bring large waves from the west and southwest. Currents generated by these waves are uniform throughout the water column, and may have a substantial influence on the transport of fine sediments (silt and clay) at depths of greater than 120 ft (U.S. Army Corp of Engineers (USACE) and Environmental Protection Agency (EPA) 2001). The regional-scale circulation of ocean surface waters on Oregon's continental shelf varies seasonally with changing wind stress patterns and is dominated by the southward-flowing California Current (USACE and EPA 2001). During the summer, offshore high-pressure weather systems and associated northerly or northwesterly winds drive upwelling of deep, dense, cold water toward the ocean surface. In contrast, low-pressure offshore weather systems during winter drive southwesterly storm winds that result in downwelling of nearshore surface water, and nearshore surface circulation is dominated by the northward-flowing Davidson Current.

On the inner continental shelf (depths less than about 35 m), water circulation is influenced by a combination of wind-driven currents, wind waves, tidal currents, and estuarine-induced currents (USACE and EPA 2001). On the middle continental shelf (depths of 35 to 90 m), water circulation is influenced mainly by wind-driven currents, whereas on the OCS (90 to 180 m), shoaling waves and regional-scale currents control water circulation seasonally (USACE and EPA 2001). The net direction of bottom currents on the mid- to outer-OCS is northward; the subsurface part of the Davidson Current is believed to flow northward year-round (USACE and EPA 2001).

Direct measurements of wave climate information have been collected through in-situ measurements at PacWave North (Cahill 2014), which is considered to be reasonably representative of PacWave South given the relative proximity of the two sites (the sites are 9 miles apart). Cahill (2014) compared wave measurements at PacWave North collected from August to October 2012 and August to October 2013, to the NDBC Buoy 46050, located 20 nautical miles west of Newport, to develop a representative, 18 year, dataset of wave parameters for PacWave North. Annual average wave heights are approximately 2 m, with the highest annual average exceeding 2.5 m. The annual average wave energy flux fluctuates between approximately 30 kW/m and 60 kW/m. The average wave power across the entire 18-year period of record was 40 kW/m. Strong seasonal trends were documented from this analysis: during winter, as would be expected, higher wave height, longer wave period, and a greater available wave energy resource occurs. Wave power during December is on average approximately eight times greater than in June, July, and August (Cahill 2014).

4.2 Area-capacity curve

An area-capacity curve showing the gross storage capacity and usable storage capacity of the impoundment, with a rule curve showing the proposed operation of the impoundment and how the usable storage capacity is to be utilized.

PacWave South will not require an impoundment or storage for operation, and therefore, this requirement is not applicable.

4.3 Hydraulic capacity of the power plant

The estimated minimum and maximum hydraulic capacity of the power plant in terms of flow and *efficiency (cubic feet per second at one-half, full and best gate), and the corresponding generator output in kilowatts*

PacWave South will not require surface water flows for operation, and therefore, this requirement is not applicable. The rated capacity of individual WECs would vary; preliminary estimates range from 150 kW to 2 MW per device. Because the rated capacity of WECs would vary depending on the number and types of units installed for testing, the average power output from PacWave South would also vary over the license term.

4.4 Tailwater rating curve

A tailwater rating curve

PacWave South is not a conventional hydropower project, but rather a wave energy test center. Therefore, this requirement is not applicable.

4.5 Power plant capability vs. head

A curve showing power plant capability versus head and specifying maximum, normal, and minimum heads.

PacWave South is not a conventional hydropower project, but rather a wave energy test center. Therefore, this data requirement is not applicable for the proposed PacWave South Project.

5.0 NEED FOR POWER

A statement of system and regional power needs and the manner in which the power generated at the project is to be utilized, including the amount of power to be used on-site, if any, supported by the following data:

PacWave South would serve as an integrated test center to evaluate the performance of commercial scale or near-commercial scale WECs. As a secondary benefit, the Project would provide electricity to the Oregon coast region. PacWave South would have a maximum installed capacity of 20 MW. This capacity is based on the OWET sponsored market analysis that forecasted future demand for berthing capacity at PacWave South (OWET 2014).

The power generated at PacWave South would vary depending on the WEC types and testing conditions; preliminary estimates range from 150 kW to 2 MW per WEC. As a result, the energy capacity of PacWave South would vary over the life of the Project. OSU expects that the capacity and number of WECs at PacWave South would be low in the initial operations term and increase gradually as the industry advances.

It is important to note, the primary purpose of PacWave South is to serve as an integrated test center to evaluate the performance of commercial scale WECs; energy generation is a secondary benefit. OSU believes that once the Project develops, the capital costs of wave energy would become more competitive with traditional generation.

The Project would connect to the CLPUD system, which serves over 38,000 customers including residential, commercial, and industrial users (CLPUD 2014). CLPUD receives all its required energy from the BPA. The energy supplied by the Project would offset only a minor part of the total demand. CLPUD serves less than 3 percent of Oregon's electrical load and is considered a "small utility" (Pacific Energy Ventures 2009) under Oregon's Renewable Portfolio Standard (ORS 469A). As a small utility, CLPUD is required to provide 10 percent of its power with renewable resources by 2025. The Project could generate up to 20 MW, which is small compared to regional demand, but would contribute renewable energy to CLPUD's future Renewable Portfolio Standard obligation.

Power generated by the Project would also support Oregon's goal to develop wave energy as a source of future renewable energy. The State of Oregon Biennial Energy Plan 2015-2017 highlights that "Oregon is at the crossroads of a developing marine energy industry, with a powerful wave climate and an environment suited for testing WEC technologies. Oregon is becoming the place to develop WECs from concept to full-scale deployment and learn how well they work in the marine environment" (ODOE 2015). Regionally, the Northwest Power and Conservation Council (2016) predicts the electricity demand in the Pacific Northwest to increase 0.5 to 1.0 percent per year, between 2015 and 2035. The testing of wave energy technology at PacWave South would advance the commercialization of wave energy and add to the diversification of Oregon's energy sources.

5.1 Load curves and tabular data

Load curves and tabular data, if appropriate

PacWave South would serve as an integrated test center to evaluate the performance of commercial scale or near-commercial scale WECs, and energy supplied to the distribution grid by the Project would offset only a minor part of the total demand. As a test center, generation of power for uses by the public is an ancillary purpose of the proposed Project as discussed previously. Since the number and types of WECs installed for testing at PacWave South will change over the term of the license, depending on when WEC developers enter into contracts with PacWave South to test their equipment and the type of WECs that are tested, load curves and tabular data required for hydropower projects that are authorized to install specific equipment under their FERC license are not appropriate for this type of project.

5.2 Conservation and rate design programs

Details of conservation and rate design programs and their historic and projected impacts on system loads

Since the primary purpose of the proposed PacWave South Project is to provide integrated testing and monitoring facilities that will be leased to WEC designers to use to refine their designs, sale of power to CLPUD is an ancillary benefit and, therefore, this information is not applicable.

5.3 Sale of power

The amount of power to be sold and the identity of proposed purchaser(s)

All power generating by WEC developers who contract to use the PacWave South integrated testing facilities is anticipated to be sold to CLPUD for distribution to their residential, commercial, and industrial users as discussed above in Section 5. The amount of power generated by the proposed Project will vary depending on the WECs being tested at the PacWave South facility at any given time during the FERC license term.

6.0 PLANS FOR FUTURE DEVELOPMENT

A statement of the applicant's plans for future development of the project or of any other existing or proposed water power project on the affected stream or other body of water, indicating the approximate location and estimated installed capacity of the proposed developments.

To allow for the testing of arrays of WECs, PacWave South could accommodate the deployment of up to 20 WECs (total) at one time. However, OSU expects that the number of WECs deployed at PacWave South would vary throughout the license term and that fewer WECs would likely be deployed in the initial years of operation (i.e., the first five years or so). An initial development scenario and a full build out scenario are described below:

- *Initial Development Scenario* (Figure B-2) – 6 WECs consisting of:
  - Berth 1 = 1 point absorber;
  - Berth 2 = 1 OWC;
  - Berth 3 = 1 attenuator; and
  - Berth 4 = 3 point absorbers with shared anchors.
- Full Build Out Scenario (Figure B-3) – 20 WECs consisting of:
  - Berth 1 = array of 5 point absorbers;
  - Berth 2 = array of 5 OWCs;
  - Berth 3 = array of 5 point absorbers; and
  - Berth 4 = array of 5 attenuators.

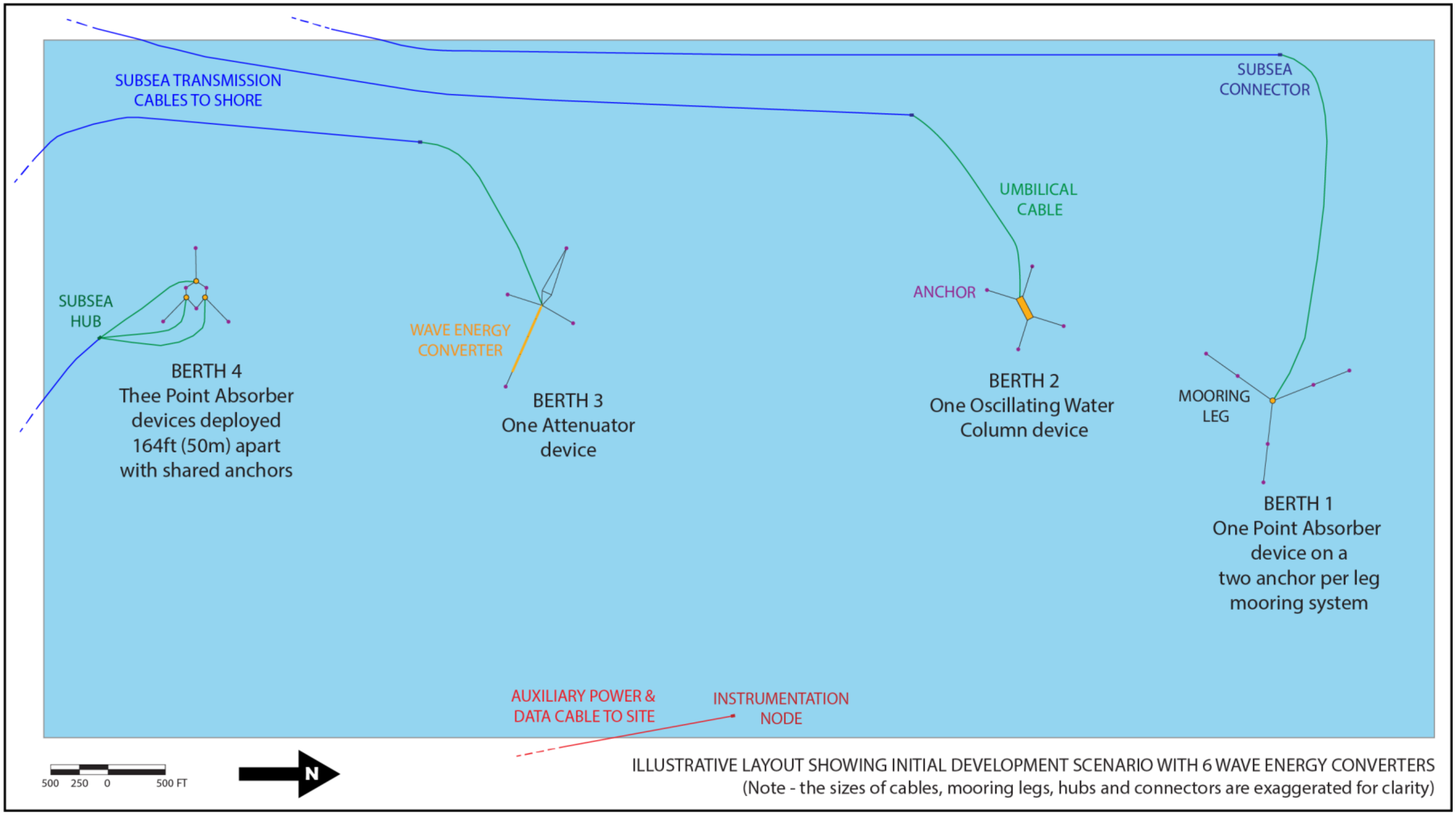

Figure B-2. Illustrative test berth configuration for the initial development scenario. Note, actual deployment would vary.

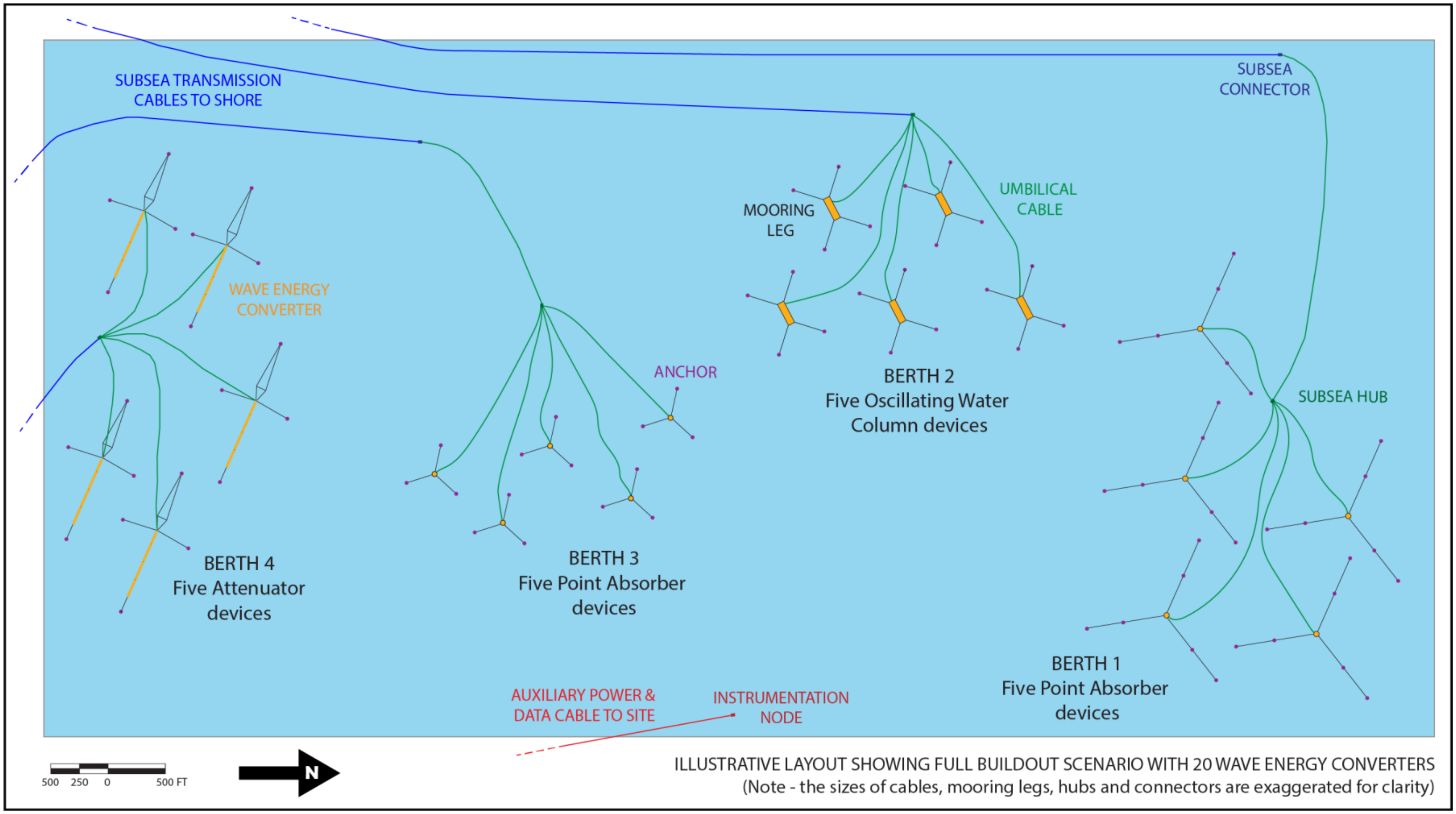

Figure B-3. Illustrative test berth configuration for the full build out scenario. Note, actual deployment would vary.

7.0 LITERATURE CITED

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EXHIBIT C: PROPOSED CONSTRUCTION SCHEDULE

1.0 COMMENCEMENT AND COMPLETION DATES

The proposed commencement and completion dates of any new construction, modification, or repair of major project works

The proposed commencement date of construction is spring 2020, with an anticipated completion date of 2022.

2.0 FIRST COMMERCIAL OPERATION DATE

The proposed commencement date of first commercial operation of each new major facility and generating unit

The proposed commencement date of the test site operations is 2022.

3.0 PREVIOUSLY CONSTRUCTED STRUCTURES OR FACILITIES

If any portion of the proposed project consists of previously constructed, unlicensed water power structures or facilities, a chronology of original completion dates of those structures or facilities specifying dates (approximate dates must be identified as such) of:

3.1 Commencement and completion dates

Commencement and completion of construction or installation.

Not applicable. PacWave South will be a new facility. Therefore, there are no previously constructed structures or facilities associated with the Project.

3.2 First commercial operation date

Commencement of first commercial operation.

Not applicable. PacWave South will be a new facility. Therefore, the Project has not been previously operated.

3.3 Additions or modifications

Any additions or modifications other than routine maintenance.

Not applicable. PacWave South will be a new facility. Therefore, there are no previous modifications or additions.

EXHIBIT D: STATEMENT OF COSTS AND FINANCING

1.0 ESTIMATED COST OF CONSTRUCTIONS

A statement of estimated costs of any new construction, modification, or repair

OSU has been awarded funding by the DOE. The Project outcomes include completing the permitting and design for PacWave South, completing procurement and construction, and initiating testing operations. One of the tasks during the initial budget period of the DOE award is to develop a detailed budget. The cost estimates provided below represent current estimates.

1.1 Land or water rights

The cost of any land or water rights necessary to the development.

The estimated cost of land and water rights needed is $300,000.

1.2 Total cost

The total cost of all major project works.

The estimated total cost of constructing PacWave South is approximately $55 million. This includes the preparation and construction of the test facility (e.g., the aids to navigation, subsea cables, subsea connectors, the cable landing site with buried beach manholes, terrestrial cabling to UCMF, the UCMF and associated equipment, and the connection to grid).

1.3 Indirect costs

Indirect construction costs such as costs of construction equipment, camps, and commissaries.

Much of the construction-related activities will be conducted by contractors, so the indirect costs, such as construction equipment, will be built into their contracts.

1.4 Interest

Interest during construction.

Not applicable – OSU will not incur interest during construction of the Project.

1.5 Overhead, construction, legal expenses, and contingencies

Costs for overhead, construction, legal expenses, and contingencies are included in the total costs provided in Section 1.2.

2.0 ORIGINAL COSTS OF PREVIOUSLY CONSTRUCTED COMPONENTS

If any portion of the proposed project consists of previously constructed, unlicensed water power structures or facilities, a statement of the original cost of those structures or facilities specifying for each, to the extent possible, the actual or approximate total costs (approximate costs must be identified as such) of:

2.1 Land or water rights

Any land or water rights necessary to the existing project works.

Not applicable. PacWave South will be a new facility. Therefore, there are no existing Project land or water rights.

2.2 Major project works

All major project works.

Not applicable. PacWave South will be a new facility. Therefore, there are no existing Project works.

2.3 Additions or modifications

Any additions or modifications other than routine maintenance.

Not applicable. PacWave South will be a new facility. Therefore, there are no previous modifications or additions.

3.0 PROJECT TAKEOVER COSTS

If the applicant is a licensee applying for a new license, and is not a municipality or a state, an estimate of the amount which would be payable if the project were to be taken over pursuant to section 14 of the Federal Power Act, 16 U.S.C. 807, upon expiration of the license in effect including:

Since OSU is applying for issuance of an original, not a new license, this application requirement is not applicable.

4.0 AVERAGE ANNUAL COST OF THE PROJECT

A statement of the estimated average annual cost of the total project as proposed, specifying any projected period if the applicant takes such changes into account changes in the costs (life-cycle costs) over the estimated financing or licensing period if the applicant takes such changes into account, including:

OSU has been awarded funding by the DOE. The Project outcomes include completing a detailed operations and maintenance plan for PacWave South. The cost estimates provided below represent current estimates.

4.1 Cost of capital (equity and debt)

There is no cost of capital for this Project.

4.2 Local, state, and federal taxes

- **Oregon Property Tax:** OSU generally benefits from the ORS 307.090(1) exemption for state-owned property.
- **Payroll Taxes:** Compensation paid to employees is subject to federal and state employment taxes, including the employer portion of social security and Medicare tax and the Oregon unemployment insurance tax.
- **Income Tax:** Oregon State University is a public university of the state of Oregon and is exempt from federal income taxation by virtue of being an integral part of the state of Oregon and the accompanying implied statutory immunity accorded the revenue of integral units of state governments.

4.3 Depreciation or amortization

There is no depreciation or amortization associated with this Project.

4.4 Operation and maintenance

Operation and maintenance expenses, including interim replacements, insurance, administrative and general expenses, and contingencies.

The annual operation and maintenance cost estimate for PacWave South is approximately $4 million. This includes: personnel, operations and maintenance (O&M) at the ocean test site, O&M of terrestrial infrastructure, inspection of subsea cable routes, miscellaneous services (e.g., transportation, marketing, outreach, IT support), and operations consultants.

4.5 Environmental measures

The estimated capital cost and estimated annual operation and maintenance expense of each proposed environmental measure.

The estimated cost for pre-installation environmental studies already completed, planned, or in progress is approximately $2 million. These studies included acoustic Doppler current profiling, wave modeling and far field effects analysis, underwater acoustics studies, water quality studies, aquatic species studies, marine mammal study, oceanographic/bathymetrical/benthic studies, and terrestrial resource studies.

As part of this Project, OSU proposes to undertake certain measures designed to gather environmental and operational data regarding the operation of the WECs. This information will be utilized to evaluate the effects of the Project and individual WECs and may result in modifications to the Project's operations. Due to the nature of the Project as a test site, many of the proposed monitoring plans are being applied to wave energy technology for the first time, making precise estimates for the overall cost of each plan extremely difficult. However, OSU estimates that the total annual cost to conduct the activities described in the proposed monitoring plans will be approximately $500,000 per year.

Specific costs are provided below in Table D-1.

Table D-1. Estimated costs of proposed environmental measures.

Proposed Environmental Measures	Capital Cost (2019$)	Annual Cost (2019$)	Levelized Annual Cost (2019$)[f]
General Environmental Measures			
1. Implement the Adaptive Management Framework (Appendix J) in conjunction with specific PM&E measures to evaluate study results, identify any Project effects, and implement and/or modify response actions (Appendix I) in consultation with key agency stakeholders.	$0	$50,000	$63,502
2. Beginning five years and six months after deployment of the first WEC at the Project, and recurring every five years thereafter, the licensee shall file with FERC a Five-Year Report and provide copies to BOEM, National Marine Fisheries Service (NMFS), U.S. Fish and Wildlife Service (FWS), and ODFW. Contents of the report are further described in Appendix I, Protection, Mitigation, and Enhancement Measures.	$0	$25,000	$31,751
3. Employ periodic, routine inspection and maintenance methods to ensure structural integrity of Project components (Appendix F, Operation and Maintenance Plan).	$0	$0[b]	$0[b]
4. Develop and implement the Emergency Response and Recovery Plan (Appendix G).	$0	$0[a]	$0[a]
Geologic and Soil Resources Measures			
5. Use HDD to install the terrestrial cables under the nearshore and intertidal habitat (to approximately the 10-m isobath) to minimize substrate disturbance. Use HDD to install the cables in up to five bores, from the beach manholes at the Driftwood Beach State Recreation Site to the UCMF, and from the UCMF to the Highway 101 grid connection point, to minimize habitat disturbance.	$0[c]	$0	$0
6. Follow best practices during installation, operation, and removal activities to avoid or minimize potential effects to sediment, including: 6a. Minimize the time that the seafloor is disturbed and sediment is dispersed and the associated effects by completing cable laying and other construction activities during appropriate construction windows and within one construction season to the extent practicable.	$0[c]	$0	$0
6b. Develop and implement an Erosion and Sediment Control Plans, where appropriate, to minimize effects of ground-disturbing activities associated with installation of the terrestrial cables and/or other terrestrial construction.	$0	$0[b]	$0[b]
7. Implement the Benthic Sediments Monitoring Plan (Appendix H) to evaluate effects on benthic habitat from anchors, WECs, and other equipment during operation, maintenance, and monitoring activities. Based on monitoring results, implement the specified measures to mitigate for potential adverse effects (Appendix I).	$0	$0[d]	$0[d]

Proposed Environmental Measures	Capital Cost (2019$)	Annual Cost (2019$)	Levelized Annual Cost (2019$)[f]
8. Project components in the estuarine environment should not bottom out so as to prevent nearshore/estuarine habitat effects.	$0	$0	$0
9. To the extent possible, minimize frequency of anchor installation/removal cycles and reuse installed anchors.	$0	$0	$0
Water Resources			
10. Follow industry best practices and guidelines[e] for antifouling applications (e.g., TBT-free) on Project structures such as marker buoys, subsurface floats, and WECs.	$0	$0[b]	$0[b]
11. Develop and implement an Emergency Response and Recovery Plan (Appendix G) with spill prevention, response actions, and control protocols, as well as and provisions for recording types and amounts of hazardous fluids contained in WECs and other Project components.	$0	$0[b]	$0[b]
12. Require all vessel operators to comply with an Emergency Response and Recovery Plan (Appendix G) for installation and maintenance of Project facilities.	$0	$0[b]	$0[b]
13. Prepare waste management, hazardous material, and spill prevention plans, as appropriate, for onshore Project facilities.	$0	$0[b]	$0[b]
14. Minimize storage and staging of WECs outside of existing dock, port, or other marine industrial facilities.	$0	$0[b]	$0[b]
15. Require that all Project chartered or contracted vessels comply with all current federal and state laws and regulations regarding aquatic invasive species management.	$0	$0[b]	$0[b]
16. Develop and implement an HDD Contingency Plan to minimize the potential for inadvertent return of drilling fluids, provide timely detection, and address potential releases by describing monitoring, containment, response and notification procedures to be implemented by the contractor.	$0[c]	$0	$0
Aquatic Resources and Threatened and Endangered Species – General			
17. Bury subsea cables at a depth of 1 to 2 meters, to the maximum extent practicable, to minimize the amount of habitat conversion (soft bottom to hard structure) from laying exposed cable on the seafloor. In areas where a cable cannot be buried or persistently becomes unburied, that portion of the cable will be on the seafloor and will be protected by split pipe, concrete mattresses or other cable protection systems.	$0[c]	$0	$0
18. To the maximum extent practicable, utilize shielding on subsea cables, umbilicals, and other electrical infrastructure to minimize electromagnetic field (EMF) emissions.	$0[c]	$0	$0

Proposed Environmental Measures	Capital Cost (2019$)	Annual Cost (2019$)	Levelized Annual Cost (2019$)[f]
19. Implement the EMF Monitoring Plan (Appendix H) to measure Project-related EMF emissions. Based on monitoring results, implement the specified measures to mitigate for potential adverse effects (Appendix I).	$0	$0[d]	$0[d]
20. In the event of an emergency in which fish or wildlife are being killed, harmed, or endangered by Project facilities or operations in a manner that was not anticipated, OSU will notify agencies with regulatory authority as soon as possible and take action to promptly minimize the impacts of the emergency, including implementing any guidance pursuant to agency legal authorities, as outlined in Appendix I.	$0	$0[a]	$0[a]
Aquatic Resources and Threatened and Endangered Species – Fish and Invertebrates			
21. Implement the Organism Interactions Monitoring Plan to track changes to pelagic and demersal fish and invertebrates (particularly Dungeness crab) that might be attracted to the installed components or affected due to the potential for reduced fishing pressure, as well as biofouling on the anchors/WECs (Appendix H).	$0	$0[d]	$0[d]
22. Develop cable routes that avoid crossing areas with rocky reef and hard substrate to the maximum extent practicable to protect sensitive habitat features.	$0[c]	$0	$0
23. Develop and implement an anchoring plan or protocol for any Project vessels that may anchor at the Project site, that: • Avoids anchoring in known rocky reef or hard substrate habitats to the maximum extent practicable; and • Minimizes the use of anchors within the Project area wherever practicable by combining onsite activities.	$0	$25,000	$31,751
Aquatic Resources and Threatened and Endangered Species – Marine Mammals			
24. Entangled Fishing Gear 24a. Conduct opportunistic visual observations from the water surface in the portions of the test site which are being visited to conduct operations, maintenance, or environmental monitoring work and review any underwater visual monitoring conducted for other purposes to detect entangled fishing gear that has the potential to increase the risk of marine species entanglement. The licensee will ensure that surface observations occur during all visits to the Project test site and at least once per quarter each year for the duration of the license.	$0[c]	$0	$0
24b. Annually following the peak storm season and period of maximum activity for the Dungeness crab fishery, the licensee shall conduct surface surveys of active WEC berths during the spring	$0	$0[d]	$0[d]

Proposed Environmental Measures	Capital Cost (2019$)	Annual Cost (2019$)	Levelized Annual Cost (2019$)[f]
season (mid-March through mid-June), or the earliest possible time after that period that avoids jeopardizing human safety, property, or the environment.			
24c. Conduct annual subsurface surveys of moorings and anchor systems using remotely operated vehicle (ROV) or other appropriate techniques with approval by NMFS concurrent with spring (mid-March through mid-June) monitoring under the Organism Interactions Monitoring Plan (Appendix H).	$0	$0[d]	$0[d]
24d. If entangled fishing gear or marine mammal (or sea turtle) stranding, entanglements, impingements, injuries, or mortalities are detected, implement the specified measures to minimize risk of marine mammal entanglement and to make every effort to return the fishing gear to the owners (Appendix I).	$0	$50,000	$63,502
25. Require vessels in transit to/from the Project site to avoid close contact with marine mammals and sea turtles and adhere to NMFS "Be Whale Wise" guidelines to minimize potential vessel impacts to marine mammals.	$0	$0	$0
26. Comply with current regulations that require marine mammal observers for certain vessel-based activity (e.g., sub-bottom profiling).	$0	$0	$0
27. Require WEC testing clients to keep their equipment in good working order to minimize sound due to faulty or poorly maintained equipment.	$0	$0	$0
28. Implement the Acoustics Monitoring Plan (Appendix H) to quantify sound levels using field measurements and validated sound propagation models. Based on monitoring results, implement specified measures to mitigate for potential adverse effects (Appendix I).	$0	$0[d]	$0[d]
29. Minimize construction activities during key gray whale migration periods, to the extent possible.	$0[c]	$0	$0
30. For use of Dynamic Positioning Vessels (DPVs) or other equipment that may exceed NMFS's published threshold for injury • Avoid use of these vessels to the maximum extent practicable during Phase B gray whale migration (April 1-June 15). If these construction activities are proposed during this migration period, the licensee will consult with ODFW regarding the timing of such activities including cable-laying in state waters. • With technical assistance from NMFS, establish and carry out the following actions and protocols necessary to maintain an appropriate acoustic zone of influence in accordance with NMFS's published harassment threshold (120 decibels (dB) re: 1 µPa) during DPV operations to minimize behavioral disturbance and protect marine resources. o Post qualified marine mammal observers during daylight hours.	$0	$0[b]	$0[b]

Proposed Environmental Measures	Capital Cost (2019$)	Annual Cost (2019$)	Levelized Annual Cost (2019$)[f]
○ The licensee will conduct dynamic positioning (DP) activities during daylight hours when feasible to ensure observations may be carried out. ○ DP for cable laying may occur during all hours; however, DP start up for cable laying will only occur during daylight hours. ○ The licensee will carry out the ramp-up procedures that are specified in Appendix I, which may be modified by agreement of the licensee and NMFS. • Implement such additional measures as may be imposed pursuant to a Marine Mammal Protection Act authorization.			
31. Make opportunistic visual observations of pinnipeds in the portions of the test site which are being visited to conduct operations, maintenance, or environmental monitoring work. If pinnipeds are observed to be hauled out on Project structures, the licensee will follow the reporting and haulout protocols specified in Appendix I.	$0	$0[d]	$0[d]
32. To the extent practicable, direct the WEC testing clients to design and maintain cables and moorings in configurations that minimize the potential for marine mammal or sea turtle entrapment or entanglement and follow the reporting and haulout protocols specified in Appendix I.	$0	$0	$0
Aquatic Resources and Threatened and Endangered Species – Birds			
33. Implement the Environmental Measures section as described in the Bird and Bat Conservation Strategy (Appendix B) to assess, minimize, and avoid impacts to birds, these are annotated below:			
33a. Conduct opportunistic visual observations from the water surface in the portions of the test site that are being visited to conduct operations, maintenance, or environmental monitoring work, and review any underwater visual monitoring conducted for other purposes, to detect derelict gear that has the potential to increase the risk of marine species entanglement. If monitoring shows that derelict gear has become entangled or collected on any Project structure, the risk that it poses will be assessed based on type of gear, and the derelict gear will be removed as soon as is practicable while avoiding jeopardizing human safety, property, or the environment, as described in Appendix I.	$0	$0[d]	$0[d]
33b. Conduct opportunistic visual observations in the portions of the WEC test site during vessel-based visits for operations, maintenance, or environmental monitoring work, to detect and document any instances of seabird perching.	$0	$0[d]	$0[d]
33c. Use low-intensity flashing lights and bird-friendly wavelengths on the Project structures to minimize seabird attraction and follow the specifications for Project lighting developed in consultation with the FWS and U.S. Coast Guard (USCG).	$0	$0[b]	$0[b]

Proposed Environmental Measures	Capital Cost (2019$)	Annual Cost (2019$)	Levelized Annual Cost (2019$)[f]
33d. Minimize lighting (e.g., use low intensity, bird-friendly wavelengths, shielded lighting not providing upward-pointing light or light directed at the sea surface) used at night by service and support vessels to reduce the potential for seabird attraction.	$0	$0[b]	$0[b]
33e. Require vessel operators to follow FWS instructions regarding appropriate handling and release of seabirds in the event of seabird fallout.	$0	$0	$0
33f. Require vessel operators to remain 500 ft away from seabird colonies during the nesting season to minimize disturbance to nesting seabirds.	$0	$0	$0
33g. Develop and implement an Emergency Response and Recovery Plan (Appendix G).	$0	$0[a]	$0[a]
Terrestrial Resources			
34. Minimize or avoid terrestrial activities in sensitive ecological areas (e.g., jurisdictional wetlands and nesting areas for listed avian species).	$0[c]	$0	$0
35. Use HDD to install the cable conduits under the beach and sand dune habitat.	$0[c]	$0	$0
36. Use HDD to run the terrestrial cable conduit directly from the Driftwood site to the UCMF, and potentially from the UCMF to the grid connection point, minimizing effects to wetlands, streams, and terrestrial habitat.	$0[c]	$0	$0
37. Employ environmental measures during installation, operation, and removal to avoid or minimize potential effects to sediment and soils. For example: • Minimize disruption of terrestrial geology and soils by maintaining buffers around wetlands to the degree practicable. • Develop and implement Erosion and Sediment Control Plans and maintaining natural surface drainage patterns. • Develop and implement stormwater runoff containment at terrestrial facilities to maintain existing drainage patterns, protect Project-adjacent habitat, and prevent contamination of streams. Develop a stormwater plan that meets all federal and state legal requirements during site design of the UCMF and associated facilities prior to any construction activities at the site.	$0[c]	$0	$0
38. Avoid to the extent practicable, disturbance of snags and of wildlife or legacy trees including live or dead trees that provide benefit to wildlife. If unavoidable, additional pre-construction, species-specific surveys may be necessary to minimize effects.	$0[c]	$0	$0
39. Avoid to the extent practicable, disturbance of forested wetlands.	$0[c]	$0	$0
40. Avoid to the extent practicable, disturbance of wetlands and adjacent areas that may provide habitat for turtles, amphibians, and other semi-aquatic wildlife.	$0[c]	$0	$0

Proposed Environmental Measures	Capital Cost (2019$)	Annual Cost (2019$)	Levelized Annual Cost (2019$)[f]
41. Avoid to the extent practicable, disturbance of riparian wetlands where restoration of natural hydrology may be unsuccessful within a short timeframe. Natural hydrology should be restored after construction is complete and may require a restoration plan with monitoring until successful restoration can be determined.	$0[c]	$0	$0
42. Minimize disturbance of streams that support fish, or are connected to fish-bearing streams. Unavoidable work within or adjacent to fish-bearing streams may be subject to in-water work windows. If terrestrial activities directly or indirectly affect any stream used by anadromous fish or fish listed as threatened or endangered under the federal or state Endangered Species Act (ESA), consult with the NMFS/ FWS staff to avoid and minimize any potential effects to listed species.	$0[c]	$0	$0
43. Avoid to the extent practicable, disturbance of seaside hoary elfin butterfly habitat within and in the vicinity of Driftwood Beach State Recreation Site. The current construction footprint has the Project well within the parking lot boundary of Driftwood, therefore interaction with kinnikinnick will be unlikely. Where unavoidable, species-specific surveys may be necessary on properties outside of Driftwood Beach State Recreation Site but within the construction footprint to determine the extent of occupied habitat and associated mitigation[3].	$0[c]	$0	$0
44. Develop a revegetation plan, in consultation with NMFS, ODFW, and appropriate agencies, using native species to the extent possible for areas disturbed during construction. This plan will the minimization measures identified in letters commenting on the DLA filed with FERC by NMFS (dated July 18, 2018) and ODFW (dated July 20, 2018) as appropriate.	$0[c]	$0	$0
45. Develop measures that will limit the introduction or spread of invasive species, to be included in a construction plan.	$0[c]	$0	$0
46. Implement the Environmental Measures section as described in the Bird and Bat Conservation Strategy (Appendix B) to assess, minimize, and avoid impacts to birds and bats; these are annotated below. • No HDD construction equipment or construction activities will occur on Driftwood Beach within suitable snowy plover nesting, roosting, or foraging habitat and is expected to be limited to the Driftwood Beach parking lot, at least 164 ft (50 m) from any potentially suitable habitat.	$0[c]	$0	$0

[3] For information on survey protocols, see Interagency Special Status/Sensitive Species Program (ISSSSP) 2005.

Proposed Environmental Measures	Capital Cost (2019$)	Annual Cost (2019$)	Levelized Annual Cost (2019$)[f]
• HDD operations in the parking lot will occur during daylight hours, but if lighting is required at night it will be appropriately shielded and directed to minimize artificial light reaching western snowy plover nesting habitat at night. Animal-proof litter receptacles and related signage and coordination will be provided to minimize potential attraction of predators. • Develop and implement an HDD Contingency Plan to minimize the potential for inadvertent return of drilling fluids, provide timely detection, and address potential releases by describing monitoring, containment, response and notification procedures to be implemented by the contractor. • If HDD is initiated during the western snowy plover nesting season (March 15 to September 15), prior to operation of the HDD, surveys of suitable nesting habitat will be conducted. If nests are detected, measures specified in the BBCS will be implemented, including noise monitoring and implementation of engineering controls, if appropriate (e.g., install temporary noise barriers such as berms, stockpiles, dumpsters, bins, and/or engineered acoustical barriers). • Prior to any vegetation clearing that occurs within the nesting season, pre-construction surveys for nesting birds will be conducted by a qualified biologist to ensure that no nests will be disturbed during vegetation clearing. • To minimize Project-related impacts on non-listed terrestrial nesting birds and avoid the creation of potential conflicts or constraints that the presence of active nests would have on Project activities (vegetation clearing), qualified biologists will remove nest-starts for any birds other than bald eagles or raptors when observed, if found within the Project footprint and within 100 ft of a construction zone and where feasible. • If an active nest is found sufficiently close to work areas to be disturbed by these activities, the biologist will determine the extent of a construction-free buffer zone to be established around the nest (typically 300 ft for raptors and 100 ft for other species), to ensure that no nests of species protected by the Migratory Bird Treaty Act (MBTA) will be disturbed during Project construction. • If nesting bald or golden eagles are identified, activities will be restricted near nest sites according to guidelines suggested in the National Bald Eagle Management Guidelines (FWS 2007). • If construction activities will not be initiated until after the start of the nesting season, all potential nesting substrates (e.g., bushes, trees, snags, grasses, and other vegetation) that are planned to be removed, will be removed in late winter, prior to the start of the nesting season.			

Proposed Environmental Measures	Capital Cost (2019$)	Annual Cost (2019$)	Levelized Annual Cost (2019$)[f]
• If necessary, the prescribed no-disturbance nesting buffers may be adjusted to reflect existing conditions including ambient noise, topography, and disturbance with approval of ODFW. • Conduct preconstruction surveys for roosting bats, and minimize construction impacts from high frequency sound disturbance, night lighting, and air quality degradation near roosts by implementing bat roost buffers, or excluding bats within bat roost buffers, or developing species and equipment specific buffers, use noise controls, and monitor bat roost activity before, during and after construction. • If lighting is required at the UCMF, it will be appropriately shielded and directed to minimize artificial light attraction and prevent potential injury or mortality to seabirds. To the maximum extent practicable, while allowing for the public safety, low intensity energy saving lighting (e.g., low pressure sodium lamps) will be used, and bright white light will be minimized to the maximum extent practicable.			
Recreation, Ocean Use, and Land Use			
47. Mark Project structures with appropriate navigation aids, as required by the USCG.	$0	$0[b]	$0[b]
48. Avoid, to the extent practicable, anchoring in areas known to contain hard substrate or rocky reef habitats as identified by available seafloor mapping.	$0	Cost above in Item 23	Cost above in Item 23
49. Conduct outreach to inform mariners of Project structures or activities to be avoided in the area (e.g., Notice to Mariners, flyers posted at marinas and docks).	$0	$10,000	$12,700
50. Install subsurface floats at sufficient depth to avoid potential vessel strike.	$0	$0[b]	$0[b]
51. Work cooperatively with commercial, charter and recreational fishing entities and interests to avoid and minimize potential space-use conflicts with commercial and recreational interests during construction and operation.	$0	$50,000	$63,502
52. Bury submarine cables 1 to 2 m deep where feasible to minimize interactions with fishing gear and anchors.	$0	$0[b]	$0[b]
Recreation, Ocean Use, and Land Use – Terrestrial Use and Recreation			
53. Use HDD to install the terrestrial cable conduits directly from the Driftwood Beach State Recreation Site to the UCMF, and potentially from the UCMF to the Highway 101 grid connection point, thus minimizing effects to adjacent landowners and traffic along Highway 101.	$0[c]	$0	$0
54. If acceptable to Oregon Parks and Recreation Department (OPRD), develop and install an interpretive display describing PacWave South in the Driftwood Beach State Recreation Site. OSU would work with to develop a plan regarding the interpretive display.	$25,000	$0	$1,058

Proposed Environmental Measures	Capital Cost (2019$)	Annual Cost (2019$)	Levelized Annual Cost (2019$)[f]
55. Comply with all state and local permitting requirements for all construction work.	$0[c]	$0	$0
56. Use construction fencing to isolate work areas from park lands.	$0[c]	$0	$0
57. Although non-Project related vehicular access to the Driftwood Beach State Recreation Site would be prohibited during construction, OSU would arrange the construction work area to maintain pedestrian public beach access, if safe and practicable. OSU would coordinate with OPRD to minimize impacts to public access and use of Driftwood Beach State Recreation Site.	$0[c]	$0	$0
58. Construction work areas or staging areas should be sited on other disturbed areas if possible.	$0[c]	$0	$0
Socioeconomic Resources – Included above under Recreation, Ocean Use and Land Use			

[a] No costs estimated since costs would be dependent on the frequency and nature of any unplanned events that occur.

[b] Cost to implement this environmental measure is included in Project operations and maintenance costs that OSU has estimated to be approximately $4 million annually (2019$).

[c] Cost to implement this environmental measure is included in Project construction capital costs that OSU has estimated to be approximately $55 million (2019$).

[d] Costs to implement this environmental measure is included in Project monitoring costs that OSU has estimated to be approximately $500,000 annually (2019$).

[e] Industry standards are sometimes published in written documents (e.g., the International Cable Protection Committee's cable recommendations available at https://www.iscpc.org/publications/recommendations/) or in manufacturer guidelines (e.g., for a vessel anchor, providing the recommended ratio of water depth to anchor line paid out). These standards are sometimes required as a condition of insurance or warranty. In other cases, industry standards represent unpublished best practices commonly implemented by a particular industry and that evolve over time.

[f] Levelized annual costs is calculated based on the annualized cost of the capital expenditures divided by 30 years.

5.0 ANNUAL VALUE OF PROJECT POWER

A statement of the estimated annual value of project power based on a showing of the contract price for sale of power or the estimated average annual cost of obtaining an equivalent amount of power (capacity and energy) from the lowest cost alternative source of power, specifying any projected changes in the costs (life-cycle costs) of power from that source over the estimated financing or licensing period if the applicant takes such changes into account.

As discussed earlier in this application, the primary purpose of PacWave South is to serve as an integrated test center to evaluate the performance of commercial scale WECs; energy generation is a secondary benefit. As such, the annual value of power generated by the proposed Project will vary depending on the number of WECs installed for testing at any given time combined with their performance characteristics. The annual value of power generated by the proposed Project cannot be reliably estimated and, therefore, this data characterization is not applicable to the proposed PacWave South Project.

6.0 OTHER ELECTRIC ENERGY ALTERNATIVES

A statement describing other electric energy alternatives, such as gas, oil, coal and nuclear-fueled power plants and other conventional and pumped storage hydroelectric plants.

From 2012 – 2014, energy in Oregon was supplied by a mix of hydropower (43%), coal (34%), natural gas (14%), wind (6%), nuclear (3%) and other sources (ODOE 2017). The Oregon Renewable Portfolio Standards (RPS) requires that 50% of the electricity provided by Oregon's largest utilities come from renewable resources by 2040 (Oregon Revised Statute Chapter 469A). PacWave South would produce up to 20 MW of power and serve as an integrated test center to evaluate the performance of commercial scale WECs. OSU believes that once the Project develops, the capital costs of wave energy would become more competitive with traditional generation.

7.0 RESULTS IF LICENSE IS DENIED

A statement and evaluation of the consequences of denial of the license application and a brief perspective of what future use would be made of the proposed site if the proposed project were not constructed.

If the license is denied, the Project would not be built, environmental resources in the Project area would not be affected, and there would not be a grid-connected wave energy test facility to facilitate industry commercialization and fully reap the benefits of this clean, renewable energy resource. Denying the license would result in no direct environmental impacts from the Project, but also would not: (1) further the State of Oregon's stated goal of utilizing responsibly sited wave energy to power Oregon; (2) meet the DOE's identified need for a demonstration center to commercialize this renewable energy sector which, ultimately, can reduce the nation's fossil fuel use; or (3) meet BOEM's goal to grow offshore renewable energy through issuing leases for renewable energy initiatives.

8.0 FINANCING AND REVENUES

A statement specifying the sources and extent of financing and annual revenues available to the applicant to meet the costs identified in paragraphs 1.0 and 4.0 of this section.

Funding for the costs identified in Section 1 and the first two years described in Section 4 are being funded by DOE. Continued funding for Section 4 activities in years 3-25 will be supported by lease revenue from testing clients.

9.0 COST OF LICENSE APPLICATION

An estimate of the cost to develop the license application.

The estimated cost to develop the license application is $6,250,000.

10.0 ON-PEAK AND OFF-PEAK VALUES OF POWER

The on-peak and off-peak values of project power, and the basis for estimating the values, for projects which are proposed to operate in a mode other than run-of-river.

The local utility, CLPUD, pays a fixed amount every month for an allotment of on-peak (HLH) and off-peak (LLH) energy. If use is more than allotted, CLPUD's pays a Load Shaping charge. If CLPUD uses less than allocated, a Load Shaping credit is issued. The rates vary each month. Table D-2 is an example of BPA's current rates.

Table D-2. BPA's rates for on-peak and off-peak power.

Month	Rate in mills/kWh	
	HLH	LLH
October	26.74	22.49
November	27.27	24.74
December	30.28	26.60
January	29.30	23.94
February	28.54	23.94
March	23.75	20.80
April	19.67	17.54
May	16.63	11.25
June	17.71	9.31
July	24.66	19.05
August	28.11	22.61
September	27.94	22.19

Note: A mill is 1/10th of a cent or 1/1,000th of a dollar. On-peak energy (HLH) and off-peak energy (LLH). Source: BPA 2017.

11.0 LITERATURE CITED

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U.S. Fish and Wildlife Service (FWS). 2007. National Bald Eagle Management Guidelines. http://www.fws.gov/northeast/ecologicalservices/pdf/NationalBaldEagleManagementGuidelines.pdf.

EXHIBIT E: APPLICANT PREPARED ENVIRONMENTAL ASSESSMENT

(Provided separately as Volume II)

EXHIBIT F: SUPPORTING DESIGN REPORT AND GENERAL DESIGN DRAWINGS

Exhibit F consists of general design drawings of the principal project works described under paragraph (b) of this section (Exhibit A) and supporting information used as the basis of design. If the Exhibit F submitted with the application is preliminary in nature, applicant must so state in the application. The drawings must conform to the specifications of § 4.39.

(1) The drawings must show all major project structures in sufficient detail to provide a full understanding of the project, including:
- *(i) Plans (overhead view);*
- *(ii) Elevations (front view);*
- *(iii) Profiles (side view); and*
- *(iv) Sections.*

(2) The applicant may submit preliminary design drawings with the application. The final Exhibit F may be submitted during or after the licensing process and must show the precise plans and specifications for proposed structures. If the project is licensed on the basis of preliminary designs, the applicant must submit a final Exhibit F for Commission approval prior to commencement of any construction of the project.

(3) Supporting design report. The applicant must furnish, at a minimum, the following supporting information to demonstrate that existing and proposed structures are safe and adequate to fulfill their stated functions and must submit such information in a separate report at the time the application is filed. The report must include:
- *(i) An assessment of the suitability of the site and the reservoir rim stability based on geological and subsurface investigations, including investigations of soils and rock borings and tests for the elevation of all foundations and construction materials sufficient to determine the location and type of dam structure suitable for the site;*
- *(ii) Copies of boring logs, geology reports and laboratory test reports;*
- *(iii) An identification of all borrow areas and quarry sites and an estimate of required quantities of suitable construction material;*
- *(iv) Stability and stress analyses for all major structures and critical abutment slopes under all probable loading conditions, including seismic and hydrostatic forces induced by water loads up to the Probable Maximum Flood as appropriate; and*
- *(v) The bases for determination of seismic loading and the spillway Design Flood in sufficient detail to permit independent staff evaluation.*

(4) The applicant must submit two copies of the supporting design report described in paragraph (g)(3) of this section at the time preliminary and final design drawings are submitted to the Commission for review. If the report contains preliminary drawings, it must be designated a "Preliminary Supporting Design Report."

1.0 REQUEST FOR CEII TREATMENT

In accordance with 18 CFR Part §388.112, OSU is requesting privileged treatment by the FERC for the Exhibit F General Design Drawings as the drawings contain Critical Energy Infrastructure Information (CEII). This request for privileged treatment is made to FERC in accordance with the series of CEII Rulemakings issued by FERC in Order Nos. 630, 630-A, 643, 649, 662, 683, and 702. OSU is requesting that the General Design Drawings be given privileged treatment because the drawings clearly show the proposed location of the critical Project features and design information. For this reason, OSU has filed the Exhibit F General Design Drawings with FERC as CEII.

In accordance with FERC's CEII Regulations, the following statement regarding access to CEII is provided:

Procedures for obtaining access to Critical Energy Infrastructure Information (CEII) may be found at 18 CFR §388.113. Requests for access to CEII should be made to the FERC CEII Coordinator.

2.0 GENERAL DESIGN DRAWINGS

Table F-1 provides a summary of the Exhibit F general design drawings submitted as part of this application in Attachment F-1.

Table F-1. Exhibit F General Design Drawings

Drawing No.	Description
F-1	Onshore Cable Landing Site Project Components
F-2	UCMF Project Components
F-3	Offshore Project Components

3.0 SUPPORTING DESIGN REPORT

This regulation, which applies to conventional hydropower projects with water-retaining structures, requires a significant amount of interpretation for PacWave South - the primary components of which an offshore test site composed of four test berths that could collectively support the testing of up to 20 floating wave energy converters (WECs), and associated moorings, anchors, subsea connectors, subsea power and communication cables, and onshore facilities. The anchoring systems being considered for the Project are based on existing technology designed, tested, and proven for other marine applications and does not involve the same level of site-specific project design that is typical of traditional hydropower projects. A description of the Project design criteria is included in Exhibit A, and the following analysis and plans support the safe design and operation of the Project: geophysical survey analysis of test site and cable route, operations and maintenance plan, and emergency response and recovery plan. OSU will work with the FERC regional engineer to provide supporting design information that meets FERC's needs for evaluating the safety of the design of the wave energy test center.

ATTACHMENT F-1
EXHIBIT F GENERAL DESIGN DRAWINGS

DRAWINGS FILED ONLY WITH THE FEDERAL ENERGY REGULATORY COMMISSION AS CRITICAL ENERGY INFRASTRUCTURE INFORMATION PURSUANT TO 18 CFR PART §388.112

EXHIBIT G: PROJECT MAPS

Exhibit G is a map of the project that must conform to the specifications of § 4.39. In addition, to the other components of Exhibit G, the Applicant must provide the project boundary data in a geo-referenced electronic format - such as ArcView shape files, GeoMedia files, MapInfo files, or any similar format. The electronic boundary data must be positionally accurate to ±40 feet, in order to comply with the National Map Accuracy Standards for maps at a 1:24,000 scale (the scale of USGS quadrangle maps). The electronic exhibit G data must include a text file describing the map projection used (i.e., UTM, State Plane, Decimal Degrees, etc.), the map datum (i.e., feet, meters, miles, etc.). Three sets of the maps must be submitted on compact disk or other appropriate electronic media. If more than one sheet is used for the paper maps, the sheets must be numbered consecutively, and each sheet must bear a small insert sketch showing the entire project and indicate that portion of the project depicted on that sheet. Each sheet must contain a minimum of three known reference points. The latitude and longitude coordinates, or state plane coordinates, of each reference point must be shown. If at any time after the application is filed there is any change in the project boundary, the applicant must submit, within 90 days following the completion of project construction, a final exhibit G showing the extent of such changes.

(1) Location of the project and principal features. The map must show the location of the project as a whole with reference to the affected stream or other body of water and, if possible, to a nearby town or any other permanent monuments or objects, such as roads, transmission lines or other structures, that can be noted on the map and recognized in the field. The map must also show the relative locations and physical interrelationships of the principal project works and other features described under Exhibit A.

(2) Project Boundary. The map must show a project boundary enclosing all project works and other features described under Exhibit A that are to be licensed. If accurate survey information is not available at the time the application is filed, the applicant must so state, and a tentative boundary may be submitted. The boundary must enclose only those lands necessary for operation and maintenance of the project and for other project purposes, such as recreation, shoreline control, or protection of environmental resources (see Exhibit E). Existing residential, commercial, or other structures may be included within the boundary only to the extent that underlying lands are needed for project purposes (e.g., for flowage, public recreation, shoreline control, or protection of environmental resources). If the boundary is on land covered by a public survey, ties must be shown on the map at sufficient points to permit accurate platting of the position of the boundary relative to the lines of the public land survey. If the lands are not covered by a public land survey, the best available legal description of the position of the boundary must be provided, including distances and directions from fixed monuments or physical features. The boundary must be described as follows:

(i) Impoundments.

(A) The boundary around a project impoundment must be described by one of the following:

(1) Contour lines, including the contour elevation (preferred method);

(2) Specified courses and distances (metes and bounds);

(3) If the project lands are covered by a public land survey, lines upon or parallel to the lines of the survey; or

(4) Any combination of the above methods.

(B) The boundary must be located no more than 200 feet (horizontal measurement) from the exterior margin of the reservoir, defined by the normal maximum surface elevation, except where deviations may be necessary in describing the boundary according to the above methods or where additional lands are necessary for project purposes, such as public recreation, shoreline control, or protection of environmental resources.

(ii) Continuous features. The boundary around linear (continuous) project features such as access roads, transmission lines, and conduits may be described by specified distances from center lines or offset lines of survey. The width of such corridors must not exceed 200 feet unless good cause is shown for a greater width. Several sections of a continuous feature may be shown on a single sheet with information showing the sequence of contiguous sections.

(iii) Noncontinuous features.

(A) The boundary around noncontinuous project works such as dams, spillways, and powerhouses must be described by one of the following:

(1) Contour lines;

(2) Specified courses and distances;

(3) If the project lands are covered by a public land survey, lines upon or parallel to the lines of the survey; or

(4) Any combination of the above methods.

(B) The boundary must enclose only those lands that are necessary for safe and efficient operation and maintenance of the project or for other specified project purposes, such as public recreation or protection of environmental resources.

(3) Federal Lands. Any public lands and reservations of the United States (federal lands) [see16 U.S.C. 796 (1) and (2)] that are within the project boundary, such as lands administered by the U.S. Forest Service, Bureau of Land Management, or National Park Service, or Indian tribal lands, and the boundaries of those Federal lands, must be identified as such on the map by:

(i) Legal subdivisions of a public land survey of the affected area (a protraction of identified township and section lines is sufficient for this purpose); and

(ii) The Federal agency, identified by symbol or legend, that maintains or manages each identified subdivision of the public land survey within the project boundary; or

(iii) In the absence of a public land survey, the location of the Federal lands according to the distances and directions from fixed monuments or physical features.

When a Federal survey monument or a Federal bench mark will be destroyed or rendered unusable by the construction of project works, at least two permanent, marked witness monuments or bench marks must be established at accessible points. The maps show the location (and elevation, for bench marks) of the survey monument or bench mark which will be destroyed or rendered unusable, as well as of the witness monuments or bench marks. Connecting courses and distances from the witness monuments or bench marks to the original must also be shown.

(iv) The project location must include the most current information pertaining to affected Federal lands as described under § 4.81(b)(5).

(4) Non-Federal Lands. For those lands within the project boundary not identified under Section 8.2, the map must identify by legal subdivision:

(i) Lands owned in fee by the applicant and lands that the applicant plans to acquire in fee; and

(ii) Lands over which the applicant has acquired or plans to acquire rights to occupancy and use other than fee title, including rights acquired or to be acquired by easement or lease.

Exhibit G provides maps depicting the proposed FERC Project Boundary for the proposed PacWave South Project in Attachment G-1. The two sheets that comprise the Exhibit G maps encompass all the primary Project features proposed for inclusion in the FERC license. The Exhibit G maps have been prepared in accordance with FERC's regulations and show the relative locations and physical relationships within the proposed FERC boundary. The principal Project works are described in detail in Exhibit A and Exhibit F of this application. Offshore, a portion of the Project will be located on the OCS. There is no public land survey or legal subdivision available. The portion of the Project enclosed within the project boundary on the OCS is depicted in the Exhibit G map.

ATTACHMENT G-1
EXHIBIT G PROPOSED FERC BOUNDARY MAPS

LEGEND

- FERC REFERENCE POINT
- NGS BENCHMARK
- PROPOSED FERC PROJECT BOUNDARY
- PACWAVE SOUTH TEST SITE
- CABLE ROUTE
- PLSS TOWNSHIP
- PLSS TOWNSHIP SECTION
- NOAA THREE NAUTICAL MILE LINE
- MUNICIPAL BOUNDARY
- ROAD
- RIVER / STREAM
- BOEM LEASE AREA
- SAND / BEACH

REFERENCE COORDINATE METADATA

PROJECTION - OREGON STATE PLANE
DATUM - NAD83
ZONE - NORTH
UNITS - U.S. SURVEY FEET

PROJECT BOUNDARY TIE DATA

THE PROJECT BOUNDARY IS TIED TO NGS BENCHMARK QE1607
N: 321,302.37', E: 7,267,231.79'
TIE POINT 1: 11736.59' ±, S 11d 56' 30.2901" E

PROPERTY NOTE

THE PROPOSED BOUNDARY SHOWN ON THE EXHIBIT G MAPS IS TENTATIVE AND HAS NOT YET BEEN SURVEYED. FOLLOWING ISSUANCE OF THE FERC LICENSE, OSU WILL OBTAIN EASEMENTS NEEDED TO USE LANDS OWNED BY THE STATE OF OREGON AND PRIVATE PARCELS FOR PROJECT PURPOSES AND WILL FILE AS-BUILT EXHIBIT G MAPS FOLLOWING COMPLETION OF CONSTRUCTION.

SURVEYORS STATEMENT

I HEREBY CERTIFY TO THE FEDERAL ENERGY REGULATORY COMMISSION (FERC) THAT THIS PLAN MEETS THE CONDITIONS SET FORTH BY FERC FOR ITS EXPRESSED PURPOSE. THE PURPOSE OF THIS MAP IS TO PROVIDE A GEOREFERENCED VISUAL DEPICTION OF THE LOCATION OF PROJECT FEATURES AND BOUNDARIES BASED ON THE BEST AVAILABLE HISTORICAL DRAWINGS AND DIGITAL REFERENCE SOURCES INCORPORATED INTO THE GEOGRAPHIC INFORMATION SYSTEM (GIS). LOCATIONS HAVE NOT BEEN VERIFIED BY PHYSICAL FIELD SURVEYS AND THIS DRAWING SHOULD NOT BE USED FOR PURPOSES OF DEVELOPING PROPERTY BOUNDARY DESCRIPTIONS.

STATE OF MAINE PROFESSIONAL LAND SURVEYOR STEPHEN W. EVERETT 2161

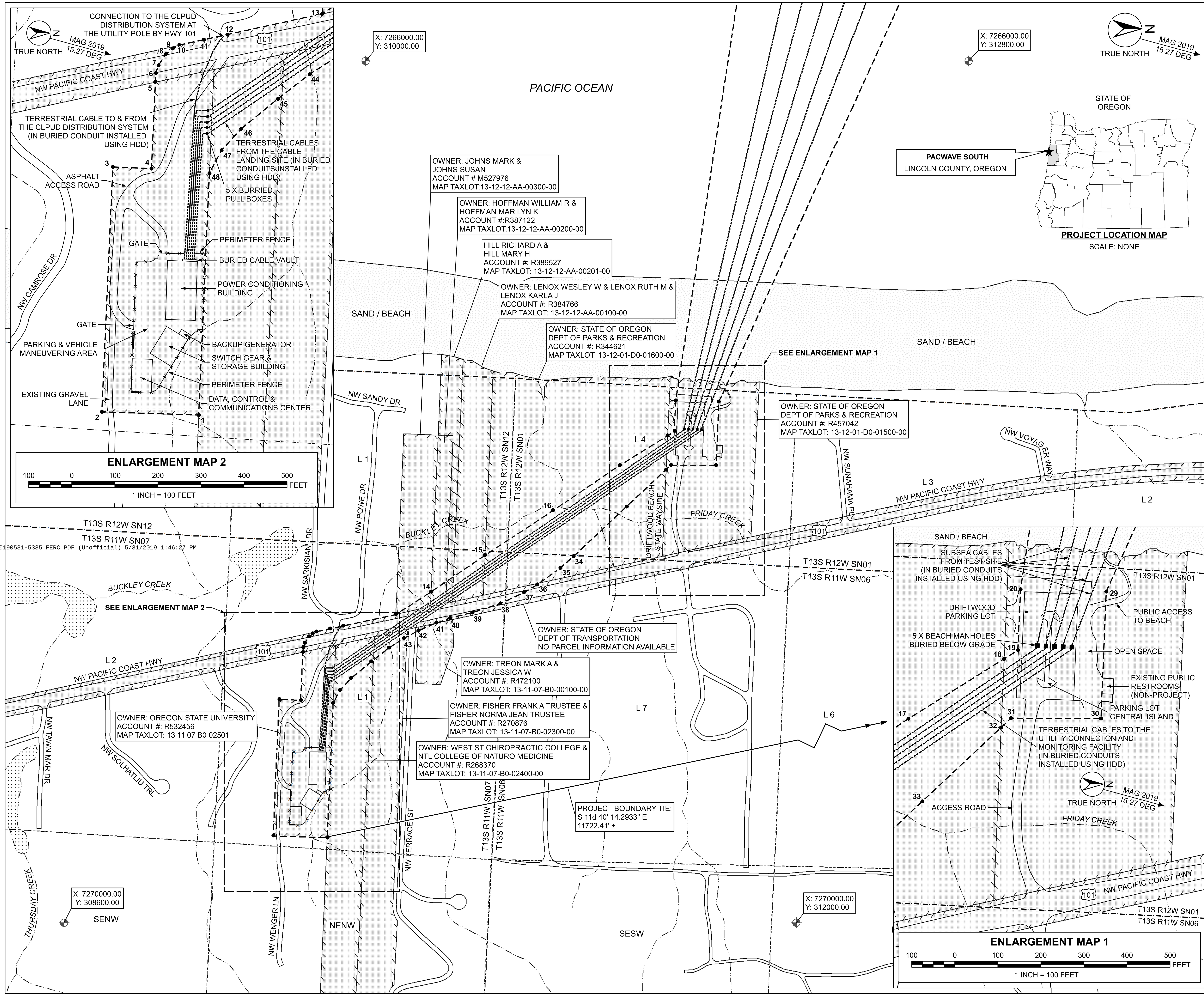
EXHIBIT G-1 | FERC No. 14616

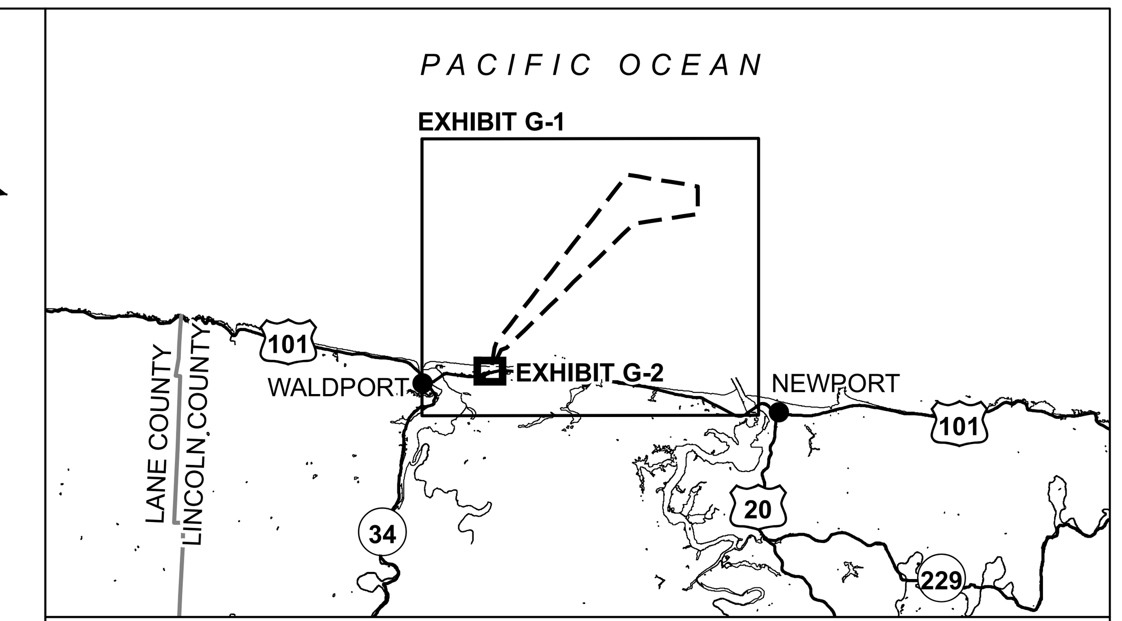
PACWAVE SOUTH BOUNDARY MAP

0.5 0 0.5 1 1.5 2 MILES

OREGON STATE UNIVERSITY

DATE: MAY 2019 | 1 INCH = 0.5 MILE | APPROVED: PENDING





LEGEND

- FERC REFERENCE POINT
- PROPOSED FERC PROJECT BOUNDARY
- CABLE ROUTE
- PERIMETER FENCE
- PLSS TOWNSHIP
- PLSS TOWNSHIP SECTION
- PLSS QUARTER-QUARTER SECTION
- ROAD
- RIVER / STREAM
- SAND / BEACH
- POND
- PARCEL BOUNDARY

REFERENCE COORDINATE METADATA

PROJECTION - OREGON STATE PLANE
DATUM - NAD83
ZONE - NORTH
UNITS - U.S. SURVEY FEET

PROJECT BOUNDARY TIE DATA

THE PROJECT BOUNDARY IS TIED TO
NGS BENCHMARK QE1607
N: 321,302.37', E: 7,267,231.79'
TIE POINT 1: 11736.59' ±, S 11d 56' 30.2901" E

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SURVEYORS STATEMENT

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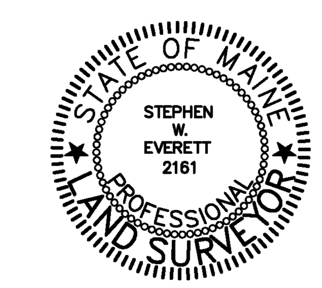

EXHIBIT G-2 | **FERC No. 14616**

PACWAVE SOUTH BOUNDARY MAP

200 0 200 400 600 800 FEET

OREGON STATE UNIVERSITY

DATE: MAY 2019	1 INCH = 200 FEET	APPROVED: PENDING

VOLUME II

PACWAVE SOUTH

APPLICANT PREPARED ENVIRONMENTAL ASSESSMENT

FERC PROJECT NO. 14616

APPLICANT:

OREGON STATE UNIVERSITY
CORVALLIS, OREGON

MAY 2019

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Appendices

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ACRONYMS AND ABBREVIATIONS

AC	Alternating current
AIS	Automatic Identification System
ALP	Alternative Licensing Process
APE	Area of potential effect
APEA	Applicant Prepared Environmental Assessment
BA	Biological Assessment
BIA	Biologically Important Areas
BPA	Bonneville Power Administration
BOEM	Bureau of Ocean Energy Management
BMPs	Best Management Practices
CLPUD	Central Lincoln People's Utility District
CEQ	Council on Environmental Quality
CWA	Clean Water Act
CWG	Collaborative Workgroup
CZMA	Coastal Zone Management Act
dB	Decibels
DLA	Draft License Application
DLCD	Department of Land Conservation and Development
DPS	Distinct population segment
DPV	Dynamic Positioning Vessels
DOE	U.S. Department of Energy
DOI	U.S. Department of the Interior
DSL	Department of State Lands
EA	Environmental Assessment
EFH	Essential Fish Habitat
EMEC	European Marine Energy Centre
EMF	Electromagnetic field
EPA	Environmental Protection Agency
EPRI	Electric Power Research Institute
ESA	Endangered Species Act
ESU	Evolutionarily significant unit
FAD	Fish aggregation device
FERC	Federal Energy Regulatory Commission
FINE	Fishermen Involved in Natural Energy
FLA	Final License Application
FMP	Fishery Management Plan
FPA	Federal Power Act
ft	Feet
FWS	U.S. Fish and Wildlife Service
G	Gauss
HAPC	Habitat Area of Particular Concern

HDD	Horizontal directional drilling
IHA	Incidental Harassment Authorization
km	Kilometer
kW	Kilowatts
kW/m	Kilowatts per meter
LASAR	Laboratory Analytical Storage and Retrieval
m	Meter
MARS	Monterey Accelerated Research System
MBTA	Migratory Bird Treaty Act
MLLW	Mean lower low water
MMPA	Marine Mammal Protection Act
MOU	Memorandum of Understanding
MW	Megawatt
NAVFAC	Naval Facilities Engineering Command
NDBC	National Data Buoy Center
NEPA	National Environmental Policy Act
NHPA	National Historic Preservation Act
NMFS	National Marine Fisheries Service
NPS	National Park Service
NOAA	National Oceanic and Atmospheric Administration
NOI	Notice of Intent
NRHP	National Register of Historic Places
OAR	Oregon Administrative Rules
O&M	Operations and Maintenance
OCS	Outer Continental Shelf
ODEQ	Oregon Department of Environmental Quality
ODFW	Oregon Department of Fish and Wildlife
ODOE	Oregon Department of Energy
ODOT	Oregon Department of Transportation
OOI	Ocean Observatories Initiative
OPRD	Oregon Parks and Recreation Department
OPT	Ocean Power Technologies
OSU	Oregon State University
OWC	Oscillating water columns
OWET	Oregon Wave Energy Trust
PAD	Pre-Application Document
PMEC-NETS	Pacific Marine Energy Center North Energy Test Site
PMEC-SETS	Pacific Marine Energy Center South Energy Test Site
PM&E	Protection, Mitigation and Enhancement
PCE	Primary constituent element
PDEA	Preliminary Draft Environmental Assessment
PFMC	Pacific Fishery Management Council

PSU	Practical salinity units
RMS	Root mean square
ROV	Remotely operated vehicle
SCADA	Supervisory control and data acquisition
SEL	Sound exposure level
SHPO	State Historic Preservation Office
SPCC	Spill Prevention, Control and Countermeasure
SPL	Sound pressure level
T	Tesla
TSP	Territorial Sea Plan
TTS	Temporary threshold shift
UCMF	Utility Connection and Monitoring Facility
USACE	U.S. Army Corps of Engineers
USCG	U.S. Coast Guard
WEC	Wave energy converter

1.0 INTRODUCTION

1.1 APPLICATION

Oregon State University (OSU) is filing with the Federal Energy Regulatory Commission (FERC) this Applicant Prepared Environmental Assessment (APEA) and application for an original license for the installation and operation of PacWave South (Project; formerly known as Pacific Marine Energy Center South Energy Test Site [PMEC-SETS]), a grid-connected wave energy test facility (FERC Project No. P-14616). The Project would be located in the Pacific Ocean, approximately 6 nautical miles off the coast of Newport, Oregon on the Outer Continental Shelf (OCS) and would occupy an area of approximately 2 square nautical miles (1,695 acres) (Figure 1-1). The Project would support up to 20 commercial-scale wave energy converters (WECs) and transfer power to a grid connection point with the Central Lincoln People's Utility District (CLPUD) in Lincoln County, Oregon. The Project could generate up to 20 megawatts (MW) that would travel through four individually buried subsea cables (along with a buried auxiliary cable) running from the test site to a terrestrial cable connection point at Driftwood Beach State Recreation Site in Seal Rock, Lincoln County, Oregon and then about 0.5 miles to the east and south to a newly built grid connection point with CLPUD (Figure 1-2). The portion of the OCS where the test site would be located is federal land administered by the Bureau of Ocean Energy Management (BOEM). The subsea cables would cross Oregon's territorial sea. The terrestrial components of the Project would be sited on state, county, and privately owned lands. The Project would serve as an integrated test center. As a grid-connected test facility, PacWave South would provide the opportunity to:

- Optimize WECs and arrays to increase their energy capture, improve their survivability and reliability, and decrease their levelized cost of energy;
- Refine deployment, recovery, operations, and maintenance procedures;
- Collect interconnection and grid synchronization data; and
- Gather information about potential environmental effects, and economic and social benefits.

FERC, under the authority of the Federal Power Act (FPA), may issue licenses for terms up to 50 years for the construction, operation, and maintenance of non-federal hydroelectric projects. OSU is requesting a 25-year license to construct and operate the Project. Pursuant to the National Environmental Policy Act (NEPA) of 1969, as amended, FERC's regulations, and other applicable laws, FERC would evaluate the environmental effects of the Project and consider reasonable alternatives to the proposed action to determine whether, and under what conditions, to issue an original license for the Project. OSU has requested and received approval from FERC to use the Alternative Licensing Process (ALP) for PacWave South, which provides for an APEA. As such, this APEA describes and evaluates potential site-specific and cumulative impacts of the proposed action compared to a no-action alternative.

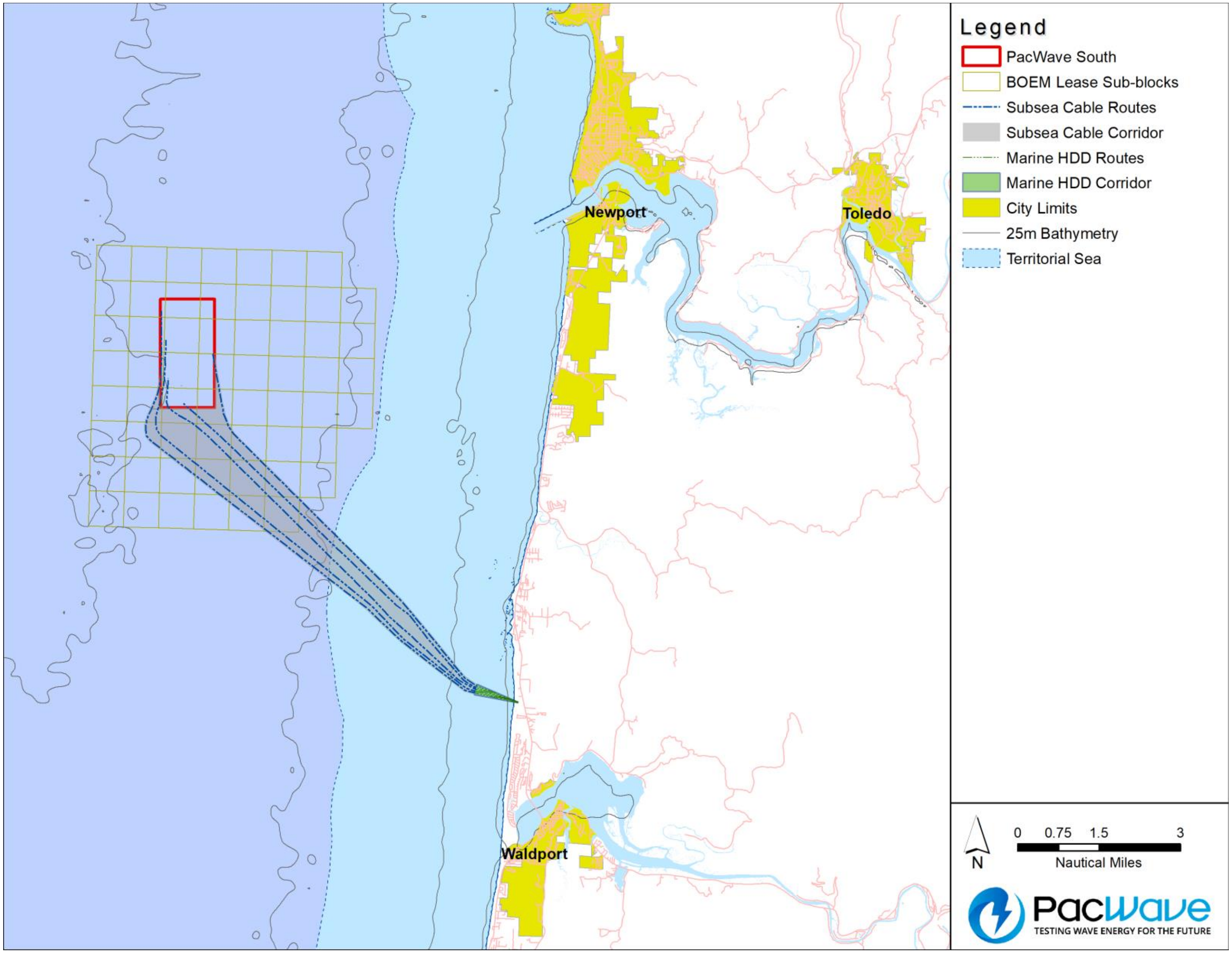

Figure 1-1. PacWave South marine Project area.

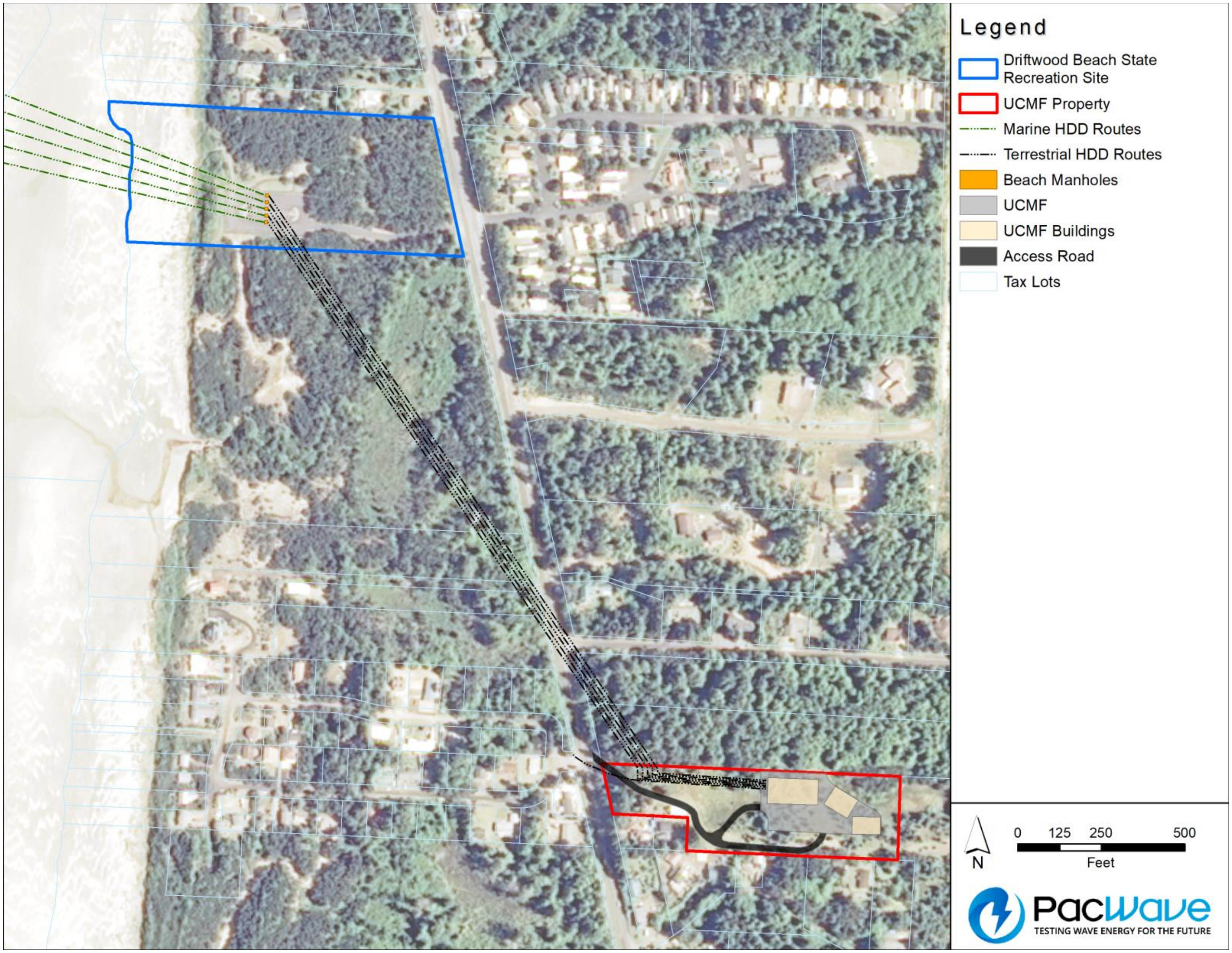

Figure 1-2. Terrestrial area of PacWave South.

1.2 PURPOSE OF ACTION AND NEED FOR POWER

1.2.1 Purpose of Action

The purpose of the action is to obtain a 25-year FERC license allowing OSU to install and operate PacWave South, a grid-connected facility to conduct testing of WECs. Research on and testing of WECs is needed to advance the development of marine renewable energy technologies by providing facilities for full-scale, open-ocean testing of WECs to promote the responsible development of marine renewable energy in the U.S. As such, this Project would support the mission, vision, and goals of the U.S. Department of Energy's (DOE) Office of Energy Efficiency and Renewable Energy Water Power Technologies Office to improve performance, lower costs, and accelerate deployment of innovative technologies for clean, domestic power generation from resources such as hydropower, waves, and tidal technologies. Testing conducted at PacWave South would advance the development of WECs, and thus further the nation's efforts to reduce its greenhouse gas emissions, diversify its energy supply, provide cost-competitive electricity to key coastal regions, and stimulate revitalization of key sectors of the economy. The Project also supports the State of Oregon's stated goal of utilizing responsibly sited wave energy to power Oregon and BOEM's goal to grow offshore renewable energy through issuing leases for renewable energy initiatives.

In deciding whether to issue a license for a hydroelectric project, FERC must determine that the Project would be best adapted to a comprehensive plan for improving or developing a waterway. In addition to the power and developmental purposes for which licenses are issued, FERC must give equal consideration to the purposes of: (1) energy conservation, (2) the protection of, mitigation of damage to, and enhancement of fish and wildlife resources, (3) the protection of recreational opportunities, and (4) the preservation of other aspects of environmental quality.

FERC, in coordination with cooperating agencies BOEM, the U.S. Army Corps of Engineers (USACE), U.S. Coast Guard (USCG), National Park Service (NPS), and DOE, will be responsible for preparing an EA to evaluate the potential environmental effects associated with construction and operation of the Project, as well as alternatives to the Project.

This APEA assesses the environmental and economic effects of construction and operation of the Project. It also considers the effects of the no-action alternative.

1.2.2 Need for Power

PacWave South would serve as an integrated test center to evaluate the performance of commercial scale or near-commercial scale WECs. As a secondary benefit, the Project would provide electricity to the Oregon coast region. PacWave South would have a maximum installed capacity of 20 MW. This capacity is based on the Oregon Wave Energy Trust (OWET) sponsored market analysis that forecasted future demand for berthing capacity at PacWave South (OWET 2014).

The power generated at PacWave South would vary depending on the WEC types and testing conditions; preliminary estimates range from 150 kilowatts (kW) to 2 MW per WEC. As a result, the energy capacity of PacWave South would vary over the life of the project. OSU expects that the capacity and number of WECs at PacWave South would be lower in the initial operations term and increase gradually as the industry advances.

As noted above, the primary purpose of PacWave South is to serve as an integrated test center to evaluate the performance of commercial scale WECs; energy generation is a secondary benefit. However, OSU believes that once the Project develops, the capital costs of wave energy would become more competitive with traditional generation.

The Project would connect to the CLPUD system, which serves over 38,000 customers including residential, commercial, and industrial users (CLPUD 2014). CLPUD is the fourth largest utility in Oregon (Oregon Department of Energy [ODOE] 2012) and receives all its required energy from the Bonneville Power Administration (BPA). The energy supplied by the Project would offset only a minor part of the total demand. CLPUD serves less than 3 percent of Oregon's electrical load and is considered a "small utility" (ODOE 2012) under Oregon's Renewable Portfolio Standard (ORS 469A). As a small utility, CLPUD is required to provide 10 percent of its power with renewable resources by 2025 (ORS 469A.055). The Project could generate up to 20 MW, which is small compared to regional demand, but would contribute renewable energy to CLPUD's future Renewable Portfolio Standard obligation.

Power generated by the Project would also support Oregon's goal to develop wave energy as a source of future renewable energy. The State of Oregon Biennial Energy Plan 2015-2017 highlights that "Oregon is at the crossroads of a developing marine energy industry, with a powerful wave climate and an environment suited for testing wave energy conversion technologies. Oregon is becoming the place to develop WECs from concept to full-scale deployment and learn how well they work in the marine environment" (ODOE 2015). Regionally, the Northwest Power and Conservation Council (2016) predicts the electricity demand in the Pacific Northwest to increase 0.5 to 1.0 percent per year, between 2015 and 2035. The testing of wave energy technology at PacWave South would advance the commercialization of wave energy and add to the diversification of Oregon's energy sources.

1.3 STATUTORY AND REGULATORY REQUIREMENTS

A FERC license for PacWave South is subject to numerous requirements under the FPA and other applicable statutes. The major federal regulatory and statutory requirements are summarized in Table 1-1 and described below.

Table 1-1. Major statutory and regulatory requirements for PacWave South.

Requirement	Agency
Section 10(j) of the FPA	Oregon Department of Fish and Wildlife (ODFW), U.S. Fish and Wildlife Service (FWS), National Marine Fisheries Service (NMFS)
Section 4(e) of the FPA	U.S. Department of Interior (DOI)
Section 401 of the Clean Water Act (CWA)	Environmental Protection Agency (EPA), Oregon Dept. of Env. Quality (ODEQ)
Section 404 of the CWA	USACE
Section 7 of Endangered Species Act (ESA)	FWS and NMFS
Section 106 of National Historic Preservation Act (NHPA)	Oregon State Historic Preservation Office (SHPO)
Magnuson-Stevens Fisheries Conservation and Management Act (Magnuson-Stevens Act)	NMFS
Marine Mammal Protection Act (MMPA)	NMFS
Migratory Bird Treaty Act (MBTA)	FWS
Section 307 of the Coastal Zone Management Act	Oregon Department of Land Conservation and Development (DLCD)
Section 106 of National Historic Preservation Act	SHPO
Approval for Navigation Aids	USCG
Section 388 of the Energy Policy Act of 2005	BOEM

1.3.1 Federal Power Act, Section 10(j) Recommendations

Under Section 10(j) of the FPA, each license issued must include conditions based on recommendations provided by federal and state wildlife agencies for the protection, mitigation, or enhancement of fish and wildlife resources affected by the Project. FERC is required to include these conditions unless it determines that they are inconsistent with the purposes and requirements of the FPA or other applicable law, or that alternative conditions would adequately address fish and wildlife issues. Before rejecting or modifying an agency 10(j) recommendation, FERC is required to attempt to resolve any such inconsistency with the agency, giving due weight to the recommendations, expertise, and statutory responsibilities of such agency.

1.3.2 Federal Power Act, Section 4(e) Mandatory Conditions

Under Section 4(e) of the FPA, licenses issued within reservations of the United States must contain such conditions as the Secretary of the department responsible for the supervision of the reservation deems necessary for the adequate protection and utilization of the reservation. For PacWave South, the Department of Interior (DOI) has mandatory conditioning authority under Section 4(e) for the portion of the Project located on the OCS.

1.3.3 Clean Water Act

The CWA (33 USC § 1344) addresses the issue of managing developments to improve, safeguard, and restore the quality of the nation's waters, including coastal waters, and to protect the natural resources and existing beneficial uses of those waters. EPA has Section 401 jurisdiction on the OCS and ODEQ has jurisdiction out to 3 nautical miles. Section 401 of the CWA requires that a Water Quality Certification be obtained from the state (or Territory) for actions that require a federal permit to conduct an activity, construction, or operation that may result in discharge to waters of the United States.

Section 404 of the CWA requires authorization for discharge of dredged or fill material into a wetland or other navigable water of the United States; USACE issues this permit. Authorization under Section 402 of the CWA would be required for ground-disturbing activities related to the installation of the terrestrial cables if those activities disturb more than 1 acre of land; this permit is issued by ODEQ.

1.3.4 Endangered Species Act

Section 7 of the Endangered Species Act (ESA) requires federal agencies to ensure that their actions are not likely to jeopardize the continued existence of endangered or threatened species or result in the destruction or adverse modification of the critical habitat of such species. In a notice dated May 27, 2014, FERC designated OSU as its non-federal representative for carrying out informal consultation pursuant to Section 7 of the ESA. OSU determined with input from the National Marine Fisheries Service (NMFS) and the U.S. Fish and Wildlife Service (FWS) that 39 fish, reptile, and marine mammal, and bird species listed under the ESA may occur in the Project area, including six species of whales, four species of sea turtles, 23 species of salmon, one species of sturgeon, one species of smelt (eulachon), and four species of birds. Critical habitat has been proposed or designated for 32 of these species, though the only species for which critical habitat is designated within the Project area are the Southern Distinct Population Segment (DPS) North American green sturgeon and the leatherback sea turtle. OSU has been working with NMFS and FWS regarding potential Project effects to species listed under the ESA and their associated critical habitat. See Section 3.3.5 for information on threatened and endangered species that may occur in the vicinity of the Project; in addition a draft Biological Assessment (BA) has been developed and is included as Appendix A.

1.3.5 Coastal Zone Management Act

Under section 307(c)(3)(A) of the Coastal Zone Management Act (CZMA), U.S.C. § 1456(3)(A), and pursuant to the 2009 Memorandum of Understanding (MOU) between FERC and the State of Oregon, FERC will not issue a license for a Project within or affecting a state's coastal zone unless the state's CZMA agency concurs with the license applicant's certification of consistency with the state's CZMA program, or the agency's concurrence is conclusively presumed by its failure to act within 180 days of its receipt of the applicant's certification. The Oregon Coastal Zone Management Program is managed by the Oregon DLCD. DLCD would evaluate the Project for consistency with the goals and policies of the Ocean Resources Management Plan, including Goal 19: Ocean Resources and the Territorial Sea Plan (TSP).

1.3.6 National Historic Preservation Act

The Project would be funded by DOE and authorized by FERC, BOEM, and USACE, and must therefore comply with Section 106 of the National Historic Preservation Act (NHPA) of 1966, as amended (54 USC § 300101). The NHPA sets forth national policy and procedures regarding cultural resources. Section 106 requires that every federal agency "take into account" how each of its undertakings could affect historic properties. Historic properties are districts, sites, buildings, structures, traditional cultural properties, and objects significant in American history, architecture, engineering, and culture that are included in or eligible for inclusion in the National Register of Historic Places (NRHP). To determine whether an undertaking could affect historic properties, cultural resources must be inventoried and evaluated for listing in the NRHP. Although compliance with Section 106 is the responsibility of the lead federal agency (in this case, FERC), others may undertake the work necessary to comply. Compliance with Section 106 requires consultation with potentially affected Native American tribes, participating agencies, the State Historic Preservation Officer (SHPO), and other interested parties throughout the Section 106 process.

A representative of the Confederated Tribes of Siletz Indians has participated in the Collaborative Workgroup (CWG), and the Confederated Tribes of Grand Ronde were invited to join as well. Additionally, FERC and BOEM have internal tribal experts who would review and revise the list of potentially affected tribes. Notice of the Project was provided to the SHPO[1] and Native American tribes[2] located near, or that would be affected by, the Project. Following acceptance of the Pre-Application Document (PAD), on April 25, 2014, FERC sent letters to the Confederated Tribes of Siletz Indians and the Confederated Tribes of Grand Ronde to invite them to meet about the Project. FERC has not received a response from either tribe to date.

In a notice dated May 27, 2014, FERC designated OSU as its non-federal representative for carrying out informal consultation, pursuant to Section 106 of the NHPA. Pursuant to Section 106, and as FERC's designated non-federal representative, OSU has been consulting with the SHPO and affected Indian tribes to locate, determine NHRP eligibility, and assess potential adverse effects to, historic properties associated with the Project. In a letter dated August 8, 2016, HDR submitted a letter on behalf of OSU to the SHPO proposing the Area of Potential Effect (APE) for both marine and terrestrial components of the Project, and outlining proposed methods for identifying historic properties within the APE. In a letter dated August 25, 2016, the SHPO concurred with the proposed APE boundaries and the proposed historic property identification efforts. Via a letter dated September 29, 2016, HDR on behalf of OSU, notified the Confederated Tribes of Siletz Indians, the Confederated Tribes of Grand Ronde, and SHPO of the cultural resources inventory to be conducted by HDR for the terrestrial portion of the Project APE. Following completion of the cultural resources inventory of the terrestrial portion of the APE, a report documenting the results of the inventory was submitted to the Confederated Tribes of Siletz Indians, the Confederated Tribes of Grand Ronde, and appropriate agencies on February 19, 2018 for a 30-day review period. Only one response was received, which was from Sam Willis, the Coastal Region Archaeologist with the Oregon Parks and Recreation Department, who provided comments on the report. Accordingly, the report was revised to address these comments and submitted to the SHPO on June 11, 2018 for review and concurrence on the report findings. In a letter dated July 6, 2018 SHPO concurred that a good faith effort for the terrestrial portion of the Project had been completed and that this portion of the Project will likely have no effect on any significant archaeological objects or sites. OSU filed copies of the terrestrial report and SHPO's concurrence letter with FERC on August 8, 2018. OSU also sent a copy of the draft License Application (DLA) to the tribes on April 23, 2018.

Since 2018, the Project footprint has been refined. Accordingly, OSU has modified both the marine and terrestrial portions of the APE to reflect the new area in which the Project could affect historic properties. A letter describing the newly proposed APE and requesting

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[1] OSU sent advance copy of the FERC Notice of Intent (NOI)/Pre-Application Document (PAD) to SHPO State Archeologist, Dennis Griffin, via an email dated April 21, 2014.

[2] OSU sent advance copy of NOI/PAD to Confederated Tribes of Siletz Indians' representative Tracy Baily and the Confederated Tribes of Grand Ronde Tribal Historic Preservation Officer via an email dated April 21, 2014.

concurrence on the appropriateness of the new APE was submitted to SHPO on May 17, 2019, and OSU is awaiting a response. . The collection of cultural resources field data for the marine portion of the APE was completed at the beginning of 2019. The review and assessment of these data in regards to historic properties identification and the potential for the marine portion of the Project to affect historic properties has been completed and documented in a study report that is included in Appendix O of this APEA. The study report will be sent to the Confederated Tribes of Siletz Indians, the Confederated Tribes of Grand Ronde, and appropriate agencies for a 30-day review period by July 2019. After which, any comments received will be addressed and the report will then be submitted to SHPO for review and concurrence on the findings of the marine investigation. A finding of effects to historic properties for the Project in its entirety will also be determined and provided to tribes, agencies, and SHPO concurrently with the marine study report for review. Concurrence on the finding of effects for the Project will be sought from SHPO. Following these consultation efforts, the final Section 106 consultation materials, including the marine study report and finding of effects assessment will be filed with FERC. OSU expects to file the final Section 106 consultation materials with FERC by December 31, 2019.

See Section 3.3.7 for more information on cultural resources.

1.3.7 Magnuson-Stevens Fishery Conservation and Management Act

The Magnuson-Stevens Fishery Conservation and Management Act (Magnuson-Stevens Act) requires federal agencies to consult with NMFS on all actions that may adversely affect Essential Fish Habitat (EFH). EFH is defined as “those waters and substrate necessary to fish for spawning, breeding, feeding, and growth to maturity.” An area within the designated EFH that is particularly important and/or sensitive is a Habitat Area of Particular Concern (HAPC). Regional Fishery Management Councils (e.g., Pacific Fishery Management Council), established under the Magnuson-Stevens Act, are responsible for preparing and amending fishery management plans (FMPs) for each fishery under their authority that requires conservation and management. Any federal action that might have an adverse effect on quality and/or quantity of EFHs is subject to consultation requirements with NMFS. In a notice dated May 27, 2014, FERC designated OSU as FERC’s non-federal representative for carrying out informal consultation, pursuant to Section 305 of the Magnuson-Stevens Act. Pursuant to the Magnuson-Stevens Act, EFH has been designated for groundfish, salmon, and coastal pelagic species; all waters within and adjoining the Project area constitute EFH.

1.3.8 Marine Mammal Protection Act

The Marine Mammal Protection Act (MMPA) prohibits, with certain exceptions, the “take” (defined under statute to include harassment) of marine mammals in U.S. waters and the high seas. In 1986, Congress amended both the MMPA, under the incidental take program, and the ESA to authorize incidental takings of depleted, endangered, or threatened marine mammals, provided the "taking" (defined under statute as actions which are or may be lethal, injurious, or harassing) was small in number and had a negligible impact on marine mammal populations.

Under MMPA Section 101(a)(5)(D), an Incidental Harassment Authorization (IHA) can be granted by NMFS if it finds that the incidental "take" would have a negligible impact on the species or stock, or would not have an unmitigatable adverse impact on the availability of the species or stock for subsistence uses (where applicable). NMFS has defined "negligible impact" as "an impact resulting from the specified activity that cannot be reasonably expected to, and would not be reasonably likely to, adversely affect the species or stock through effects on annual rates of recruitment or survival." IHAs include permissible methods of taking and requirements for mitigation and monitoring to ensure that takings result in the lowest practicable adverse impacts on affected marine mammal species or stocks.

OSU held a conference call with NMFS regional and marine mammal staff on September 7, 2018, to discuss whether an IHA would be needed for construction or operation of the Project. OSU subsequently provided copies of the draft BA and PDEA to NMFS's marine mammal permitting staff for review, and staff provided preliminary feedback that no IHA was likely required. On April 10, 2019, OSU requested a determination in writing that the Project's construction and operation was not expected to result in "take" under the MMPA. NMFS issued a letter on May 30, 2019 concluding that neither construction nor operation of the Project is expected to result in take of marine mammals and that no IHA is therefore required (Appendix N). Therefore, no authorization is required pursuant to the MMPA.

1.3.9 Migratory Bird Treaty Act

The federal Migratory Bird Treaty Act (MBTA) (16 U.S.C., § 703, Supp. I, 1989) prohibits killing, possessing, or trading in migratory birds except in accordance with regulations prescribed by the Secretary of the Interior.

Under Executive Order 13186, "Responsibilities of Federal Agencies to Protect Migratory Birds," Federal agencies have been directed to take certain actions to further implement the MBTA. To this end, the FWS has entered into MOUs with over a dozen agencies, including FERC and the Minerals Management Service (precursor to BOEM). The MOU, signed in June 2009, obligated the two agencies to strengthen migratory bird conservation through enhanced collaboration and to work together to reduce negative impacts of resource development projects on migratory birds. Specifically, it obligates BOEM to integrate migratory bird conservation principles, as well as reasonable and feasible conservation measures and management practices into BOEM approvals, procedures and practices consistent with the

Council on Environmental Quality's (CEQ) regulations, and FWS and BOEM guidelines and procedures. While this MOU expired in 2014, FWS and BOEM are in the process of updating it and the 2009 MOU is indicative of the agencies' commitments to work collaboratively to conserve migratory birds. OSU has coordinated with FWS to develop a Bird and Bat Conservation Strategy (Appendix B); key elements of the strategy have been integrated into this APEA.

1.3.10 U.S. Coast Guard Approval for Navigation Aids

The USCG Thirteenth District is responsible for the permitting of all Private Aids to Navigation located in Idaho, Montana, Oregon, and Washington. USCG District 13 enforces federal laws on the high seas and navigable waters off of Oregon and maintains aids to navigation, such as buoys. The Project would require USCG approval for new Private Aids to Navigation (e.g., lighting and reflectors) to be affixed to the WECs and navigation marker buoys. A USCG Local Notice to Mariners would also be requested for the deployment of in-water infrastructure and equipment associated with the Project, and OSU would implement any navigational designations prescribed by the USCG.

1.3.11 Energy Policy Act

Subsection 8(p)(1)(C) of the OCS Lands Act (43 U.S.C. § 1337(p)(1)(3)), which was added by Section 388 of the Energy Policy Act of 2005, gave the Secretary of the Interior the authority to issue leases for marine hydrokinetic projects on the OCS. This authority has been delegated to BOEM. OSU submitted an Unsolicited Request for Renewable Energy Research Lease to BOEM on October 29, 2013; on June 19, 2014, BOEM determined that it is appropriate to issue a lease for the Project on a non-competitive basis.

1.4 PUBLIC REVIEW AND COMMENT

FERC's regulations (18 CFR § 4.38) require that applicants consult with appropriate resource agencies, tribes, and other entities before filing an application for a license. This consultation is the first step in complying with the Fish and Wildlife Coordination Act, the ESA, the NHPA, and other federal statutes. Pre-filing consultation must be complete and documented according to FERC's regulations.

1.4.1 NEPA Scoping

Before preparing this document, OSU conducted scoping to determine what issues and alternatives should be addressed. Scoping Document 1 was distributed on June 5, 2014. Two scoping meetings were held on July 9, 2014, in Newport, Oregon to request comments on the

Project. Additionally, a site visit was held on July 10, 2014. A court reporter recorded all comments and statements made at the scoping meetings and these are part of FERC's public record for the Project. In addition to verbal comments provided at the scoping meetings, written comments were provided by the entities listed in Table 1-2.

Table 1-2. Commenting entities on Scoping Document 1.

Commenter	Date
Oregon Parks and Recreation Department (OPRD) – SHPO	June 17, 2014
Pacific Fishery Management Council	July 8, 2014
Oregon Department of Land Conservation and Development (DLCD) through the Oregon Coastal Management Program	July 31, 2014
FWS	August 1, 2014
NMFS	August 4, 2014
ODFW	August 4, 2014
OPRD	August 4, 2014
ODOE	August 4, 2014
Marine Mammal Commission	August 4, 2014
OWET	August 4, 2014

A revised scoping document (Scoping Document 2), addressing these comments, was filed with FERC on September 16, 2014.

1.4.2 Agency Consultation

The Project site was selected in consultation with Fishermen Involved in Natural Energy (FINE), a committee established by Lincoln County to ensure the fishing community was represented in discussions about offshore renewable energy in the region. FINE identified a 6 square nautical mile area off the coast of Newport that the fishermen felt would be both a suitable and acceptable area within which to locate PacWave South based on their extensive knowledge of the local marine environment. It was also a site FINE felt would have minimal effects on other ocean users. Based on the area identified by FINE, OSU submitted a research lease application to BOEM.

In conjunction with the community site selection process, OSU began engaging with both FERC and BOEM in fall 2012 to share information about the Project and help prepare for the regulatory process. OSU held conference calls with each agency individually to share initial information about the Project, followed by a conference call with FERC and BOEM to discuss the licensing and leasing processes.

In January 2013, OSU formed an advisory team comprised of federal and state agencies involved in the PacWave South authorization process, as well as non-governmental organizations representing stakeholder interests, to collectively explore the Project and identify key regulatory and environmental considerations. In 2014, this group was formalized as the CWG pursuant to FERC's alternative licensing procedures (CFR 18, Section 4.34(i)) for pre-filing consultation. Members of the CWG represented the following 26 entities:

- Oregon Parks & Recreation Department
- Oregon Department of Environmental Quality
- Oregon Department of Land Conservation & Development
- Oregon Office of the Governor
- Oregon Department of Energy
- Oregon Department of Fish and Wildlife
- Oregon Department of State Lands
- Port of Newport
- City of Newport
- Lincoln County
- Port of Toledo
- Newport Community
- Oregon State University (PacWave)
- Confederated Tribes of Siletz Indians
- Confederated Tribes of Grand Ronde
- Federal Energy Regulatory Commission
- National Marine Fisheries Service
- Bureau of Ocean Energy Management
- US Army Corps of Engineers
- US Coast Guard
- US Department of Energy
- US Environmental Protection Agency
- US Fish and Wildlife Service
- Surfrider
- Oregon Shores
- Oregon Wave Energy Trust

A primary focus of the CWG was on how the Project would meet regulatory standards and undertake approval processes under the FPA and other federal and state approvals. As part of these efforts, OSU and other members of the CWG agreed that the ALP would be the most appropriate for PacWave South because it would allow the CWG members to work cooperatively toward the ultimate OSU proposal. As a requirement of FERC's alternative procedure, a Communications Protocol was established to guide the CWG's consensus-based collaborative process. Additional details about the establishment of the CWG, as well as the process used to develop and reach consensus, are provided in the Request to Use the ALP and the associated Communications Protocol that were filed with the PAD in April 2014.

Throughout the pre-filing timeframe the CWG convened over 30 times to discuss, review, and provide input on the following aspects of the license application:

- Type and level of information needed to support the regulatory process;
- Study plans, including study questions and methods;
- Interpretation of study results or effects analysis;
- An Adaptive Management Plan that includes a structure for evaluating information and a process to determine how to use that information in the implementation of adaptive management measures and responses; and
- Protection, Mitigation and Enhancement (PM&E) measures.

In addition to engaging one-on-one with interested parties, OSU has held a number of meetings with agencies and stakeholders since January 2013. Table 1-3 provides a list of all meeting dates and organizational attendees; all of the meetings listed below were held in-person, with the exception of those with an asterisk, which were conducted via webinar.[3]

Table 1-3. PacWave South agency and stakeholder meetings.

Date	Organizational Attendees
January 15, 2013	FERC, BOEM, NMFS, FWS, USACE, USDOE, ODEQ, DLCD, ODFW, OWET
March 13, 2013	FERC, BOEM, NMFS, USDOE, ODEQ, DLCD, ODFW, OPRD, OWET, Oregon Shores, Surfrider
March 14, 2013	FERC, BOEM, NMFS, ODEQ, DLCD, ODFW, OPRD, Oregon Shores
May 8, 2013	BOEM, FWS, NMFS, ODFW, USACE
May 29, 2013	FERC, BOEM, NMFS, FWS, ODEQ, DLCD, Oregon Department of State Lands (DSL), ODFW, OPRD, OWET
July 16, 2013	BOEM, NMFS, FWS, ODFW
September 19, 2013	FERC, BOEM, NMFS, FWS, USACE, EPA, ODEQ, DLCD, DSL, ODFW, OPRD, ODOE, Governor's Office, Oregon Shores, Surfrider, Fishermen Involved in Natural Energy (FINE), OWET
November 12, 2013	CLPUD, OPRD, Port of Newport
December 5, 2013	FERC, BOEM, NMFS, FWS, USACE, EPA, ODEQ, DLCD, ODFW, ODOE, OPRD, Confederated Tribes of Siletz Indians, Port of Toledo, FINE, Surfrider
January 20, 2014	FERC, BOEM, NMFS, FWS, DSL, DLCD, ODFW, ODOE, OPRD, Confederated Tribes of Siletz Indians, FINE, OWET
March 13, 2014	FERC, BOEM, NMFS, FWS, USACE, DLCD, DEQ, ODOE, ODFW, DSL, OPRD, Confederated Tribes of Siletz Indians, Oregon Shores
May 28, 2014	FERC, BOEM, NMFS, FWS, ODFW, DSL, OPRD, Confederated Tribes of Siletz Indians, Port of Toledo, City of Newport
July 10, 2014	FERC, BOEM, NMFS, FWS, EPA, OPRD, ODFW, DSL, ODFW, DLCD, FINE, OWET
September 10, 2014	FERC, BOEM, USACE, NMFS, FWS, OPRD, ODFW, DSL, DEQ, Office of the Governor
December 11, 2014	FERC, BOEM, USACE, NMFS, FWS, OPRD, ODFW, DSL, DEQ, DLCD, Office of the Governor, Port of Toledo
February 25, 2015	FERC, BOEM, NMFS, FWS, ODFW
April 22, 2015	FERC, BOEM, USACE, NMFS, FWS, USCG, OPRD, ODFW, DSL, DEQ, DLCD
May 14, 2015	FERC, BOEM, NMFS, FWS, USCG, ODFW, DLCD
December 8, 2015	FERC, BOEM, NMFS, FWS, USCG, ODFW, DLCD, OPRD, DSL, DEQ

[3] Participants unable to attend in-person joined the meetings by telephone and/or webinar.

Date	Organizational Attendees
March 10, 2016	FERC, BOEM, NMFS, FWS, USEPA, ODFW, DLCD, OPRD, DEQ, Office of the Governor
April 13, 2016	BOEM, FWS, ODFW
April 21, 2016	BOEM, USCG, OPRD, ODFW, NMFS, FERC, DLCD, OWET
June 23, 2016	ODFW, FERC, NMFS, BOEM, FWS, DLCD
July 14, 2016	ODFW, NMFS, FERC, DLCD, USCG, BOEM, OPRD, FWS
August 2, 2016	OPRD, FWS, ODFW, DLCD
March 16, 2017*	FERC, BOEM, USACE, DOE, NMFS, FWS, ODFW, DLCD, Port of Newport
April 26, 2017	FERC, BOEM, USACE, DOE, NMFS, FWS, OPRD, ODFW, DLCD, Port of Newport
May 10, 2017*	FERC, BOEM, USACE, DOE, NMFS, FWS, ODFW, DLCD, Port of Newport
May 15, 2017*	FERC, BOEM, USACE, DOE, NMFS, FWS, OPRD, ODFW, DLCD, Port of Newport
February 1, 2018*	FERC, BOEM, USACE, USDOE, NMFS, FWS, USEPA, USCG, DSL, OPRD, ODFW, ODLCD, Confederated Tribe of the Siletz Indians
September 7, 2018	NMFS
February 13, 2019	FERC, BOEM, USDOE, NMFS, FWS, USEPA, DSL, OPRD, ODFW, USACE

*meeting conducted by webinar only

Additional small group topic-specific discussions occurred on June 1, 2015; August 19, 2015; September 3, 2015; January 6, 2016; February 17, 2016; March 29, 2016; April 15, 2016; May 3, 2016; July 13, 2016; August 2, 2016; and December 6, 2016.

Throughout the collaborative process, the CWG provided input to, reviewed and reached consensus[4] (except as noted in Table 1-4) on several CWG Products that have been incorporated into the license application. The CWG agreed that it should attempt to reach agreement on these license application components and related documents (CWG Products). Other license application components, such as the APEA, draft BA, and Navigation Safety Risk Assessment, were prepared by OSU with input from CWG parties but are not considered CWG Products. Table 1-4 provides a summary of the CWG Products and the outcome of CWG consensus decision making.

[4] Section 1.5.1 of the Communications Protocol, *Effects of Agreements*, states that, absent specific language to the contrary, agreements reached by the CWG participants are not intended to create legally binding obligations. However, it is the intent of the CWG that parties will support (or not object to) their agreements before FERC and will, without predetermining the outcome of any regulatory process, endeavor to act consistent with the CWG agreements in carrying out their respective authorities.

Table 1-4. Summary of the CWG Products and the outcome of CWG consensus decision making.

CWG Product	CWG Outcome
Communications Protocol	Consensus agreement reached on March 13, 2014.
Site Characterization Studies	Consensus agreement reached on September 10, 2014.
Resource Issues to be Analyzed in PDEA	Consensus agreement reached on September 10, 2014.
Monitoring Plans • Acoustics • Electromagnetic Field (EMF) • Benthic • Organism Interaction	Initial consensus agreement was achieved on March 10, 2016 for Acoustics, Benthic, and EMF pending further consideration of all monitoring and PM&E components. After further discussion, final consensus agreement was achieved on May 15, 2017 with one exception. ODFW agreed with the EMF monitoring plan but had concerns about shielding the hubs/connectors or field validations of the model at these locations and indicated that the agency would likely provide comments on this issue as part of the licensing comment process.
Bird and Bat Conservation Strategy	Consensus was reached on May 15, 2017 with the exception of issues around appropriate buffer zones. OSU held follow-up discussions regarding buffer zones with ODFW and FWS on July 20, 2017, and the proposed PM&E measures include buffer zone mitigation language developed collaboratively with these agencies.
PM&E Measures. Examples include: • Impacts of EMF on marine resources • Marine species entanglement or collision • Impacts of sound from WECs and their mooring systems on marine resources • Water Resources • Terrestrial Resources	Consensus was reached on May 15, 2017 among all parties with one exception. ODFW agreed with the proposed PM&E measures but noted concerns about potential EMF at hubs and connectors as well as the response timeframe for exceedance of acoustic thresholds, and indicated that the agency would likely provide comments on these two issues as part of the licensing process.
Adaptive Management Framework	Consensus agreement was reached on May 15, 2017, with OSU's commitment to work with NMFS to develop wildlife emergency procedures for inclusion in the PM&E measures. The proposed PM&E measures include wildlife emergency procedures developed collaboratively with NMFS.

1.4.3 Interventions

To be completed by FERC at a future date.

1.4.4 Comments on the Draft License Application

On April 20, 2018, OSU filed its draft License Application (DLA), which included a Preliminary Draft Environmental Assessment (PDEA) and draft BA, for the proposed PacWave South Project. The comment period on the DLA closed on July 20, 2018 (90 days from the filing date). Written comments on the DLA are provided in Table 1-5 and in Appendix L.

Table 1-5. Comments on the DLA

Commenting Entity	Date Filed
FERC	July 18, 2018
NMFS	July 18, 2018
NPS	July 20, 2018
ODFW	July 20, 2018
OPRD	July 20, 2018
Natural Resource Defense Council, Center for Biological Diversity, Whale and Dolphin Conservation and Defenders of Wildlife	July 23, 2018
FWS	July 24, 2018
NMFS	September 10, 2018

Appendix L also contains a table that summarizes the comments that were filed, OSU's responses to those comments, and whether modifications were made to the APEA and other final license application documents.

1.4.5 Comments on the Draft Environmental Assessment

To be completed by FERC at a future date.

2.0 PROPOSED ACTIONS AND ALTERNATIVES

2.1 NO-ACTION ALTERNATIVE

The No-Action Alternative is considered in this APEA and provides a benchmark, enabling decision-makers to evaluate the magnitude of environmental effects of the Project. The no-action alternative for this Project is license denial. Under the no-action alternative, the Project would not be built, environmental resources in the Project area would not be affected, and there would not be a grid-connected wave energy test facility to enable industry commercialization and fully reap the benefits of this clean, renewable energy resource. The no-action alternative would result in no direct environmental impacts from the Project, but also would not meet the purpose and need of this Project, and there are no other existing or planned wave energy test facilities in the United States that would meet those needs.

2.2 PROPOSED ACTION

OSU is seeking issuance of a 20 MW FERC license to construct and operate an offshore wave energy test site composed of four test berths that could collectively support the testing of up to 20 WECs, and associated moorings, anchors, subsea connectors and hubs, subsea power and communication cables, and onshore facilities. The PacWave South test site would occupy approximately 2 square nautical miles in federal waters about 6 nautical miles off the coast of Newport, Oregon. Water depths at PacWave South range from 65 to 79 m (MLLW) and OSU expects types of deep water WECs (described in more detail below) to be tested at the site; however, it would not be feasible to test medium to shallow water, or shoreline-based WECs at this site. OSU would oversee and manage all activities, and clients deploying WECs at PacWave South would be subject to test center protocols and procedures.

As noted in Section 1.4.2, the Project site was selected in consultation with FINE, a committee established by Lincoln County to ensure the fishing community was represented in discussions about offshore renewable energy in the region. FINE identified a 6 square nautical mile area off the coast of Newport that the fishermen felt would be both a suitable and acceptable area within which to locate PacWave South based on their extensive knowledge of the local marine environment. It was also a site FINE felt would have minimal effects on other ocean users. Based on the area identified by FINE, OSU submitted a research lease application to BOEM. OSU subsequently conducted site-specific surveys and gathered information from agencies and stakeholders to characterize the physical and biological conditions of the area and used this information to select a 2 square nautical mile test site. The coordinates for the corners of the 2 square nautical mile Project site are below:

NW:	44° 35' 00.00"N	124° 14' 30.00"W
NE:	44° 35' 02.75"N	124° 13' 06.17"W
SE:	44° 33' 02.75"N	124° 12' 58.51"W
SW:	44° 33' 00.00"N	124° 14' 22.41"W

Primary Project components include WECs, marker buoys, anchors and mooring systems, support buoys and instrumentation, subsea connectors and hubs, subsea transmission and auxiliary cables, and an utility connection and monitoring facility (UCMF) to transfer power to the grid. The WECs, support buoys, anchors and mooring systems, and subsea connectors and hubs would be located in the test berths. From the subsea connectors, the subsea cables would transmit medium voltage alternating current (AC) power and data from the PacWave South test berths to shore. Around the 10-m (33 ft)isobath (i.e., depth contour), each subsea cable would enter a dedicated conduit, installed by HDD, running to an onshore cable landing point, or beach manhole. Each of the five beach manholes would consist of an approximately 10 x 10 x 10 ft buried concrete splice vault. Within the beach manholes, the subsea cables would be connected to terrestrial cables, which would connect to an onshore UCMF. The cable conduits between the beach manholes and the UCMF would be installed by HDD. Cableconduits would also be buried by HDD from the UCMF, across the UCMF property to the grid connection point with the CLPUD overhead distribution line along Highway 101.

The area encompassing the 2 square nautical mile test site, subsea cable corridor, cable landing at Driftwood Beach State Recreation Site, terrestrial cable route, and onshore facilities are collectively referred to as the Project area in this APEA.

2.2.1 Project Facilities

2.2.1.1 Wave Energy Converters

WEC technology is expected to evolve over the duration of the Project’s FERC license and various types of WECs would be tested. To accommodate near-term and long-term industry needs, OSU surveyed and interviewed WEC technology developers to ascertain what types of WECs could be reasonably expected to be deployed at PacWave South, based on the location of the test site (e.g., water depth and wave resources) and present state of technology. Based on this research, the following WEC types are expected to be tested (singly or in arrays) at PacWave South (Figure 2-1):

- **Point absorbers:** floating or submerged structures with components at or near the ocean surface that capture energy from the motion of waves, which drives a generator. Point absorbers may be fully or partly submerged.

- **Attenuators:** structures that respond to the curvature of the waves rather than the wave height. These WECs may consist of a series of semi-submerged sections linked by hinged joints. As waves pass along the length of the WEC, the sections move relative to one another. The wave-induced motion of the sections is captured and used to drive a generator.
- **Oscillating water columns (OWC):** structures that are partially submerged and hollow (i.e., open to the sea below the water line), enclosing a column of air above the water. Waves cause the water under the device to rise and fall, which in turn compresses and decompresses the air column above. This air is forced in and out through a turbine, which usually has the ability to rotate regardless of the direction of the airflow (i.e., a bi-directional turbine).
- **Hybrids:** WEC types that use two or more of the above-listed technology types. For example, some WECs that are the relative size and shape of a point absorber may generate power through movements that resemble an attenuator. Another example is a class of WECs with moving masses that are internal to a hull with no external moving parts exposed to the ocean. An example of this technology is the Vertical Axis Pendulum, which consists of a structural hull that contains all moving parts; inside, a pendulum rotates and converts the kinetic energy of the ocean waves into electrical power.

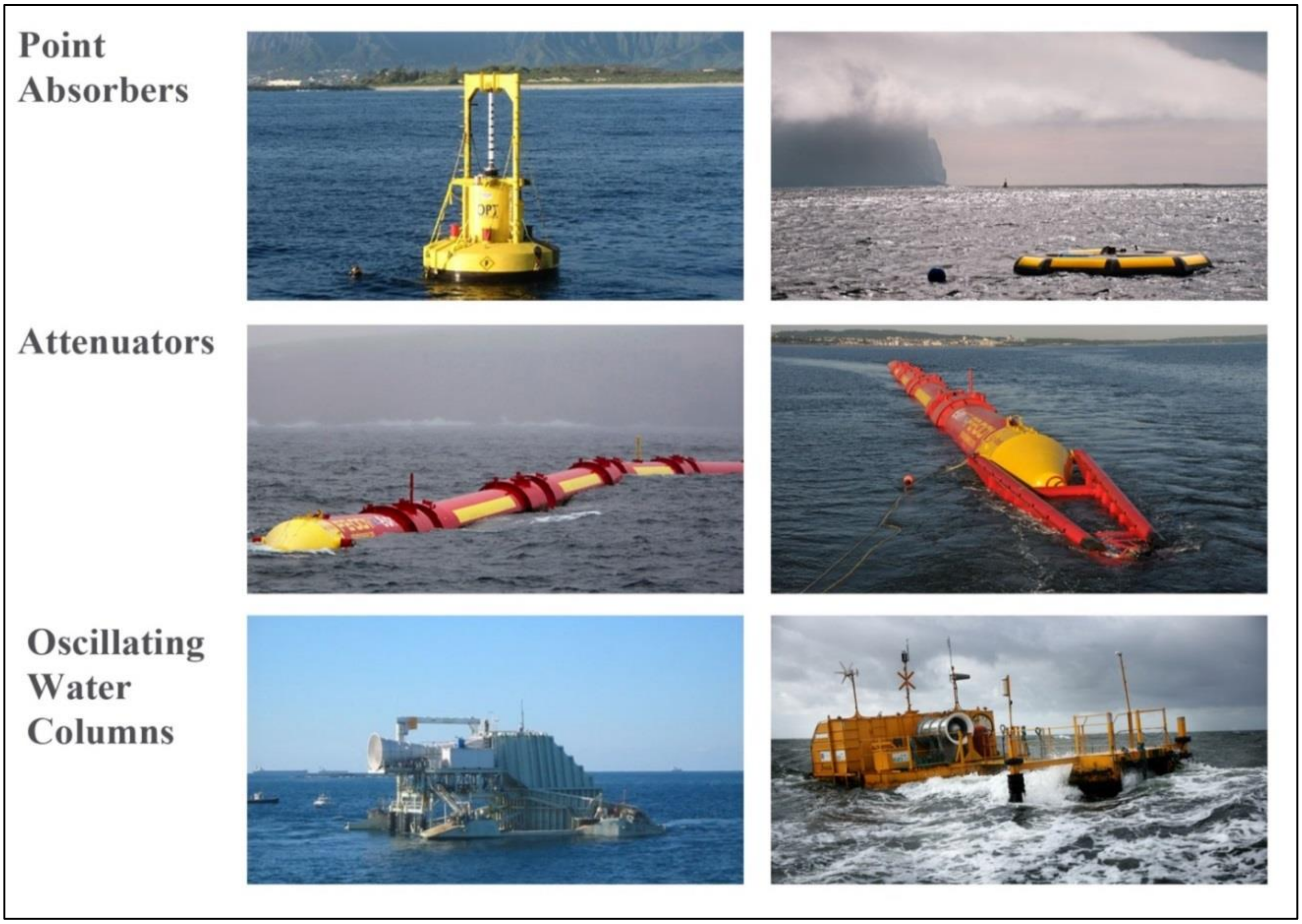

Figure 2-1. Examples of different types of WECs.

To allow for the testing of arrays of WECs, PacWave South could accommodate the deployment of up to 20 WECs (total) at one time. However, OSU expects that the number of WECs deployed at PacWave South would vary throughout the license term and that fewer WECs would likely be deployed in the initial years of operation (i.e., the first five years or so). To evaluate the true range of potential effects that the Project might have over a 25-year license term, this APEA evaluates both an initial development scenario and a full build out scenario, as follows:

- *Initial Development Scenario* (Figure 2-2) – 6 WECs consisting of:
    - Berth 1 = 1 point absorber;
    - Berth 2 = 1 OWC;
    - Berth 3 = 1 attenuator; and
    - Berth 4 = 3 point absorbers with shared anchors.
- *Full Build Out Scenario* (Figure 2-3) – 20 WECs consisting of:
    - Berth 1 = array of 5 point absorbers;
    - Berth 2 = array of 5 OWCs;

- Berth 3 = array of 5 point absorbers; and
- Berth 4 = array of 5 attenuators.

WECs would likely be deployed 50 to 200 m or more apart from each other within a berth[5] (Figures 2-4 and 2-5). PacWave South would have a maximum installed capacity of 20 MW. The rated capacity of individual WECs would vary, and preliminary estimates range from 150 kW to 2 MW per device. Based on these estimates, the installed capacity for the initial development scenario is expected to range from 750 kW to 10 MW, and the installed capacity for the full build out scenario is expected to range from 10 to 20 MW. Because the rated capacity of WECs would vary depending on the units installed for testing at the site at any given time, the average power output from PacWave South would also vary during the term of the FERC license. Accordingly, the characterization of power and generation produced by the proposed PacWave South Project would similarly vary with time, including the average capacity factor, availability, and value of installed capacity.

Supporting buoys and instrumentation would also be used to gather data on site conditions and support testing operations. This equipment would likely be similar to those previously deployed at OSU's nearby PacWave North[6] (formerly known as Pacific Marine Energy Center North Energy Test Site [PMEC-NETS]).

[5] The referenced distance refers to the separation of the WECs; the moorings may be located closer to each other.

[6] PacWave North is an existing wave energy test facility developed by OSU in 2012. The facility, which is north of the proposed PacWave South site, is not grid connected and is not part of the PacWave South license application.

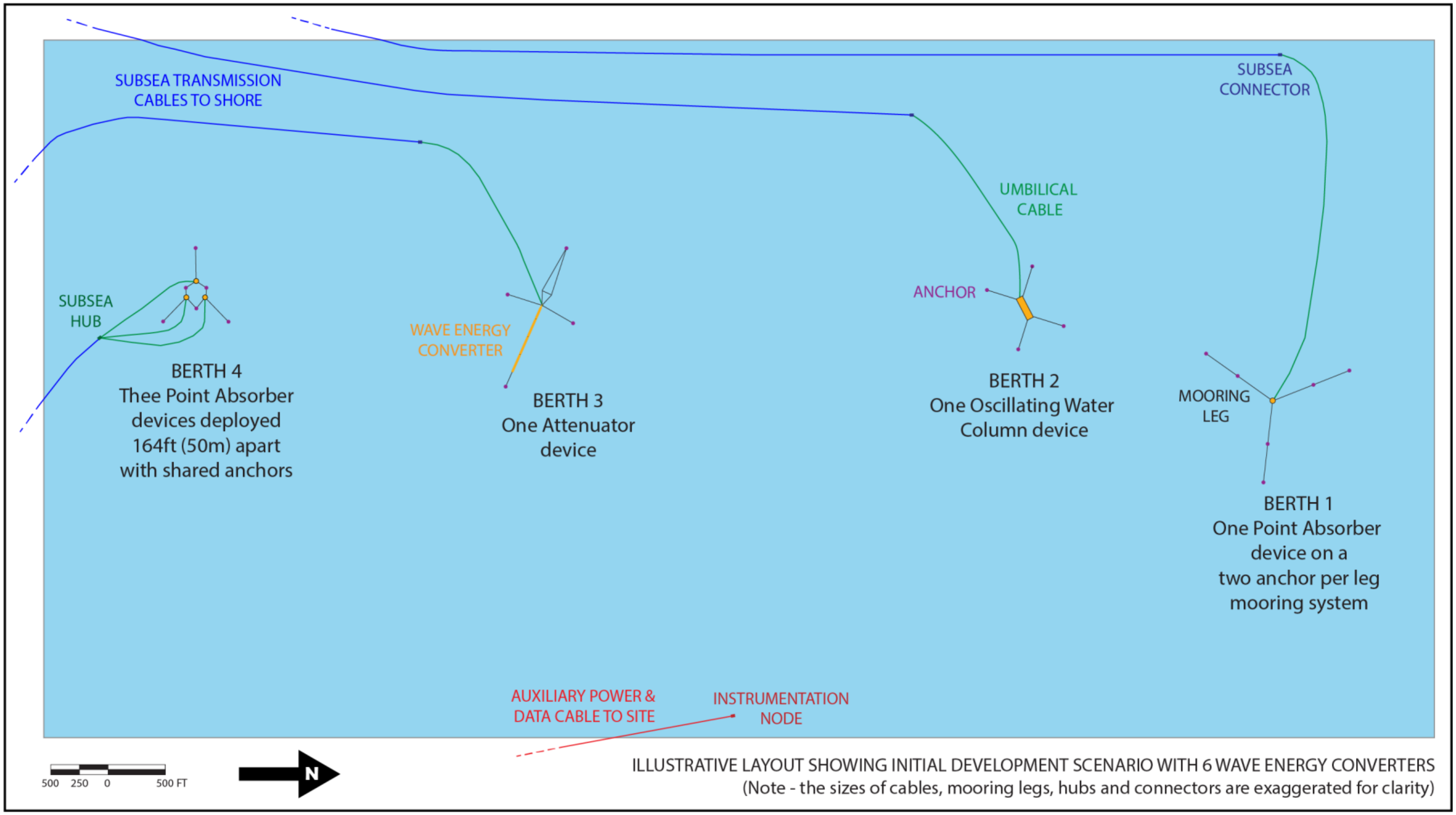

Figure 2-2. Illustrative test berth configuration for the initial development scenario. Note, actual deployment would vary.

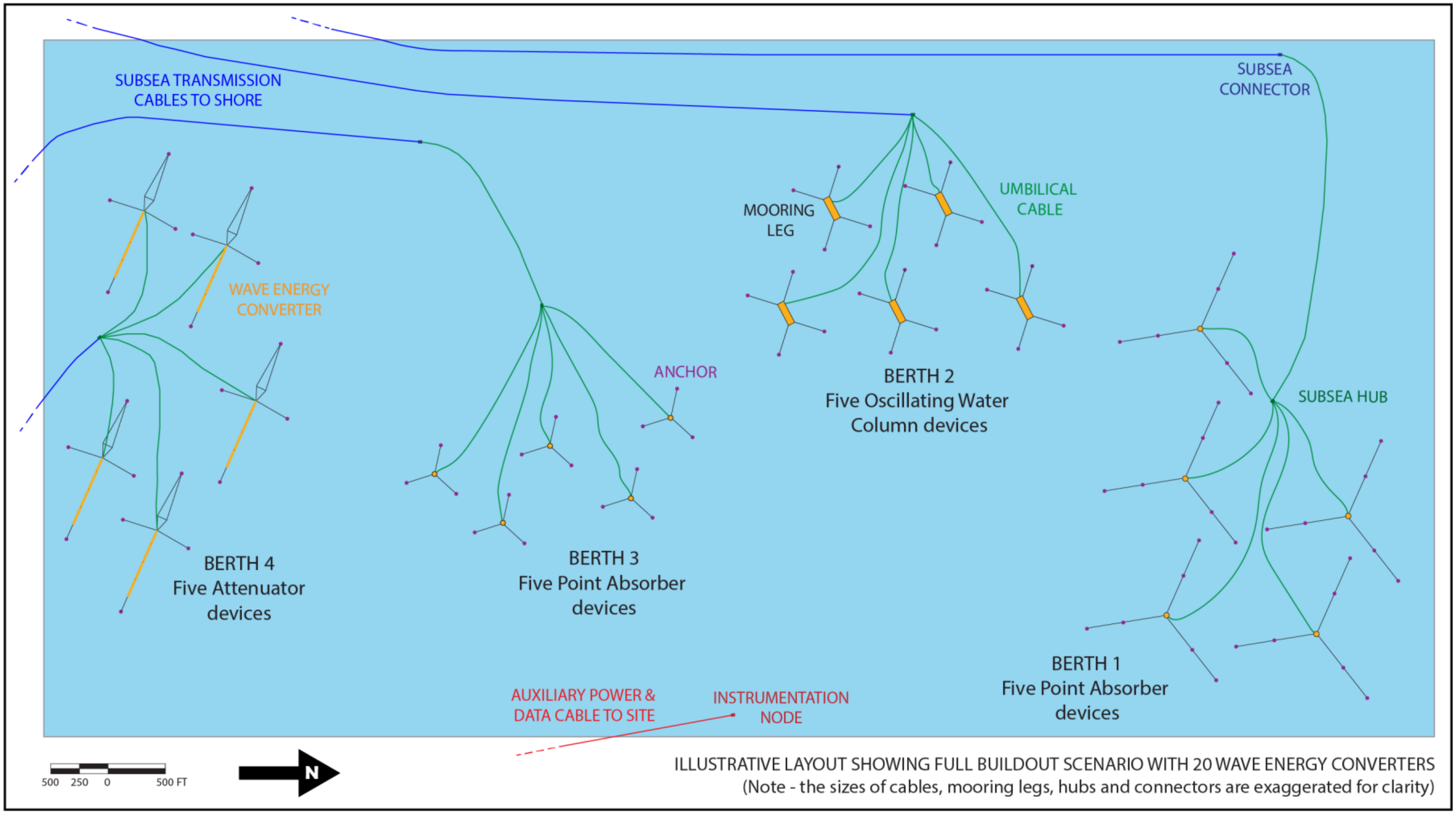

Figure 2-3. Illustrative test berth configuration for the full build out scenario. Note, actual deployment would vary.

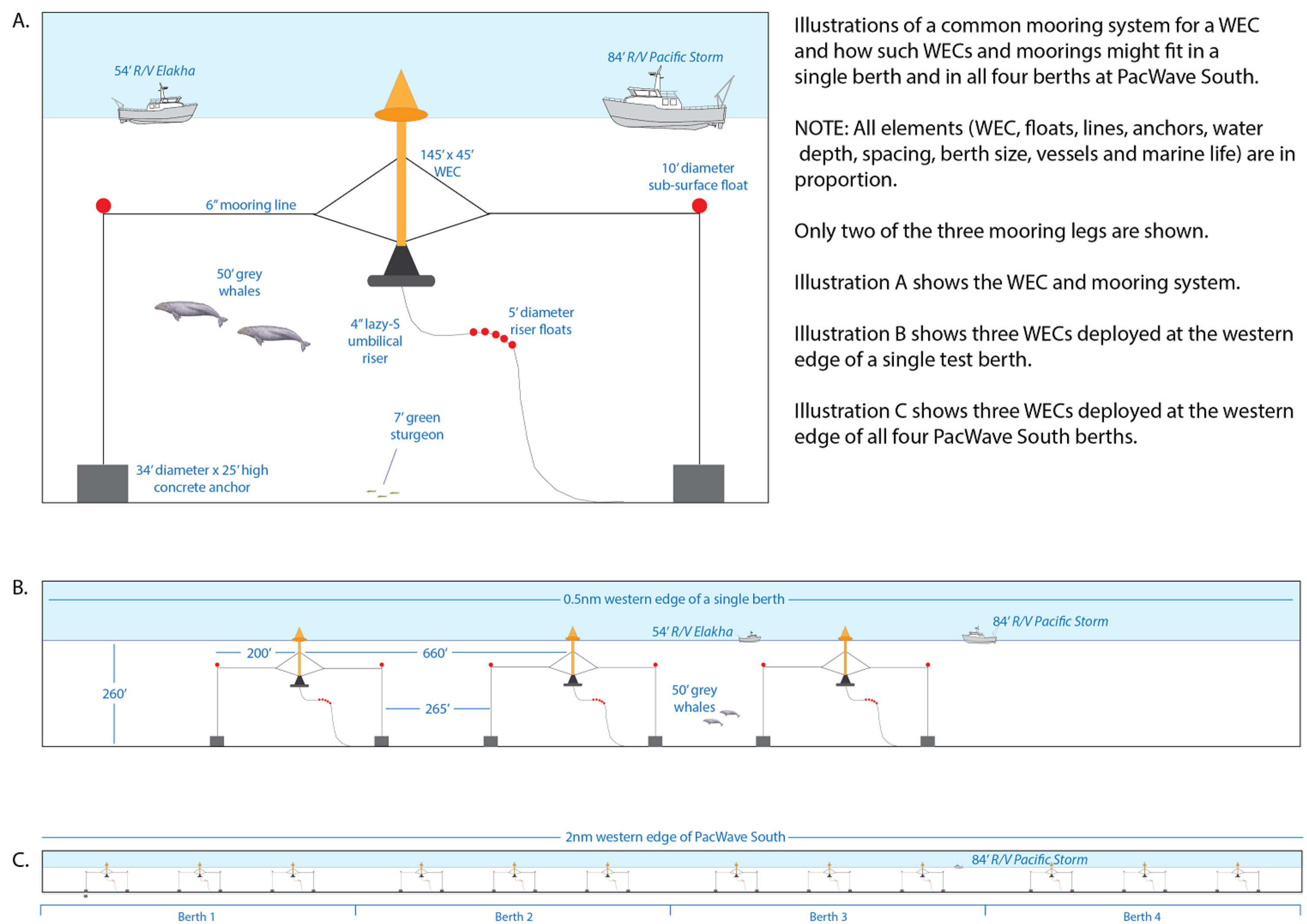

Figure 2-4. Scale drawing of WECs at 200 m spacing (660 ft).

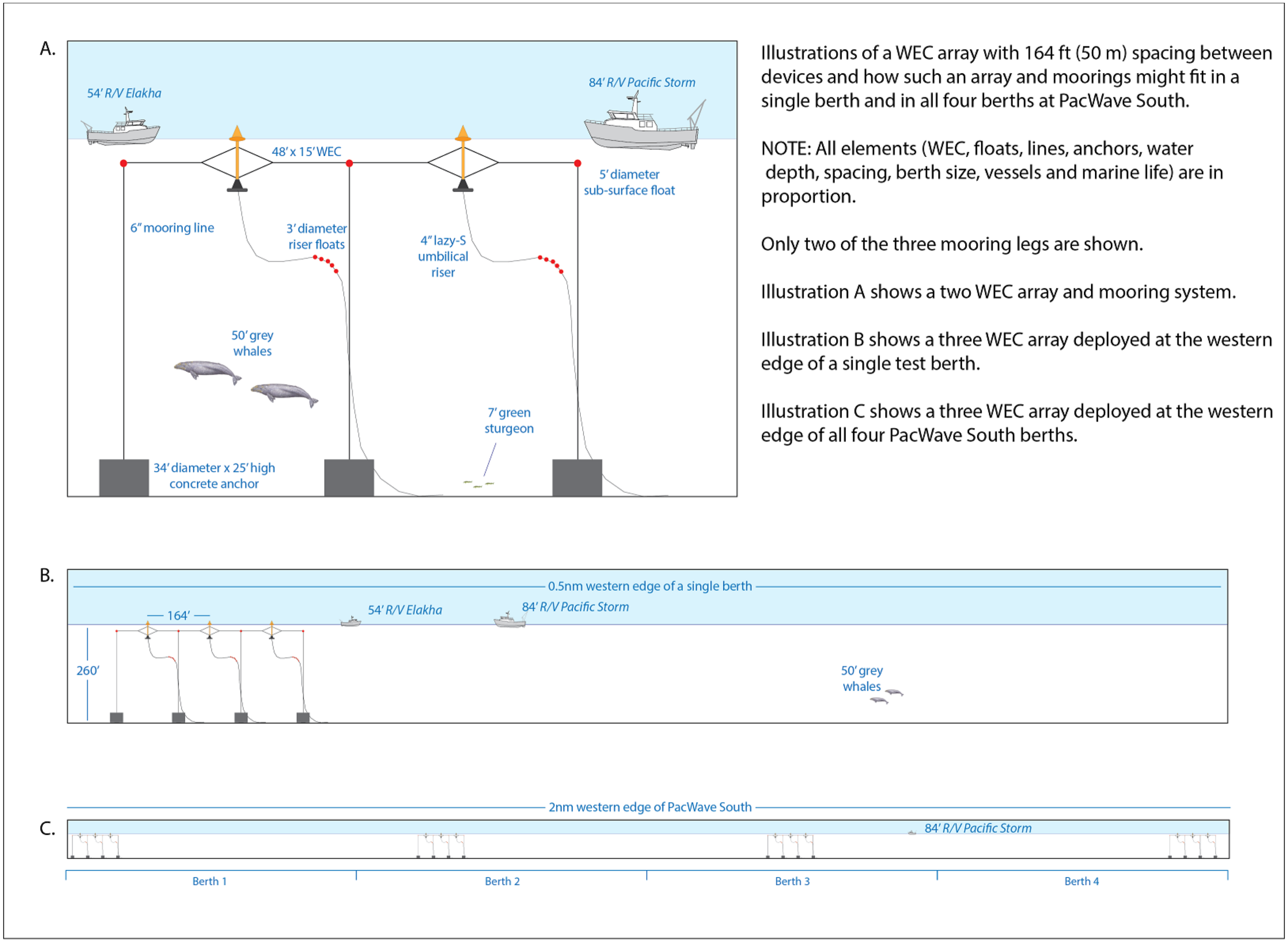

Figure 2-5. Scale drawing of WECs at 50 m spacing (164 ft).

2.2.1.2 Anchors and Mooring Systems

The specific anchor types and mooring configurations at PacWave South would vary based on the specific WECs being deployed. However, because the physical and environmental conditions within the test site are relatively uniform, the general types of anchoring and mooring systems would not vary substantially. Furthermore, the anchors and mooring systems used at PacWave South would be the same as, or similar to those commonly used for other applications in the marine environment. An OWET-funded report, titled *Advanced Anchoring and Mooring Studies*, describes common types and features of mooring systems (Sound & Sea Technology 2009).

Results of the OSU survey of WEC technology developers indicate that anchoring systems used at PacWave South would likely include gravity anchors, drag embedment anchors, suction anchors, and plate anchors (Figure 2-6). In some cases, a combination of anchor types might be used. The survey results also show that anchors would likely consist of steel, concrete, or a combination of the two.

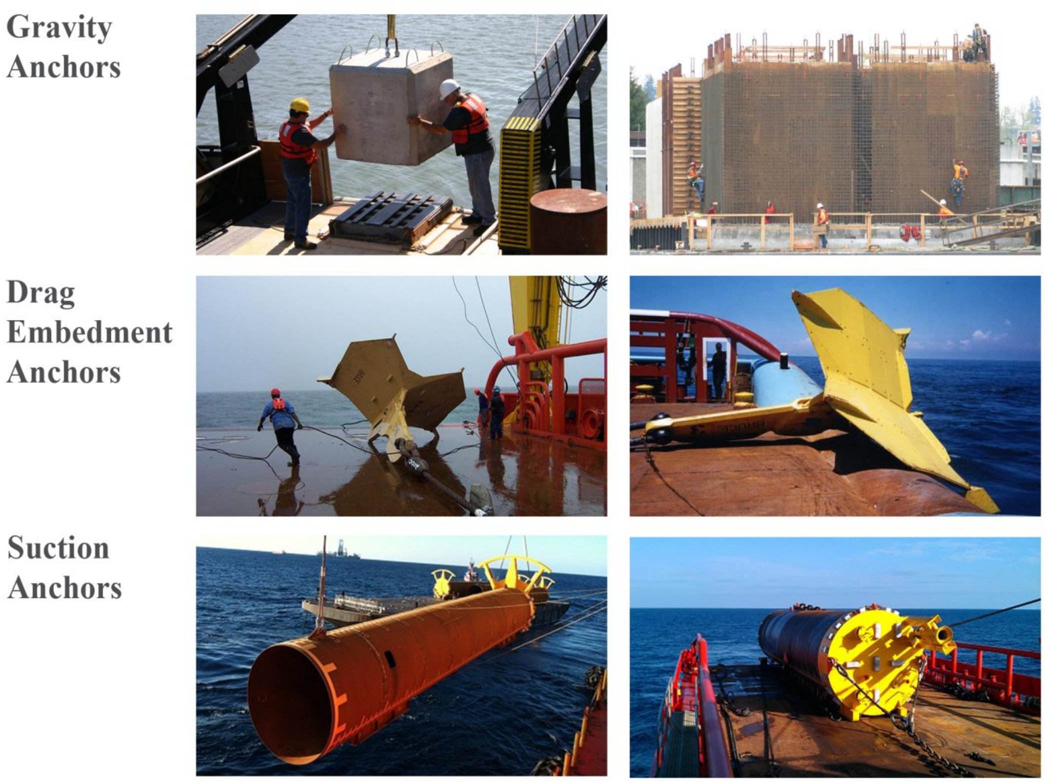

Figure 2-6. Examples of different anchor types.

The maximum estimated area covered by the anchors (i.e., the anchor footprint) under the initial and full build out scenarios are provided in Table 2-1. The estimates are based on exclusive use of 34-ft diameter cylindrical gravity anchors as these represent the largest anchors that might be expected to be used at PacWave South; however, other types of smaller anchors would likely be used for many of the WECs, and shared anchors may be used for some WECs when feasible. Therefore, the actual seafloor anchor footprint is expected to be considerably smaller than the estimates in Table 2-1.

Table 2-1. Estimated maximum anchor footprints for initial development and full build out scenarios by berth.

Scenario	WEC Type	No. WECs	Total No. Anchors	Maximum Seafloor Anchor Footprint (ft^2)*
Initial Development				
Berth 1	Point absorber	1	6	5,448
Berth 2	OWC	1	4	3,632
Berth 3	Attenuator	1	4	3,632
Berth 4	Point absorber with shared anchors	3	7	6,356
Maximum Total Anchor Footprint = **19,068 ft^2 (0.4 acres)**				
Full Build Out				
Berth 1	Point absorber	5	30	27,240
Berth 2	OWC	5	20	18,160
Berth 3	Point absorber	5	30	27,240
Berth 4	Attenuator	5	20	18,160
Maximum Total Anchor Footprint = **90,800 ft^2 (2 acres)**				

* Based on the total footprint of 34-ft-diameter gravity anchors (908 ft^2 per anchor), representing the largest possible footprint per anchor; other anchor types will have a considerably smaller footprint.

The OSU survey of WEC technology developers also asked developers about mooring systems, and analysis of the results shows that most WECs would use single- or three-point mooring systems (25 percent and 28 percent of responses, respectively). Mooring systems are generally classified by their configuration (e.g., single- or multi-leg) and components (i.e., anchors, buoys, and lines). As with anchor types, mooring lines would consist of types commonly used in the marine industry (e.g., chain, steel wire, or synthetic materials). Like the rest of the marine industry, WEC technologies use various combinations of these anchor types and mooring system components. Mooring infrastructure may also include buoys and/or subsurface floats. Although these components can be combined in various ways, there are only a few different component types (i.e., three common types of mooring line and four common types of anchor), as shown in Table 2-2.

Table 2-2. Standard mooring systems configurations and components.

CONFIGURATION	COMPONENTS		
A. Single Leg	**Anchors** (steel/concrete/both)	**Buoys**	**Lines**
B. Multi Leg	A. Gravity/deadweight	A. Steel	A. Chain
1. Three-point	B. Drag embedment	B. Composite	B. Wire rope
2. Four-point	C. Suction embedment	1. Surface	C. Synthetic
3. Five-point	D. Plate embedment	2. Subsurface	
4. Six-point			
i. Catenary			
ii. Taut			

Sample mooring and anchor specifications for different types of WECs are presented in Table 2-3.

Table 2-3. Illustrative WEC mooring and anchoring configurations.

	Point Absorber	**Point Absorber**	**Attenuator**	**Oscillating Water Column**
Mooring Configuration	Single leg	Multi-leg Catenary	Multi-leg Catenary	Multi-leg Taut
Approx. Water Depth (ft)	250	250	250	250
Line Length per Leg (ft)	~300	~600	~400	~350
Line Material	Chain & wire rope	Chain & synthetic rope	Chain & synthetic rope	Wire & synthetic rope
No. of Legs	1	3	4	4
No. of Anchors Per Leg	1	2	1	1
Anchor Type	Suction	Drag & gravity	Drag	Gravity
Anchor Sizes (ft)	DxH (Qty) 6x8 (1)	LxWxH (Qty) Drag: 12x13x8 (3) Gravity: 8x6x4 (3)	LxWxH (Qty) 16x18x11 (3) 22x24x15 (1)	DxH (Qty) 34x25 (4)
Anchor Material	Steel	Drag: Steel Gravity: Steel & concrete	Steel	Steel & concrete

*Note: D = Diameter; H = Height; L = Length; W = Width; (Qty) = number of anchors.

Anchor deployment and recovery would be infrequent. The OSU industry survey and OWET market analysis indicate that most developers plan to deploy WECs for multi-year test periods (e.g., 3-5 years), so anchors would likely also be deployed for multi-year periods. Furthermore, it is unlikely that anchor systems would be adjusted during a WEC test due to the high costs associated with installing and removing them. Therefore, disturbance due to anchor installation and removal operations within a berth should only occur occasionally (e.g., once a year, or perhaps only once every several years). Additionally, these activities rely on specific weather windows, so the timeframes within which anchor deployment and recovery operations could occur are limited. Finally, it is OSU's intent to reuse anchors wherever practicable. If an incoming WEC developer could use an anchor and/or mooring configuration that was already in place from a previous test, then the anchors could be left in place to limit seafloor disturbance.

2.2.1.3 Power Transmission and Grid Interconnection

Subsea Connectors

Power generated by WECs would be transferred via umbilical cables (also known as dynamic risers) to a subsea connector attached to the end of a subsea cable and located on the seafloor at each test berth; from there, electricity would be transmitted from the subsea connector via the subsea cable to shore. As the WECs will be on or near the surface, the umbilical cables will run from the WEC to the seafloor and will therefore be partially suspended in the water column. The common configuration for such umbilical cables is to attach subsurface floats to create a "lazy-S", which maintains tension but allows enough motion to prevent the umbilical from being damaged by WEC movements. There would be one umbilical cable per WEC. If a client were testing an array of WECs, or needed additional power conditioning or conversion support, the umbilicals would all connect to a client-supplied hub, which would then connect to the PacWave South subsea connector at that berth.

The final subsea connector choice will depend on a number of factors including the final cable specification. Subsea connectors are also an area of on-going research and development. However, one option is the GreenLink Inline Termination manufactured by MacArtney Underwater Technology (Figure 2-7). The connector has no external moving parts and can be dry, oil, gel or nitrogen filled as required. It is a "drymate" system, which requires the connector to be winched onto a vessel for a WEC to be connected or disconnected.

Using a system like this would allow test clients to easily connect their WECs to the subsea cables, monitor device performance, and export power to the grid via the onshore UCMF. Subsea connector systems such as this typically have built-in cathodic protection and are expected to operate for up to 25 years. The subsea connectors would be installed at the same time as the subsea cables to shore.

Figure 2-7. Example of subsea connector (MacArtney's GreenLink Inline Termination).

Subsea Cables

Four subsea transmission cables are planned, one for each of the four test berths. In addition, an auxiliary cable would also connect power to the site. The subsea transmission cables would transfer power back to shore and allow for the monitoring and control of WECs via fiber optic elements incorporated into the transmission cables themselves. The cable corridor dimensions and routing are described in further detail below.

The auxiliary cable would increase the monitoring capabilities at PacWave South. An auxiliary cable would allow for extended deployments of instruments or equipment with high data bandwidths or power requirements. Cabling instruments could also greatly reduce maintenance costs associated with some instrumentation (e.g., acoustic landers require battery replacements every few months) and increase the feasibility of real-time data. Field testing cutting edge technology and having real-time data for environmental and WEC monitoring will greatly enhance the PacWave South testing capabilities, and could potentially benefit other offshore projects and marine industries that require technological solutions.

OSU anticipates that the subsea transmission cables would be three-conductor, AC cables with a rated voltage of 35 kV, like the cable shown in Figure 2-8. At present, OSU is considering cables with either 70-mm^2 or 50-mm^2 copper conductors, which are slightly less than 4 inches in diameter and weigh between 7 and 8 pounds per foot.

The exact specifications for the subsea cables would be developed during final design. All the cables would use standard industrial shielding and armoring (e.g., galvanized steel wires), as illustrated in Figure 2-8. Electric fields from energized AC cable conductors are shielded effectively by metallic sheathing and armoring.

Figure 2-8. Example of medium-voltage subsea cable.

Within the Project site, the umbilical cables and a segment (approximately 300 m) of the subsea cables would remain unburied to allow for access during WEC deployment and removal, and maintenance activities (Figure 2-9); however, the majority of the subsea cable segment would, to the extent practicable, be buried to a target depth of 1 to 2 m from the offshore test site back to the HDD conduits. In areas where burial is not feasible (due to unsuitable seafloor conditions), the cables would be laid on the seafloor and protected by split pipe, concrete mattresses, or other cable protection systems. The subsea cables would enter HDD-installed conduits at approximately the 10 m isobath and continue to shore passing under the beach and dune system and into the parking lot at Driftwood Beach State Recreation Site (Figure 2-10). The industry best practice for minimum spacing between buried subsea cables is 1.5 times the water depth. The eastern edge of the Project site is in approximately 65 m of water, and the HDD conduits would be located in approximately 10 m of water. Accordingly, the minimum spacing between each cable at the edge of the Project site would be at least 100 m (i.e., 65 m x 1.5 = 97.5 m), and the minimum spacing between each cable at the HDD conduits would be approximately 15 m, resulting in a cable corridor that converges from at least 400 m at the offshore test site to a minimum of 60 m at the nearshore HDD conduits. As the seafloor does not shelve evenly, the cable corridor would not widen at a constant rate between the HDD conduits and the Project site (see Figure 2-9).

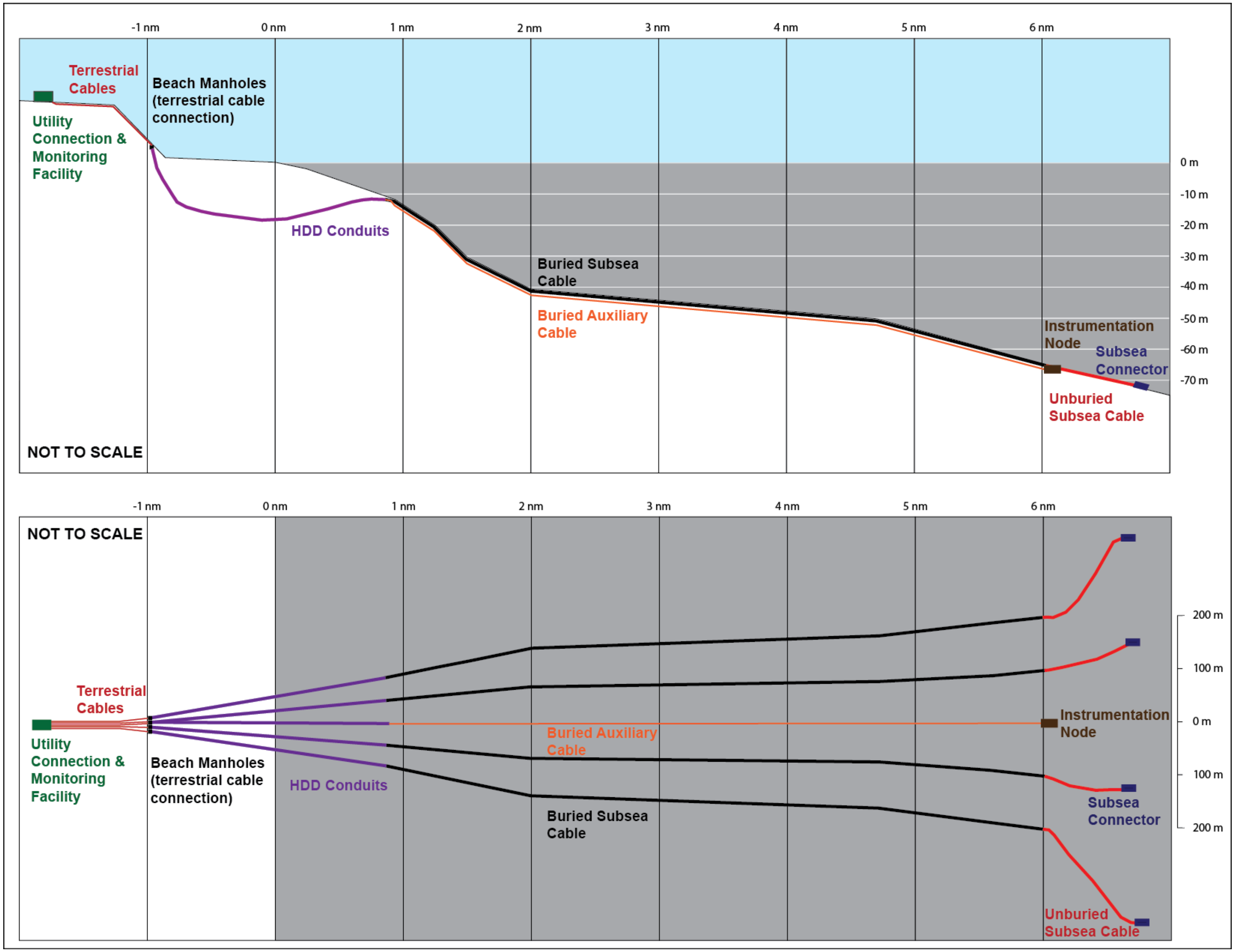

Figure 2-9. Subsea cables schematic. Note – these schematics are illustrative and are not to scale.

While a number of cable route corridor alternatives were evaluated, OSU has selected one cable corridor for the Project. The proposed corridor runs south of an area of rocky geology that extends along the coast to the north, and the cables would come ashore at Driftwood Beach State Recreation Site in Seal Rock (Figure 2-10). The subsea cables would be buried approximately 1 to 2 m below the seafloor to around the 10-m isobath using a jet plow or a similar technique. At the 10-m isobath the cables would enter the HDD conduits.

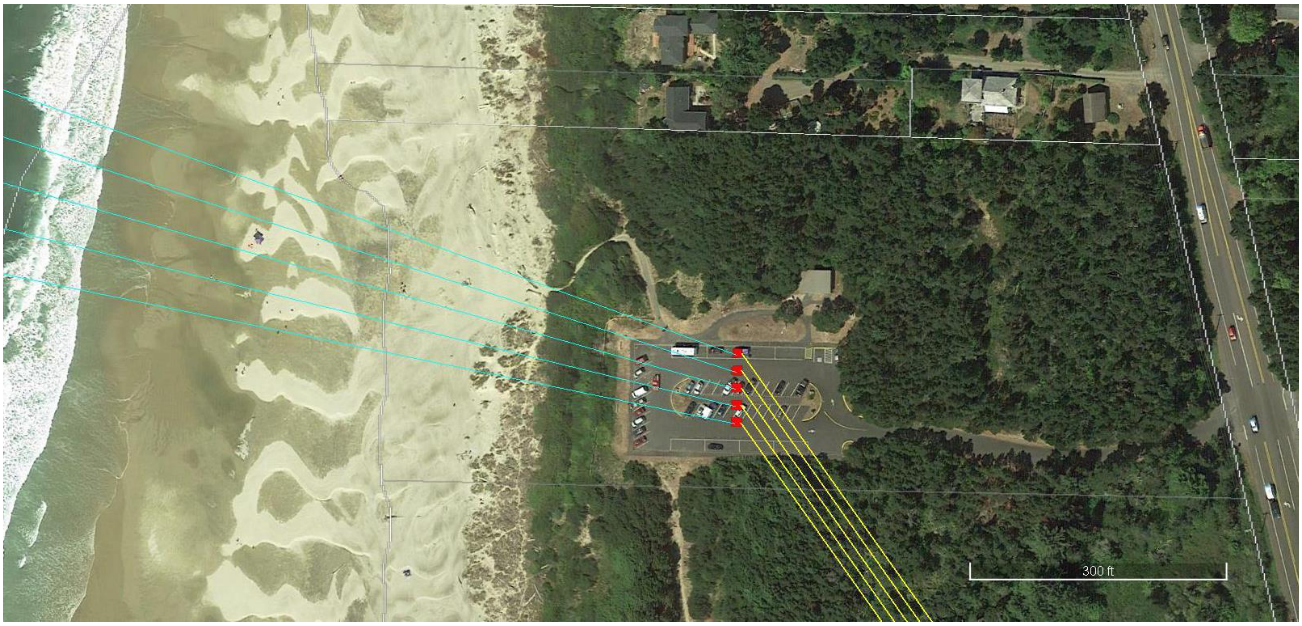

Figure 2-10. PacWave South landfall, Driftwood Beach State Recreation Site. Beach manholes are shown in red, the buried HDD conduits to the test site are shown in green, and the underground HDD conduits to the Utility Connection and Monitoring Facility are shown in yellow.

HDD would be used to install five separate conduits (for four subsea transmission cables and one auxiliary cable) from the Driftwood Beach State Recreation Site, approximately 50-100 ft, beneath the beach and dune system and, out to about the 10-m isobath, a distance of about 0.6 nautical miles (Figure 2-9). The four transmission cables and auxiliary cable would each run through separate HDD conduits to individual, onshore cable splice vaults, known as a beach manholes, where the subsea cables would transition to terrestrial cables. It is anticipated that there would be five beach manholes, which would be made of precast concrete. The buried concrete vaults would measure approximately 10 x 10 x 10 feet. Access to each beach manhole would be via a standard manhole cover, similar to those used to access underground utilities (sewer, power, and telephone). The proposed Project subsea cable route would be about 8.3 nautical miles, consisting of about 3.7 nautical miles located on the OCS, 4.0 miles in the Territorial Sea and 0.6 miles of HDD conduit nearshore zone.

Terrestrial Cables

From the beach manholes at the Driftwood Beach State Recreation Site, the cables would be installed in up to five HDD bores to the UCMF property. From the beach manholes, the cables would run to the southeast, under the southern portion of the Driftwood Beach State Recreation Site. The HDD cable conduits would then run under small sections of six private properties located on either side of Highway 101, and then to the OSU-owned UCMF parcel east of the highway. From the UCMF, additional conduits would also be buried by HDD west to, and under, Highway 101 to the grid connection point with the CLPUD overhead distribution lines along the road; for this part of the construction, the HDD rig would be set up on the UCMF property. The total distance of the terrestrial cables would be about 0.5 miles (Figure 1-2). The specifications of the terrestrial cables are dependent on the final subsea cable design and coordination with CLPUD to ensure compatibility with existing infrastructure. At this stage, OSU anticipates that the terrestrial transmission cables would either be three-conductor cables, such as the Okonite cable (Figure 2-11), or single-conductor terrestrial cables such as the Kerite cable (Figure 2-12). If three-conductor terrestrial cables are used, then one terrestrial cable would be needed for each subsea cable, plus the auxiliary (i.e., five terrestrial cables total). If single-conductor terrestrial cables are used, three terrestrial cables would be needed for each subsea cable (i.e., 15 terrestrial cables total).

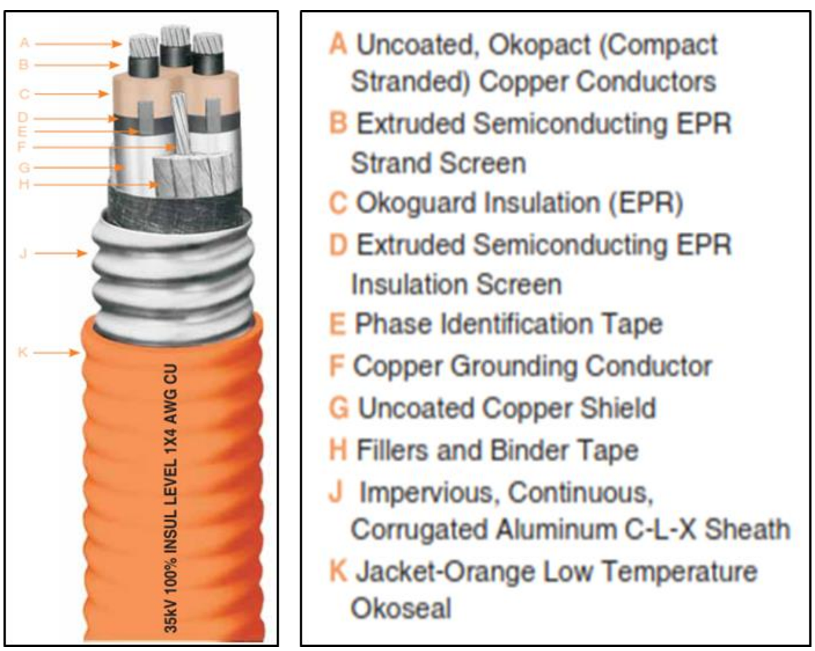

Figure 2-11. An example of an Okonite three-conductor terrestrial cable.

Depending on insulation type, the three-conductor cables are typically between 3.2 and 3.7 inches in diameter and weigh between 4.7 and 5.7 pounds per foot. The single conductor cables are between 1.4 and 1.6 inches in diameter and weigh between 0.9 and 1.5 pounds per foot. Due to the number, size, and weight of the cables, using the existing above-ground utility poles would not be feasible, and it would be necessary to bury the cables.

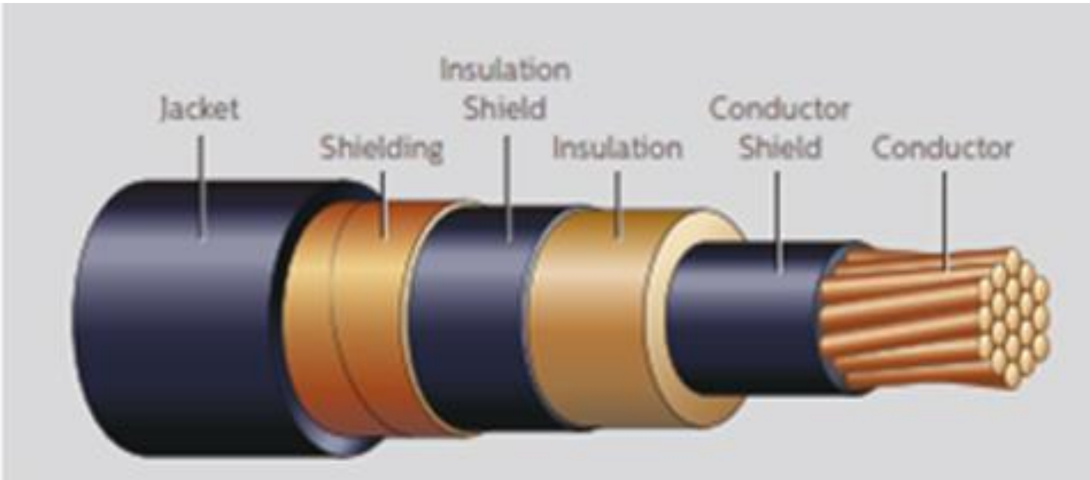

Figure 2-12. An example of a Kerite single-conductor terrestrial cable.

Utility Connection and Monitoring Facility

Power monitoring, conditioning, utility equipment and other electrical operations would be performed at the onshore UCMF, located on the OSU-owned property 0.3 miles south of Driftwood Beach State Recreation Site. The current plans for the UCMF include three, single-story buildings (Figure 1-2). One building would accommodate the conditioning and monitoring equipment for each of four potential test clients and would be approximately 11,250 ft^2. A second, 4,800 ft^2 building would include the PacWave South switch gear, utility equipment and general storage. The third building would be the Project's data, control, and communications center and would contain monitoring, communications, data storage, and supervisory control and data acquisition (SCADA) systems. The building would also contain operational support infrastructure such as restrooms and a maintenance/supply area. This building would be approximately 4,250 ft^2. The existing gravel lane (NW Wenger Lane) would be paved to accommodate semi-truck access to the UCMF. The improved road would be approximately 20 ft wide and 800 ft long and would run from Highway 101 to the UCMF compound. The UCMF compound would include the three buildings and a parking/laydown area large enough to allow truck access (approximately 80 feet by 200 ft). The entire area of the UCMF compound would be approximately 1.2 acres, and would be fenced and covered by security cameras and necessary lighting to meet building code standards.

The grid connection to CLPUD's distribution system would run from the UCMF to CLPUD's distribution lines on the west side of Highway 101. The proposed power line from the electrical meters at the UCMF to the grid connection on Highway 101 would be owned by OSU or owned and maintained by CLPUD, in which case OSU would negotiate the right to undertake any action required by FERC. All wire, conduit, transformers, meters, and other ancillary equipment needed to support the grid connection would be specified by CLPUD. OSU would be responsible for HDD installation of the conduits along the route, and CLPUD would then pull the wires through the conduits and complete the installation. It is expected that three 4-inch diameter conduits, and a bare copper ground wire would be required.

The CLPUD has existing telemetering capabilities at BPA's Toledo substation, which meet federal interconnection requirements. In addition, the CLPUD has experience installing and operating data and communications systems, including SCADA, ION metering, Distribution Automation, Smart Grid technologies, and other fiber optic communications. This expertise, along with the CLPUD's proven track record of operating a highly reliable system, would facilitate a successful test facility operation at PacWave South. A single line diagram showing each component of power transmission and grid interconnection is provided in Figure 2-13.

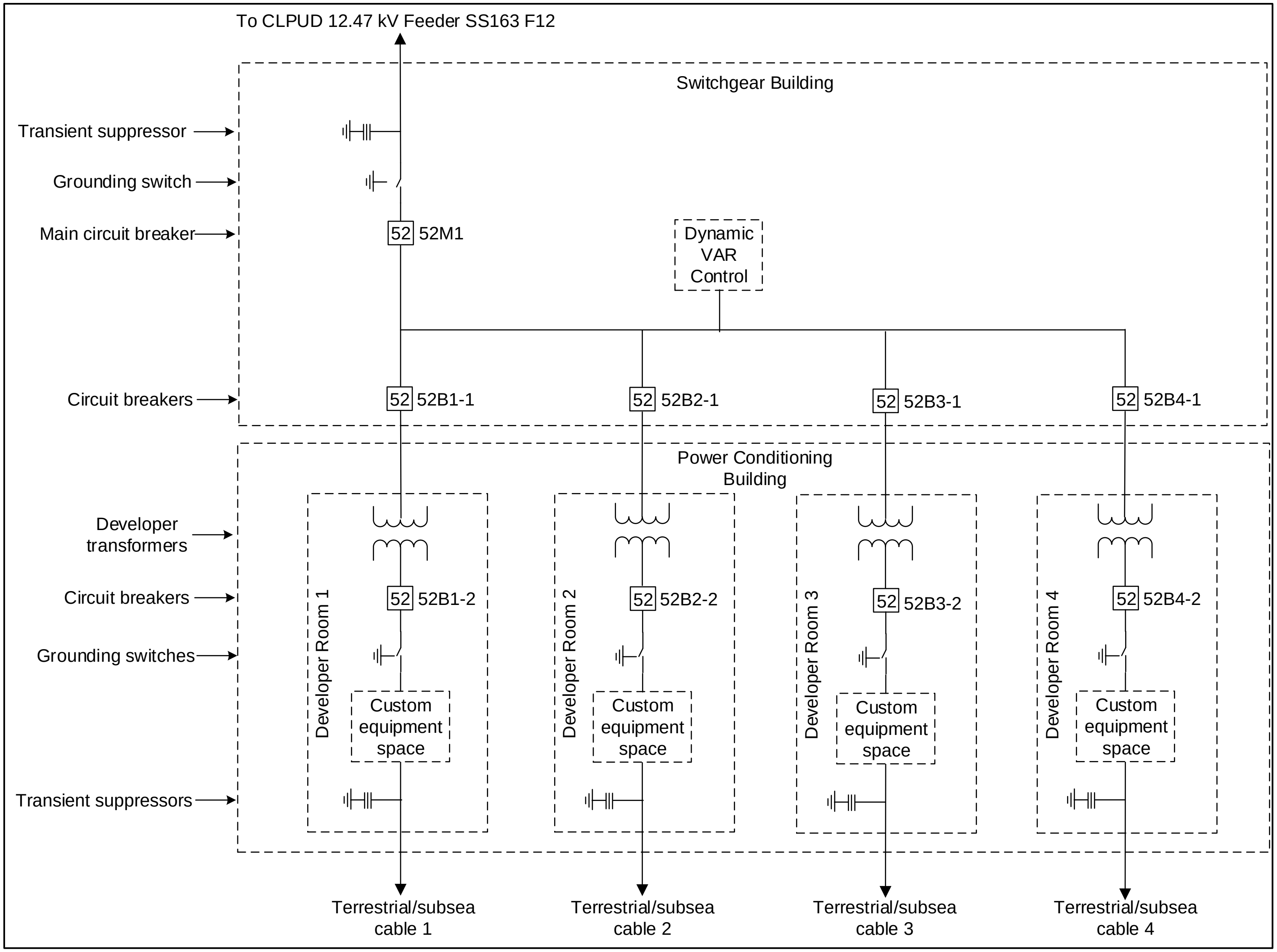

Figure 2-13. Single line diagram of PacWave South transmission.

OSU has worked with CLPUD to develop and submit an application for grid interconnection to BPA. The application submittal has placed PacWave South into the BPA project queue and OSU and BPA have completed a series of grid interconnection studies to help ensure that the proper design requirements are developed during the PacWave South design process. In addition to power transmission and grid-connection, OSU is also exploring power purchase options with the CLPUD. CLPUD has stated that there is sufficient grid capacity to accommodate the Project, but OSU would continue to coordinate with both CLPUD and BPA to determine whether grid upgrades would be necessary to achieve the planned 20 MW of generating capacity as the facility approaches maximum capacity. If grid upgrades are determined to be necessary in the future to directly accommodate the generating capacity of the Project, such upgrades may be subject to FERC approval and any required federal and state environmental review. OSU is seeking issuance of a 25-year FERC license with an authorized installed capacity of 20 MW license for the proposed PacWave South Project.

2.2.2 Project Safety

To limit the potential for vessel collisions with Project structures, OSU proposes to properly illuminate the WECs and Project structures and OSU will require WECs to be equipped with Automatic Identification System (AIS) equipment. The site boundaries would be clearly marked on National Oceanic and Atmospheric Administration (NOAA) navigation charts. OSU has been coordinating with the USCG and would implement any navigational measures required by the USCG (e.g., special designations, restrictions, notices, etc.).

Pursuant to the Spill Prevention, Control and Countermeasure (SPCC) regulations, facilities subject to the Environmental Protection Agency's (EPA) Oil Pollution Prevention Rule must prepare and implement a plan to prevent discharge of oil into or upon navigable waters of the United States or adjoining shorelines. However, the Project would not be subject to the SPCC regulations because it would not meet the threshold of having an aggregate above-ground storage capacity great than 1,320 gallons (in containers of 55 gallons or greater) [(40 CFR §112)]. Similarly, the Project would not meet the criteria for substantial harm requiring a Facility Response Plan. Although the Project would be below the SPCC or substantial harm criteria, OSU has developed and will implement an Emergency Response and Recovery Plan (Appendix G) that would include spill prevention and control measures. This plan would also include provisions for recording the types and amounts of hazardous fluids contained in Project structures and WECs to ensure that the necessary measures and procedures were in place to prevent and respond to accidental spills or leaks in the marine environment.

Additionally, OSU would require all vessels used for Project activities to be licensed, and have insured operators with the necessary spill prevention and response plans and would require WEC clients to adhere to waste management, hazardous material, and spill prevention protocols (as provided for in the Emergency Response and Recovery Plan). As part of the post-licensing compliance process, FERC would evaluate the adequacy of the Project facilities and safety measures. Commission staff would inspect the licensed Project both during and after construction. Inspections during construction would concentrate on adherence to Commission-approved plans and specifications, any special license articles relating to construction, and accepted engineering practices and procedures. Operational inspections would focus on the continued safety of the structures, efficiency and safety of operations, proper maintenance and compliance with the terms of the license.

2.2.3 Cable Installation, Test Site Operation, and Maintenance

As a grid-connected test facility, PacWave South would provide domestic and international developers, clients, utilities, economists, and scientists with the opportunity to:

- Optimize WECs and arrays to increase their energy capture, improve their survivability and reliability, and decrease their levelized cost of energy;
- Refine deployment, recovery, operations, and maintenance procedures;
- Collect interconnection and grid synchronization data; and
- Gather information about potential environmental effects, and economic and social benefits.

OSU would oversee each stage of testing: deployment; testing plans, protocols, and procedures; WEC performance monitoring; environmental monitoring; demobilization; and removal.

As noted, up to six WECs would likely be deployed during the initial development scenario and a maximum of 20 WECs would be deployed for the full build out, with a maximum total capacity of 20 MW. OSU expects that fewer WECs would be deployed at PacWave South during initial operations and this number would increase gradually as the industry advances. However, the number of WECs will fluctuate based on clients' needs.

Project components would be fabricated at land-based facilities prior to being installed at the test site. The primary staging areas for PacWave South would likely center around the Port of Newport, Toledo or other private facilities. The WECs, mooring and anchor systems, navigational buoys, and monitoring equipment, would be staged at mobilization sites for vessel transport to the Project site for installation. In addition, OSU would develop a Removal and Decommissioning Plan for the facility. OSU anticipates that this plan would be developed in the future as a license term nears its end and implemented when the overall Project is decommissioned.

As a test center, deployment and recovery of WECs, supporting infrastructure and instrumentation, and associated anchor and mooring systems would occur throughout the license term of the Project.

2.2.3.1 Power Transmission and Grid Interconnection

The subsea cables would be buried approximately 1 to 2 m below the seafloor to around the 10-m isobath using jet plowing or a similar technique. Jet plowing is a standard technique used for burying subsea cables. This technique uses a plowshare and high pressure water jets to fluidize a trench in the seafloor. Using a barge or a dynamically positioned cable ship and towed plow device, installers simultaneously lay and embed the subsea cables. Cable installation would take approximately 30 days for active installation of all five cables, assuming no weather delays, and 10 days for post-installation inspections. During cable installation a constant tension must be maintained to ensure the integrity of the cable. Each of the subsea cables will weigh between 175 to 275 tons (equivalent to 14 to 22 regular school buses) therefore any significant stoppage or loss of position during jet plow activities has the potential to result in significant damage to the cable. As with all cable laying operations, these activities at PacWave South will need to occur 24 hours a day until installation is completed.

The HDD from the shore out to approximately the 10-m isobath would likely be accomplished using a “drill and leave” technique where the drill pipe is left in place and becomes the cable conduit. This technique allows for installation of the conduits in a single pass and eliminates the need for successive reaming and conduit pullback. The HDD laydown area would be in the Driftwood Beach State Recreation Site and each bore would be spaced about 20 ft apart at the shoreside end. Drilling fluids, generally a mixture of bentonite clay and water, would be circulated through the drilling tools to lubricate the drill bit and conduits, and to remove drill cuttings. The HDD would be conducted per the requirements of an HDD Contingency Plan. Each HDD bore is expected to take up to one month to complete; the onshore cable landing installation will occur over a period of 6 to 8 months.

Each test berth at PacWave South would include a subsea connector that would rest on the seafloor. A surface buoy would likely mark the location of the subsea connector. The subsea connector would be hoisted onto the deck of an operations vessel (which could employ dynamic positioning), where it would be mated to the WEC umbilical cable or hub; based on experience at European Marine Energy Centre (EMEC), this may occur approximately once a year, but could occur as often as several times per year or as infrequently as once every 3 years or more (EMEC 2015). Once the connection is made, the mated umbilical cable and connector would be lowered to the seafloor. The final design process would provide a comprehensive set of engineering and operational requirements that minimize risks to equipment and personnel, as well as provide equipment and vessel requirements for installation and maintenance of the subsea connectors and cables.

As noted above, the terrestrial cables will be installed using up to five HDD bores from the Driftwood Beach State Recreation Site parking lot directly to the UCMF property on the east side of Highway 101. From the UCMF, conduits would also be buried west out to, and under, Highway 101 to the grid connection point with the CLPUD overhead distribution line adjacent to the highway; HDD would also be used for this operation, with the HDD rig set up on the UCMF property.

The planned start date for construction at the Driftwood Beach State Recreation Site (Phase I - HDD operations and beach manhole and conduit installation) is spring 2020. A second phase (Phase II - cable pull/installation) would likely occur in spring 2021. Phase I would last approximately 6-8 months and Phase II would last approximately 45-60 days. It is anticipated the Driftwood Beach State Recreation Site would need to be closed to vehicular traffic during both phases. It may be possible to maintain limited pedestrian access during construction; however, OSU would need to work with OPRD to determine the feasibility of maintaining such access while ensuring public safety.

2.2.3.2 Anchors and Mooring Systems

Installation of anchors and mooring systems would occur prior to WEC deployment. Anchors would be deployed and recovered by a vessel(s) with adequate assets and load-handling capabilities. For example, smaller anchors and mooring systems could be installed using a vessel such as OSU's 82-ft, 510-horsepower (hp) *R/V Pacific Storm*. Larger anchors or more complex mooring systems would likely require tug boats and multi-purpose, offshore work vessels. OSU previously chartered the 159-ft, 486-ton, *NRC Quest* for operations at PacWave North. The *Quest* was equipped with a 122- by 28-ft stern deck, a 22-ton deck crane, and two Manitowoc 390 double drum winches with 10,000 ft of 1.25-inch wire rope. Similar type vessels are stationed in Oregon and Washington ports, and these are expected to be available for Project needs. While the number of vessels needed for anchor installation or removal would depend on the number and size of anchors being deployed, these activities typically require two to four vessels (specialized work vessels, tugs, barges, and smaller crafts).

Based on OSU's experience at the nearby PacWave North, it is anticipated that it could take up to seven days to install the mooring system for a single WEC, and an additional one to two days to connect the WEC to the mooring. If an array was installed, which consisted of a number of WECs on individual mooring systems, this process would need to be repeated for each device. This time would not necessarily be continuous as weather could delay the start-to-finish completion, however, actual at-sea activities would not be expected to take more than nine days to install one mooring system and WEC. Although it is uncertain, it is possible that WEC and mooring system turnover could affect two berths per year.

Once the anchors arrived at the test site, the installation vessels would be positioned over preselected anchor locations. These locations would be selected based on the WEC mooring system design and engineering analysis of the sea floor characteristics. For drag embedment anchors, a second anchor handling vessel would likely be required to deploy and set the anchors.

A drag anchor resembles an "inverted kite". These are installed by positioning the anchor orientation at the seafloor and then tensioning the mooring line using a vessel. During the tensioning, the flukes penetrate the seafloor, and as tension increases, the anchor embeds itself to deeper depths (DOE 2011). Drag anchors are commonly used and are relatively easy to install. Large size and capacity anchors are available for both sandy seafloor conditions, as well as mud/soft clay (Sound & Sea Technology 2009).

Sound & Sea Technology (2009) noted that "Suction piles are a relatively new type of pile system; however their use has been growing steadily in the offshore industry particularly for soft soil in deep water. They are also effective in normal sand seafloors but are not appropriate for hard bottom conditions." For deployment of suction anchors, a floating crane is used to lift and lower the caissons to the sea floor, and suction equipment, a remotely operated vehicle (ROV), control cabin, and launch cradle are also frequently needed (DOE 2011). An important feature of suction piles is their ability to be extracted and recovered by reversing the pump to apply pressure inside the pile (Sound & Sea Technology 2009). An advantage of suction piles is that they are installed using a submerged pump, which produces low levels of sound (further described in Section 3.3.3.2) (Laurinollo et al. 2005).

Sound & Sea Technology (2009) further describes installation of suction piles:

> During installation, the suction caisson acts as an inverted bucket. Initial penetration of the suction caisson into the seabed occurs due to the self weight; subsequent penetration is by the "suction" created by pumping water out from the inside of the caisson. The installation method involves applying a pressure differential.
>
> The rim of the inverted bucket seals with the seafloor, and then water is pumped out of the upper end of the enclosed volume. This produces a net downward pressure, or suction, forcing the bucket into the seabed. In clays, the pressure is sufficient to bring the suction caisson to a substantial depth. In sands, water inflow reduces the effective stresses in the sand near the bucket rim, allowing the bucket to penetrate the seafloor. Once installed to sufficient

> depth, the pumps are removed and the valves are sealed, with the sand quickly regaining its bearing capacity. Suction caissons can easily be removed by reattaching the pumps and pumping water back into the bucket cavity, forcing it out of the seabed.

Gravity anchors are heavy objects placed on the seafloor that resist vertical and lateral loading. They are typically made of concrete and/or steel, and are placed directly on the seafloor (Sound & Sea Technology 2009, DOE 2011).

Most anchors would likely be retrieved by winching the anchor up to the surface and onto a vessel (using the mooring system itself or a recovery line). Recovery lines may be installed at the time of deployment and activated by acoustic releases when retrieval is underway, or may be attached to the anchor at the time of recovery using an ROV. Removal of embedment anchors is achieved by pulling the mooring line in a perpendicular direction to lift the anchor out of the sediment along the reverse of its initial traverse (DOE 2011). For removal of suction anchors, water would be pumped into the anchor chamber, creating positive pressure, and the mooring line pulled up raising the caisson from the sediment. Once the anchor is free of the seafloor, it would be raised to the deck of the vessel and brought to shore (DOE 2011). For removal of gravity anchors, the anchor would be raised from the seafloor and hoisted on board a vessel, or remain suspended from the vessel and be transported to a port or sheltered location on a route chosen to ensure it did not come in contact with the sea floor during transit. The anchor would then be recovered by shoreside crane or an inshore crane vessel (DOE 2011).

As noted previously, anchor deployment periods would align with WEC test durations, so they would likely be in place for 3-5 years at a time. Anchors could be in place up to 25 years if the anchors are to be used for multiple WEC tests throughout the Project life. Marker buoys may be installed between WEC deployments if anchors are not removed at the same time as the WECs. Although anchor deployment and recovery would occur periodically over the duration of the Project, OSU intends to limit the frequency of anchor deployment and recovery to the extent possible. These activities rely on specific weather windows, so the timeframes within which anchor installation or removal could occur are limited. Additionally, most clients will likely plan to deploy WECs for multi-year test periods, and it is unlikely that anchor systems would be adjusted or replaced during a WEC test due to the high costs associated with installing and removing them. Finally, OSU would aim to reuse anchors wherever possible.

2.2.3.3 WECs

Once the anchors and mooring systems are in place, the WECs would be deployed singly or in arrays. Results of the OSU industry survey and the OWET market analysis show that average deployment timeframes are likely to range from one to five years; the market analysis also indicates that five-year deployment periods are most likely during the initial stage of Project operations. OSU anticipates that most WECs would be transported by truck, barge, or marine tow transport to Newport for deployment. Acquisition of applicable permits required for shipment would be the responsibility of the test client. If a WEC were transported from a foreign location, it would require proper permits and licenses to enter the United States, which would also be the responsibility of the test client.

In general, WECs would be towed or barged to the site, configured, and attached to the mooring system. In most cases, two or three vessels would be needed to deploy a WEC, although some are designed to be deployed using a single vessel. Examples of vessels that might be used for such operations are OSU's *R/V Pacific Storm* and tug boats such as the 38-foot, 465-hp *Thea Knutson,* operated by Wiggins Tow & Barge. Larger, 3,000 to 8,000-hp, ocean-going tugs are located in Coos Bay and Astoria. Once the WEC is attached to its mooring system, it is anticipated that an umbilical cable would be attached to the WEC to connect it to the subsea connector, possibly through a developer-supplied hub. Connecting to the subsea connector would likely require that the connector be winched up onto the deck of a vessel with sufficient lift capacity. Therefore, if a test berth had five WECs, there would be five umbilical cables connecting to the developer-supplied hub, and the hub would be connected to the subsea connector. Test-specific deployment procedures would be developed to address each WEC deployment and subsea connection. OSU anticipates that it would take one to two days to deploy a single WEC and up to seven days to deploy a small array of WECs. Like anchor deployment, these operations would not necessarily be continuous because weather could delay the start-to-finish timeframe completion or postpone certain activities.

When a test is complete, the WEC would be de-energized and a suitable vessel would be used to disconnect the umbilical cable. With the umbilical cable detached, the WEC would be removed from the test site. If any materials are to be disposed of after the testing period, OSU would require test clients to dispose of these at permitted facilities in accordance with federal, state, and local environmental control regulations.

2.2.3.4 Estuarine Activities

As noted, Project components would be fabricated at land-based facilities prior to being installed at the test site. The primary staging area for PacWave South will likely be centered on the Port of Newport.

The natural harbor of Yaquina Bay provides a protected haven for commercial fishing vessels, and the Port provides a number of support facilities for the local fleet and the locally-based distant water fleet (commercial fishing boats that spend much of the year in waters off the coast of Alaska), including moorage, space for suppliers and services, fuel, and other essentials.

The Port also leases space to seafood processors (FCS Group 2014). The North Shore Development Area of the Port is Newport's working waterfront, which includes a 214-slip marina that is used primarily by commercial fishers and the Newport-based distant water fleet (Port of Newport 2013). In addition to these and other amenities, there is over 240 ft of floating moorage for boat maintenance, and a 220-ft fixed moorage that contains four hoists of varying capacities, enabling vessels to perform gear changes, off-load fish product, and do other maintenance or repair work (Port of Newport 2013). In 2000, the most recent year for which data were available, 393 commercially registered vessels (residents and non-residents) delivered landings to Newport (NOAA 2007).

The subsea cables, WECs, mooring and anchor systems, navigational buoys, and monitoring equipment, would likely be transferred from other locations to Newport, Toledo or other nearby ports for mobilization and transfer to PacWave South. Project components, other than WECs and subsea cables, are expected to be staged on land for the installation vessels to pick up and transport to the Project site.

The primary Yaquina Bay estuarine activities would be the following:

- Berthing one or more WECs dockside in Newport prior to being towed to PacWave South.
- Vessel traffic in and out of Yaquina Bay to transport WECs, anchors, and other Project components, as well as operations and maintenance (O&M) and environmental monitoring crews.

Project-related vessels would stay within navigation channels and specifically designated areas for vessel use in Yaquina Bay. Test clients would use marine industrial facilities that have been and continue to be dredged to a sufficient depth. For example, the International Terminal is dredged to 33 ft.

2.2.4 Proposed Environmental Measures

OSU has committed to incorporating the following measures for the construction and operation of PacWave South to facilitate the safe and compliant deployment of WECs, and to minimize impacts on the environment. This is a summary of the proposed measures; more detailed descriptions of these requirements can be found in relevant appendices. These measures have been developed in coordination with agencies and stakeholders and the basis for their incorporation are further discussed in the Environmental Analysis (Section 3.0).

General

- Implement the Adaptive Management Framework (Appendix J) in conjunction with specific PM&E measures to evaluate study results, identify any Project effects, and implement and/or modify response actions (Appendix I) in consultation with key agency stakeholders.
- Beginning five years and six months after deployment of the first WEC at the Project, and recurring every five years thereafter, the licensee shall file with FERC a Five-Year Report and provide copies to BOEM, NMFS, FWS, and ODFW. Contents of the report are further described in Appendix I, Protection, Mitigation, and Enhancement Measures.
- Employ periodic, routine inspection and maintenance methods to ensure structural integrity of Project components (Appendix F, Operation and Maintenance Plan).
- Develop and implement the Emergency Response and Recovery Plan (Appendix G).

Geologic and Soil Resources

- Use HDD to install the cables under the nearshore and intertidal habitat (to approximately the 10-m isobath) to minimize substrate disturbance.
- Use HDD to install the terrestrial cables in a up to five bores, from the beach manholes at the Driftwood Beach State Recreation Site to the UCMF property to minimize habitat and substrate disturbance. The cable conduits from the UCMF to the Highway 101 grid connection point will also be installed using HDD.
- Follow best practices during installation, operation, and removal activities to avoid or minimize potential effects to sediment, including:
    - Minimize the time that the seafloor is disturbed and sediment is dispersed and the associated effects by completing cable laying and other construction activities during appropriate construction windows and within one construction season to the extent practicable.
    - Develop and implement an Erosion and Sediment Control Plan, where appropriate, to minimize effects of ground disturbing activities associated with installation of the terrestrial cables and/or other terrestrial construction.
- Implement the Benthic Sediments Monitoring Plan (Appendix H) to evaluate effects on benthic habitat from anchors, WECs, and other equipment during operation, maintenance and monitoring activities. Based on monitoring results, implement the specified measures to mitigate for potential adverse effects (Appendix I).
- Project components in the estuarine environment should not bottom out so as to prevent nearshore/estuarine habitat effects.
- To the extent possible, minimize frequency of anchor installation/removal cycles and reuse installed anchors.

Water Resources

- Follow industry best practices and guidelines[7] for antifouling applications (e.g., TBT-free) on Project structures such as marker buoys, subsurface floats and WECs.
- Develop and implement an Emergency Response and Recovery Plan (Appendix G) with spill prevention, response actions, and control protocols, as well as and provisions for recording types and amounts of hazardous fluids contained in WECs and other Project components.
- Require all vessel operators to comply with an Emergency Response and Recovery Plan (Appendix G) for installation and maintenance of Project facilities.
- Prepare waste management, hazardous material, and spill prevention plans, as appropriate, for onshore Project facilities.
- Minimize storage and staging of WECs outside of existing dock, port or other marine industrial facilities.
- Require that all Project chartered or contracted vessels comply with current federal and state laws and regulations regarding aquatic invasive species management.
- Develop and implement an HDD Contingency Plan to minimize the potential for inadvertent return of drilling fluids, provide timely detection, and address potential releases by describing monitoring, containment, response and notification procedures to be implemented by the contractor.

Aquatic Resources and Threatened and Endangered Species

General

- Bury subsea cables at a depth of 1 to 2 meters, to the maximum extent practicable, to minimize the amount of habitat conversion (soft bottom to hard structure) from laying exposed cable on the seafloor. In areas where a cable cannot be buried or persistently becomes unburied, that portion of the cable will be on the seafloor and will be protected by split pipe, concrete mattresses or other cable protection systems.
- To the maximum extent practicable, utilize shielding on subsea cables, umbilicals, and other electrical infrastructure to minimize EMF emissions.

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[7] Industry standards are sometimes published in written documents (e.g., the International Cable Protection Committee's cable recommendations available at https://www.iscpc.org/publications/recommendations/) or in manufacturer guidelines (e.g., for a vessel anchor, providing the recommended ratio of water depth to anchor line paid out). These standards are sometimes required as a condition of insurance or warranty. In other cases, industry standards represent unpublished best practices commonly implemented by a particular industry and that evolve over time.

- Implement the EMF Monitoring Plan (Appendix H) to measure Project-related EMF emissions. Based on monitoring results, implement the specified measures to mitigate for potential adverse effects (Appendix I).
- In the event of an emergency in which fish or wildlife are being killed, harmed or endangered by Project facilities or operations in a manner that was not anticipated, OSU will notify agencies with regulatory authority as soon as possible and take action to promptly minimize the impacts of the emergency, including implementing any guidance pursuant to agency legal authorities, as outlined in Appendix I.

Fish and Invertebrates

- Implement the Organism Interactions Monitoring Plan to track changes to pelagic and demersal fish and invertebrates (particularly Dungeness crab) that might be attracted to the installed components or affected due to the potential for reduced fishing pressure, as well as biofouling on the anchors/WECs (Appendix H).
- Develop cable routes that avoid crossing areas with rocky reef and hard substrate to the maximum extent practicable to protect sensitive habitat features.
- Develop and implement an anchoring plan or protocol for any Project vessels that may anchor at the Project site, that:
    - Avoids anchoring in known rocky reef or hard substrate habitats to the maximum extent practicable; and
    - Minimizes the use of anchors within the Project area wherever practicable by combining onsite activities.

Marine Mammals

- Entangled fishing gear
    - Conduct opportunistic visual observations from the water surface in the portions of the test site which are being visited to conduct operations, maintenance, or environmental monitoring work and review any underwater visual monitoring conducted for other purposes to detect entangled fishing gear that has the potential to increase the risk of marine species entanglement. The licensee will ensure that surface observations occur during all visits to the Project test site, and at least once per quarter each year for the duration of the license.
    - Annually following the peak storm season and period of maximum activity for the Dungeness crab fishery, the licensee shall conduct surface surveys of active WEC berths during the spring season (mid-March through mid-June), or the earliest possible time after that period that avoids jeopardizing human safety, property or the environment.
    - Conduct annual subsurface surveys of moorings and anchor systems using ROV

or other appropriate techniques with approval by NMFS concurrent with spring (mid-March through mid-June) monitoring under the Organism Interactions Monitoring Plan (Appendix H).
    - If entangled fishing gear or marine mammal (or sea turtle) stranding, entanglements, impingements, injuries or mortalities are detected, implement the specified measures to minimize risk of marine mammal entanglement and to make every effort to return the fishing gear to the owners (Appendix I).
- Require vessels in transit to/from the Project site to avoid close contact with marine mammals and sea turtles and adhere to NMFS "Be Whale Wise" guidelines to minimize potential vessel impacts to marine mammals.
- Comply with current regulations that require marine mammal observers for certain vessel based activity (e.g., sub-bottom profiling).
- Require WEC testing clients to keep their equipment in good working order to minimize sound due to faulty or poorly maintained equipment.
- Implement the Acoustics Monitoring Plan (Appendix H) to quantify sound levels using field measurements and validated sound propagation models. Based on monitoring results, implement specified measures to mitigate for potential adverse effects (Appendix I).
- Minimize construction activities during key gray whale migration periods, to the extentpossible.
- For use of DPVs or other equipment that may exceed NMFS's published threshold for injury
    - Avoid use of these vessels to the maximum extent practicable during Phase B gray whale migration (April 1-June 15). If these construction activities are proposed during this migration period, the licensee will consult with ODFW regarding the timing of such activities including cable-laying in state waters.
    - With technical assistance from NMFS, establish and carry out the following actions and protocols necessary to maintain an appropriate acoustic zone of influence in accordance with NMFS's published harassment threshold (120 dB re: 1µPa) during DPV operations to minimize behavioral disturbance and protect marine resources
        - Post qualified marine mammal observers during daylight hours.
        - The licensee will conduct dynamic positioning (DP) activities during daylight hours when feasible to ensure observations may be carried out.
        - DP for cable laying may occur during all hours; however, DP start up for cable laying will only occur during daylight hours.
        - The licensee will carry out the ramp-up procedures that are specified in Appendix I, which may be modified by agreement of the licensee and NMFS.
    - Implement such additional measures as may be imposed pursuant to a Marine

Mammal Protection Act authorization.

- Make opportunistic visual observations of pinnipeds in the portions of the test site which are being visited to conduct operations, maintenance, or environmental monitoring work. If pinnipeds are observed to be hauled out on Project structures, the licensee will follow the reporting and haulout protocols specified in Appendix I.
- To the extent practicable, direct the WEC testing clients to design and maintain cables and moorings in configurations that minimize the potential for marine mammal or sea turtle entrapment or entanglement and follow the reporting and haulout protocols specified in Appendix I.

Seabirds

- Implement the Environmental Measures section as described in the Bird and Bat Conservation Strategy (Appendix B) to assess, minimize, and avoid impacts to birds, these are annotated below:
    - Conduct opportunistic visual observations from the water surface in the portions of the test site, that are being visited to conduct operations, maintenance, or environmental monitoring work, and review any underwater visual monitoring conducted for other purposes, to detect derelict gear that has the potential to increase the risk of marine species entanglement. If monitoring shows that derelict gear has become entangled or collected on any Project structure, the risk that it poses will be assessed based on type of gear, and the derelict gear will be removed as soon as is practicable while avoiding jeopardizing human safety, property or the environment, as described in Appendix I.
    - Conduct opportunistic visual observations in the portions of the WEC test site during vessel-based visits for operations, maintenance or environmental monitoring work, to detect and document any instances of seabird perching.
    - Use low-intensity flashing lights and bird-friendly wavelengths on the Project structures to minimize seabird attraction and follow the specifications for Project lighting developed in consultation with the FWS and USCG.
    - Minimize lighting (e.g., use low intensity, bird-friendly wavelengths, shielded lighting not providing upward- pointing light or light directed at the sea surface) used at night by service and support vessels to reduce the potential for seabird attraction.
    - Require vessel operators to follow FWS instructions regarding appropriate handling and release of seabirds in the event of seabird fallout.
    - Require vessel operators to remain 500 feet away from seabird colonies during the nesting season to minimize disturbance to nesting seabirds.
    - Develop and implement an Emergency Response and Recovery Plan (Appendix G).

Terrestrial Resources

- Minimize or avoid terrestrial activities in sensitive ecological areas (e.g., jurisdictional wetlands and nesting areas for listed avian species).
- Use HDD to install the cables conduits under the beach and sand dune habitat.
- Use HDD to install the terrestrial cables in a up to five bores, from the beach manholes at the Driftwood Beach State Recreation Site to the UCMF property to minimize habitat and substrate disturbance. The cable conduits from the UCMF to the Highway 101 grid connection point will also be installed using HDD.
- Employ environmental measures during installation, operation, and removal to avoid or minimize potential effects to sediment and soils. For example:
  - Minimize disruption of terrestrial geology and soils by maintaining buffers around wetlands to the degree practicable.
  - Develop and implement an Erosion and Sediment Control Plan, and maintaining natural surface drainage patterns.
  - Develop and implement stormwater runoff containment at terrestrial facilities to maintain existing drainage patterns, protect Project-adjacent habitat, and prevent contamination of streams. Develop a stormwater plan that meets all federal and state legal requirements during site design of the UCMF and associated facilities prior to any construction activities at the site.
- Avoid to the extent practicable, disturbance of snags and of wildlife or legacy trees including live or dead trees that provide benefit to wildlife. If unavoidable, additional pre-construction species specific surveys may be necessary to minimize effects.
- Avoid to the extent practicable, disturbance of forested wetlands.
- Avoid to the extent practicable, disturbance of wetlands and adjacent areas that may provide habitat for turtles, amphibians, and other semi-aquatic wildlife.
- Avoid to the extent practicable, disturbance of riparian wetlands where restoration of natural hydrology may be unsuccessful within a short timeframe. Natural hydrology should be restored after construction is complete, and may require a restoration plan with monitoring until successful restoration can be determined.
- Minimize disturbance of streams that support fish, or are connected to fish-bearing streams. Unavoidable work within or adjacent to fish-bearing streams may be subject to in-water work windows. If terrestrial activities directly or indirectly affect any stream used by anadromous fish or fish listed as threatened or endangered under the federal ESA, consult with NMFS staff to avoid and minimize any potential effects to listed species.
- Avoid to the extent practicable, disturbance of seaside hoary elfin butterfly habitat within and in the vicinity of Driftwood Beach State Recreation Site. The current construction footprint has the Project well within the parking lot boundary of Driftwood, therefore interaction with kinnikinnick will be unlikely. Where unavoidable, species-specific

surveys may be necessary on properties outside of Driftwood Beach State Recreation Site but within the construction footprint to determine the extent of occupied habitat and associated mitigation[8].

- Develop a revegetation plan, in consultation with NMFS, ODFW, and appropriate agencies, using native species to the extent practicable for areas disturbed during construction. This plan will include the minimization measures identified in letters commenting on the DLA filed with FERC by NMFS (dated July 18, 2018) and ODFW (dated July 20, 2018) as appropriate.
- Develop measures that will limit the introduction or spread of invasive species, to be included in a construction plan.
- Implement the Environmental Measures section as described in the Bird and Bat Conservation Strategy (Appendix B) to assess, minimize, and avoid impacts to birds and bats; these are annotated below.
    - No HDD construction equipment or construction activities will occur on Driftwood Beach within suitable snowy plover nesting, roosting, or foraging habitat and is expected to be limited to the Driftwood Beach parking lot, at least 164 feet (50 meters) from any potentially suitable habitat.
    - HDD operations in the parking lot will occur during daylight hours, but if lighting is required at night it will be appropriately shielded and directed to minimize artificial light reaching western snowy plover nesting habitat at night. Animal-proof litter receptacles and related signage and coordination will be provided to minimize potential attraction of predators.
    - Develop and implement an HDD Contingency Plan to minimize the potential for inadvertent return of drilling fluids, provide timely detection, and address potential releases by describing monitoring, containment, response and notification procedures to be implemented by the contractor.
    - If HDD is initiated during the western snowy plover nesting season (March 15 to September 15), prior to operation of the HDD, surveys of suitable nesting habitat will be conducted. If nests are detected, measures specified in the BBCS will be implemented, including noise monitoring and implementation of engineering controls, if appropriate (e.g., install temporary noise barriers such as berms, stockpiles, dumpsters, bins, and/or engineered acoustical barriers).
    - Prior to any vegetation clearing that occurs within the nesting season, pre-construction surveys for nesting birds will be conducted by a qualified biologist to ensure that no nests will be disturbed during vegetation clearing.

[8] For information on survey protocols, see Interagency Special Status/Sensitive Species Program (ISSSSP) 2005.

- To minimize Project-related impacts on non-listed terrestrial nesting birds and avoid the creation of potential conflicts or constraints that the presence of active nests would have on Project activities (vegetation clearing), qualified biologists will remove nest-starts for any birds other than bald eagles or raptors when observed if found within the Project footprint and within 100 feet of a construction zone, and where feasible.
- If an active nest is found sufficiently close to work areas to be disturbed by these activities, the biologist will determine the extent of a construction-free buffer zone to be established around the nest (typically 300 feet for raptors and 100 feet for other species), to ensure that no nests of species protected by the MBTA will be disturbed during Project construction.
- If nesting bald or golden eagles are identified, activities will be restricted near nest sites according to guidelines suggested in the National Bald Eagle Management Guidelines (FWS 2007b).
- If construction activities will not be initiated until after the start of the nesting season, all potential nesting substrates (e.g., bushes, trees, snags, grasses, and other vegetation) that are planned to be removed, will be removed in late winter, prior to the start of the nesting season.
- If necessary, the prescribed no-disturbance nesting buffers may be adjusted to reflect existing conditions including ambient noise, topography, and disturbance with approval of ODFW.
- Conduct preconstruction surveys for roosting bats, and minimize construction impacts from high frequency sound disturbance, night lighting, and air quality degradation near roosts by implementing bat roost buffers, or excluding bats within bat roost buffers, or developing species and equipment specific buffers, use noise controls, and monitor bat roost activity before, during and after construction.
- If lighting is required at the UCMF, it will be appropriately shielded and directed to minimize artificial light attraction and prevent potential injury or mortality to seabirds. To the maximum extent practicable, while allowing for the public safety, low intensity energy saving lighting (e.g., low pressure sodium lamps) will be used, and bright white light will be minimized to the maximum extent practicable.

Recreation, Ocean Use, and Land Use

Ocean Use and Recreation

- Mark Project structures with appropriate navigation aids, as required by the USCG.
- Avoid, to the extent practicable, anchoring in areas known to contain hard substrate or rocky reef habitats as identified by available seafloor mapping.

- Conduct outreach to inform mariners of Project structures or activities to be avoided in the area (e.g., Notice to Mariners, flyers posted at marinas and docks).
- Install subsurface floats at sufficient depth to avoid potential vessel strike.
- Work cooperatively with commercial, charter and recreational fishing entities and interests to avoid and minimize potential space-use conflicts with commercial and recreational interests during construction and operation.
- Bury subsea cables 1 to 2 m deep where feasible to minimize interactions with fishing gear and anchors.

Terrestrial Use and Recreation

- Use HDD to install the terrestrial cables in a up to five bores, from the beach manholes at the Driftwood Beach State Recreation Site to the UCMF property to minimize habitat and substrate disturbance. The cable conduits from the UCMF to the Highway 101 grid connection point will also be installed using HDD.
- If acceptable to OPRD, develop and install an interpretive display describing PacWave South in the Driftwood Beach State Recreation Site parking lot. OSU would work with OPRD to develop a plan regarding the interpretive display.
- Comply with all state and local permitting requirements for all construction work.
- Use construction fencing to isolate work areas from park lands.
- Although non-project related vehicular access to the Driftwood Beach State Recreation Site would be prohibited during construction, OSU would arrange the construction work area to maintain pedestrian public beach access, to the extent safe and practicable and with concurrence of OPRD. OSU would coordinate with the OPRD to mitigate impacts to public access and use of Driftwood Beach State Recreation Site.
- Construction work areas or staging areas should be sited on other disturbed areas if possible.

Socioeconomic Resources

- See Recreation, Ocean Use, and Land Use measures.

Cultural Resources

At this time, no historic properties have been identified within the APE and therefore, no impacts to historic properties have been identified. However, should historic properties be identified in the Project APE, OSU would either modify the Project to exclude the historic property from the Project APE or would develop a Historic Properties Management Plan to consider and manage identified and potential historic properties throughout the life of the FERC license. If no historic properties are identified within the Project APE and it is determined that the Project will have no effect on historic properties, OSU will move forward with Project construction and operations with an understanding that should any previously unidentified cultural resources be identified during the course of construction and operations OSU will consult with FERC to determine the best course of action pursuant to Section 106 of the NHPA.

2.2.5 Modifications to Applicant's Proposal – Mandatory Conditions

To be completed by FERC at a later date.

2.3 STAFF ALTERNATIVE

To be completed by FERC at a later date.

2.4 STAFF ALTERNATIVE WITH MANDATORY CONDITIONS

To be completed by FERC at a later date.

2.5 OTHER ALTERNATIVES

To be completed by FERC at a later date.

2.6 ALTERNATIVES CONSIDERED BUT ELIMINATED FROM DETAILED STUDY

2.6.1 Site Location

In 2011, OSU initiated an extensive public outreach program as part of the technical evaluation of candidate sites for PacWave South. In coordination with Oregon Sea Grant, OSU conducted outreach in the communities being considered for the Project site to share information about and gather feedback on the Project. In particular, OSU held a series of public forums in Newport, Reedsport, and Coos Bay for members of the public to learn more about the Project and identify issues of concern and interest.

OSU conducted a feasibility study of candidate sites along the Oregon coast in 2011. After identifying candidate sites, industry feedback on requirements for an optimal grid-connected ocean test site was gathered to inform the site evaluation criteria. Applying both the objectives of the test site and needs identified by industry, technical criteria were established and applied to screen candidate locations off the coast of Oregon. Possible sites were initially evaluated using the following screening criteria:

- Proximity to facilities for deployment;
- Proximity to port for service vessels capable of conducting onboard maintenance;
- Proximity to facilities for dockside repair;
- Logistical convenience for staff, developers, and researchers;
- Energy resources;
- Proximity to interconnection points;
- Potential environmental effects;
- Potential effects on human uses; and
- Access to utilities for energy off take.

Based on this screening, OSU narrowed possible tests sites to Warrenton, Newport, Reedsport, and Coos Bay.

Recognizing that community input and support are crucial to a successful project, OSU also initiated an extensive outreach program during the technical evaluation of candidate sites. Results of the outreach process, along with the screening criteria above, were used to narrow the candidate sites to the two communities that demonstrated the most interest in and best matched the criteria for the test site: Reedsport and Newport. Apart from the community interest criteria, Warrenton was not selected as it did not meet the water depth and port facilities requirements, and Coos Bay was not selected because of spatial constraints from other competing ocean projects. In fall 2012, Reedsport and Newport each formed a Community Site Selection Team to develop proposals for PacWave South, including commercial and recreational fishermen and other ocean users, tribal representatives, the CLPUD, Lincoln and Douglas Counties, city and port representatives, and the public. Representatives from a variety of stakeholder groups were directly involved in the preparation and approval of the community proposals for PacWave South.

In developing their proposals, the Community Site Selection Teams considered all aspects of the Project, including technical criteria for the test facility, community resources, economic development, marine traffic, marine debris and salvage aspects, and environmental resources. The community teams submitted their proposals in December 2012, and in January 2013 OSU selected Newport as the location for PacWave South. The decision was based on a combination of community input and preferred site criteria, including physical and environmental characteristics, subsea and terrestrial cable route options, port and industry capabilities, potential impacts on existing ocean users, permitting considerations, stakeholder participation in the proposal process, and support of the local fishing communities. OSU determined that the Reedsport site was not a feasible alternative for a number of reasons, including: (1) it does not have robust project-related marine operations, (2) the limited cable landing options would not have provided sufficient project planning flexibility, and (3) interconnection to the local grid presented technical challenges that would have been difficult and costly to overcome. Since identifying the Project study area off the coast of Newport, OSU has continued to maintain ongoing communication and coordination with the local community and the fishing industry in particular.

2.6.2 Subsea Cable Route

Two alternatives for the subsea cable route to the mainland were also considered:

- Airport Route: A cable path through a 100-m wide opening through the nearshore rocky reef that would have landed at the Newport Municipal Airport.
- Ona Beach/ODOT: A cable path through the same 100-m wide opening through the nearshore rocky reef as the Airport Route, but with two alternative cable landing locations. One landing was located near the local Oregon Department of Transportation (ODOT) maintenance yard, and the other was located near Ona Beach. This route was the shortest of the three identified.

These routes were dismissed as not feasible because, unlike the selected route to Driftwood Beach State Recreation Site, they crossed a nearshore rocky reef. This rocky reef is known locally as Seal Rock Reef and measures 12 square miles; it supports an abundance of rocky reef fish species and, consequently, supports the highest fishing effort in the recreational groundfish fishery in Oregon (letter from D.O. McIsaac, Ph.D., Executive Director, Pacific Fishery Management Council (PFMC) to FERC and OSU, July 8, 2014). Also, burying the cables would not be possible for the segments of the Airport and Ona Beach cable routes that ran through the rocky reef. Additionally, the Airport Route would be closer to shipping and towlanes associated with the Yaquina River channel; vessel traffic along these routes increases the risk of damage to cables (e.g., from anchor drag; 3U Technologies 2013).

The selected cable corridor between the PacWave South site and Driftwood passes to the south of Seal Rock Reef. From the offshore HDD breakout point, the five cables will run in a northwesterly direct out toward the test site. The distance between the cables will increase with depth to maintain sufficient separation between the cables to safely allow for installation and repair, if every required. The selected cables routes were developed based on geophysical and geotechnical seafloor and sub-bottom data and aim to achieve maximum burial. The cable routes therefore avoid areas where cable burial may be challenging. At the test site, two cables will enter along the western edge, two will enter from the south and the fifth cable will enter along the easterly boundary.

2.6.3 UCMF Location and Terrestrial Cable Route

Various sites in the vicinity of the Driftwood Beach State Recreation Site cable landing site were considered as locations for the UCMF. Initially, OSU considered a location on Legion

Road, 1.5 miles from Driftwood. Following input from CLPUDand discussions with additional prospective land owners, the Legion Road site was rejected because OSU could not secure a lease or purchase, and instead found a property much closer (0.3 miles from Driftwood). The Legion Road site was therefore considered, but rejected.

In the DLA, OSU proposed burying the cables by trench excavation and/or short range HDD boring between Driftwood Beach State Recreation Site and the UCMF along Highway 101. With this approach, the five cables would run from the beach manholes at Driftwood for about 0.2 miles along the Driftwood access road out to Highway 101. Here they would pass under the highway and run about 0.3 miles south within the Highway 101 right-of-way, and then turn east and run about 0.2 miles across OSU's property to the UCMF. The total distance of the terrestrial cable route would be about 0.7 miles.

Due to the technical and environmental challenges of the Highway 101 cable route that had been initially proposed, and as large scale HDD drilling equipment is already required to construct the marine shore landing aspects of the Project, as presented above, OSU is now proposing to use a single step, long range HDD bore to install the terrestrial cable conduits directly from the Driftwood Beach State Recreation Site to the UCMF. This approach will result in avoiding or minimizing effects to wetlands, streams, terrestrial habitat, adjacent landowners, and Highway 101 users.

3.0 ENVIRONMENTAL ANALYSIS

This environmental analysis of the Project first presents a general description of the Project area, including historical and present conditions, and then considers the environmental effects of the proposed action compared to the baseline condition, including an assessment of the effects of proposed environmental measures, and any potential cumulative impacts of the proposed action. Sections are organized by resource area. It is important to note that the level of detail provided is commensurate with the significance and likelihood of the potential impact or risk to the resource (as determined by the analysis).

3.1 GENERAL DESCRIPTION OF THE AREA

The Project includes a test site located in federal waters about 6 nautical miles off the coast of Newport, Oregon; buried subsea cables from the test site to a terrestrial cable connection point at Driftwood Beach State Recreation Site in Seal Rock, Lincoln County, Oregon, and then terrestrial cables running to the UCMF, and from the UCMF and to the CLPUD grid connection. In addition, vessel traffic would occur between these areas and the Port of Newport or other Oregon ports. Ocean areas surrounding the Project area support diverse assemblages of marine species and offer important economic and recreational opportunities for the surrounding communities. The Oregon coast near Newport is a high wave-energy, dynamic ocean environment and suitable for testing of WECs. General marine habitat features in the Project area include soft bottom subtidal, some hard bottom, open water pelagic, and surf zone habitats. Areas of hard bottom substrate occur closer inshore of the test berths and to the north of the cable route. The terrestrial portions of the Project would cross under a beach and dune system and would be located on upland areas east of the beach within the Driftwood Beach State Recreation Site and would run directly to the UCMF and to the grid connection point with the CLPUD. The terrestrial areas of the Project are mainly low mountains of the Coast Ranges, covered in Douglas fir and Sitka spruce, along with residential housing. The coastal uplands typically have a mild, marine-influenced climate that has an extended winter rainy season and minimal seasonal temperature extremes.

Oregon’s beaches and coastal areas typically have mild temperatures, with mean summer temperatures in the low 60s (degrees Fahrenheit; °F) and mean winter temperatures in the low 40s (°F). Average annual precipitation is 75 to 90 inches. Strong winds typically strike in advance of winter storms and can exceed hurricane force. Winter weather, which is typically wet, is generally influenced by counterclockwise-rotating low-pressure systems that cross the North Pacific, resulting in frontal cyclonic storms characterized by heavy rains and high south to southwesterly winds. Summers are relatively dry and fair, with mild north-northwesterly winds, driven by a persistent, seasonal, offshore high, and frequent strong afternoon breezes and coastal fog.

3.2 SCOPE OF CUMULATIVE IMPACTS ANALYSIS

According to the Council on Environmental Quality's regulations for implementing NEPA (40 CFR §1508.7), a cumulative impact is "the impact on the environment that results from the incremental impact of the action when added to other past, present, and reasonably foreseeable future actions regardless of what agency (federal or non-federal) or person undertakes such other actions." Cumulative impacts can result from individually minor but collectively significant actions taking place over a period of time, including offshore renewable energy and other land and water development activities.

The following resources that have the potential to be cumulatively affected by the Project, in combination with other recent, on-going, or proposed activities in these resource areas: geology and soils; aquatic resources; threatened and endangered species, critical habitat and essential fish habitat; recreation, ocean use, and land use; and socioeconomic resources. These specific resource issues were identified in the scoping process, as described in Scoping Document 2. The cumulative impacts are described by each resource topic within their respective sections.

3.2.1 Geographic Scope

The geographic scope of analysis for cumulatively affected resources defines the physical limits or boundaries of: (1) the proposed action's effect on the resources that may be cumulatively affected and (2) contributing effects from other marine activities in the area. This cumulative impacts analysis considers impacts of PacWave North, which is located about 9 miles northeast of the proposed Project site, as well as other projects that have been proposed, or are reasonably foreseeable to take place, in the Project vicinity. The general geographic scope of analysis is defined to encompass (a) the Driftwood Beach State Recreation Site and cable route to, and including, the UCMF as well as grid connection to the CLPUD, where the terrestrial component of the Project would be; (b) the Oregon State territorial waters from the shoreline of the Lincoln County coast to the OCS, where the subsea cables would be deployed; (c) the subsea cable from the western edge of the territorial sea to the offshore facility site; and (d) the 2 square nautical mile area on the OCS where WECs would be deployed. These four components of the Project area, are referred to as either the "terrestrial portion" of the Project, the "cable route," and the "test site," in this document. In addition, the geographic scope includes: (a) the acoustic environment around the test site to a distance of 125 m (410 ft); (b) a vertical and horizontal distance of 3 m beyond each subsea cable during installation; and (c) the vessel transit area between the Project site and the primary staging point, the Port of Newport.

3.2.2 Temporal Scope

The temporal scope of analysis includes a discussion of the past, present, and reasonably foreseeable future actions and their effects on the following resource areas: geology and soils;

aquatic resources; threatened and endangered species, critical habitat and essential fish habitat; recreation, ocean use, and land use; and socioeconomic resources. Based on the term of the proposed license, this analysis looks 25 years into the future (the potential license term), concentrating on the effects on these resources from reasonably foreseeable future actions.

3.2.3 Projects in the Vicinity

There are four types of existing or reasonably foreseeable activities that could or do occur in the vicinity of PacWave South: (1) offshore marine and hydrokinetic energy development, (2) dredged material disposal, (3) deployment of sensor arrays for oceanographic monitoring, and (4) commercial fishing. These proposed actions, in combination with the PacWave South Project, could result in cumulative impacts on resources.

3.2.3.1 Offshore Marine and Hydrokinetic Energy Development

PacWave North

PacWave North is a 1 square nautical mile, non-grid connected test site located 2 to 3 nautical miles offshore of Newport, Oregon, approximately 9 miles northeast of the proposed Project. It opened in 2012 and is operated by OSU. Primary components include the Ocean Sentinel instrumentation buoy, wave measurement buoys, and associated mooring systems. It can accommodate short-term testing of up to two WECs at a time. WEC(s) being tested and the Ocean Sentinel would be moored approximately 150 m apart and connected by a power and communications cable. Developers must obtain test-specific permits to deploy WECs at PacWave North.

Camp Rilea Ocean Renewable Energy Project

The proposed Camp Rilea Ocean Renewable Energy Project would be located just south of the Columbia River mouth approximately 100 miles north of the proposed PacWave South. It may consist of multiple types of WECs up to approximately 9 nautical mile miles offshore with a cable connection to shore. As of August 2018, only one deployment has occurred at Camp Rilea, the M3 Wave Device, with a proposed deployment by Resolute Marine Energy that could be in spring 2019, and most likely in spring 2020 (personal communication with Rick Williams, Oregon Applied Research, August 28, 2018).

3.2.3.2 Yaquina Ocean Dredged Material Disposal Site

The Yaquina Ocean Dredged Materials Disposal Site includes two areas (the “North site” and the “South site”) located approximately 1.75 miles offshore from the Yaquina Bay entrance channel. These disposal sites are located approximately 5 miles northeast of PacWave South. Each site occupies an area of 597 acres of sea floor and has the capacity to receive dredged materials for 20 years. Since the Ocean Dredged Materials Disposal Site began receiving dredged material in 1928, over 21 million cubic yards of dredged material have been placed at this site (USACE and U.S. EPA). Active disposal took place at the North site until about 2011; the South site recently became active and is presently used for dredged material disposal.

3.2.3.3 Ocean Observatories Initiative

The Ocean Observatories Initiative (OOI) includes the Endurance Array, a multi-scaled array utilizing fixed and mobile technologies to observe cross-shelf and along-shelf variability in the coastal upwelling region of the Oregon and Washington coasts. The Endurance Array has two cross-shelf moored array lines, the Oregon Line (also called the Newport Line) and the Washington Line (also known as the Grays Harbor Line). Each line includes ocean sensors and infrastructure (e.g., surface and subsurface moorings at 25, 50, 80, 150, and 500 m depths, and buoys), linked by a submarine cable providing power and data connectivity to shore. A Finding of No Significant Impact was signed in 2011 for this project.

3.2.3.4 Commercial Fishing

Commercial fishing for a variety of species occurs in the Project area, including coastal pelagic and migratory fishes, crab, salmon, shellfish, and shrimp (NOAA 2007), as described in Section 3.3.6.1. For purposes of this analysis, it is reasonable to assume that the existing level of commercial fishing will continue into the future, and the effects on marine resources will be commensurate to those of past fishing activities, and is analyzed in the baseline.

3.3 PROPOSED ACTION AND ACTION ALTERNATIVES

This section considers the potential effects of the Project on environmental resources, and it is organized by resource area. For each resource area, the affected environment is described first. The affected environment is the existing and baseline condition, which is used to assess Project impacts. Site-specific environmental issues and cumulative impacts are then evaluated. These issues were identified through the scoping process and agreed to by the CWG, as described in Scoping Document 2.

OSU determined that the following resources may be affected by the Project: geological and soil; water quality; aquatic; terrestrial; threatened and endangered species, critical habitat and essential fish habitat; recreation, ocean use, and land use; cultural; aesthetic; and socioeconomic. OSU also determined that the following do not require detailed analysis because they have little potential for significant effects: effects of the Project on air quality, effects of

Project operations and facilities on some measures of water quality (i.e., total dissolved gasses, water temperature, circulation, and pH), and effects of wave attenuation on surfing opportunities; therefore, these issues are not assessed in this APEA.

OSU conducted site characterization studies at PacWave South in 2013, 2014, and 2015 (Table 3-1); these studies, which were based on input from and agreed to by the CWG, are described in Scoping Document 2. OSU has also conducted environmental studies at PacWave North since 2009 (Table 3-2); where applicable, information collected at PacWave North was used to inform assessment of environmental conditions at PacWave South. Information from these studies is incorporated into the sections that follow for each related resource area.

Table 3-1. Environmental surveys conducted at PacWave South.

Survey	2013					2014												2015					
	Aug	Sept	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	June
Sediment & Macrofauna	✔		✔						✔		✔		✔		✔						✔		✔
Crab Pots		✔			✔				✔		✔			✔				✔			✔		✔
Reef Visual														✔									
Bird Observers	✔	✔	✔	✔		✔	✔		✔		✔	✔	✔	✔	✔						✔		✔
Marine Mammal Obs.			✔	✔		✔	✔		✔		✔		✔	✔	✔						✔		✔
Acoustics (Lander)									Apr-July 2014														✔*
Acoustics (ADUH Drifter)		✔					✔				✔												
DMONs										✔	✔	✔	✔	✔	✔								

* Hydrophone lander was deployed in June 2015 and recorded until November 2015.

Table 3-2. Environmental surveys conducted at PacWave North.

Survey	2008 & 2009	2010			2011						2012					2013					2014					2015				2016
		Jun	Aug	Oct	Feb	Apr/ May	Jun	Aug	Oct	Dec	Jan	Apr	Jun	Aug/ Sept**	Oct/ Nov	Apr	Jun	Aug*/ Sept*	Oct^	Dec^	Feb^	Apr/ May^	Jun^	Aug/ Sept^	Oct^	Feb^	Apr/May^	June^	Aug^	Apr
Sediment & Macrofauna		✔	✔	✔		✔	✔	✔	✔	✔			✔	✔	✔		✔	✔	✔			✔	✔	✔	✔		✔	✔		✔
Beam Trawl		✔	✔	✔	✔	✔	✔	✔	✔	✔			✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	
Video			✔		✔	✔	✔	✔	✔					✔				✔	✔					✔			✔			✔
Bird Observers																		✔	✔		✔	✔	✔	✔	✔		✔	✔	✔	
Marine Mammal Observers	✔										✔	✔						✔		✔	✔	✔	✔	✔	✔		✔	✔	✔	
Acoustics (Lander)		March 2010-April 2011																												
Acoustics (Drifting)														✔				✔												

* Ocean Sentinel only deployed at PacWave North

**WEC and Ocean Sentinel deployed at PacWave North

^Anchors only deployed at PacWave North

3.3.1 Geologic and Soil Resources

3.3.1.1 Affected Environment

Oregon's continental shelf is relatively narrow and extends about 10 to 46 miles off the coast (Electricity Innovation Institute 2004). A rocky submarine bank, Stonewall Bank, begins about 15 miles offshore of Newport and extends southwest offshore about 40 miles south to the Siuslaw River, where the shelf is about 30 miles across (Electricity Innovation Institute 2004; USACE and EPA 2001). The Project would be located shoreward of the Stonewall Bank, where sediments are mostly sand to depths of 300 ft (91 m) (Figure 3-1), with a small percentage of silt and clay. The sediments present at PacWave South are typical of much of the Oregon coast, with small variations in the concentration of fine-sized particles in the seafloor sediments due to local currents (USACE and EPA 2001).

Sediment sampling by OSU within and surrounding the PacWave South Project area from August 2013 to June 2015 at water depths from 30 to 70 m (total sample size = 117) indicated high spatial and temporal variability in the sediment conditions (Henkel 2016a). Generally, coarser sediment (average median grain size [mgs] = 364 µm) was found at the 60 to 70 m stations compared to the 30 to 50 m stations inshore (average mgs = 313 µm). When all samples were analyzed together, median grain size of the sediment did not appear to vary seasonally, though percent fines did, ranging from 0.98 percent fines to 0.12 percent. In contrast, at the 60 and 70 m stations directly within and surrounding the Project Site, strong seasonal differences in median grain size were detected. These variations with season were not consistent, however. For example, in April 2015 median grain sizes were larger at the 70 m stations while in June 2015 median grain sizes were smaller as compared to the 60 m stations. This is consistent with the observations made during the June 2014 mapping effort that indicated finer sand in the deeper half of the study area. Based on data collected at Ocean Dredged Material Disposal Sites off the coast of Newport, local sediments near PacWave South are consistent with those found on much of the Oregon shelf, consisting predominantly of medium-grained sand with some shell debris and a minor amount (less than 2 percent) of silt and smaller material (USACE and EPA 2011), presumably as a result of winnowing by wave energy.

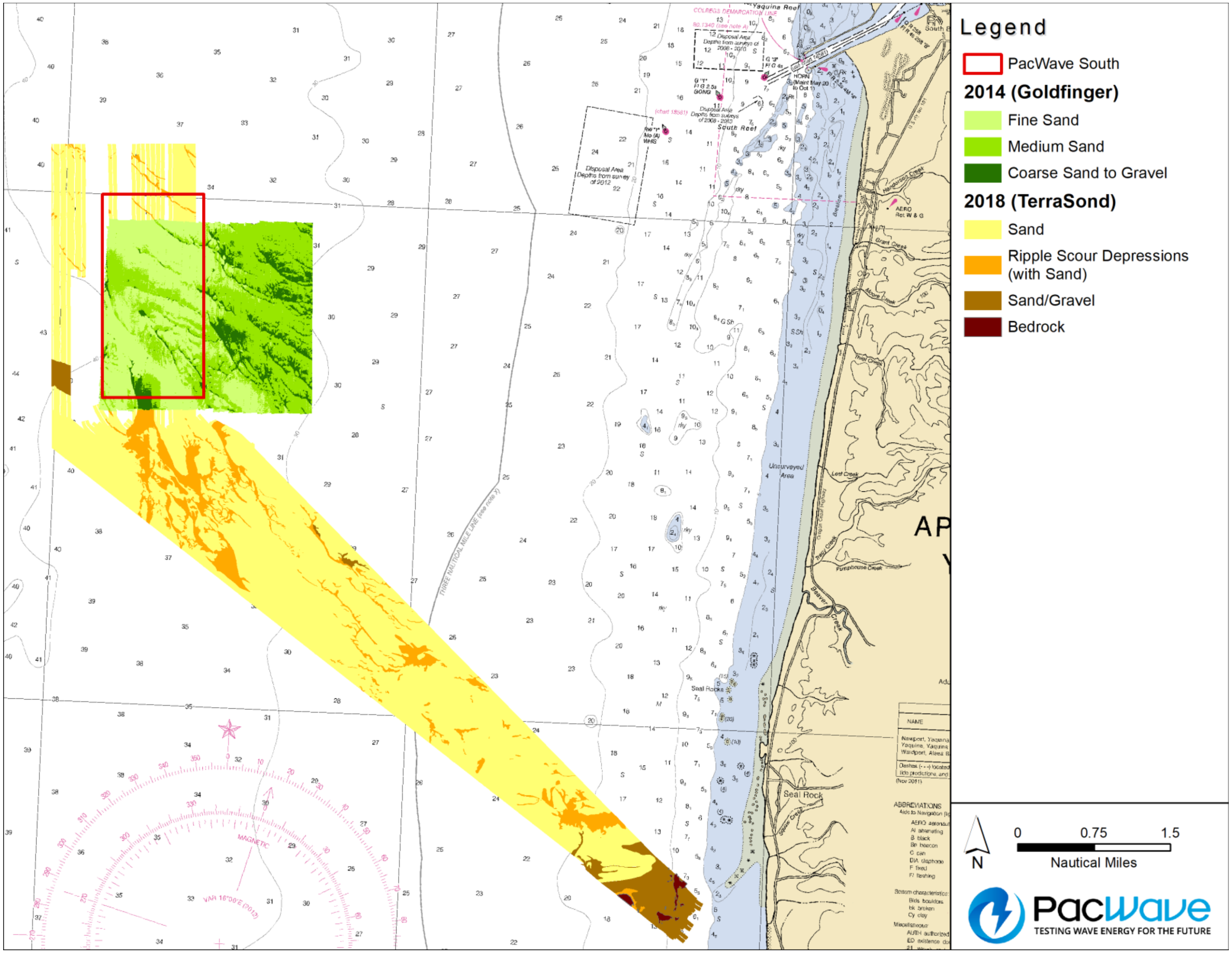


Figure 3-1. Sediment classification at PacWave South by Goldfinger (in 2014) and TerraSond (in 2018).

In 2014, OSU conducted marine geophysical surveys at the proposed PacWave South and along a number of potential subsea cable routes (Goldfinger et al. 2014). The 2014 surveys included: (1) a high-resolution chirp multibeam sonar survey producing detailed bathymetry and backscatter coverage of the test site and potential cable routes, (2) a chirp sub-bottom survey, (3) a boomer seismic survey, and (4) a magnetometer survey. The marine Project area (the test site and cable route) can be characterized as a fold-thrust belt associated with the Cascadia Subduction Zone, and locally dominated by the North-South trending Seal Rock Anticline, which brings Miocene-age rock to the surface in the inshore parts of the subsea cable route. The older rocks are intruded and modified by the Columbia River Basalt group flows that crop out on shore at Seal Rock. PacWave South would be located in the synclinal sedimentary basin that lies between these two major structures. The major rock outcropping in the area is the Miocene Astoria Formation/Nye Formation rocks of the Seal Rock Anticline (Goldfinger et al. 2014).

Goldfinger et al. (2014) noted that the geology of the test site appears to be primarily an extensive field of paleo dunes. The height of the eroded dunes ranges from 1 to 5 m, but are typically 2 to 3 m high and spaced about 100 to 400 m apart. In the swales between the dunes, the backscatter data and limited core data suggest fine sand to silt fills in the low areas (Figure 3-2). The dunes themselves are likely composed of medium to coarse sand and may be partially indurated (i.e., consolidated). The steeper faces of the dunes are eroded in dendritic and formless patterns that expose material of high backscatter 0.5 to 1 m below the surface of the dunes. The high backscatter material is most likely the ubiquitous transgressive gravel lag deposit encountered in numerous localities nearby. In the southern part of the test site, the dunes gradually transition to sandy surface substrate formed into short wavelength, low-amplitude sand waves that may represent active sediment transport (Goldfinger et al. 2014).

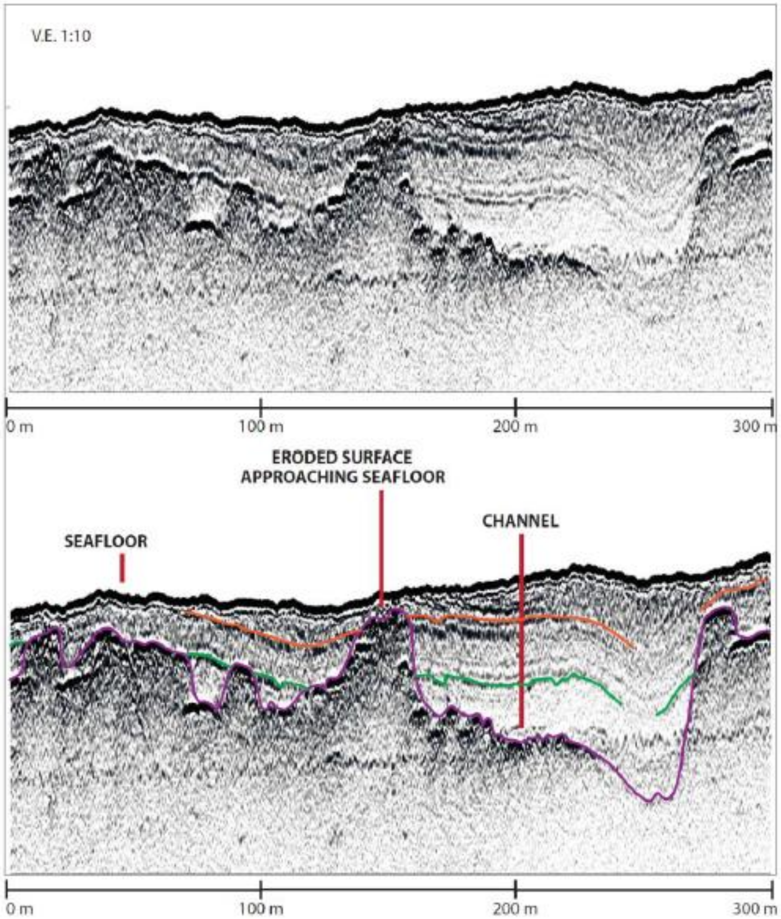


Figure 3-2. Chirp profile in PacWave South showing subsurface paleo-topographic surface, a buried channel, and overlying transgressive sand cover (Goldfinger et al. 2014).

OSU conducted additional geophysical and geotechnical surveys in 2018 at PacWave South and within the subsea corridor (TerraSond 2019)(Appendix M). The 2018 survey included a: (1) side scan sonar survey, (2) sub-bottom profiler survey, (3) high-resolution multibeam sonar survey, and (4) magnetometer survey (TerraSond 2019). Review of the sidescan sonar data showed:

> "... a range of lower reflectivity interpreted to be relatively finer grained sands, to medium to strong reflectivity interpreted to be coarser grained sands, to very strong reflectivity interpreted to be rock. Rippled scour depressions ... were recognized in the area by Goldfinger et al. (2014) and observed in the western part of the cable corridor and across the width of the (PacWave) area. The features are visible in (multibeam and side scan sonar) data. Rippled scoured depressions are observed in continental shelf areas worldwide (Davis et al., 2013) and are thought to be formed by storm generated currents. They are often elongate, shallow (less than 2 m deep) depressions filled with relatively coarser grained seabed sediments

(with higher SSS reflectivity) relative to the surrounding seabed sediments." (TerraSond 2019)."

The purpose of the 2014 and 2018 geophysical surveys of the subsea cable route from PacWave South to Driftwood Beach State Recreation Site was to help ascertain the best route to shore, with the primary focus being to avoid hard substrates and maximize burial depth.

Surface geology nearshore ranges from sand and coastal terrace deposits to sandstone, mudstone, and occasional basalt. The surface geology at Driftwood Beach State Recreation Site consists of Coast Terrace deposits with Yaquina formation sandstone and possible mudstone layers below (3U Technologies LLC 2013). Sand is the predominant surface material in the beaches, dunes, and lower elevations of this area. Basalt is found in the Seal Rock area and is likely present in the form of thin layers below the surface at nearby sites. Soil types in the terrestrial portion of the Project include (generally west to east) Waldport fine sand with 0 to 30 percent slopes for the Study Area closest to the Pacific Ocean, Yaquina fine sand with 0 to 3 percent slopes running north/south parallel and east of that, Urban land-Nelscott complex with 0 to 12 percent slopes, Nelscott loam with 12 to 50 percent slopes, and Bandon fine sandy loam with 3 to 12 percent slopes (NRCS 2016). These soil types range from somewhat poorly drained to excessively drained, with the well and moderately-well drained areas being around Highway 101 at the entrance of the Driftwood Beach State Recreation Site and in the southernmost portion of the Study Area. OSU conducted geophysical surveys along the marine HDD route in 2017 and 2018 (Siemens & Associates 2017 and 2018), and a geophysical survey of the terrestrial portion of the Project area in 2019 (Siemens & Associates 2019)(Appendix M).

3.3.1.2 Environmental Impacts Related to Geological and Soil Resources

This section evaluates the effects of Project installation, operation, and removal activities on local geology and soils, including sediment transport processes (i.e., sediment scour and deposition).

OSU conducted seafloor surveys to identify geologic hazards, hard bottom areas, and sensitive seafloor habitats in order select a cable route that avoids these features to the greatest extent possible. Because of adjustments made to the proposed cable route, additional seafloor surveys were conducted in 2018. OSU would implement the following measures to minimize the extent of disturbance of geologic and soil resources:

- Use HDD to install the cables under the nearshore and intertidal habitat (to approximately the 10-m isobath) to minimize substrate disturbance. Use HDD to install the terrestrial cables in a up to five bores, from the beach manholes at the Driftwood Beach State Recreation Site to the UCMF propertyto minimize habitat and substrate disturbance. The cable conduits from the UCMF to the Highway 101 grid connection point will also be installed using HDD.

- Follow best practices during installation, operation, and removal activities to avoid or minimize potential effects to sediment, including:
  - Minimize the time that the seafloor is disturbed and sediment is dispersed and the associated effects by completing cable laying and other construction activities during appropriate construction windows and within one construction season to the extent practicable.
  - Develop and implement an Erosion and Sediment Control Plan, where appropriate, to minimize effects of ground disturbing activities associated with installation of the terrestrial cables and/or other terrestrial construction
- Implement the Benthic Sediments Monitoring Plan (Appendix H) to evaluate effects on benthic habitat from anchors, WECs, and other equipment during operation, maintenance and monitoring activities. Based on monitoring results, implement the specified measures to mitigate for potential adverse effects (Appendix I).
- Project components in the estuarine environment should not bottom out so as to prevent nearshore/estuarine habitat effects.
- To the extent possible, minimize frequency of anchor installation/removal cycles and reuse installed anchors.

Anchor types would vary to suit the different types of WECs, but would likely include gravity anchors, drag embedment anchors, plate anchors, and suction anchors (see section 2.2.1.2). The footprint of each anchor would vary, as would the depth to which it would penetrate the seafloor. Suction and plate anchors are placed into and under the seafloor, and therefore would have minimal footprint other than the hardware used to connect the mooring lines from the anchors up to the WEC. Some mooring configurations could use one anchor for adjoining WECs, in which case the footprint on the seafloor would be further reduced.

The largest type of anchor that would sit on the seafloor would be a gravity anchor, one of which could have a footprint on the seafloor of up to 908 ft^2. For the two scenarios being evaluated – the initial development and full build-out scenarios (see Section 2.2.1.1), the estimated total footprint of the anchors is shown in Table 3-3.

Table 3-3. Estimated maximum anchor footprints for initial development and full build-out scenarios by berth.

Scenario	WEC Type	No. WECs	Total No. Anchors	Maximum Seafloor Anchor Footprint (ft^2)*
Initial Development				
Berth 1	Point absorber	1	6	5,448
Berth 2	OWC	1	4	3,632

Scenario	WEC Type	No. WECs	Total No. Anchors	Maximum Seafloor Anchor Footprint (ft^2)*
Berth 3	Attenuator	1	4	3,632
Berth 4	Point absorber with shared anchors	3	7	6,356
Maximum Total Anchor Footprint = **19,068 ft^2 (0.4 acres)**				
Full Build Out				
Berth 1	Point absorber	5	30	27,240
Berth 2	OWC	5	20	18,160
Berth 3	Point absorber	5	30	27,240
Berth 4	Attenuator	5	20	18,160
Maximum Total Anchor Footprint = **90,800 ft^2 (2 acres)**				

* Based on the total footprint of 34-ft-diameter gravity anchors (908 ft^2 per anchor), representing the largest possible footprint per anchor; other anchor types will have a considerably smaller footprint.

As indicated in Table 3-3, the maximum footprint of the anchors would be 19,068 ft^2 (0.4 acres) for the initial development and 90,800 ft^2 (2 acres) for the full build out, which is approximately 0.1 percent of the total Project site surface area (2 acres out of 1,695 acres). The estimates are based on exclusive use of large 34-ft-diameter gravity anchors; however, other types of smaller anchors will likely be used for some of the WECs, and shared anchors may be used for some WECs when feasible, so the actual seafloor footprint is expected to be considerably smaller than these estimates. As noted previously, anchor deployment periods would align with WEC test durations, so they would likely be in place for 3-5 years at a time. Anchors could be in place up to 25 years if the anchors are to be used for multiple WEC tests throughout the Project life.

The placement of anchors on the seafloor could result in localized areas of scour or deposition. Benthic sampling at both PacWave South and PacWave North indicate that substrate composition along this section of the Oregon coast consists of medium to coarse sand, with larger grain sizes found at the greater depths present at the test site (Henkel et al. 2014, Henkel 2016a). The particle size range found at PacWave South is thus less susceptible to movement than areas with finer-grained sediment (percent fines in the PacWave South area were very low, less than 1 percent, Henkel et al. 2014, Henkel 2016a). Scour is analyzed in Section 3.3.3.2 *(Effects on the Benthic Community from Project Structures*); in summary, it is anticipated that scour depths may be up to 1 m, and scour widths may extend as far from the anchors as 20 m. OSU would conduct the Benthic Sediments and Organism Interactions monitoring plans (Appendix H) to evaluate if Project-related scour or deposition is occurring and its extent.

Umbilical cables would descend from the WECs and run along the seafloor to the subsea connectors. As noted in Section 2.2.1.3, each test berth would have a subsea connector. The subsea cables would be buried 1 to 2 m beneath the seafloor between the test site and the HDD breakout point at approximately the 10-m isobath; the cables would be buried using a jet plow or similar technique. Jet plowing is a common technique that uses a plow share and high pressure water jets to simultaneously lay and embed underwater transmission cables in areas with soft sediment; as a result, sand and fine sediment would be temporarily suspended into the water column. The proposed cable route corridor would have a total distance of 7.7 nautical miles from the test site to the seaward end of the HDD conduits.

The placement of the subsea cables would displace sand and fine sediment as the cables are buried using jet plow or other methods. The skids or wheels of the jet plow would be expected to impact about a 2 m wide swath of substrate along each of the cable paths, but the jet plow would fluidize a pathway less than approximately 1 m wide. Part of the displaced sand would be placed back in the trench to cover the cable, and another portion would be dispersed by currents and resettle onto the seafloor (FERC 2010). The re-deposited layer of sediment is expected to be thin beyond the immediate vicinity of the trench (FERC 2010). This disturbance could cause small-scale topographic changes in the seafloor along the path of the cable; however, the natural movements of the sediments by ocean currents would reestablish natural bottom topography. For example, a study of the Monterey Accelerated Research System (MARS) cable in California, using ROV video transection and sediment samples, found little detectable impact to seafloor geomorphology and no detectable change in mean grain size after cable installation at both 18 and 37 months (Kuhnz et al. 2011). Suspended sediment is discussed further in Section 3.3.2.2.

Use of HDD from the Driftwood Beach State Recreation Site, through the intertidal area, and out to a breakout point about 800 m offshore would avoid effects to geological resources in the nearshore, intertidal, and sand dune areas crossed by the cables. The HDD drill rig would be set up in the paved parking lot of the Driftwood Beach State Recreation Site, and therefore, minimal disturbance would occur. Excavated soils and drill cuttings resulting from HDD activities would be stockpiled on site and disposed at an approved disposal location. The drilling of the HDD bores is a one-time disturbance associated with construction of the Project.

Use of HDD for installation of the terrestrial cables from the Driftwood Beach State Recreation Site to the UCMF, and from the UCMF to the CLPUD grid connection, would avoid effects to geological resources along the terrestrial cable route. The cables would be installed in up to five HDD bores under the southern portion of Driftwood Beach State Recreation Site, under small sections of five or six private properties located on either side of Highway 101, and then to the OSU-owned UCMF parcel east of the highway. The total distance of the terrestrial cables would be about 0.5 miles. The grid connection to CLPUD’s distribution system would be installed by HDD from the UCMF to CLPUD’s distribution lines on the west side of Highway 101. Soils and drill cuttings resulting from the HDD activities would be stored temporarily on site and then disposed of at an approved disposal location. The HDD drilling is a one-time disturbance associated with construction of the Project. Disturbance of soils associated with construction of the UCMF would result from clearing and site preparation for approximately 1.2

acres to accommodate the UCMF buildings, the paved and fenced exterior laydown area, parking, and NW Wenger Lane. During construction, the soils in the disturbed area would be compacted and covered by an impervious surface. Effects to geology and soils resulting from Project construction would be minimized by development and implementation of an Erosion and Sediment Control Plan and implementation of appropriate best management practices (BMPs; e.g., minimizing impacts to wetlands by maintaining buffers around wetlands, and maintaining natural surface drainage patterns).

In summary, the Project would have negligible effects on geological resources over the life of the Project. The footprint of the anchors, even under full build out using the largest types of anchors, would be fairly small – approximately 2 acres total, spread out over the 1,695-acre test site (i.e., 0.1 percent of the test site), resulting in localized areas of scour or deposition. Other components on the seafloor, such as the four subsea connectors and the umbilical cables lying on top of the seafloor (from below the WECs to the subsea connectors), would be smaller still. Jet plow installation of the buried portions of the subsea cables and auxiliary cable (from the offshore test site to the seaward end of the HDD bores) in separate trenches would result in a temporary disturbance of the sand bottom. Use of HDD would avoid disturbance to intertidal, sand dune, and terrestrial cable route areas. Standard construction BMPs for construction of terrestrial components of the Project would minimize effects of on-land disturbance.

Discussion of Project effects on geological resources as they relate to impacts on biological resources are discussed in Section 3.3.3.2.

3.3.1.3 Cumulative Impacts

The Project would have negligible effects on area geology and soils because of the small footprint of the Project on the seafloor and temporary nature of the installation and removal activities. Therefore, it is not expected that the Project, in combination with WEC testing at PacWave North, the Camp Rilea Ocean Renewable Energy Project, dredged material disposal at the Yaquina Ocean Dredged Material Disposal Sites, and the OOI Project would result in cumulative impacts on geology and soils.

3.3.2 Water Resources

3.3.2.1 Affected Environment

Wind, Waves, and Currents

The high level of wave energy that exists on the Oregon coast is caused by prevailing western winds and the large fetch of the North Pacific Ocean (Boehlert et al. 2008). Wave energy on the coast varies considerably by season, such that the wave energy flux is approximately eight times greater during winter than summer (Bedard 2005). Episodic winter storms bring large waves from the west and southwest. Currents generated by these waves are uniform throughout the water column, and may have a substantial influence on the transport of fine sediments (silt and clay) at depths of greater than 120 ft (USACE and EPA 2001). The regional-scale circulation of ocean surface waters on Oregon's continental shelf varies seasonally with changing wind stress patterns and is dominated by the southward-flowing California Current (USACE and EPA 2001). During the summer, offshore high-pressure weather systems and associated northerly or northwesterly winds drive upwelling of deep, dense, cold water toward the ocean surface. In contrast, low-pressure offshore weather systems during winter drive southwesterly storm winds that result in downwelling of nearshore surface water, and nearshore surface circulation is dominated by the northward-flowing Davidson Current.

On the inner continental shelf (depths less than about 35 m), water circulation is influenced by a combination of wind-driven currents, wind waves, tidal currents, and estuarine-induced currents (USACE and EPA 2001). On the middle continental shelf (depths of 35 to 90 m), water circulation is influenced mainly by wind-driven currents., whereas on the OCS (90 to 180 m), shoaling waves and regional-scale currents control water circulation seasonally (USACE and EPA 2001). The net direction of bottom currents on the mid- to outer-OCS is northward; the subsurface part of the Davidson Current is believed to flow northward year-round (USACE and EPA 2001).

Based on site-specific surveys, water depth at the Project site ranges from 65 to 79 m (Goldfinger et al. 2014). Figure 3-3 illustrates bathymetry at the offshore test site; bathymetry along the proposed cable route is shown in Figure 3-4. (Note that both figures are based on less accurate, pre-survey data.)

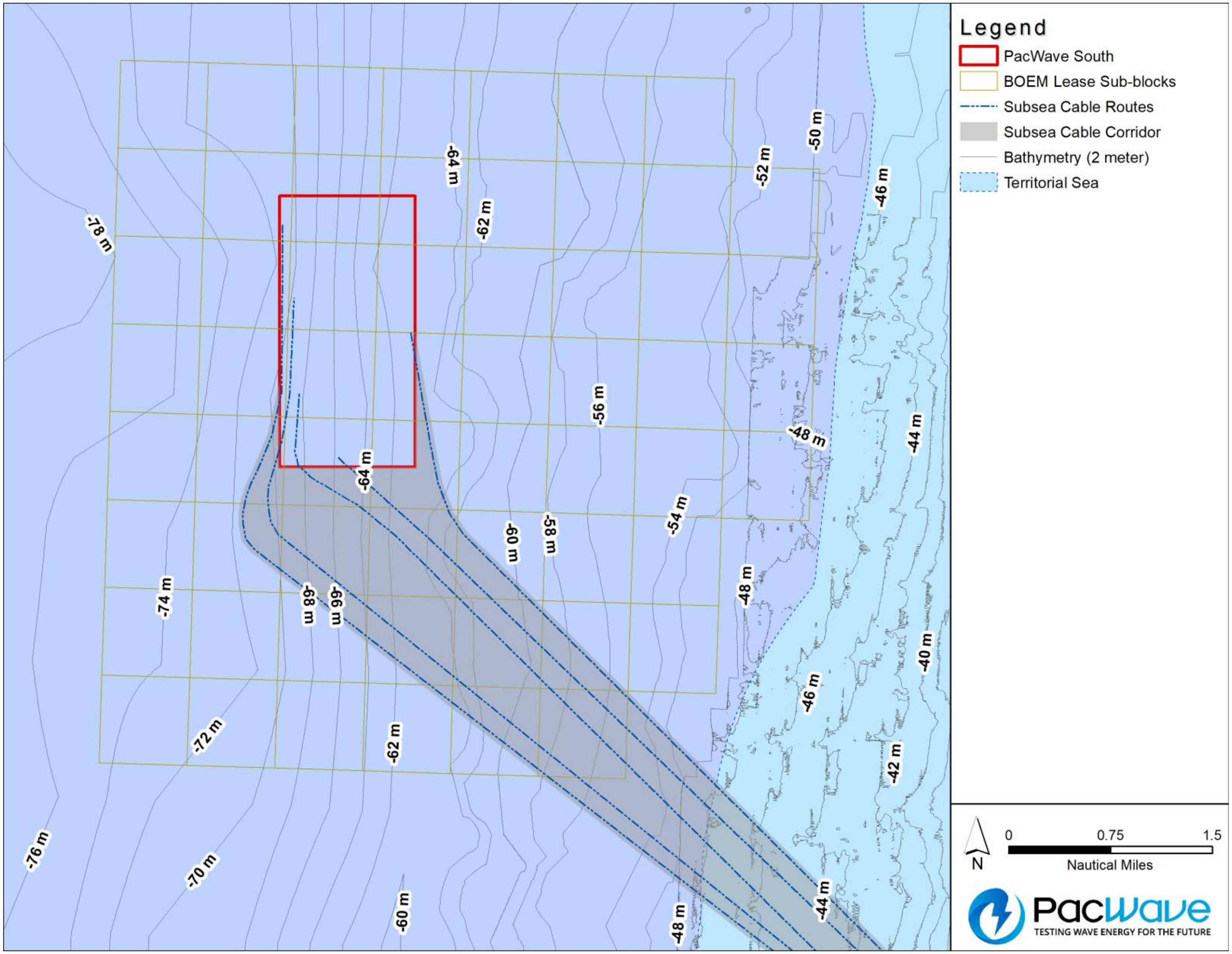


Figure 3-3. **PacWave South bathymetry.**

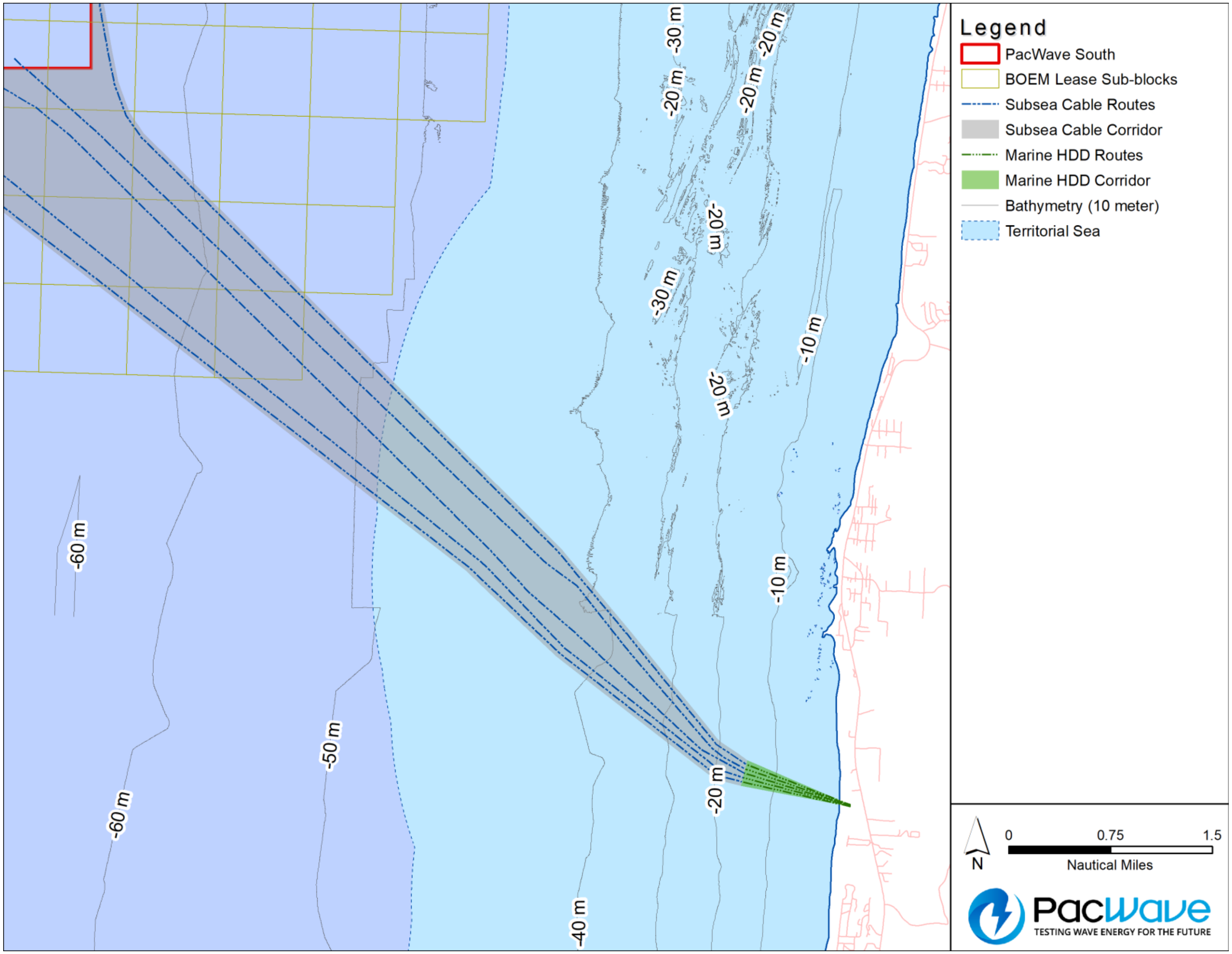


Figure 3-4. Cable route bathymetry.

Direct measurements of wave climate information have been collected through in-situ measurements at PacWave North (Cahill 2014), which is considered to be reasonably representative of PacWave South given the relative proximity of the two sites (the sites are 9 miles apart). Cahill (2014) compared wave measurements at PacWave North collected from August to October 2012 and August to October 2013, to the National Data Buoy Center (NDBC) Buoy 46050, located 20 nautical miles west of Newport, to develop a representative, 18 year, dataset of wave parameters for PacWave North. Annual average wave heights are approximately 2 m, with the highest annual average exceeding 2.5 m. The annual average wave energy flux fluctuates between approximately 30 kilowatts per meter (kW/m) and 60 kW/m. The average wave power across the entire 18-year period of record was 40 kW/m. Strong seasonal trends were documented from this analysis: during winter, as would be expected, higher wave height, longer wave period, and a greater available wave energy resource occurs. Wave power during December is on average approximately eight times greater than in June, July, and August (Cahill 2014).

Surface Waters

Streams and rivers are distributed statewide in Oregon and Washington, forming a continuous network connecting high mountain areas to lowlands and the Pacific coast. The western Cascades in Washington and Oregon are composed of volcanically derived rocks and are more stable than streams typically found in other parts of the Pacific Northwest. They have low sediment-transport rates and stable beds composed largely of cobbles and boulders, which move only during extreme events. The Project area is located within the Beaver Creek-Waldport Bay Watershed (HUC 1710020505), a subset of the Northern Oregon Coast Watershed.

One named stream, Friday Creek, was identified in the Driftwood Beach State Recreation Site during surveys conducted in May 2016 and June 2017 (Figure 3-5). No streams were identified at the UCMF property. Friday Creek flows from north to south at the eastern extent of northern end of the Project area. The stream leaves the Project area at this location and re-enters the Project area further south, flows west through a culvert under Highway 101, then flows south in a roadside ditch for approximately 270 feet on the west side of the highway. The stream enters a culvert under the entrance to Driftwood Beach State Recreation Site, exits on the south side of the entrance and continues to flow south through scrub-shrub wetland in an open channel where it flows into Buckley Creek. The channel width just south of the park entrance is approximately 2 feet wide and ranges from 5 to 10 feet wide north of the entrance (Appendix C).

In 2019, a wetland and waterway survey was also conducted along the terrestrial HDD corridor, which included Buckley Creek, Friday Creek, and “Stream 4” (Figure 3-5). In this area, Buckley Creek was approximately 4 to 5 feet wide with depths ranging from 1 to 2 feet, and Friday Creek was approximately 2 to 10 feet wide with depths ranging from 1 to 1.5 feet.

"Stream 4" flows into the Project area from the northeast through Wetland D before flowing into Friday Creek and Buckley Creek. The wetted width of this channel was approximately 4 feet wide and depths were around 6 inches during the field survey (HDR 2019). Wetlands in the Project area will be discussed later in Section 3.3.4, and a detailed description of each wetland and stream is provided in the Wetland Delineation Report in Appendix C (HDR 2017, 2019).

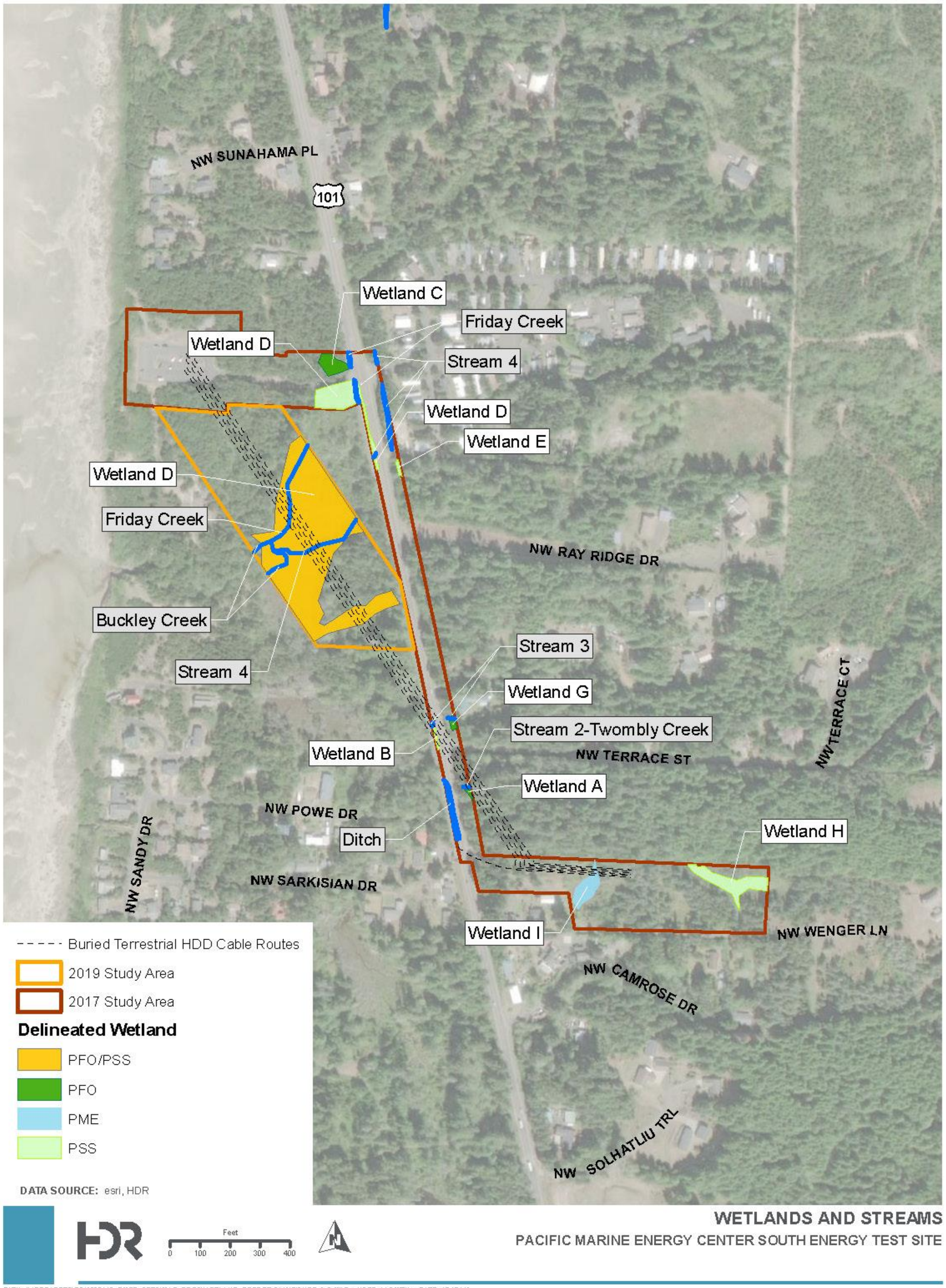


Figure 3-5. Surface waters and wetlands in the terrestrial Project area.

Water Quality

Part of the Project's cable route would be located within the territorial limits of the State of Oregon, and installation of the cables must comply with the water quality standards outlined in the Oregon Administrative Rules (OAR) 340-041. Relevant rules applicable to the Project are the following:

(1) support aquatic species without detrimental changes in the resident biological communities;
(2) prevent a reduction in ambient dissolved oxygen concentrations;
(3) maintain pH between 7.0 and 8.5;
(4) prevent water temperature increases that adversely affect fish or other aquatic species; and
(5) prevent the introduction of toxic substances above natural background levels in amounts, concentrations, or combinations that may be harmful to aquatic life, public health, or other designated beneficial uses.

Marine Project Area

The designated beneficial uses for marine waters adjacent to the Mid-Coast (which contain the Project area) are industrial water supply, fish and aquatic life, wildlife and hunting, fishing, boating, water contact recreation, aesthetic quality, commercial navigation, and transportation.

ODEQ administers 15 statewide narrative criteria for water quality, per Oregon Administrative Rules 340-04; these include the following criteria relevant to this Project:

(1) creation of tastes or odors or toxic or other conditions deleterious to aquatic life or affecting the potability of drinking water or the potability of fish or shellfish;
(2) formation of appreciable bottom or sludge deposits or the formation of any organic or inorganic deposits deleterious to aquatic life or injurious to public health, recreation, or industry;
(3) objectionable discoloration, scum, oily sheens, or floating solids, or coating of aquatic life with oil films; and
(4) aesthetic conditions offensive to human senses of sight, taste, smell, or touch.

Water quality on the Oregon coast varies seasonally. During winter, temperatures of nearshore surface waters are generally around 9 to 10°C and salinities range from about 30 to 32 practical salinity units (PSU, Boehlert et al. 2008, Landry et al. 1989). Light transmission is higher during winter and decreases with the transition to spring/summer upwelling conditions, when phytoplankton blooms occur (Boehlert et al. 2008). Spring/summer upwelling results in a net transport of shallow water to the west, bringing deeper, colder, more saline water onto the inner shelf. Summer surface temperatures are about 8 to 14°C and salinities are about 30 to 32 PSU (Boehlert et al. 2008, Landry et al. 1989). Wind and wave conditions are relatively calm during the early spring (March and April), and early fall conditions (September and October) transition between oceanographic regimes (Boehlert et al. 2008).

Water quality data taken in proximity to the marine Project area are available in the ODEQ Laboratory Analytical Storage and Retrieval (LASAR) Database, and sediment quality data were reported during studies performed prior and subsequent to designation of the dredged material disposal areas offshore of Newport. Also, on June 10, 2003, ODEQ collected water quality data just west of PacWave South (Site ID 30223). Two readings were taken every half meter throughout the water column (e.g., near surface to near bottom at 60 m). The average is provided at three sampling depths in Table 3-4. Chlorophyll α, water temperature, dissolved oxygen concentrations, and transmittance differed most substantially near the surface. All parameters, with the exception of transmittance and salinity, typically decreased with increasing depth.

Table 3-4. Average water quality data from ODEQ Site 30223.

Parameter	Sampling Location		
	Near Surface (2 m)	Mid-Water (30 m)	Near Bottom (60 m)
Chlorophyll *a* (µg/L)	14.5	0.6	0.2
Dissolved oxygen (mg/L)	10.0	5.9	3.1
Salinity (ppt or PSU)	31.5	33.0	34.0
Temperature (°C)	12.0	8.2	7.5
Transmittance (percent)	76.0	94.0	93.5
Dissolved oxygen (percent saturation)	113.5	61.5	32.0

Source: ODEQ 2014. Notes: µg/L = micrograms per liter, mg/L = milligrams per liter, ppt = parts per thousand (equivalent to PSU), °C = degrees Celsius

Sediment samples were also taken from sites outside Yaquina Bay in various years from 1984 to 2000, mostly in summer and fall (USACE and EPA 2001). The 18 sample locations are in the open waters offshore of Yaquina Bay, an area that, like the test site and most of the cable route, has a uniform sand bottom. Metals concentrations detected in all samples were far below the screening levels outlined in the USACE's Sediment Evaluation Framework for the Pacific Northwest (USACE et al. 2009). All detected concentrations of organic compounds were either below the USACE's Sediment Evaluation Framework screening levels or below laboratory reporting limits.

Surface Waters

The state of Oregon identifies receiving waterbodies as water quality limited through a state biennial assessment report, as required by Section 305(b) of the CWA. Section 303(d) of the CWA requires that states (e.g., ODEQ) periodically prepare a list of all surface waters in the state for which beneficial uses, such as drinking, recreation, aquatic habitat, and industrial use are impaired by pollutants. The most recent list approved by the EPA for Oregon was in 2010, and was updated in 2012 (ODEQ 2012). Friday Creek or Buckley Creek was not listed as impaired by ODEQ (ODEQ 2012).

3.3.2.2 Environmental Impacts Related to Water Resources

Installation and operation of the Project is not expected to affect total dissolved gases, water temperature, circulation, or pH in the surrounding waters. Based on the scoping process, potential effects of the Project on water quality include the following:

- Effects of sediment suspension caused by anchor and cable installation on water quality;
- Effects of inadvertent return of drilling fluids; and
- Effects of toxins introduced by the Project on water quality, including:
    - Antifouling paint or coatings;
    - Accidental spills of fuel, lubricants, and hydraulic oil; and
- Effects of ground disturbing activities

Effects of Anchor and Cable Installation on Water Quality

As stated in Section 2.2.4, OSU would bury the subsea cables to minimize interaction with fishing gear (see Section 3.3.6) and reduce the exposure of marine resources to EMF emissions (see Section 3.3.3). However, the installation of the cables by jet plowing (or similar method) would cause sediment to become temporarily suspended into the water column, which could temporarily impact water quality. OSU would minimize the extent of substrate disturbance by using HDD to run the subsea cables from approximately the 10-m isobath to shore. Installation of anchors and the subsea connectors would also cause temporary suspension of sediment in the water column. Anchors placed on the seafloor surface, such as gravity anchors, would result in minimal sediment suspension, whereas anchors placed under the seafloor, such as embedment or suction anchors, would result in greater sediment suspension. Benthic sampling at both PacWave South and PacWave North indicate that substrate composition on the mid- to inner-shelf along this section of the Oregon coast consists of sand, with larger grain sizes found at greater depths (Henkel et al. 2014, Henkel 2016a).

Sediment transport modeling completed for the subsea cable installation for the Deepwater Wind Project off Block Island, Rhode Island (Tetra Tech 2012a), estimated that, in areas characterized by mostly coarse sand (particle diameter > 130 µm), sediment suspended during jet plow operations dropped quickly to the seafloor, and formation of major plumes would not occur in the water column. Suspended sediment concentrations within a few meters of the jet plow would be elevated, though outside of this nearfield zone, no concentrations would exceed 100 mg/L. Concentrations above 10 mg/L would be confined to an area primarily within 50 m (160 ft) of the jet plow route and would last for approximately 10 minutes. This modeling also estimated that sediment deposition would exceed 10 mm (0.4 in) immediately adjacent to the trench, and sediment re-deposition would not exceed 1 millimeter beyond 40 m (130 ft) from the plow path (Tetra Tech 2012a).

Sediment transport modeling conducted for the Virginia Offshore Wind Technology Advancement Project estimated that suspended sediment (particle diameter <200 µm) during subsea cable burying would extend vertically about 2 m above the trench and horizontally up to 100 to 160 m, sediment would deposit on the seafloor within 6 to 7 minutes, and sediment re-deposition would not exceed 1 mm within 100 m of the activity (BOEM 2014). Grain sizes at and inshore of PacWave South are larger (mean median grain size = 364 µm) than the grain sizes evaluated by the studies in Virginia and Rhode Island; accordingly, less suspension and faster settling are expected with cable laying, subsea connector installation, and anchor installation and removal at PacWave South.

It is expected that the local conditions at the PacWave South site will differ from those at the Rhode Island and Virginia sites. Different water depths, salinities, currents and other hydrodynamic forcing and water quality parameters all combine to affect the magnitude and extent of sediment advection and transport. In a simplified sense, though, coarse, non-cohesive sediments exist at all locations. Therefore, it is scientifically reasonable to assume that the sediments will settle out of suspension rapidly after re-suspension. Coarse sediments that are advected away from the site will also likely settle out rapidly. Fine sediments, if re-suspended, will be advected the furthest away before depositing.

Rough estimates of the settling velocity of grain sizes in the 200-600 µm diameter size range, the grain sizes at the PacWave South site, are 2.5 cm/s for 200 µm diameters and 8.5 cm/s for 600 µm diameters (Hallermeier 1981, Van Rijn 1984, both from Soulsby 1997). These are slightly conservative as they are based on ideal conditions where there is no water current or additional turbulence from construction activity or hindered settling. However, for a practical example, if these sediment grains were suspended 10 m into the water column as a result of the construction activities, it would take the 200 µm and 600 µm sediments approximately 6.5 minutes and 2 minutes to settle out of suspension, respectively, given the settling velocities above. The settling velocities would be affected by ambient current speeds, the range of particle sizes that will be resuspended, and any impacts of hindered settling, these settling estimates may vary, but are anticipated to remain on the order of a factor of 1-3 times the zero-flow settling velocities (i.e., less than 20 minutes).

Similar to cable deployment, subsea connector deployment and anchor installation and removal would be expected to result in a very temporary (minutes) and localized increase in turbidity. As with cable installation, subsea connector installation would only occur during initial Project construction. Anchor deployment would occur periodically over the life of the Project, but it would be infrequent because anchors would remain in place for the duration of the WEC deployment periods (which are expected to be 3-5 years). It is unlikely that anchors would be changed out during a WEC test due to the high costs associated with installing and removing them. Further, if an incoming WEC could use anchors already installed, the anchors could be left in place between tests.

In summary, the Project would result in only minor, short-term disturbance of sediments during deployment of the subsea connectors and cables, and sediment suspension caused by periodic installation and removal of anchors would be temporary and localized. Following these activities, it is expected that re-suspended sand would quickly settle; therefore, it is not expected that the Project would increase turbidity to the extent that it would degrade water quality. For these reasons, sediment suspension caused by the Project would not cause permanent or significant effects on water quality.

Effects of Inadvertent Return of Drilling Fluids

As stated in section 2.2.1, the subsea cables will be installed from approximately the 10-m isobath to shore using boring (HDD), and the terrestrial cables will be installed in up to five bores from the Driftwood Beach State Recreation Site parking lot to the UCMF. From the UCMF, a cable would also be buried by HDD west to, and under, Highway 101 to the grid connection point with the CLPUD overhead transmission line along the road; for this operation the HDD rig would be set up on the UCMF property. Boring is less intrusive than traditional open-cut trenching where habitats sustain direct soil disturbance. Between the start and end points, no environmental impacts are anticipated unless there is an accidental return of drilling fluids through an unidentified weakness or fissure in the soil (i.e., an inadvertent return). HDD uses a slurry, composed of a fine clay material such as bentonite, as a drilling fluid. The drilling fluids are non-toxic, but water quality can be temporarily impacted if it is released.

For this Project, the risks of an inadvertent return are being minimized by drilling deep below the Buckley Creek wetland system and the Highway 101 right-of-way. The plan is to drill through any unconsolidated sediments and terrace deposits and into moderate to higher strength sedimentary rock (e.g. Nye, Yaquina and Alsea Formations). The HDD bore is expected to reach depths of over 200 feet and will be in the moderate to higher strength rock when passing under the Buckley Creek wetland system and Highway 101. While the risks of an inadvertent return are extremely low, OSU will develop and implement an HDD Contingency Plan to minimize the potential for inadvertent return of drilling fluid, provide timely detection, and address potential releases by describing monitoring, containment, response and notification procedures to be implemented by the contractor. OSU also conducted additional wetland delineation surveys around Buckley Creek so that the location of the wetlands can be incorporated into any response plans.

In summary, the Project would have a low likelihood of inadvertent return of drilling fluids associated with subsea and terrestrial cable installation, which if it occurred, would result in only minor, short-term, localized impacts on water quality. It is not expected that the Project would cause permanent or significant effects on water quality or aquatic habitats.

Effects of Toxins Introduced by the Project on Water Quality

It is anticipated that mooring buoys and any subsurface floats would be treated with antifouling applications (i.e., paints and coatings) to prevent marine life from colonizing these components. Antifouling applications are commonly used in marinas, offshore structures, and ships (Schiff et al. 2007). Antifouling marine applications can leach copper, zinc, iron, and ethyl benzene over time, which could impact water quality (ODEQ 2011). Antifouling paints could leach from the Project site, or from the WECs in the Port of Newport when the WECs are moored dockside, as well as during transport from the Port of Newport to the test site. The Port of Newport is full of vessels many of which are coated in antifouling paint and are docked for months on end or that transit waters off the coast of Oregon. Developers are likely to be using Port of Newport dockage or other commercial facilities within Yaquina Bay that have been designed, permitted and are used for dockage. Antifouling paints are already present and in use on vessels and structures in the Port of Newport and nearshore marine waters.

Accidental spills of hazardous materials (e.g., fuel) from vessels used during construction and operation, or from the WECs themselves, are not expected, but may occur. Accidental spills of hazardous material may possibly occur from Project-support vessels or WECs in the Port of Newport or during transit from The Port of Newport to the test site. The Project could also result in an accidental spill of hazardous materials associated with terrestrial construction activities. Construction activities require the use of fuel and other chemicals, such as coolants, hydraulic fluids, and brake fluids, to operate heavy equipment and vehicles.

To minimize effects on water quality from toxins introduced by the Project, OSU would implement the following environmental measures:

- Follow industry best practices and guidelines[9] for antifouling applications (e.g., TBT-free) on Project structures such as marker buoys, subsurface floats and WECs.
- Develop and implement an Emergency Response and Recovery Plan (Appendix G) with spill prevention, response actions, and control protocols, as well as and provisions for recording types and amounts of hazardous fluids contained in WECs and other Project components.
- Require all vessel operators to comply with an Emergency Response and Recovery Plan (Appendix G) for installation and maintenance of Project facilities.
- Prepare waste management, hazardous material, and spill prevention plans, as appropriate, for onshore Project facilities.
- Minimize storage and staging of WECs outside of existing dock, port or other marine industrial facilities.

OSU would also obtain a Water Quality Certificate in compliance with the Clean Water Act, as related to the FERC license, the BOEM lease, and the Section 404 permit from the USACE.

A number of vessels, including tugs, installation vessels, and other workboats would be used for the construction, operation, and maintenance of the Project. These vessels contain fuel, hydraulic fluid, and other potentially hazardous materials, and as noted above, OSU would require vessel operators used for installation and maintenance to have vessel-specific spill response plans.

Although WECs are designed for survivability at sea and to minimize the potential for leaks, they can contain fluids toxic to marine life, such as hydraulic fluid. The volume of fluids used in each WEC would be expected to be relatively small. For example, the WEC deployed at PacWave North in 2012 contained less than 25 gallons of hydraulic fluid (DOE 2012). Reedsport Ocean Power Technologies' (OPT) PB150, a point absorber WEC, would contain 198 to 264 gallons of hydraulic fluid; by comparison, an average commercial crabbing boat contains 10,000 to 30,000 gallons of diesel fuel (Reedsport Ocean Power Technologies [OPT] Wave Park, LLC. 2010). In addition, OSU would develop and implement an Emergency Response and Recovery Plan that includes provisions for recording the types and amounts of hazardous fluids contained

[9] Industry standards are sometimes published in written documents (e.g., the International Cable Protection Committee's cable recommendations available at https://www.iscpc.org/publications/recommendations/) or in manufacturer guidelines (e.g., for a vessel anchor, providing the recommended ratio of water depth to anchor line paid out). These standards are sometimes required as a condition of insurance or warranty. In other cases, industry standards represent unpublished best practices commonly implemented by a particular industry and that evolve over time.

in WECs to ensure that appropriate measures and procedures are in place to prevent and respond to accidental spills or leaks.

Petroleum-based contaminants, such as fuel, oil, and some hydraulic fluids, contain polycyclic aromatic hydrocarbons, which can kill fish and marine life at high levels of exposure and cause sublethal effects such as compromised immune response, increased susceptibility to pathogens, reduced reproductive success and reduced growth rates at lower concentrations (Arkoosh and Collier 2002, Spromberg and Meador 2006). Exposure to dissolved copper at relatively low concentrations has been shown to impair the olfactory sense in freshwater fish, resulting in an impaired avoidance of predators and may also reduce growth rates. In freshwater or sterile seawater, these effects were seen at concentrations between 1-3 μg/L over varying exposure durations, but in saltwater with a normal load of dissolved organic material, copper ions bind with dissolved organic material, decreasing the bioavailability of copper and partially protecting organisms against copper's neurotoxicity (Hecht et al. 2007, City of San Jose 2005).

The Project test site is 65 to 79 m deep; at this depth ocean advection along the continental shelf would quickly dissipate any toxins released from antifouling applications, preventing them from reaching high concentrations, and there is good understanding of the potential effects certain chemicals may have if leached into the marine environment because each commercially available paint and coating has undergone rigorous approval testing and processes (Copping et al. 2016). Concentrations of antifouling substances in sediment and the adjacent water column depends on the water flow and on specific characteristics such as whether the body of water is enclosed (e.g., harbors and marinas), the number of vessels/area with antifouling coatings; typically, higher concentrations are found in enclosed waters such as bays and harbors, where there are a large number of commercial and recreational vessels docked, and lower in the open ocean (Konstantinou and Albanis 2004). In addition, the sandy bottom at PacWave South reduces the likelihood that antifouling paint contaminants would adhere to the sediment or reentering the water column.

For OPT's proposed wave energy project off Reedsport, Oregon, the ODEQ concluded that the concentration of constituents released from antifouling paint from 10 WECs and associated subsurface floats would be well below the water quality criteria (both chronic and acute criteria) to protect marine life (where applicable), as shown in Table 3-5 (ODEQ 2011, FERC 2010, Reedsport OPT, LLC 2010). This conclusion is relevant to both the initial development scenario (six WECs) and the full build-out scenario (20 WECs) at PacWave South as the Project site would be at similar depth to the Reedsport project and exposed to similar current patterns of the OCS. For example, considering there would be 20 WECs at PacWave South, doubling the calculated concentrations for the 10-WEC project shown in Table 3-5, yields values well below the standards.

Table 3-5. Constituent concentration comparison with criteria for 10-WEC Reedsport OPT Wave Park.

Constituent Name	Calculated Concentration with Project Boundary (µg/l/day)	Calculated Concentration with Project Boundary (µg/l) over 4 days	Protection of Aquatic Life*	
			Marine Chronic Criteria (µg/l)	Marine Acute Criteria (µg/l)
Total Copper	0.02	0.08	2.9	2.9
Total Zinc	0.09	0.36	95	86
Total Iron	0.01	0.04	NA	NA
Ethyl Benzene	0.0	0	NA	NA

* The acute criteria refer to the average concentration for one (1) hour and the chronic criteria refer to the average concentration for 96 hours (4 days), and that these criteria should not be exceeded more than once every three (3) years.
Source: ODEQ 2011

According to a 2013 BOEM study on the environmental risks, fate, and effects of chemicals associated with offshore wind turbines on the Atlantic OCS (Bejarano et al. 2013), the likelihood of catastrophic spills would be very low (one time in 1,000 years). Even in the highly unlikely event of an accidental release, the most likely types of releases for the wind turbines would be up to a few thousand gallons of oil. Bejarno et al. (2013) stated that these releases would cause minimal effects to water quality and that they would be limited spatially and temporally to the vicinity of the point of release. WECs and infrastructure have been deployed since 2003 at the Wave Energy Test Site at Marine Corps Base Hawaii, and there has been no evidence of significant effects on marine water quality resulting from deployment and operation (Naval Facilities Engineering Command [NAVFAC] 2014). In the *State of the Science Report: Environmental Effects of Marine Renewable Energy Development Around the World*, the risk associated with chemical leaching from coatings, or from accidental spills, was rated as “low” for small-scale and large-scale commercial marine energy projects (Copping et al. 2016). Accidental release of oil or toxic substances is unlikely to occur because OSU will develop and implement an Emergency Response and Recovery Plan (Appendix G) that includes spill prevention and control protocols to minimize the potential for and, if needed, respond to accidental release of oils and toxic chemicals into the marine environment.

Antifouling paints could leach from the WECs in the Port of Newport when they are moored dockside or while being transported from the Port of Newport to the test site and accidental spills of hazardous material could occur from Project-support vessels or WECs in the Port of Newport or during transit from the Port of Newport to PacWave South, but effects are expected to be negligible. Newport is full of vessels, many of which are coated in antifouling paint and are docked for months on end or that transit waters off the coast of Oregon. Developers are likely to be using Port of Newport dockage or other commercial facilities within Yaquina

Bay that has been designed, permitted and is used for dockage. Thus, antifouling paints are already present and in use in the Port of Newport and nearshore marine waters.

To summarize, there is a negligible mechanism of effect of the Project to water quality or beneficial uses of the waters in the Project area. The concentrations of antifouling paints in the marine environment due to the Project are expected to be undetectable. Spill control and response measures proposed by OSU would greatly reduce the likelihood that a spill of hydraulic fluids or other petroleum-based contaminants would be large enough to adversely affect more than a few individual fish, or to affect habitat function. In addition, the location of PacWave South in the open ocean further minimizes the likelihood of impacts, because any minor effects on water or sediment quality would quickly dissipate. Occurrence of many species are likely to be low and/or short-term/transitory in the Project area, thus their potential exposure to toxic substances, if they are released, would likely be very low. For these reasons, toxic substances are not expected to adversely affect marine life that could be in the Project area.

Effects of Ground Disturbing Activities

OSU will avoid ground disturbing activities along the terrestrial cable route by using HDD for installation, and by avoiding construction impacts near Friday Creek at the entrance to the Driftwood Beach State Recreation Site (no streams are located at the UCMF site). Indirect impacts on water quality could occur during ground disturbing activities at the Driftwood Beach State Recreation Site and UCMF site if sediment-laden runoff from construction work areas enters streams and results in increased turbidity. These potential impacts would be avoided by developing and implementing an Erosion and Sediment Control Plan and implementing appropriate BMPs (e.g., minimizing impacts to wetlands by maintaining buffers around wetlands, and maintaining natural surface drainage patterns).

3.3.3 Aquatic Resources

3.3.3.1 Affected Environment

Marine Vegetation and Algae

Marine plants offshore the coast of Newport are nonvascular and include phytoplankton and sessile algae. Phytoplankton are simple free-floating uni- and multi-cellular organisms like cyanobacteria, diatoms, dinoflagellates, silicoflagellates, and coccolithophorids. Sessile algae, commonly termed seaweeds, include many species of large brown, green, and red algae. Sessile algae occur in rocky intertidal and subtidal areas of the coast within the photic zone (water depths to which sunlight can penetrate), generally a maximum of 25 m depth (ODFW 2006). The largest such algae include several species of brown kelp, that along the Oregon coast consist almost exclusively of bull kelp, which grows subtidally. Kelp is valued commercially as a raw material and provides habitat for protected fish species (USACE and EPA 2001, 2008). As a result, canopy kelp has been identified as a HAPC (NOAA 2014c).

No hard or rocky substrate is known to occur within the vast majority of the Project area. Rocky geology with the potential to support kelp growth is present in the nearshore area to the north of the subsea cable route. OSU does not expect macrophytes to occur in the Project area because it is primarily deep and sandy, though some macrophytes could occur near any rocky areas in the shallows near shore. Bull kelp, native eelgrass, sea palm, and surf grass are the four species of macrophytes identified in the ODFW's *Oregon Nearshore Strategy* (ODFW 2016).[10] Bull kelp occurs in shallow reef areas. Eelgrass occurs only in intertidal and shallow subtidal habitat with soft sediment and adequate light. Sea palm occupies high-energy rocky shores. Surf grass (*Phyllospadix* spp.) typically occurs in mixed rocky/sandy shores. The cable route has been sited to avoid these habitats, so these species are not expected to occur along the cable route.

Zooplankton, Crab Larvae, and Fish Larvae

The zooplankton community offshore of central Oregon consists of small invertebrate organisms that either spend their entire life cycle in the water column (holozooplankton) or spend only a brief developmental time in the water column before a metamorphosis to an adult life in a nektonic or benthic habitat (merozooplankton). Species composition changes seasonally and is also influenced by various periodic and episodic factors including prevailing ocean currents, coastal upwelling, and offshore wind direction. The coastal zooplankton community offshore of central Oregon is dominated by copepods (EPA 2008, 2009, *cited in* Peterson and Keister 2003). Of the total 58 copepod species reported as being present in these waters, only eight occur throughout the year, seven occur only during the summer, and six occur only in the winter. Abundance is typically lower in the winter than in the summer. During summer, when the offshore winds blow predominantly from the northwest, surface waters move southward and offshore, allowing the deeper, colder, more saline, and nutrient-rich waters to upwell along the

[10] The *Oregon Conservation Strategy* and its marine component, the *Oregon Nearshore Strategy*, provide a conservation blueprint for actions to benefit Oregon's native fish and wildlife and their habitats. The Nearshore Strategy does not create or recommend any specific regulations, but rather, it presents recommendations that prioritize ODFW's management of marine fish and wildlife and identifies potential areas of opportunity for other public or private entities, state and local agencies, and tribes to contribute to the sustainability of Oregon's nearshore resources. Using these criteria, 53 Strategy Species were designated, based on the species status (overharvested, rare, declining population, etc.), ecological importance, vulnerability to human or natural factors, and economic, social and cultural importance fisheries, tribal significance, etc.

coast. Between January and May, the megalops larvae of the Dungeness crab are abundant inshore (DOE 2012).

The plankton community offshore of Oregon also includes gelatinous planktonic animals such as jellyfish, salps, doliolids, and ctenophores. Jellyfish, including the brown sea nettle, may be numerous in certain locations in summer and fall (NMFS 2012c).

In general, species assemblages of fish larvae in Oregon are classified into three categories: coastal, transitional, and offshore. Of these, species belonging to the coastal assemblage occur in the Project area and are typically dominated by smelt larvae, accompanied by English sole, sand lance, sanddab, starry flounder, and Pacific tomcod larvae (DOE 2012). The highest fish larval abundance typically occurs between February and July (USACE and EPA 2001). Northern anchovy, slender sole, rockfish, northern lampfish, and blue lanternfish are the dominant taxa along the Newport Hydrographic Line (43.65°N), which is a major long-term regional monitoring line, and includes a NOAA zooplankton sampling transect that runs west of Newport for approximately 200 miles (Auth et al. 2007).

Benthic Invertebrates

Benthic invertebrate communities inhabiting the nearshore marine environment provide important secondary production in marine food webs and are integral to the breakdown and recycling of organic material in the marine ecosystem. They also provide a key food source for important commercial and recreational fish and macroinvertebrate species like Dungeness crab, as well as for other protected or managed fish species.

OSU has conducted surveys at least three times per year for 5 years at PacWave North, and EPA's Ocean-Dredged Material Sites dredge disposal monitoring has also occurred in the area since 1986. Therefore, the range of variability in species composition and abundance in the area and seasonal and inter-annual patterns are well characterized. To further characterize the bottom type in and around the Project area and describe the presence and abundance of macrofaunal invertebrate species, benthic habitat stations at PacWave South and PacWave North were surveyed from 30 to 60 m from August 2013 to June 2015 (8 total surveys), and in 2015 a 70 m station was added at the test site, which was surveyed in April and June (Figure 3-6) (Henkel 2016a).

Thirty-nine macrofaunal taxa were collected during box core sampling in 2013 (selected to show representative data) at PacWave South (approximately 60 m depth) and 117 macrofaunal taxa were collected in the larger benthic study area (30-60 m depths, Figure 3-6). Abundance of species with more than 10 organisms collected during the 2013 sampling from 28 0.1-m^2 grabs is summarized in Table 3-6. Polychaetes were the most abundant taxa at the Project site. The macrofaunal species assemblages identified at PacWave South were consistent with those collected at PacWave North over the same time period (2013-2015), and they varied in response to depth and median grain size (Henkel 2016a). Two major "assemblages" of macro-invertebrates were described for the vicinity of PacWave South: a deeper, larger grain size-associated assemblage, and a smaller grain size-associated assemblage. At 50 m, two different assemblages were detected; however the stations with larger median grain size (PUD and SBC; Figure 3-6) had similar invertebrates to the 60 m stations. This suggests that, at these depths, differences in species assemblage are more strongly related to the sediment characteristics than the specific depth (Henkel 2016a).

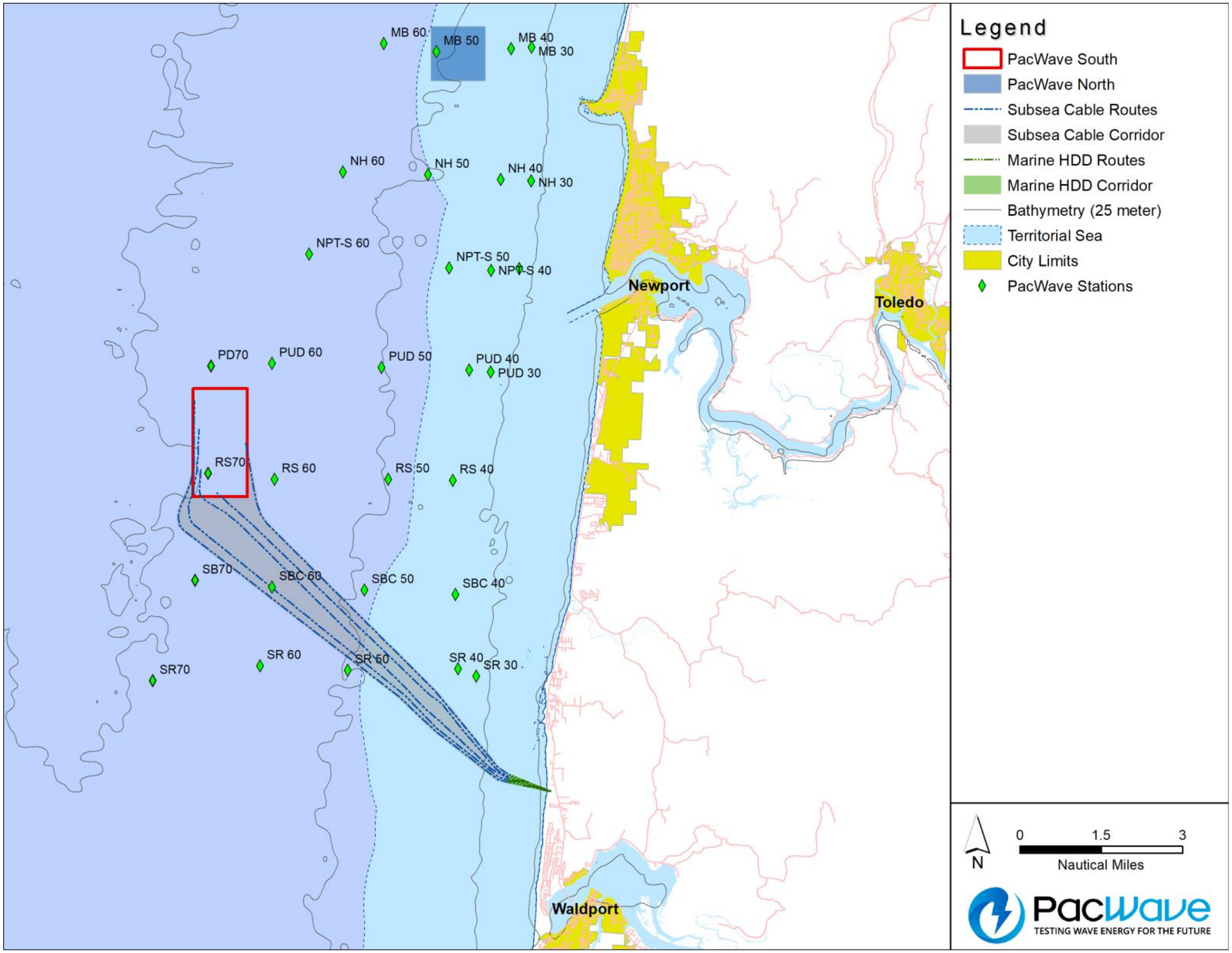


Figure 3-6. OSU sampling stations at PacWave South and vicinity (2013-2015).

Table 3-6. Most abundant invertebrates (more than 10 organisms) collected in 2013 at depths ranging from 30-60 m.

Species	Total	PacWave South	Species	Total	PacWave South
Molluscs – Bivalves			**Polychaetes**		
Acteocina sp.	13		*Axiothella rubrocincta*	25	6
Axinopsida serricata	286	8	*Chaetozone bansei*	59	
Macoma carlottensis	28		*Chaetozone* sp.	21	
Nutricola lordi	663	56	*Euclymeninae* juv	31	7
Tellina nuculoides	74	20	*Glycera oxycephala*	20	9
Molluscs – Gastropods			*Glycinde armigera*	10	1
Alia gausapata	51	1	*Heteromastus filiformis*	11	1
Callianax baetica	59	11	*Leitoscoloplos pugettensis*	12	
Callianax biplicata	26		*Magelona sacculata*	339	
Callianax pycna	67		*Mediomastus californiensis*	19	
Cylichna attonsa	118	8	*Nephtys caecoides*	75	3
Crustaceans			*Nephtys* sp. juv	45	5
Ampelisca careyi	53	2	*Notomastus latericeus*	10	1
Balanus crenatus	20		*Onuphis iridescens*	23	
Bathycopea daltonae	10		*Ophelia assimilis*	165	43
Cheirimedeia cf. macrodactyla	26		*Phyllodoce hartmanae*	28	5
Cheirimedeia macrocarpa ss. americana	24		*Scolelepis squamata*	83	31
Cylindroleberididae	11	1	*Spio cf. thulini*	111	1
Diastylopsis dawsoni	14	14	*Spiophanes berkeleyorum*	43	
Eohaustorius sawyer	30		*Spiophanes norrisi*	3,685	173
Gibberosus myersi	7	3	**Nemerteans**		
Majoxiphalus major	43		*Carinoma mutabilis*	100	1
Photis macinerneyi	21		*Micrura* sp.	14	2
Rhepoxynius vigitegus	22		*Tubulanus* sp. A	20	2
			Echinoderms		
			Dendraster excentricus	151	
			Phoronids		
			Phoronis sp.	44	

Note: Results presented are number of organisms collected for larger Project vicinity (*Total*, 28 grab samples) and within the Project Site (*PacWave South*, 4 grab samples).

Principal findings from benthic monitoring (box cores, trawls, and videography) at PacWave North from May 2010 to December 2011 (10 total surveys; Henkel 2011) included:

- Two distinct sediment types: silty sand at approximately 30 m, and potentially shallower; and nearly pure sand at 40 m and deeper;
- Distinct macrofaunal invertebrate assemblages occur in the two sediment types;
- Distinct macrofaunal invertebrate assemblages occur at the deeper stations; and
- Mysid and crangonid shrimp are highly abundant and likely form the basis of the food web in this nearshore zone, as opposed to the euphausiid (krill)-supported food web farther offshore.

The soft-bottom habitat of PacWave South is also used by crabs, and the use and distribution of Dungeness crab are of particular interest due to its high value as a commercial fishery. Red and Pacific/brown rock crabs are also high value species that may occur near the Project area but these species prefer harder substrates such as the areas surrounding the Seal Rock Reef.

OSU conducted 8 sampling trips in 2013-2015 to characterize crab use near the Project area and vicinity by deploying modified crab pots to measure along-shelf and cross-shelf crab distribution (Henkel 2016b). Within the 40-m contour, there were no differences in crab abundance between the Project area and stations to the north or south; likewise, within the 60-m contour, there were no differences between the Project area and stations to the north or south. There were significantly more crabs collected from the 40-m stations than at the 60-m stations. There were some temporal differences in the number of crabs collected, the ratio of males to females, and the size of collected crabs; however, no consistent seasonal patterns were apparent.

ODFW identified 14 invertebrate species as strategy species under its Oregon Nearshore Strategy: blue mud shrimp, California mussel, Dungeness crab, flat abalone, native littleback clam, ochre sea star, Olympia oyster, Pacific giant octopus, purple sea urchin, razor clam, red abalone, red sea urchin, rock scallop, and sunflower star (ODFW 2016). Most of the invertebrates are associated with rocky shore or rocky subtidal habitat and therefore a low likelihood that these rocky habitat associated species would regularly occur in the Project area. Dungeness crab and giant octopus area associated with soft bottom habitats and are expected to regularly occur in the Project area. Similarly, razor clams occur in sandy beaches like the beach areas that would be crossed by the subsea cable.

Fish

Marine Project Area

The nearshore and offshore regions of the Project area encompass soft bottom subtidal habitats and the open water pelagic environment and are in the vicinity of rocky bottom habitats. This area, therefore, supports a variety of fish species that typically inhabit all three habitats with frequent movement of fishes between them. Typical fish species that inhabit these areas are discussed below. Although hard bottom substrate is not known to be present in the Project site or along the cable route, natural subtidal reefs closer inshore of the test berths and to the north of the cable route support pelagic and benthic fish communities that are associated with rocky, rather than soft, substrates.

Fish species commonly observed in sandy and soft bottom areas offshore of the coast of Newport include English sole, butter sole, Pacific sanddab, speckled sanddab, and starry flounder (USACE and EPA 2010, Henkel 2011). Other fish species commonly associated with shallow and deep soft bottom habitats include bat ray, calico surfperch, grunt sculpin, lumptail sea robin, Pacific electric ray, Pacific hooker sculpin, pricklebreast poacher, pygmy poacher, roughback sculpin, saddleback gunnel, sailfin sculpin, sharpnose sculpin, silver surfperch, spotfin surfperch, sturgeon poacher, tubesnout, walleye surfperch, and white surfperch (ODFW 2006). Sampling at PacWave North found butter sole, English sole, and speckled sanddab as the most abundant species during the spring and fall in 2012 (Table 3-7), which may also be representative of the fish species that occur at PacWave South.

Table 3-7. Total number of fish (by species and month) collected in 2012 beam trawl tows at PacWave North.

Common name	Scientific name	June (9 tows)	September (9 tows)	November (7 tows)
Butter sole	*Isopsetta isolepis*	130	20	6
English sole	*Parophrys vetulus*	77	47	56
Speckled sanddab*	*Citharichthys stigmaeus*	80	149	65
Pacific sanddab*	*Citharichthys sordidus*	9	35	23
Sanddab spp.*	*Citharichthys* spp	36	7	3
Sand sole	*Psettichthys melanostictus*	37	7	1
Pacific Tomcod	*Microgadus proximus*	43	46	0
Pacific sand lance	*Ammodytes hexapterus*	3	4	0
Whitebait smelt	*Allosmerus elongatus*	0	12	0
Juvenile smelt	*Osmeridae* spp.	2	0	0
Pacific staghorn sculpin	*Leptocottus armatus*	1	3	0
Showy snailfish	*Liparis pulchellus*	1	0	0
Snailfish sp.	*Liparidae* spp.	2	0	0
Warty poacher	*Chesnonia verrucosa*	5	0	1
Tubenose poacher	*Pallasina barbata*	0	0	2
Big skate	*Raja binoculata*	0	1	2

Common name	Scientific name	June (9 tows)	September (9 tows)	November (7 tows)
Spotted ratfish	*Hydrolagus colliei*	0	1	0
Rex sole	*Glyptocephalus zachirus*	1	0	0
Dover sole	*Microstomus pacificus*	0	1	0
Bay pipefish	*Syngnathus leptorhynchus*	0	1	1
Canary rockfish	*Sebastes pinniger*	0	1	0

Note: *Reduction in sanddab spp. from June to September and increased numbers of speckled and Pacific sanddab is because fish were larger later in the year and able to be identified to species. The same transition is the case for smelt.

Rocky subtidal or hard bottom habitats typically experience a wide variety of wave and current regimes, substrates, depths, and food sources, producing diverse biological communities (ODFW 2006). Rocky reefs provide important habitat for fish species that include sculpins, surf perch, and rocky reef fishes. Shallow reefs up to 20 m (66 ft) in depth are dominated by black rockfish, while deeper reefs (20-50 m) are dominated by lingcod, yellow rockfish, and black rockfish (USACE and EPA 2001). Although areas of rocky subtidal habitat are located outside the Project area, juvenile lingcod and rockfish would likely use pelagic and soft bottom habitats, and older mature fish typically associated with rocky subtidal habitats would often be found swimming in the deeper soft bottom regions. For example, reef associated canary rockfish and tubenose poacher were captured in low numbers during beam trawls at PacWave North (Table 3-7). Accordingly, lingcod and rockfish may be present in the Project area to a limited extent.

A number of environmental factors affect the fish species present in the pelagic zone, including light penetration, water temperature, proximity to river plumes, and underwater currents (ODFW 2006). Pelagic species commonly found in the area include Pacific herring, northern anchovy, and Pacific Ocean perch. The area is also used by salmon, steelhead, and shad that migrate alongshore, including some stocks that migrate through the Yaquina Bay estuary to spawn upriver (USACE and EPA 2001).

The species predominantly caught by sport fisheries in ocean waters outside of the Port of Newport and to the immediate north and south, including the Project site, consist of various species of rockfish, salmon, lingcod, tuna, and Dungeness crab. Pacific halibut and salmon fishing are the most popular recreational fishing activities (Pacific Recreational Fishing Information Network from the years 2004 to 2009 *cited in* DOE 2012). Commercial and recreational fishing are further discussed in Section 3.3.6. Federally listed species are discussed in Section 3.3.5.

Oregon has its own ESA that requires state agencies to protect and promote the recovery of state listed endangered or threatened species. Aquatic species listed under Oregon's ESA that may occur in the Project area comprise Lower Columbia River Coho salmon (endangered), Snake River Chinook salmon (threatened), green sea turtle (endangered), leatherback sea turtle (endangered), loggerhead sea turtle (threatened), and the Pacific Ridley sea turtle (threatened; ODFW 2018). These species are also federally listed and discussed in Section 3.3.5.

Oregon also identifies fish species in its Oregon Nearshore Strategy for special management consideration; these include the bony and cartilaginous fish listed in Table 3-8 (ODFW 2016). In general, fish species associated with neritic and soft bottom subtidal habitat are most likely to occur in the Project area. However, some fish species associated with rocky habitat may still use soft bottom habitat, like those present in the Project area, for some portion of their life history. Therefore, all fish species identified in the Oregon Nearshore Strategy could be present in the Project area at some time with the possible except of wolf eel, which are solely associated to rock reef habitat.

Table 3-8. Strategy Species habitat usage, by life history phase: Adult (A), Spawning/Mating (S/M), Eggs/Parturition (E/P), Larvae (L), Juveniles (J).

Strategy Species	Rocky Shore	Sandy Beach	Rocky Subtidal	Soft Bottom Subtidal	Neritic	Estuarine	Habitat Unknown	Comments
Big skate *Raja binoculata*				A, S/M, E/P, J				Soft seafloor spawning habitat. May be affected by wave energy development.
Black rockfish *Sebastes melanops*	J		A, J	J	A, L, J	A, J	S/M, E/P	
Blue rockfish *Sebastes mystinus*	J		A, S/M, J	J	L, J	J	E/P	
Brown rockfish *Sebastes auriculatus*			A, S/M, E/P, J			A, S/M, E/P, L, J		
Cabezon *Scorpaenichthys marmoratus*	J		A, S/M, E/P, J		L, J	A, S/M, E/P, L, J		
Canary rockfish *Sebastes pinniger*	J		A, E/P, J	J	L, J		S/M	Will inhabit artificial reefs.
China rockfish *Sebastes nebulosus*			A, E/P, J		L, J		S/M	Will inhabit artificial reefs.
Chinook salmon *Oncorhynchus tshawytscha*			A		A, J	A, J	A, J	Anadromous; substantial data gaps regarding habitat usage in nearshore waters; sometimes caught near rocky reefs and in open neritic waters.
Chum salmon *Oncorhynchus keta*					A, J	A, J	A, J	Anadromous; substantial data gaps regarding habitat usage in nearshore.
Coastal cutthroat trout *Oncorhynchus clarki clarki*					A, J	A, J	A, J	Anadromous; substantial data gaps regarding habitat usage in nearshore waters.
Coho salmon *Oncorhynchus kisutch*					A, J	A, J	A, J	Anadromous; substantial data gaps regarding habitat usage in nearshore waters.
Copper rockfish *Sebastes caurinus*			A, J	J	E/P, J	A, S/M, E/P, L, J		Will inhabit artificial reefs.
Deacon rockfish *Sebastes diaconus*	J		A, S/M, J	J	A, L, J	A, J	J	Newly described cryptic species found in OR waters.
Eulachon *Thaleichthys pacificus*					A, L, J	A, L		Anadromous; spawn in fresh water. Also school offshore.
Grass rockfish *Sebastes rastrelliger*	J		A, E/P, J	J	L			Shallow rocky reefs; sometimes found in tidepools.

Strategy Species	Rocky Shore	Sandy Beach	Rocky Subtidal	Soft Bottom Subtidal	Neritic	Estuarine	Habitat Unknown	Comments
Green sturgeon *Acipenser medirostris*	A		A	A	A	A, S/M, E/P, L, J		Northern DPSlisted as species of concern. Uses all nearshore waters and estuaries. Most marine-oriented of sturgeon species.
Kelp greenling *Hexagrammos decagrammus*			A, S/M, E/P, J		L, J	A, S/M, E/P, L, J		Will inhabit pilings and jetties.
Lingcod *Ophiodon elongatus*			A, S/M, E/P, J	A, J	L, J	A, S/M, E/P, L, J		Will inhabit pilings and jetties.
Longfin Smelt *Spirinchus thaleicthys*					A, J	A, J		Anadromous fish that utilizes estuaries and coastal waters but spawns in freshwater rivers. Life cycle requires estuarine conditions. Only known to occur in waters near Columbia River, Yaquina Bay, and Coos Bay in Oregon and those estuaries and rivers
Northern anchovy *Engraulis mordax*					A, S/M, E/P, L, J			Pelagic forage fish; commonly found in nearshore kelp beds and bays.
Pacific herring *Clupea pallasii*					A, J	A, S/M, E/P, L, J		Pelagic forage fish. Utilizes estuary spawning habitat in OR.
Pacific lamprey *Entosphenus tridentatus*							A	Anadromous. Requires fine gravel beds in freshwater for spawning. Gaps in knowledge of habitats used in marine life history phase.
Pacific sand lance[2] *Ammodytes hexapterus*		S/M, E/P			A, L, J			
Pile perch *Rhacochilus vacca*			A	A		A	S/M, E/P, J	Rocky shores; around kelp, pilings and underwater structures. Unknown habitat associations for some life history stages.
Quillback rockfish *Sebastes maliger*			A, E/P, J	J	L, J	A, S/M, E/P, L, J		Will inhabit artificial reefs.
Redtail surfperch *Amphistichus rhodoterus*				A		S/M, J	E/P	Juveniles and adults found in estuaries along CA and OR coasts. Unknown habitats for some life history stages. Estuaries and sandy surfzone.
Rock greenling *Hexagrammos lagocephalus*			A, E/P, J	A		S/M, J	E/P	Found in subtidal algae beds and rocky reefs during spawning.
Shiner perch *Cymatogaster aggregata*			A	A		A, J	S/M, E/P	Adults are common in estuaries as prey for salmonids.

Strategy Species	Rocky Shore	Sandy Beach	Rocky Subtidal	Soft Bottom Subtidal	Neritic	Estuarine	Habitat Unknown	Comments
Spiny dogfish *Squalus acanthias*			A, J	A, E/P, J	A, S/M, J	A, E/P, J		
Starry flounder *Platichthys stellatus*			L, J	A, S/M, J	E/P, L	A, S/M, E/P, L, J		Will inhabit areas with pilings.
Striped perch *Embiotoca lateralis*			A, J		A	A, J	S/M, E/P	Unknown habitats for most life history stages.
Surf smelt *Hypomesus pretiosus*		S/M, E/P		S/M	A, L, J	A		Extremely specialized habitat requirements for spawning beaches (temperature for substrate and air, light). Intertidal spawning habitat on beaches.
Tiger rockfish *Sebastes nigrocinctus*			A				S/M, E/P, L, J	Rocky reefs. Note that this is designated shelf rockfish in federal FMP, but defined as nearshore fish in ORS and is a component of both commercial and sport fishery harvest in nearshore waters. Will inhabit artificial reefs.
Topsmelt *Atherinops affinis*			A	A	A, J	A, S/M, E/P, L, J		Specialized spawning habitat in shallow waters with vegetation for eggs to adhere to.
Vermilion rockfish *Sebastes miniatus*			A, J	J	L, J		S/M, E/P	Rocky reefs; life stage history gaps. Will inhabit artificial reefs.
Western river lamprey *Lampetra ayresii*							A	Anadromous. Movements and habitat use of adult life stage for the approximately 10 weeks they are in marine habitats are poorly understood, but thought to be limited to nearshore and estuarine areas.
White sturgeon *Acipenser transmontanus*				A		A, L, J		Anadromous. Movements in marine habitats poorly understood.
Wolf-eel *Anarrhichthys ocellatus*			A, S/M, E/P, J		J		L	Benthic, rocky subtidal.
Yelloweye rockfish *Sebastes ruberrimus*			A, E/P, J				S/M, L	Will inhabit artificial reefs. Juvenile usage of nearshore.
Yellowtail rockfish *Sebastes flavidus*	J		A, S/M, E/P, J	A, S/M, E/P, J	L, J			Juvenile usage of nearshore.

Source ODFW 2016.

Surface Waters

The terrestrial Project area is located in the Beaver Creek-Waldport Bay watershed (HUC 1710020505), a subunit of the Northern Oregon Coast watershed. Aquatic habitat in the watershed is limited by factors including spawning gravel quantity, summer rearing habitat complexity, and large wood (OWEB 2008). Streams in the Project area are low-gradient with high sediment loads and highly vegetated banks. One fish-bearing stream was identified in Driftwood Beach State Recreation Site during a wetland and waterway survey in May 2016 and June 2017. In addition to Friday Creek, two other fish-bearing streams, Buckley Creek and "Stream 4", were also identified during the 2019 wetland and waterway along the terrestrial HDD corridor (Figure 3-5). Buckley Creek is reported by ODFW to support anadromous coastal cutthroat trout (*Oncorhynchus clarkia clarkii* [Kelly 2016]) (HDR 2019). OSU will avoid ground disturbing activities along the terrestrial cable route by using HDD for installation, and by avoiding construction impacts near Friday Creek at the entrance to the Driftwood Beach State Recreation Site (no streams are located at the UCMF site). Implementation of an Erosion and Sedimentation Control Plan will prevent construction related impacts to the stream. See Section 3.3.2.1 and the Wetland Delineation Report in Appendix C for additional details of each stream.

In addition to cutthroat trout, typical freshwater fish species known to occur in smaller streams in the Middle Coast basin include Pacific and brook lamprey, several species of dace, redside shiner, squawfish, chum salmon, coho salmon, rainbow trout, summer and winter steelhead, several species of sculpin, and suckers (ODFW 1972). Regional ESUs of chum salmon, coho salmon, and steelhead are all listed under the ESA and are discussed in detail in Section 3.3.5.1.

Marine Mammals

Marine mammals potentially present in the Project area include cetaceans (whales, dolphins, and porpoises), pinnipeds (seals and sea lions), and possibly, sea otters. Table 3-9 lists marine mammal species expected to occur in the OCS waters off Oregon, although many of these species are infrequent visitors to nearshore waters off of Oregon. The Pacific harbor seal is the most commonly observed pinniped in Oregon, with Steller sea lions present year-round in smaller numbers. Male California sea lions are commonly seen in Oregon from September through May, but female sightings are rare in Oregon. Northern elephant seals are occasionally observed in Oregon coastal areas (ODFW 2011). Figure 3-7 shows pinniped haul-out locations and gray whale sightings along the Oregon coast in the Project area. The California sea lion, gray whale, harbor porpoise, killer whale, northern elephant seal, Pacific harbor seal, and Steller sea lion are designated as Strategy Species in the Oregon Nearshore Strategy (Krutzikowsky et al. 2016).

Table 3-9. Marine mammal species found in OCS waters off Oregon. Source: letter from Marine Mammal Commission to FERC dated August 4, 2014.

Pinnipeds	
California sea lion *Zalophus californianus*	Northern elephant seal *Mirounga angustirostris*
Guadalupe fur seal *Arctocephalus townsendi*	Northern fur seal *Callorhinus ursinus*
Harbor seal *Phoca vitulina richardsi*	Steller sea lion *Eumetopias jubatus*
Cetaceans	
Baird's beaked whale *Berardius bairdii*	Minke whale (CA/OR/WA stock) *Balaenoptera cutorostrata*
Blue whale (eastern north Pacific stock) *Balaenoptera musculus*	Northern Pacific right whale *Eubalaena japonica*
Bottlenose dolphin (CA/OR/WA offshore stock) *Tursiops truncatus*	Northern right whale dolphin (CA/OR/WA stock) *Lissodelphis borealis*
Cuvier's beaked whale *Ziphius cavirostris*	Pacific white-sided dolphin (CA/OR/WA stock) *Lagenorhynchus obliquidens*
Dall's porpoise (CA/OR/WA stock) *Phocoenoides dalli*	Pygmy sperm whale *Kogia breviceps*
Dwarf sperm whale *Kogia sima*	Risso's dolphin (CA/OR/WA stock) *Grampus griseus*
Fin whale (CA/OR/WA stock) *Balaenoptera physalus*	Sei whale (eastern north Pacific stock) *Balaenoptera borealis*
Gray whale (eastern and western stocks) *Eschrichtius robustus*	Short-beaked common dolphin *Delphinus delphis*
Harbor porpoise (northern CA/southern OR stock) *Phocoena phocoena*	Short-finned pilot whale *Globicephala macrorhynchus*
Humpback whale (CA/OR/WA stock) *Megaptera novaeangliae*	Sperm whale *Physeter macrocephalus*
Killer whale (offshore stock, Southern Residents) *Orcinus orca*	Striped dolphin *Stenella coeruleoalba*
Mesoplodont beaked whales *Mesoplodon spp.*	

Source: letter from Marine Mammal Commission to FERC dated August 4, 2014.

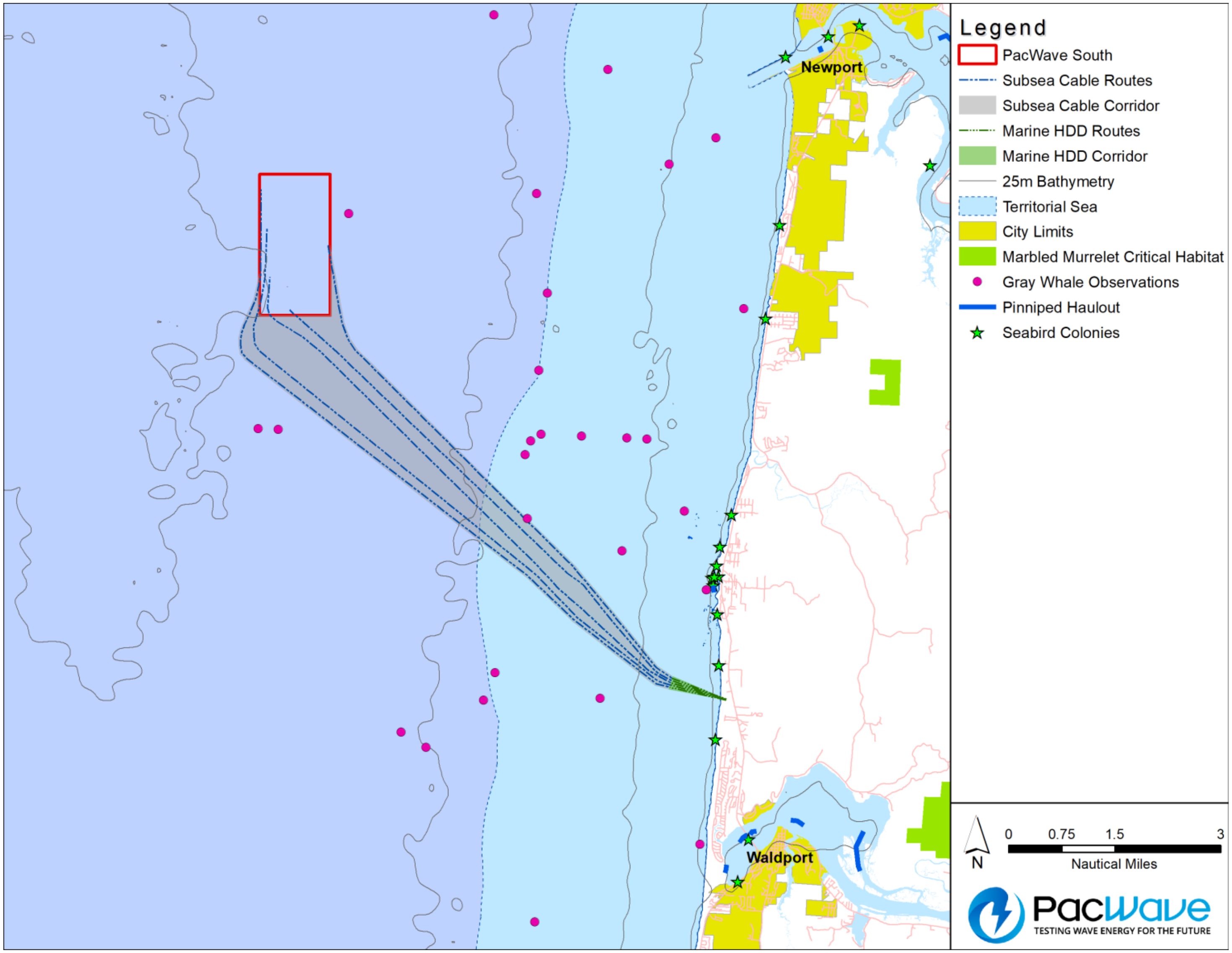


Figure 3-7. Gray whale observations, pinniped haulout sites, seabird colonies, and marbled murrelet critical habitat in Project area.

Cetaceans that potentially occur in the Project area include transient killer whales, which appear along the Oregon coast in April. Southern Resident killer whales are federally listed and are discussed in Section 3.3.5. Cetacean species listed under the federal ESA are also listed as endangered by the state; however, Oregon also lists gray whales as endangered. State threatened species include the sea otter (ODFW 2018), and a few sea otters are occasionally seen along the Oregon coast (FWS 2013). In addition, ODFW considers California sea lion, gray whale, harbor porpoise, northern elephant seal, and Steller sea lion as strategy species in the Oregon Nearshore Strategy (Krutzikowsky et al. 2006).

Surveys from aircraft conducted offshore of northern California, Oregon, and southern Washington in 2011 and 2012 detected gray whales (17 sightings of 26 total individuals), and rarely, minke whales (1 sighting), at similar depths (0-100 m depth stratum) as the Project area (Adams et al. 2014). Pinnipeds were frequently observed at the 0-100 m depth stratum; California sea lions were most abundant (76 sightings of 157 individuals), then harbor seals (37 sightings of 53 individuals), northern elephant seals (15 sightings of 16 individuals), Steller sea lion (3 individuals), and northern fur seal (3 sightings of 4 individuals) (Adams et al. 2014).

Gray whales migrate up and down the Pacific Coast between their Alaskan feeding waters (summer) and Mexican breeding grounds (winter). This migration covers 10,000 to 14,000 miles for a round trip (DOI 1989), and it represents the longest migration of any mammal. About 200 to 250 whales from the Eastern North Pacific stock do not migrate to Alaska, but instead remain along the Pacific coast south of Alaska. These animals are referred to as the Pacific Coast Feeding Aggregation (NMFS 2008). Gray whales feed by straining sediment through their baleen, eating primarily invertebrate prey consisting of bottom-dwelling crustaceans, worms and molluscs; the pits generated by their feeding activities are typically less than 15 cm deep (Johnson et al. 1983, Weitkamp et al. 1992). Migrating gray whales occur off Oregon between March and June on their northward migration, and between December and March on their southward migration. OSU researchers conducted three shore-based observational studies on migrating gray whales along the central Oregon coast, using theodolites to provide accurate locations of whales as they passed Yaquina Head (personal communication with Barbara Lagerquist, Martha Winsor, and Bruce Mate, OSU Marine Mammal Institute, December 1, 2016); the first of these studies characterized the distribution and behavior of gray whales during the 2007/2008 migration, and the other two were part of a study to test the effectiveness of an acoustic deterrent device for gray whales and took place during the 2012 and 2013 migrations. In addition, satellite-tracking studies have also taken place in Oregon and northern California, in 2009, 2012, and 2013, to document long term movements and distribution of Pacific Coast Feeding Group gray whales. Theodolite observations in 2007/2008 indicated differences between the three migration phases, with locations during southbound migration being the furthest from shore, those during Northbound B migration being the closest, and locations during Northbound A having intermediate distances (Table 3-10). Depths of locations were also significantly different between the three migration phases. Two minke whales, observed during the end of May 2008, were the only other cetaceans seen during the study (Ortega-Ortiz and Mate 2008). Figure 3-7 shows locations of gray whales sighted between 1985 and 2004.

Table 3-10. Distance to shore for gray whale locations obtained using a theodolite at Yaquina Head, Oregon, during shore-based observations of the 2007/2008 migration.

2007/2008 Distance to shore (nautical miles)							
Migration Phase	**n**	**Mean**	**Standard Deviation**	**Median**	**Min**	**Max**	**Upper Quartile**
Southbound	58	3.9	1.5	4.1	1.4	7.9	5.1
Northbound A	74	2.9	1.1	2.9	0.8	5.4	3.9
Northbound B	38	1.7	1.0	1.5	0.1	4.1	2.6
Overall	170	3.0	1.5	3.0	0.1	7.9	4.0

Source: Personal communication with Barbara Lagerquist, Martha Winsor, and Bruce Mate, OSU Marine Mammal Institute, December 1, 2016.

The acoustic deterrence study was conducted on the southbound and northbound A phases of gray whale migration on the Oregon coast, and did not include any observations from the northbound B phase. Neither distance to shore nor depth of locations differed significantly between southbound and northbound A migration phases in 2012; statistical analysis of 2013 data was not conducted due to heterogeneity of variances (personal communication with Barbara Lagerquist, Martha Winsor, and Bruce Mate, OSU Marine Mammal Institute, December 1, 2016). The satellite tracking study was conducted on 35 Pacific Coast Feeding Group gray whales tagged between 2009 and 2013 off the coast of central Oregon and northern California. Only high-quality Argos locations (those with an error radius of less than or equal to 1,500 m) that fell within the latitudinal borders of Oregon (42.0-46.27 degrees north) were limited to 20 tagged whales with locations within Oregon: mean distance to shore ranged from 0.4-4.6 nautical miles for these 20 whales, and mean depths ranged from 14-76 m (personal communication with Barbara Lagerquist, Martha Winsor, and Bruce Mate, OSU Marine Mammal Institute, December 1, 2016).

Harbor porpoises are small cetaceans that occur year-round along the Oregon coast. Porpoise inhabiting the west coast of the U.S. generally do not migrate, rather they have a limited local range (NOAA 2014d). Surveys have shown that harbor porpoise abundance decreases significantly at depths greater than 60 m (Carretta et al. 2001 *cited in* NOAA 2014d). It is estimated that there are 36,000 harbor porpoises in the northern California/ southern Oregon stock, based on 2007-2011 aerial surveys (Forney et al. 2013 *cited in* NOAAd).

Other than gray whales, the seasonal abundance and distribution of marine mammals in Oregon's nearshore waters is not well documented, with a particular lack of data for small cetacean species (porpoises and dolphins). Except for two Global Ocean Ecosystem Dynamics (GLOBEC) surveys conducted in late spring and early summer (Tynan et al. 2005) and gray whale migration observations from shore (Yaquina Head, e.g., Ortega-Ortiz and Mate 2008, personal communication with Barbara Lagerquist, Martha Winsor, and Bruce Mate, OSU Marine Mammal Institute, December 1, 2016), periodic marine mammal surveys off the Pacific Northwest coast have been restricted to late-summer and fall months (e.g., Carretta et al. 2009). Therefore, OSU conducted visual observations and passive acoustic recordings within and adjacent to the Project area to better characterize marine mammal species composition and the spatial and temporal patterns of marine mammal presence in the Project area. This effort provides supplemental information on occurrence of species that could interact with Project structures or WECs.

In 2014, OSU deployed two seafloor lander hydrophones (similar to the one used at PacWave North for over a year) to record ocean ambient sound levels in frequencies dominated by wind, rain, breaking waves, vessel traffic, and marine mammal vocalizations. The "offshore" lander at PacWave South was placed at a depth of 62 m in order to locate it near the center of the test site, and the "nearshore" lander was placed at 30-m depth, east of the test site to characterize physical and biological sound sources related to the nearby rocky reef structure. In addition to ambient noise level measurements obtained from acoustic recordings by the hydrophones, a C-POD© was mounted on the offshore PacWave South lander system (Haxel 2019). Species in the greater Project area that can be detected by the C-POD include Cuvier's beaked whales, killer whales, false killer whales, short-finned pilot whale, common dolphin, Pacific white-sided dolphin, Risso's dolphin, and harbor porpoise. The offshore lander placed at PacWave South was damaged and not recovered; an acoustic mooring consisting of an AUH hydrophone to record continuously providing frequency content from 5 Hz-13 kHz was then deployed in 2015 (Haxel 2019). The nearshore lander detected humpback whale, killer whale, and harbor porpoise vocalizations during the 4-month period of deployment from April-July 2014. In 2015, Haxel (2019) collected baseline ambient noise levels in the southern region of the PacWave South area for site characterization. During this deployment, humpback whale vocalizations were observed with increasing regularity from early September through the end of recording in November 2015 (Haxel 2019). OSU also made a series of short term (~10 day) deployments between May and October 2014 of lightweight moorings equipped with specialized DMON (Digital Monitoring) tag recorders on lease from Woods Hole Oceanographic Institution. The DMONs recorded on a duty cycle 1 minute of every 10-minute period, capturing acoustic data and targeting bioacoustics signals up to 200 kHz. DMON deployments indicated frequent and regular use of the Project area from May-October by harbor porpoise, with higher levels of acoustically active animals at the inshore (30-depth) than offshore (PacWave South) stations (Haxel 2019, Henkel et al. 2019).

OSU conducted vessel-based, standard-line transect surveys from October 2013 to September 2015 (a total of 37 cruises) in the PacWave South and PacWave North Project areas, and along the Newport Hydrographic Line, a cross-shelf line that extends west of Newport for approximately 40 km (Henkel et al. 2019). A total of 209 marine mammals and 10 species were observed (Table 3-11).

Table 3-11. Marine mammal species observed near the PacWave South and PacWave North Project areas and along the Newport Hydrographic Line, October 2013-September 2015.

Species	Individuals observed
Harbor porpoise	81
Gray whale	24
Pacific white sided dolphin	22
Humpback whale	20
Steller sea lion	20
California sea lion	14
Dall's porpoise	7
Unidentified sea lion	7
Killer whale	4
Unidentified whale	3
Unidentified porpoise	3
Harbor seal	2
Fin whale	1
Unidentified cetacean	1
Total:	**209**

Feeding Biologically Important Areas (BIAs) have been delineated for gray[11] and humpback whales in the general Project area (Figure 3-8). The feeding BIA for gray whales is approximately 199 square km (Calambokidis et al. 2015) and occurs inshore of the proposed PacWave South Project area. The feeding BIA for humpback whales is approximately 2,573 square km area (Calambokidis et al. 2015) and includes the Project area. Calambokidis (et al. 2015) indicated gray whales and humpback whales would primarily occur in the associated feeding BIAs from May to November.

[11] Pacific coast feeding group, a sub-population of Eastern North Pacific gray whales.

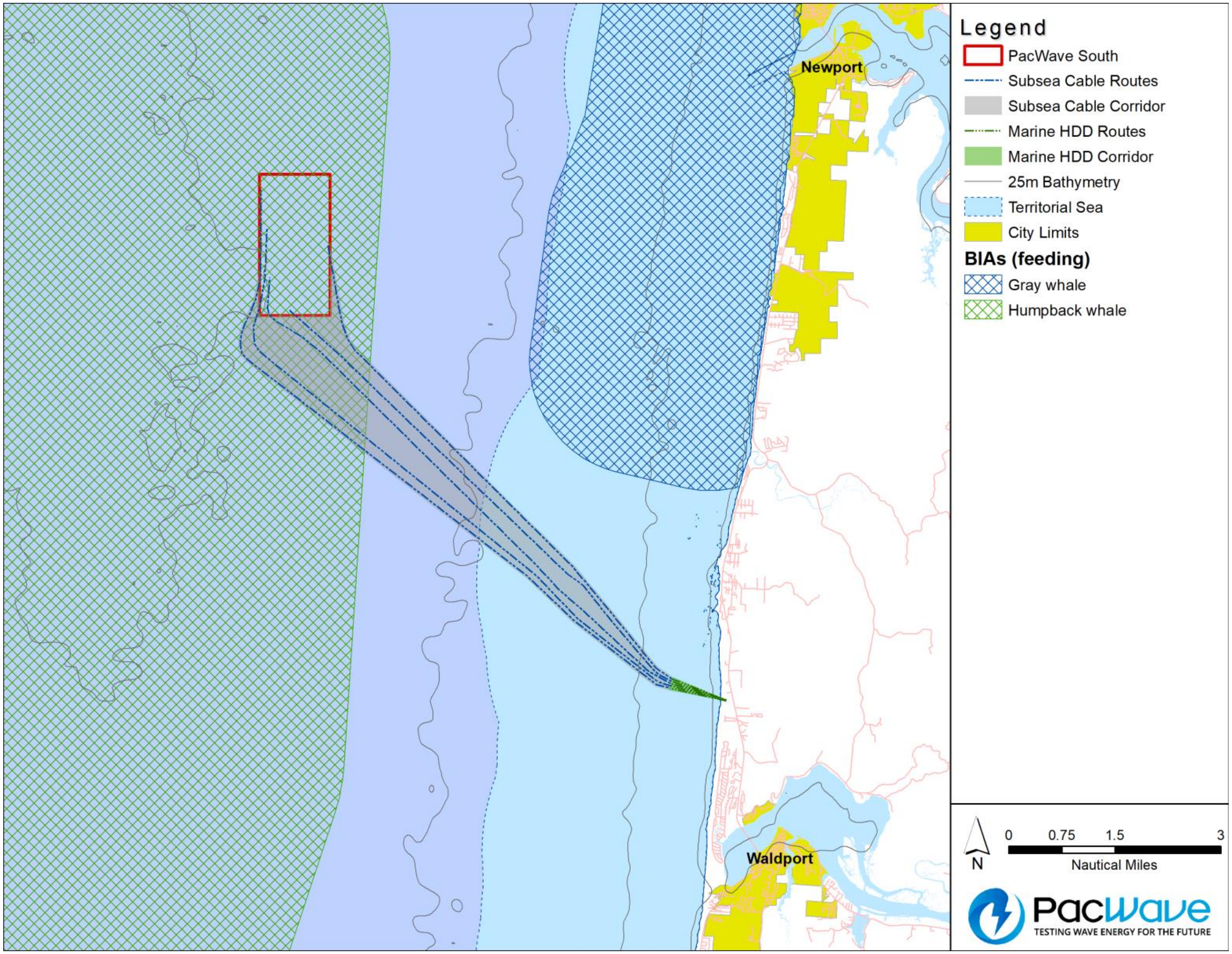


Figure 3-8. Feeding Biologically Important Areas (BIAs) for gray and humpback whales in the Project area (NOAA 2018).

Seabirds

The rocky islands and rugged habitats of the Oregon coast provide habitat for about 1.3 million nesting seabirds of 15 species. The most abundant breeding seabirds include common murres, concentrated in colonies in both northern and southern Oregon, and Leach's storm-petrels, with colonies concentrated in southern Oregon (Naughton et al. 2007, Suryan et al. 2012). The north-central Oregon coast, where the Project is located, has extensive sandy beaches and hosts relatively few nesting seabirds; it is home to about 6 percent of the Oregon seabird breeding population. Eleven species of breeding seabirds are known to nest in this region (Table 3-12); the majority nest at Yaquina Head located about 15 km to the northeast of the Project site, although a few cormorants, gulls, pigeon guillemots, and black oystercatchers nest along the shores south of Newport, potentially in the general vicinity of the shore cable landing. With the exception of black oystercatchers, which are restricted to shore, any of the other seabird species that nest in the area could occur in and forage in waters around PacWave South.

Table 3-12. Breeding seabirds on the North-Central Oregon Coast.

Species	Scientific Name	Number of Breeding Birds[1]
Leach's storm-petrel	*Oceanodroma leucorhoa*	112
Brandt's cormorant	*Phalacrocorax penicillatus*	6,047
Double-crested cormorant	*Phalacrocorax auritus*	843
Pelagic cormorant	*Phalacrocorax pelagicus*	2,396
Black oystercatcher	*Haematopus bachmani*	117
Common murre	*Uria aalge*	98,315
Pigeon guillemot	*Cepphus columba*	1,329
Cassin's auklet	*Ptychoramphus aleuticus*	20
Rhinoceros auklet	*Cerrorhinca monocerata*	5
Tufted puffin	*Fratercula cirrhata*	15
Western/Glaucous-winged gull	*Larus occidentalis/ L. glaucescens*	2,224

[1] Based on the most recent survey data from Colony Groups 8-16 (as labeled in Table 3 and Fig. 1 in Suryan et al. 2012); surveys were conducted in the years 2008-2009.

Oregon coastal waters provide important foraging habitat for seabirds throughout the year, but particularly in the fall, as millions of marine birds that breed elsewhere (e.g., auklets, albatrosses, shearwaters, loons, grebes, sea ducks, and gulls) are known to migrate to Oregon's productive coastal waters to feed (Naughton et al. 2007, Suryan et al. 2012). Based on aerial surveys conducted in 2011-2012 from Fort Bragg, California to Grays Harbor, Washington and from shore to 2,000-m depth (e.g., inner-shelf waters to continental slope waters), the highest marine bird densities occurred along the entire nearshore (<100 m depth) Oregon coast during fall (49.4 ± 5.0 birds/km^2), with smaller but similar densities in winter and summer (37.4 ± 4.6 birds/km^2 and 37.5 ± 6.4 birds/km^2, respectively; Adams et al. 2014). Common murres and sooty shearwaters were the most abundant species in the Project area in spring and summer, based on boat and aerial surveys conducted in the inner shelf waters (<100 m depth) around Newport in March-August 2003-2009 (Suryan et al. 2012), in 2011-2012 (Adams et al. 2014), and in 2013-2014 (R. Suryan, unpubl. data); these two species are also the most abundant seabirds along the entire Oregon coast in spring and summer (Strong 2009, Suryan et al. 2012, Zamon et al. 2014).

Focused vessel-based strip transect surveys conducted in 2013-2015 around the PacWave South and PacWave North test sites and along the Newport Hydrographic Line (1.6-40 km from shore) reported common murres and sooty shearwaters as the most abundant species around the PacWave South test site; common murres were most densely aggregated in spring (800-1,100 murres/km^2), while sooty shearwaters dominated in fall (100-220 shearwaters/km^2) (Porquez 2016). The PacWave South test site had low overall relative abundance compared to adjacent areas, although the whole area appears to be productive foraging habitat for many seabird species (Porquez 2016). Brown pelicans and marbled murrelets were observed inshore of the test site, and black-footed albatross were only detected west of the site (Porquez 2016).

Aerial surveys in 2011-2012 indicated that the inner shelf waters (<100 m depth) around Newport had an influx of seabirds such as shearwaters, northern fulmars, Cassin's auklets, rhinoceros auklets, and brown pelicans in the fall (Adams et al. 2014). Thus, seabirds would likely occur and forage in the test site throughout the year; abundance would likely be highest in the fall, and species composition would change throughout the year. The seabird species included in Table 3-13 represent a list of species that have been reported in nearshore waters (e.g., 0-20 km from shore) in the vicinity of the test site and could be expected to occur at the test site throughout the year. However, some of these species, including scoters, cormorants, loons, and some species of gulls (e.g., ring-billed and California), generally occur less than 5 km from shore (Strong 2009), and are therefore unlikely to occur at the test site where the WECs would be deployed (more than 11 km from shore).

Table 3-13. Marine bird species that could occur in the PacWave South offshore WEC deployment area based on survey data (Strong 2009, Adams et al. 2014, R. Suryan, unpubl. data, Porquez 2016) and Birds of Oregon (Marshall et al. 2006).

Species	Scientific name	Status	Spring/ Summer	Fall	Winter
Surf scoter[1]	*Melanitta perspicillata*	--	U	U[5, 6]	U[5, 6]
White-winged scoter[1]	*Melanitta fusca*	--	U	U[5]	U[5]
Pacific loon	*Gavia pacifica*	--	U	U[5, 7]	U[5, 6, 7]
Common loon	*Gavia immer*	--	U[7]	U[5, 6, 7]	U[5, 6, 7]
Laysan albatross	*Phoebastria immutabilis*	BCC	U	U	U
Black-footed albatross	*Phoebastria nigripes*	BCC	U[6]	U	U
Northern fulmar	*Fulmarus glacialis*	--	U	C[5]	C[6]
Pink-footed shearwater	*Ardenna creatopus*	BCC	C[6]	C[5, 6]	U
Flesh-footed shearwater	*Ardenna carneipes*	--	U[6]	U[6]	U

Species	Scientific name	Status	Spring/ Summer	Fall	Winter
Buller's shearwater	*Ardenna bulleri*	--	U	C[5]	U
Sooty shearwater	*Ardenna grisea*	--	C[5, 6, 7, 8]	C[5, 6, 7, 8]	C[6, 8]
Short-tailed shearwater	*Ardenna tenuirostris*	--		C[6, 7]	C[6]
Fork-tailed storm-petrel	*Oceanodroma furcata*	S, CS (N)	U[5]	U[6]	U[6]
Leach's storm-petrel	*Oceanodroma leucorhoa leucorhoa*	S, CS (N)	U[5]	U[6]	U[6]
Brandt's cormorant[2]	*Phalacrocorax penicillatus*	--	C[5, 6, 7, 8]	C[5, 6, 7, 8]	C[5, 6, 7, 8]
Double-crested cormorant	*Phalacrocorax auritus*	--	U[6]	U	U[6]
Pelagic cormorant[2]	*Phalacrocorax pelagicus*	BCC	U[5, 6, 7, 8]	U[5, 6, 7, 8]	U[5, 6, 7, 8]
Brown pelican	*Pelecanus occidentalis*	FD, SE, CS (N)	U[6]	U[5, 6]	U
Red-necked phalarope[3]	*Phalaropus lobatus*	--	C[6, 8]	C[5, 6, 8]	
Red phalarope[3]	*Phalaropus fulicarius*	--	U	C[5]	U
South polar skua	*Stercorarius maccormicki*			U	
Pomarine jaeger	*Stercorarius pomarinus*	--	U	U	U
Parasitic jaeger	*Stercorarius parasiticus*	--	U	U	U
Long-tailed jaeger	*Stercorarius longicaudus*		U	U	
Common murre	*Uria aalge*	--	C[5, 6, 7, 8]	C[5, 6, 7, 8]	C[5, 6, 7, 8]
Pigeon guillemot	*Cepphus columba*	--	U[6, 7]	U[6, 7]	U
Marbled murrelet	*Brachyramphus marmoratus*	BCC, FT, SE, CS (CR, N)	U[6, 7]	U[6, 7]	U
Ancient murrelet	*Synthliboramphus antiquus*	--	U	U	U
Guadalupe/Scripps's murrelet	*Synthliboramphus hypoleucus/scrippsi*	SOC	U	U	U
Cassin's auklet	*Ptychoramphus aleuticus*	--	U[6, 8]	C[5, 6, 7, 8]	C[5, 6, 7, 8]
Rhinoceros auklet	*Cerorhinca monocerata*	--	U[6]	C[5, 6, 7]	C[5, 6]
Tufted puffin	*Fratercula cirrhata*	SC, CS (CR, N)	U	U	U
Black-legged kittiwake	*Rissa tridactyla*	--	U	C	C[5]
Sabine's gull	*Xema sabini*	--	U	U	
Bonaparte's gull	*Chroicocephalus philadelphia*	--	U	U	U
Heermann's gull	*Larus heermanni*	--	U	U[6, 7]	U[6]
Mew gull	*Larus canus*	--	U	U	U[6]
Ring-billed gull	*Larus delawarensis*	--	U	U[6]	U[6, 7]
Western gull	*Larus occidentalis*	--	C[5, 6, 7, 8]	C[5, 6, 7, 8]	C[5, 6, 7, 8]
California gull	*Larus californicus*	--	C[5, 6, 7]	C[5, 6, 7]	C[5, 6]
Herring gull[4]	*Larus argentatus*	--	U	C[5]	C[5]
Iceland (Thayer's) gull[4]	*Larus glaucoides thayeri*	--	U	U[5]	U[5]
Glaucous-winged gull	*Larus glaucescens*	--	U[5]	C[5, 6]	C[5, 6]
Caspian tern	*Hydroprogne caspia*	BCC, S, CS (CR, N)	U	U[7]	U
Common tern	*Sterna hirundo*	--	U	U	
Arctic tern	*Sterna paradisaea*	BCC	U	U	

Species	Scientific name	Status	Spring/ Summer	Fall	Winter

Notes: BCC – Birds of Conservation Concern (FWS 2008); FE – Federally endangered; FT – Federally threatened; FD – Federally delisted; EP – Protected under the Bald and Golden Eagle Protection Act; SOC – FWS Species of Concern; ST – Oregon State threatened; SE – Oregon State endangered; S – Oregon sensitive species list, Sensitive in Coast Range (CR) and/or Nearshore (N) ecoregions; SC – Oregon sensitive species list, Sensitive-Critical in Coast Range (CR) and/or Nearshore (N) ecoregions (ODFW 2016); CS – Oregon Conservation Strategy species, designated in Coast Range (CR) and/or Nearshore (N) ecoregions as needing management attention (Krutzikowsky et al. 2016)

C – Common; U – Uncommon

[1] Surf and white-winged scoters were indistinguishable and thus reported together in aerial surveys (Adams et al. 2014)

[2] Brandt's and pelagic cormorants were indistinguishable and thus reported together in aerial surveys (Adams et al. 2014)

[3] Red and red-necked phalaropes were indistinguishable and thus reported together in aerial surveys (Adams et al. 2014)

[4] Herring and Thayer's gulls were indistinguishable and thus reported together in aerial surveys (Adams et al. 2014)

[5] Species reported from aerial surveys conducted 0-100 m depth offshore of Newport in 2011-2012 (Adams et al. 2014)

[6] Species reported from boat surveys conducted within 20 km of shore around PacWave South in 2013-2014 (R. Suryan, unpubl. data)

[7] Species reported from boat surveys conducted 0-10 km from shore around PacWave North (<10 km north of PacWave South) in 2013-2014 (R. Suryan, unpubl. data)

[8] Reported as a "dominant" species from boat surveys conducted 1.6-40 km from shore around PacWave South and PacWave North in 2013-2015 (Porquez 2016)

While the brown pelican was federally delisted in 2009 (64 FR 59444), the species remains listed as endangered by the State of Oregon. The California brown pelican subspecies occurs in western North America, and nests on islands off southern California and western Mexico. There is a post-breeding movement of brown pelicans in fall, generally following forage fishes in nearshore waters along the U.S. west coast including offshore Oregon and Washington. Pelicans roost on offshore rocks and islands, sand bars, and manmade structures such as breakwaters, pilings and jetties (FWS 1983). Although uncommon farther offshore, they could occur occasionally in the Project area. They could also occur on the beach in the cable landing area.

Bats

Bat species that could occur in the marine Project area include hoary bats, which are known to migrate south in autumn offshore and along the coast of central California (Cryan and Brown 2007). Although eastern red bats are known to migrate offshore along the mid-Atlantic (Hatch et al. 2013) and western red bats are also known to migrate offshore of central California (Cryan and Brown 2007), western red bats do not occur north of the California – Oregon border. Therefore, western red bats are not expected to occur in the marine Project area. No other species of bats are expected to occur in the marine Project area based on the lack of museum records and literature.

3.3.3.2 Environmental Impacts Related to Aquatic Resources

This section evaluates the following potential effects on aquatic resources; each bullet below is represented by a corresponding subheading in the latter text. Effects to threatened and endangered species, including sea turtles, are discussed in Section 3.3.5.

- Effects of alteration of habitat
    - Suspended sediment during installation and redeployments
    - Effects on the benthic community from Project structures
    - Changes to marine community composition and behavior (e.g., use patterns, attraction, and avoidance)
        - Changes in the presence of biofouling species, species interaction, and predator-prey interactions
        - Effects of pinniped haulout and seabird perching on Project structures
        - Effects of seabird avoidance/displacement of Project area
        - Effects of artificial lighting
        - Effects of changes in wave energy to habitat
- Effects of underwater sound/vibration on marine mammals, fish, and seabirds
- Effects or risk of collision or entanglement with Project structures, entangled gear, or service vessels to marine species
- Effects of EMF emissions on species sensitive to electric and magnetic fields
- Effects on bats
- Effects on freshwater fish in surface streams

In addition to the measures listed in Section 3.3.2.2. to minimize effects to water resources, OSU would implement the following measures to minimize or mitigate for potential effects to aquatic resources:

General

- Bury subsea cables at a depth of 1-2 meters, to the maximum extent practicable, to minimize the amount of habitat conversion (soft bottom to hard structure) from laying exposed cable on the seafloor. In areas where a cable cannot be buried or persistently becomes unburied, that portion of the cable will be on the seafloor and will be protected by split pipe, concrete mattresses or other cable protection systems.
- To the maximum extent practicable, utilize shielding on subsea cables, umbilicals, and other electrical infrastructure to minimize EMF emissions.
- Implement the EMF Monitoring Plan (Appendix H) to measure Project-related EMF emissions. Based on monitoring results, implement the specified measures to mitigate for potential adverse effects (Appendix I).

- In the event of an emergency in which fish or wildlife are being killed, harmed or endangered by Project facilities or operations in a manner that was not anticipated, OSU will notify agencies with regulatory authority as soon as possible and take action to promptly minimize the impacts of the emergency, including implementing any guidance pursuant to agency legal authorities, as outlined in Appendix I.

Fish and Invertebrates

- Implement the Organism Interactions Monitoring Plan to track changes to pelagic and demersal fish and invertebrates (particularly Dungeness crab) that might be attracted to the installed components or affected due to the potential for reduced fishing pressure, as well as biofouling on the anchors/WECs (Appendix H).
- Develop cable routes that avoid crossing areas with rocky reef and hard substrate to the maximum extent practicable to protect sensitive habitat features.
- Develop and implement an anchoring plan or protocol for any Project vessels that may anchor at the Project site, that:
    - Avoids anchoring in known rocky reef or hard substrate habitats to the maximum extent practicable; and
    - Minimizes the use of anchors within the Project area wherever practicable by combining onsite activities.

Marine Mammals

- Entangled fishing gear
    - Conduct opportunistic visual observations from the water surface in the portions of the test site which are being visited to conduct operations, maintenance, or environmental monitoring work and review any underwater visual monitoring conducted for other purposes to detect entangled fishing gear that has the potential to increase the risk of marine species entanglement. The licensee will ensure that surface observations occur during all visits to the Project test site, and at least once per quarter each year for the duration of the license.
    - Annually following the peak storm season and period of maximum activity for the Dungeness crab fishery, the licensee shall conduct surface surveys of active WEC berths during the spring season (mid-March through mid-June), or the earliest possible time after that period that avoids jeopardizing human safety, property or the environment.
    - Conduct annual subsurface surveys of moorings and anchor systems using ROV or other appropriate techniques with approval by NMFS concurrent with spring (mid-March through mid-June) monitoring under the Organism Interactions Monitoring Plan (Appendix H).

    - If entangled fishing gear or marine mammal (or sea turtle) stranding, entanglements, impingements, injuries or mortalities are detected, implement the specified measures to minimize risk of marine mammal entanglement and to make every effort to return the fishing gear to the owners (Appendix I).
- Require vessels in transit to/from the Project site to avoid close contact with marine mammals and sea turtles and adhere to NMFS "Be Whale Wise" guidelines to minimize potential vessel impacts to marine mammals.
- Comply with current regulations that require marine mammal observers for certain vessel based activity (e.g., sub-bottom profiling).
- Require WEC testing clients to keep their equipment in good working order to minimize sound due to faulty or poorly maintained equipment.
- Implement the Acoustics Monitoring Plan (Appendix H) to quantify sound levels using field measurements and validated sound propagation models. Based on monitoring results, implement specified measures to mitigate for potential adverse effects (Appendix I).
- Minimize construction activities during key gray whale migration periods, to the extent possible.
- For use of DPVs or other equipment that may exceed NMFS's published thresholds for injury
    - Avoid use of these vessels to the maximum extent practicable during Phase B gray whale migration (April 1-June 15). If these construction activities are proposed during this migration period, the licensee will consult with ODFW regarding the timing of such activities including cable-laying in state waters.
    - With technical assistance from NMFS, establish and carry out the following actions and protocols necessary to maintain an appropriate acoustic zone of influence in accordance with NMFS's published harassment threshold (120 dB re: 1 μPa) during DPV operations to minimize behavioral disturbance and protect marine resources
        - Post qualified marine mammal observers during daylight hours.
        - The licensee will conduct DP activities during daylight hours when feasible to ensure observations may be carried out.
        - DP for cable laying may occur during all hours; however, DP start up for cable laying will only occur during daylight hours.
        - The licensee will carry out the ramp-up procedures that are specified in Appendix I, which may be modified by agreement of the licensee and NMFS.
    - Implement such additional measures as may be imposed pursuant to a Marine Mammal Protection Act authorization.
- Make opportunistic visual observations of pinnipeds in the portions of the test site which are being visited to conduct operations, maintenance, or environmental monitoring work.

If pinnipeds are observed to be hauled out on Project structures, the licensee will follow the reporting and haulout protocols specified in Appendix I.

- To the extent practicable, direct the WEC testing clients to design and maintain cables and moorings in configurations that minimize the potential for marine mammal or sea turtle entrapment or entanglement and follow the reporting and haulout protocols specified in Appendix I.

Seabirds

- Implement the Environmental Measures section as described in the Bird and Bat Conservation Strategy (Appendix B) to assess, minimize, and avoid impacts to seabirds, these are annotated below:
    - Conduct opportunistic visual observations from the water surface in the portions of the test site, that are being visited to conduct operations, maintenance, or environmental monitoring work, and review any underwater visual monitoring conducted for other purposes, to detect derelict gear that has the potential to increase the risk of marine species entanglement. If monitoring shows that derelict gear has become entangled or collected on any Project structure, the risk that it poses will be assessed based on type of gear, and the derelict gear will be removed as soon as is practicable while avoiding jeopardizing human safety, property or the 7environment, as described in Appendix I.
    - Conduct opportunistic visual observations in the portions of the WEC test site during vessel-based visits for operations, maintenance or environmental monitoring work, to detect and document any instances of seabird perching.
    - Use low-intensity flashing lights and bird-friendly wavelengths on the Project structures to minimize seabird attraction and follow the specifications for Project lighting developed in consultation with the FWS and U.S. Coast Guard.
    - Minimize lighting (e.g., use low intensity, bird-friendly wavelengths, shielded lighting not providing upward-pointing light or light directed at the sea surface) used at night by service and support vessels to reduce the potential for seabird attraction.
    - Require vessel operators to follow FWS instructions regarding appropriate handling and release of seabirds in the event of seabird fallout.
    - Require vessel operators to remain 500 feet away from seabird colonies during the nesting season to minimize disturbance to nesting seabirds.
    - Develop and implement an Emergency Response and Recovery Plan (Appendix G).

Effects of Alteration of Habitat

Suspended Sediment During Installation and Redeployments

It is anticipated that during each deployment, connection, disconnection, and retrieval event, sediment from the seafloor would be disturbed. Sediment will be disturbed as a result of placement of Project components on the seafloor. Subsequently, sediment will be disturbed during recovery as it is likely that the Project components (anchors, cables) will have become buried to varying degrees.

As noted above, it is anticipated that it would take up to 7 days to install each mooring system and 1 to 2 days to attach the WEC to the mooring. If an array was installed, which consisted of a number of WECs on individual mooring systems, this process would need to be repeated for each device.. Deployment activity would not necessarily be continuous as weather and unforeseen issues could interfere with operations. However, actual at-sea activities are not expected to take more than nine days to install one mooring system and WEC. It is anticipated that each WEC would be deployed for a year or more. The number of WECs deployed throughout the license term would vary and fewer WECs would likely be deployed in the initial years of operation.

The suspension of sand during these events would be temporary and localized, including during initial Project construction (e.g., jet plowing of the subsea cables), and periodic as sediment would be temporarily suspended during deployment, connection, disconnection, and retrieval events that would occur throughout the 25-year license term. Sediment transport modeling completed for the subsea cable installation for the Deepwater Wind Project off Block Island, Rhode Island (Tetra Tech 2012a), estimated that, in areas characterized by mostly coarse sand (particle diameter > 130 µm), sediment suspended during jet plow operations dropped quickly to the seafloor, and major plumes would not form in the water column. Suspended sediment concentrations within a few meters of the jet plow would be elevated, though outside of this nearfield zone, and no concentrations would exceed 100 mg/L. Concentrations above 10 mg/L would be confined to an area primarily within 50 m (160 ft) of the jet plow route and would last for approximately 10 minutes. This modeling also estimated that sediment deposition would exceed 10 mm (0.4 in) immediately adjacent to the trench, and sediment re-deposition would not exceed 1 mm beyond 40 m (130 ft) from the plow path (Tetra Tech 2012a).

Sediment transport modeling conducted for the Virginia Offshore Wind Technology Advancement Project estimated that suspended sediment (particle diameter <200 µm) during subsea cable burying would extend vertically about 2 m above the trench and horizontally up to 100 to 160 m, sediment would deposit on the seafloor within 6 to 7 minutes, and sediment re-deposition would not exceed 1 mm within 100 m of the activity (BOEM 2014).

Grain sizes at and inshore of PacWave South are larger (mean median grain size = 364 µm) than the grain sizes evaluated by the studies in Virginia and Rhode Island; accordingly, less suspension and faster settling are expected with cable laying, subsea connector installation, and anchor installation and removal at PacWave South.

It is expected that the local conditions at the PacWave South site will differ from those at the Rhode Island and Virginia sites. Different water depths, salinities, currents and other hydrodynamic forcing and water quality parameters all combine to affect the magnitude and extent of sediment advection and transport. In a simplified sense, though, coarse, non-cohesive sediments exist at all locations. Therefore, it is scientifically reasonable to assume that the sediments will settle out of suspension rapidly after re-suspension. Coarse sediments that are advected away from the site will also likely settle out rapidly. Fine sediments, if re-suspended, will be advected the furthest away before depositing.

Rough estimates of the settling velocity of grain sizes in the 200-600 µm diameter size range, the grain sizes at the PacWave South site, are 2.5 cm/s for 200 µm diameters and 8.5 cm/s for 600 µm diameters (Hallermeier 1981, Van Rijn 1984, both from Soulsby 1997). These are slightly conservative as they are based on ideal conditions where there is no water current or additional turbulence from construction activity or hindered settling. However, for a practical example, if these sediment grains were suspended 10 m into the water column as a result of the construction activities, it would take the 200 µm and 600 µm sediments approximately 6.5 minutes and 2 minutes to settle out of suspension, respectively, given the settling velocities above. Given the uncertainties involved in estimating the settling velocities, the likely ambient current speeds, the range of particle sizes that will be resuspended, and the impacts of hindered settling, these settling estimates may vary, but are anticipated to remain on the order of minutes or tens of minutes.

Seafloor sediment would be disturbed slightly upon initial installation of the subsea connector. The connector will be lowered by winch to the seafloor, the result likely being a small amount of sediment re-suspension, benthic disruption, and possibly settling of the connector into the sediment slightly. The subsea connector will be hoisted to the water surface to be connected to the WEC umbilical or hub. During this process, the sediments and macrofauna that exist on the connector and cable will be shed as the connector is brought to the surface. The result will likely be a low sediment concentration plume that drifts off the connector and cable as it is being brought to the surface. The sediments and macrofauna will settle out of suspension rapidly, according to the ambient hydrodynamic turbulence, elevation above the seafloor, water depth, and fall velocity. After being connected to an umbilical or hub, the connector, connector cable and umbilical will be lowered back to the seafloor. The sediment (which may or may not be in the same location on the seafloor) will be disturbed again. Sediment will be re-suspended due to the impact of the components on the bed, benthos may be disrupted, and there may be some settlement into the seafloor again. The disturbance process will repeat itself on a periodic basis over the 25-year Project license term, as new WEC umbilicals or hubs are connected, old ones are disconnected, and subsea connectors are retrieved and deployed. Given the nature of a test site, and that WECs would periodically be deployed and retrieved throughout the license term, there would be intermittent, though localized, temporary disturbances throughout the license term. Suspended sediment resulting from cable laying, subsea connector installation, and anchor installation/ removal at PacWave South, is expected last for minutes or tens of minutes.

HDD has a potential for inadvertent returns if drilling fluids leak through an unidentified weakness or fissure in the soil. HDD uses a slurry, composed of a fine clay material such as bentonite, as a drilling fluid. The drilling fluids are non-toxic but could result in increased suspended sediment and turbidity and possibly affect aquatic organisms. As the suspended material settles out of the water column, sedimentation would partially or entirely cover the waterbody substrate and any sessile benthic organisms, although effects would be minor, localized, and temporary. Inadvertent return during HDD or boring operations is considered highly unlikely. An HDD Contingency Plan will be developed to minimize the potential for inadvertent return of drilling fluids, provide timely detection, and address potential releases by describing monitoring, containment, response and notification procedures to be implemented by the contractor.

Benthic fauna (e.g., polychaetes, clams, and amphipods) that inhabit the subsea cable route are likely to be adapted to dynamic ecosystems and likely would be unaffected by sediment burial. For example, Maurer et al. (1982) suggest that certain species of bivalves, amphipod crustaceans, and polychaetes can withstand burial under 3 inches of sediment from ocean dredged material disposal. It was also concluded that dredged material disposal associated with the Yaquina Bay OMDS would not affect green sturgeon prey species because many invertebrate prey species are capable of vertical migration through a deposition layer of 0.8 to 2.8 inches, therefore, rehabilitation of prey species at the site occurs within days (EPA 2011). Suspended sediment during cable laying is expected to dissipate quickly and not reach levels that would harm fish in the Project area (Vize et al. 2008), and fish would likely move away from the area of disturbance. The width of the jet plow trench would be only about 3 ft wide, and would be surrounded by ample undisturbed habitat from which new recruits could be drawn. It is likely that affected areas would be quickly recolonized from nearby undisturbed areas (DOE 2012). In conclusion, increases in suspended sediment are not expected to adversely affect fish or invertebrates in the Project area.

Effects on the Benthic Community from Project Structures

The presence of Project structures on the seafloor will result in both direct and indirect disturbance to the benthic community. The subsea cables, extending from the test site to the

HDD conduits near shore, would be installed in individual trenches 1 to 2 m below the seafloor using jet plowing or other trenching methods. This would cause temporary displacement of unconsolidated sediments as the cable is buried. Benthic and infaunal organisms (e.g., amphipods, bivalves, and polychaetes) within the pathway of the plow would be removed, displaced, or killed during the trenching process. Additionally, as the plow moves along the seafloor, slow-moving infaunal or surface dwelling organisms located in the path of the plow's skids or wheels that span the trench likely would be killed. Mobile invertebrates (e.g., crabs), fish species that feed on or near the bottom, and species that shelter on the bottom at times would likely move away from the immediate vicinity of the anchors and cable and move to nearby areas during deployment and removal activities (Roegner and Fields 2015). While these activities would result in short-term benthic habitat disturbance, benthic fauna (e.g., polychaetes, clams, and amphipods) that inhabit the area are likely to be adapted to dynamic ecosystems and likely would be unaffected by sediment burial.

There would be long-term loss of unconsolidated sand habitat within the footprint of the WEC anchors. Suction caisson and plate anchors would be placed into and under the seafloor, and therefore would have a minimal footprint on the seafloor other than the mooring hardware and line extending from the anchor under the seafloor up to the WEC. The maximum footprint of the anchors would be 19,068 ft^2 (0.4 acres) for the initial development and 90,800 ft^2 (2 acres) for the full build out (Table 2-1), which is 0.1 percent of the total Project site surface area (1,695 acres). The estimates are based on exclusive use of large 34 ft diameter gravity anchors; however, other types of smaller anchors will likely be used for some of the WECs, and shared anchors may be used for some WECs when feasible, so the actual seafloor footprint is expected to be considerably smaller than these estimates.

Installation of drag embedment anchors requires dragging the anchor a lateral distance across the seafloor to set them at a sufficient penetration (sediment depth). It is anticipated that most of this disturbance would be below the seafloor surface. The spatial extent of habitat modification would vary depending on anchor type and number of anchors, considering some anchor types would be buried and not rest on the seafloor. As anchors are removed, the disturbed areas are expected to recover over time by natural sediment transport processes.

Additional direct disturbance would result from the footprint of any hub, the four subsea connectors (each with a footprint of approximately 30 ft^2), umbilical cables, and the segment of the cables that would be laid on the seafloor in a U-form (looped) spanning a distance of approximately 300 m, that would not be buried to allow access during maintenance activities (the remainder of the cable routes would be buried).

The placement of anchors on the seafloor could result in localized areas of scour or deposition; however, the particle size range found at PacWave South is likely less susceptible to movement than areas having finer grained sediment. Based on reviews of bottom changes resulting from deployment of artificial reefs and offshore oil platforms (Henkel et al. 2014), sedimentary changes could be expected to occur at least 20 m away from an anchor installation (the actual distance that scour and sediment change occurs will be monitored in the Organism Interactions and Benthic Sediments monitoring plans [Appendix H]). Based on surveys at PacWave North, changes to benthic conditions (particularly higher proportions of very coarse sand and shell hash accumulation) may also be expected to occur; however, this accumulation did not have a measureable effect on the composition of the macrofaunal community (Henkel and Hellin 2016). Anchors may also reduce available benthic foraging habitat, although the total area lost by anchors would be small, as quantified above.

Whitehouse (1998) mentions that there is only a limited amount of experimental data and numerical studies of the flow field and scouring around gravity installations. However, physical model results at HR Wallingford for the scour around a large cylinder indicated maximum scour depths of 0.064xD for collinear waves and currents, plus accretions of 0.028xD in some areas adjacent to the installation (Rance 1980, from Whitehouse 1998). As a representative calculation, for a 10 m diameter gravity base anchor at PacWave South, this would amount to 0.64 m equilibrium scour depth at the upstream side of the anchor and up to 0.28 m of accretion in lee of the structure. Field observations of scour in sandy sediment have been reported at 0.5 to 1.0 m for a 10.5 m diameter obstruction (Bishop 1980, from Whitehouse 1998). A second calculation was made using the methods of Sumer and Fredsoe (2002): assuming a water depth of 60 m, a wave height of 10 m, a wave period of 15 second and a 10 m diameter anchor, the maximum scour depth was estimated at 1 m[12].

Some additional minor and short-term bottom disturbance would be expected from the anchoring of vessels used for installation, maintenance, and environmental monitoring. As noted above, it is anticipated that it would take up to 7 days to install each mooring system and 1 to 2 days to attach a single WEC to the mooring. If an array was installed, which consisted of a number of WECs on individual mooring systems, this process would need to be repeated for each device. Deployment activity would not necessarily be continuous, because weather could delay the start-to-finish timeframe or postpone completion of certain activities. However, actual at-sea activities are not expected to take more than nine days to install one mooring system and WEC. Based on the experience at PacWave North, the anchoring of support vessels (e.g., for maintenance and monitoring) is typically not required. Because vessel anchoring would be short-

[12] Typical extreme wave conditions for this example were obtained from the NOAA NDBC website for Station 46050 – Stonewall Bank, located 20 nautical miles West of Newport, Oregon.

term and represent a small disturbance, any effects on the seafloor would be negligible and similar to the anchoring of vessels that occurs regularly along the Oregon coast.

In summary, it is anticipated that scour depths may be up to 1 m, and scour widths may extend at least as far from the anchors as 20 m (the actual distance that scour and sediment change occurs will be monitored in the Organism Interactions and Benthic Sediments monitoring plans [Appendix H]). Including an additional 20 m (65 ft) radius around each 34-ft diameter anchor to consider scour development and sediment re-deposition, the total direct and indirect disturbance surface area is anticipated to be approximately 21,124 ft^2 per anchor (which assumes a 164 ft diameter of direct and indirect disturbance). For the initial development scenario with 21 anchors, this could result in approximately 10 acres, or 0.6 percent of the total Project site being potentially affected. For the full build-out scenario with 100 anchors, this could result in approximately 48 acres, or 3 percent of the total Project site being potentially affected.

Changes in benthic habitat as a result of benthic habitat disturbance in the Project area could result in changes to prey type or availability for fish in the Project Area. The NMFS Biological Opinion for PacWave North stated that best available indicator for the level of incidental take associated with changes to benthic habitat was changes in substrate grain size and distribution over a substantial portion of the test site (NMFS 2012c). The threshold for ESA consultation reinitiation was a change in substrate type (grain size and distribution) from baseline conditions (188 µm to 462 µm) to another state (e.g., from a fine grained to a coarse sand) over 50 percent of the test site, and changes in substrate types from baseline conditions were well below the 50 percent threshold. The Project site is also unlikely to exceed this threshold.

In addition, total area of benthic habitat disturbed at the test site would be minor in comparison to surrounding available habitat (for the full build out scenario, 0.1 percent [2 acres] for direct effects to the seafloor and 3 percent [48 acres] for indirect effects to the seafloor).

Because it is assumed that the Project site is a high energy site (based on the existence of larger median grain sizes and low fine sediment percentages), it is estimated that the physical recovery will occur quickly. High energy sites are typically inhabited by opportunistic organisms tolerant of disturbance (Pemberton and MacEachern 1997). At PacWave North, benthic community recovery was rapid (i.e., within 2 months) and species diversity and relative abundances of benthic macroinvertebrates was “indistinguishable” pre- (2010 and 2011) and post-installation (2012-2014) (NNMREC 2015a). Effects at PacWave South are expected to be minimized given that anchors installation/removal is not likely to occur more than once a year in a berth and anchors would likely be deployed for multi-year (e.g., 3-5 year) periods. More specifically, the number of species and species diversity of invertebrates collected in cores around the Ocean Sentinel anchors at PacWave North (about 45 m deep) were not different from the number of species and species diversity of invertebrates collected from the reference stations at 40 m and 50 m depths (NNMREC 2015b). Assuming non-mobile macroinvertebrates are important groundfish prey as well as the organisms most susceptible to disturbance impacts from the Project, the best available science suggests that recovery/ recolonization times are minimal and there would be no impacts to predators (e.g., sturgeon and groundfish) of these macrofaunal invertebrates. The abundances of mobile, slightly larger prey, such as Crangon shrimp and small fishes did not seem to vary in a way attributable to deployment activities at PacWave North. For Crangon biomass collected at PacWave North across twenty months from 2010 to 2014, the only significantly different month was August 2011 when two exceptionally high catches occurred. Other than that, there has been no significant variability across 19 other months of sampling in Crangon biomass at the nine reference stations around the Ocean Sentinel at PacWave North. Fish density at PacWave North was higher in summer 2013 and 2014 than previous years (2010-2012), although the June catches across all years were not actually statistically significantly different. This general increase began in spring 2013, four months before the Ocean Sentinel installation. Overall, any effects on prey availability due to WECs or anchors (if there are any) must be extremely localized; there certainly is no evidence that shrimp and fish species vacate the area. Therefore, any loss of prey species would not significantly reduce prey availability or abundance for fishes.

When anchors are removed at the test site, there may be scour holes or settlement pits remaining on the seafloor that will be initially void of macrofauna (due to the previous existence of the anchor). According to Collie et al. (2000) and Dernie et al. (2003), and depending upon the near-bottom hydrodynamics post-anchor removal, the seafloor is expected to revert back to native physical conditions relatively quickly because the substrate comprises sand as opposed to finer, muddy sediments. It is difficult to predict recovery times of the sediment and benthic habitat because their respective recoveries are dependent upon several variables; namely, the near-bottom current magnitudes and directions following disturbance. Occurrences of high energy (i.e., high current velocity) events may act to reshape the seafloor rapidly following disturbances; however, milder hydrodynamics may result in longer durations before the sediment is re-worked and benthos migrate back to the disturbed areas. Dernie et al. (2003) compared recovery rate of benthic assemblages and habitat parameters in different sediment types[13]. Dernie et al. (2003) stated that “sediment composition is largely controlled by hydrodynamic forces (Snelgrove and Butman 1994, from Dernie et al. 2003)…such that clean, coarse sandy bottoms predominate in high-energy environments…. Presumably, the communities that inhabit such different sediment types have adapted to very different environmental disturbance regimes (Hall

[13] The Dernie et al (2003) experiment was restricted solely to the intertidal zone so they could facilitate site access for frequent physical measurements. But the scale of the disturbance was “chosen to be relevant to fishing impacts that occur intertidally and subtidally (e.g., digging, raking, dredging and trawling).”

1994, from Dernie et al. 2003). Many species that are typical of wave-exposed sandy environments exhibit behaviors that enable them to survive daily tidal scouring events" (Gorzelany and Nelson 1987, from Dernie et al. 2003). In general, they found that "clean sand had the most rapid recovery rate following disturbance. It is generally assumed that communities found in dynamic sandy habitats will recover more quickly following physical disturbance than those found in less energetic muddy environments based on the adaptive strategies of the differing assemblages" (Kaiser 1998, Ferns, Rostron and Siman 2000, both from Dernie et al. 2003). Dernie et al. (2003) determined a time on the order of 100 days to return to pre-disturbed conditions. Collie et al. (2000) came to similar conclusions.

Summary – The total area of benthic habitat disturbed at the test site would be very small relative to the range of and available marine habitat for species that use the Project area, and minor in comparison to surrounding available habitat (for full build out, maximum direct effects to the seafloor would occur for about 0.1 percent of the Project area [2 acres] and maximum indirect effects to the seafloor would occur for about 3 percent [48 acres] of the Project area). Effects at PacWave South are expected to be minimized given that anchor installation/removal is not likely to occur more than once a year in a berth and anchors may be deployed for multi-year periods. Any effects on prey availability due to WECs or anchors (if there are any) is expected to be extremely minor, localized, short-term, and temporary, though intermittent throughout the 25-year license term. Thus, benthic habitat disturbance is not expected to adversely affect Project area fish and invertebrates.

Although no difference in macrofaunal assemblages was detected around the Ocean Sentinel anchors after one year of deployment at PacWave North, uncertainty remains regarding the potential long-term changes to benthic habitat, given that PacWave South will be a larger project and a longer deployment time than PacWave North. OSU would conduct 1) the Organism Interactions Monitoring Plan (Appendix H) to track changes to pelagic and demersal fish and invertebrates (particularly Dungeness crab) that might be attracted to the installed components or affected due to the potential for reduced fishing pressure, as well as biofouling on the anchors/WECs, and 2) the Benthic Sediments Monitoring Plan in consultation with appropriate agencies or pursuant to the Adaptive Management Framework to track changes to benthic habitat in the vicinity of Project components (i.e., anchors) to determine what (if any) changes in sediment characteristics result in changes to the benthic invertebrate communities, and implement mitigation measures, if warranted.

Fish species associated with soft bottom habitats that are listed as Oregon Nearshore Strategy species may occur on the sandy bottom habitat within the footprint of the PacWave South Project. These species are unlikely to be affected because they would likely move away from the immediate vicinity of the anchors and cables and move to nearby areas during deployment and removal activities.

Changes to Marine Community Composition and Behavior

WECs, anchors, moorings, subsea cables, and umbilicals would be placed in a portion of the OCS that is sandy and generally devoid of vertical habitat features on the seafloor, within the water column, and on the water surface. Thus, the Project components on the seafloor, in the water column, and on the water's surface would add complexity to the homogenous sandy seafloor and open ocean environment, which could result in the following effects to the species and community composition in the area:

- Changes in the presence of biofouling species, species interaction, and predator-prey interactions;
- Effects of pinniped haulout and seabird perching on Project structures;
- Effects of seabird avoidance of the Project area;
- Effects of artificial lighting; and
- Effects of changes in wave energy on habitat.

Changes in the Presence of Biofouling Species, Species Interaction, and Predator-Prey Interactions – WECs, anchors, moorings, umbilicals, hubs, and subsea connectors would introduce structure on the seafloor, in the water column, and at the surface, which could result in changes to marine community composition and behavior, and affect Project area aquatic life. Areas of shelter, structure, or cover often are used by fish for protection from predators (Johnson and Stickney 1989). At full build-out, seafloor structure could include up to 100 anchors that would occupy a total footprint of up to 90,800 ft^2 (2 acres), and water column and/or surface structure of up to 20 WECs (each separated by a distance of 50 to 200 m or more) and associated moorings and umbilicals. These structures would be placed on sand substrate that is generally lacking vertical habitat features, which could result in localized seafloor habitat changes as the hard structures (e.g., anchors) are deployed. Based on reviews of bottom changes resulting from deployment of artificial reefs and offshore oil platforms, sedimentary changes could be expected to occur at least 20 m away from an anchor installation (Henkel et al. 2014). Structures would likely become colonized ("biofouled") by algae and invertebrates, such as barnacles, mussels, bryozoans, corals, tunicates, and tube-dwelling worms and crustaceans, termed "biofouling" (Boehlert et al. 2008). Based on surveys at PacWave North, changes to the benthos (particularly shell hash accumulation) may be expected to occur up to 250 m away from an anchor installation; however, this accumulation does not appear to have a measureable effect on the composition of the macrofaunal community (Henkel and Hellin 2016).

The CWG provided feedback to OSU that they were concerned that predator-prey relations could change, so this analysis considered the potential for added structure to increase forage opportunities and attract these species. The change in habitat complexity resulting from the exposure of anchors above the sea floor and any resulting localized scour or shell mounding might also increase habitat complexity and provide habitat for structure-associated fish. Some types of pelagic fishes are also known to associate with floating objects (Castro et al. 2002, Nelson 2003), so Project structures in the water column and at the surface (e.g., WECs, marker buoys and mooring lines) and associated biofouling might act as fish aggregating devices (FADs) and attract pelagic fishes through visual and/or olfactory cues (Dempster and Kingsford 2003). If Project-related structures do attract marine life regularly, predictably, and in significant numbers, they might also attract larger fish predators, which could then prey on the attracted organisms. Cormorants and brown pelicans might roost on above-surface structures of WECs, and California sea lions might haul out on the structures, and these species may also occasionally prey on fish species that are present. In general, although there is uncertainty about the degree to which marine animals may be attracted to WEC structures, there is no data that suggest that there would be any significant adverse effects to individuals or populations (Copping et al. 2016).

Structure is not novel or unusual in the marine environment along the U.S. West Coast, and includes natural and manmade objects in the water column and at the surface such as navigational buoys, kelp, floating debris, piers, and oil platforms, as well as seafloor structure such as large natural rocky reefs, artificial reefs, marine debris, and oil platforms; some types of fish (e.g., rockfishes) are known to associate with these structures (Kramer et al. 2015). The following describes their potential use of seafloor, water column, and surface Project structures, and potential effects on marine life as a result of changes to marine community composition, forage opportunities, and predator/prey abundances, in the following paragraphs.

Seafloor Structure – Project structures at or near the bottom (e.g., anchors) may act as an artificial reef and provide habitat for structure-oriented fishes, such as rockfish (Danner et al. 1994, Love and Yoklavich 2006). Artificial reefs, defined as any manmade structure intentionally or unintentionally placed on the seafloor, are constructed out of a variety of materials including concrete rubble, quarry rock, scrap automobiles and train cars, pipes, shipwrecks, marine debris, tires, and attraction and concentration to these structures by structure-oriented fishes is well-known (Caselle et al. 2002, Broughton 2012, Wilhelmsson and Langhamer 2014). Oil platforms, although not entirely analogous to wave energy facilities, are known to provide habitat for reef-associated fishes and invertebrates and even contribute to the production of rockfishes offshore of southern California (Claisse et al. 2014). Attraction to Project structures could alter the fish species composition in and around the Project area by concentrating structure-oriented fishes, and may also affect predator/prey interactions (Wilhelmsson and Langhamer 2014). The development of an artificial reef or attraction of structure-oriented fish may in turn also attract other predators, including marine mammals and birds. However, PacWave South would differ from artificially constructed reefs in that the anchors and other components would be spaced throughout the Project site, with WECs separated 50 to 200 m or more. In addition, some anchor types would be deployed below the seafloor, and therefore would not contribute to an artificial reef effect.

Anchors and WECs would be installed and removed, over the life of the Project, so changes to marine community composition due to presence of in-water structures would vary over time and the number of WECs being tested (i.e., single WEC versus array testing). Fish attracted to Project components (e.g., anchors) could include the deep rocky reef (>25 m depth) associated fish species listed in the Oregon Nearshore Strategy, and the structure could provide additional habitat, enhanced forage opportunities, and/or expose some of these fish species to increased predation by predatory fishes, seabirds, and/or marine mammals. However, most of the Oregon Nearshore Strategy deep rocky reef fish species are also known to occur at the bottom and midwater structures of oil platforms offshore of southern and central California (Casselle et al. 2002, Love et al. 2010), and negative population-level effects on reef-associated species at these oil platforms have not been reported. In fact, the oil platforms contribute to rockfish productivity and have some of the highest secondary production per unit area of any marine habitat studied globally (Claisse et al. 2014). The Project would not be expected to have a population-level impact on rocky reef fishes due to the small overall footprint and low density of WECs; however, the offshore oil platform studies suggest that artificial structure does not negatively affect rocky reef fishes. Thus, the impact on Oregon Nearshore Strategy fish species due to Project structures is expected to be minor.

<u>Water Column/Surface Structure</u> – Project structures in the water column and at the surface are unlikely to act as FADs that would attract pelagic fish. In general, fish associations with FADs are not found in temperate waters like they are known to in tropical waters, based on evaluation of the fish assemblages found at various types of natural and manmade structures in marine waters along the U.S. West Coast and in Hawaii (Kramer et al. 2015). At existing wind and wave energy projects (that have both seafloor and vertical structure) in cold-temperate waters of Europe, none of them reported a measurable “FAD effect”, but all of them reported an artificial reef effect where demersal fish were attracted (e.g., Wilhelmsson et al. 2006, Langhamer et al. 2009, Leonhard et al. 2011, Bergstrom et al. 2013, Reubens et al. 2014, Krone et al. 2013). In temperate ocean waters of California, Oregon, and Washington, fish associations with midwater and surface structures were generally limited to pelagic juvenile rockfishes, which have been reported at various structures such as attached kelp (Matthews 1985, Bodkin 1986, Gallagher and Heppell 2010), floating kelp (Mitchell and Hunter 1970, Boehlert 1977), oil platforms (Love et al. 2010, 2012), vertical structures of docks and pilings (Gallagher and Heppell 2010), and “SMURFs” (Ammann 2004, Caselle et al. 2010, Woodson et al. 2012, Jones and Mulligan 2014). Given that pelagic fish, such as juvenile and adult salmonids, are highly mobile and movements generally follow available prey, which includes highly mobile pelagic or surface-oriented crustaceans and fish, they could occasionally occur at Project structures in the water column and at the surface but they are unlikely to remain there. Therefore, pelagic juvenile rockfish could occur at Project structures in the water column and at the surface before settling to the bottom, but other typical FAD-associated taxa, such as piscivorous scombrids, are unlikely to occur at PacWave South due to its location in cold-temperate waters.

Summary – Because of the small size of the Project, it is not anticipated that the addition of Project structures to the marine environment would represent a significant change to marine habitat above existing conditions. Any changes to marine community composition as result of the presence of these structures are not expected to adversely affect marine life that could be in the Project area. OSU would conduct the Organism Interactions Monitoring Plan (Appendix H) to evaluate fish associations and biofouling on the anchors/WECs.

Effects of Pinniped Haulout and Seabird Perching on Project Structures – Pinnipeds may attempt to use WECs as haulouts. They are known to haulout on manmade structures, especially those with underwater components that attract fish and increase foraging opportunities, such as navigation buoys. Haulout opportunities, combined with possible fish attraction to the Project's underwater structures, could increase pinniped predation on fish associated with those structures. Pinnipeds that are hauled out on WECs could detrimentally affect operation of those devices or preclude access for maintenance activities. Possible deterrence measures include special coatings and physical barriers (i.e., fencing). However, for many WECs, such measures may not be feasible if they preclude access for maintenance or if the design of the WEC does not lend itself to implementation of deterrence measures. For example, an attenuator or point absorber WEC submerges below the surface periodically, and fencing could result in capturing of marine life when the WEC surfaces. The need for deterrence measures is lessened, however, because the creation of artificial haulout opportunities is not expected to negatively affect pinnipeds; in fact, it could be beneficiary if it provides areas to rest. As a test center, experience gained at PacWave South would inform appropriate design measures to minimize opportunities for pinniped haulout.

Seabirds, such as gulls and cormorants, could roost or attempt to nest on above-water structures at PacWave South. Perching on buoys and other manmade structures is a common behavior for gulls and cormorants, and is not generally considered to adversely affect these birds. However, if they do perch on the structures, they could also forage around underwater WEC components and potentially be subject to collision with underwater WEC components or entanglement with marine debris that becomes entangled with the components, although this effect is also unlikely to occur (Henkel et al. 2013, see "potential effects of collision or entanglement" section below).

Increased foraging is not expected to occur with pinniped haulout or seabird perching since attraction of forage fish to underwater Project structures is not expected to be significant (as discussed above with regards to community changes). Significant adverse effects on seabirds as a result of perching on Project structures or feeding on fish are not expected to occur. OSU would make opportunistic visual observations in the portions of the WEC test site during vessel-based visits to conduct operations, maintenance or environmental monitoring work to detect and document any instances of pinniped haulout or seabird perching at least once per quarter. If pinniped haulout is recorded or if seabird perching is such that it may prevent access to a WEC (e.g., nest(s) are observed, accumulated guano prevents safe access), or may result in damage to a WEC (guano is corroding to treated surfaces), OSU and the WEC testing client will devise a plan in coordination with FWS to prevent or discourage future seabird perching.

Effects of Seabird Avoidance/Displacement of Project Area – Some species of seabirds or sea ducks could exhibit avoidance behavior around the WECs. In Europe, common eiders and pink-footed geese have been shown to avoid offshore wind farms during their migration between wintering and breeding grounds, by adjusting their flight trajectories and flying around the farms (Desholm and Kahlert 2005, Masden et al. 2009, Plonczkier and Simms 2012), and several species of loons, sea ducks, and seabirds have been estimated to have a moderate to high risk of displacement by offshore wind farms (Bradbury et al. 2014). Avoidance behavior could have the positive effect of reducing their risk of collision with turbines, but it could also result in increased energetic costs associated with migration (Masden et al. 2009).

Although avoidance behavior has been reported for some species of sea ducks at offshore wind farms, this behavior is unlikely to occur in response to WECs at PacWave South. Wind turbines are considerably taller than the WECs at PacWave South (>100 m versus < approximately 15 m height) presenting a greater barrier to migratory flight. In the study on wave and tidal energy converters in Scottish waters, the vulnerability of seabird populations to adverse effects from WECs was ranked as low or very low (with the exception of divers/loons, which were ranked as moderate), and one of the seven vulnerability factors used for this ranking was the potential for exclusion from foraging habitat (Furness et al. 2012). Therefore, there is a low likelihood of avoidance or displacement of seabirds as a result of the Project.

Effects of Artificial Lighting – Phototactic seabirds such as shearwaters, petrels, auklets, and murrelets could be attracted to U.S. Coast Guard (USCG) required navigational lighting on Project structures (WECs and navigation marker buoys), and servicing and support vessels associated with installation, maintenance, or monitoring of the Project and could collide with or land on Project structures or vessels, or become exhausted by continual circling around the lights (Montevecchi 2006). Phototactic seabirds have been shown to be highly attracted to artificial light in the marine environment; typical sources of light include boats, lighthouses, oil and gas platforms, coastal resorts, and commercial fishery operations. Continuous high-intensity white lighting has a higher likelihood of attracting phototactic seabirds than lower-intensity, colored lights and those that flash at intervals (Montevecchi 2006, Poot et al. 2008). Phototactic seabirds are most susceptible to light attraction in cloudy, foggy, or hazy conditions, in light rain, and when the moon is absent or obscured. Immature and nonbreeding phototactic seabirds tend to be more attracted to light than breeding adults (Montevecchi 2006, Miles et al. 2010).

To minimize the potential for seabird attraction to lights on Project structures, low-intensity flashing lights that meet the minimum USCG and FWS requirements would be used.

The specifications for Project lighting would also be developed in compliance with FWS lighting requirements. For the Reedsport OPT Wave Park, OPT consulted with the FWS, and agreed that navigation lights would be shielded, to direct light only towards approaching watercraft (and not directly upwards) and that the flash timing interval would be equal to or greater than 4 seconds for each individual light to minimize the potential for seabird attraction (Reedsport OPT Wave Park, LLC 2010). OSU expects to implement similar measures to minimize effects of Project lighting, as determined in coordination with the USCG and FWS. Seabirds are unlikely to be attracted to navigational lights on WECs or Project structures with implementation of the environmental measures in the Bird and Bat Conservation Strategy (Appendix B).

The potential effects on seabirds from vessel lighting are expected to be short-term and intermittent, limited to installation of the WECs and during periodic maintenance and repair activities; environmental monitoring is unlikely to occur at night. To minimize the potential for seabird attraction to lighting on service and support vessels, servicing and maintenance operations at PacWave South would occur during daylight whenever practicable. Managing Project lighting requirements properly would minimize the likelihood that seabirds would be affected by navigational lighting on Project structures, or on servicing and support vessels. Therefore, significant adverse effects on seabirds as a result of artificial lighting associated with the Project are not expected to occur and will be minimized by the environmental measures in the Bird and Bat Conservation Strategy (Appendix B).

Effects of Changes in Wave Energy to Habitat – Wave energy on the Oregon coast varies considerably by season, such that the wave energy flux is approximately eight times greater during winter than summer (Bedard 2005). Episodic winter storms bring large waves from the west and southwest. As waves encounter the floating WECs, the wave energy would be absorbed or reflected (i.e., radiated) to another direction, causing localized eddies or gyres as currents pass by the WECs. However, attenuation of wave energy by WECs would be indistinguishable outside of the test site, as any changes to the hydrodynamics at the WEC arrays would be subject to the far stronger influences of the circulations of the California Current. Because of the dominance of medium to coarse sandy habitat in the Project area and the lack of finer grained sediment (percent fines in the PacWave South area are very low, less than 1 percent; Henkel 2016), it is not expected that scour around Project structures would result in significant changes to the seafloor.

Changes to the littoral zone and shoreline habitat would be unlikely due to the distance between PacWave South and the shoreline (i.e., about 6 nautical miles) and the permeability of the test site (as the WECs would be spaced about 50 to 200 m or more apart). Wave patterns closer to shore are influenced by land features, bathymetry, tidal currents, and estuarine-induced currents (USACE and EPA 2012); none of these factors would be affected by the Project. At full build out, the arrays of WECs at PacWave South are not anticipated to significantly impact wave energy and related habitat-forming processes. Likewise, the absorption of wave energy at PacWave South would not affect species or habitats listed in the Oregon Nearshore Strategy.

Effects of Underwater Sound/Vibration on Marine Mammals, Fish, and Seabirds

The primary sources of Project-related underwater sound would be from vessels at PacWave South and transiting between Newport and the site, cable laying, and from WECs and associated Project structures. Sound from these sources would vary in intensity and duration based on the activity and the sea state, and all would be continuous (i.e., not impulsive) sounds. Underwater sounds generated by the Project may be similar to, or masked by, ambient underwater sounds in the Project area, which are reported to be higher than the typical deep ocean sound found in the northeast Pacific Ocean (Haxel et al. 2011), likely due to wave activity and existing vessel traffic. Ambient sound in the marine environment originates from both natural and anthropogenic sources, such as commercial and recreational vessel traffic, wave action, marine life (e.g., marine mammal vocalizations), atmospheric sound, and others (Haxel et al. 2013). Baseline underwater sound monitoring at PacWave North recorded sound pressure levels (SPL) between 95 decibels (dB) root mean square (RMS) re:1 μPa and 136 dB RMS re:1 μPa, with a time-averaged SPL for the monitoring period of 113 dB RM re:1 μPa (Haxel et al. 2011). In 2015, Haxel (2019) collected baseline ambient noise levels over an approximately 6 week period in the southern region of the PacWave South area for site characterization. SPL RMS from 7 Hz-13 kHz was used to generate a cumulative distribution function (CDF) of noise levels where the 50th percentile (101 dB RMS re:1 μPa) was representative of a "typical" background sound level at PacWave South. Baseline monitoring recorded minimum SPL RMS levels for this time period of 83 dB RMS re:1 μPa, while local vessels generated the maximum RMS sound pressure level (138 dB RMS re:1 μPa) from a total of 61,380 SPL RMS values. Despite the measured maximum value of 138 dB, less than 1 percent of the measurements surpassed the 116 dB level at PacWave South (Haxel 2019).

Vessel Sound

Vessels used during initial Project construction and WEC installation, maintenance, environmental monitoring, and decommissioning (e.g., anchor handling and towing tugs, material transport barges, research vessels, and crew vessels) would regularly transit between Newport and PacWave South. Vessels transmit sound through water predominantly through propeller cavitation, although other ancillary sounds may be produced, and the intensity of sound from service vessels is roughly related to ship size and speed (Hildebrand 2009). Large ships tend to be noisier and have lower frequencies than small ones, and ships underway with a full load (or towing or pushing a load) produce more sound than unladen vessels (Hildebrand 2009). For vessels used at PacWave North, NMFS (2012a) assumed that "sound intensity generated by tugs, barges, and diesel-powered vessels (i.e., the types that would be used for Project installation and maintenance) when fully underway (traveling to and from the test site) or due to cavitation during starts and stops, would be no greater than 130 to 160 dB (re: 1 μPa) over a frequency range of 20 Hz to 10 kHz" (also see Richardson et al. 1995, DOE 2012). This assumption would also be applicable to PacWave South. These levels would occur when vessels are fully underway, coming to or leaving the site, which for most trips between the test site and Newport would last 1 to 1.5 hours. The sound intensity would be lower when the vessels are operating at very slow or idle speed, which is likely to occur at the test site when conducting monitoring or maintenance activities.

A vessel with dynamic positioning thrusters could be used during cable lay operations at the beginning of the Project and potentially during installation of individual WECs. In its EA for the Virginia Offshore Wind Technology Advancement Project on the Atlantic Outer Continental Shelf Offshore Virginia, BOEM (2014) estimated that the sound source-level for the dynamic positioning cable laying vessel would be 177 dB re 1 μPa at 1 m, and Deepwater Wind LLC's Block Island Wind Farm estimated the sound source-level for the dynamic positioning cable laying vessel would be 180 dB re 1 μPa at 1 m (NMFS 2015i).

Yaquina Bay is a large commercial harbor with many recreational, charter, and commercial boats, and vessel traffic is often concentrated near the mouth of the bay, so it is assumed that Project-related vessel sounds would not be significantly greater or different than existing conditions. Although vessel sound could be expected to result in avoidance by marine mammals, fish, and seabirds (DOE 2012), these effects would be temporary and short term, and exposure to the stressor would be limited to locations and times where a vessel and marine life are in close proximity.

The estimated annual number of days during which vessels will be transiting between Newport and PacWave South for the initial development scenario and full build out scenario are shown in Table 3-14. During some days, only one vessel may be on site (e.g., environmental monitoring or O&M activities), while during deployment or removal activities, a number of vessels may be on site.

Table 3-14. Estimated number of days during which vessels will be transiting between Newport and PacWave South for the initial development and full build out scenarios.*

Build Out Scenario	Estimated Annual Vessel Round Trips Between Newport and PacWave South		
	Deployment, O&M, and Retrieval	Monitoring	Total
Initial Development (6 WECs)	36	45	81
Full Build Out (20 WECs)	69	36	105

* Note, during days when deployment activities are occurring, multiple vessels will be at PacWave South and transiting between the Port of Newport and PacWave South. During other days, only one vessel may be on site (e.g., environmental monitoring or O&M activities).

Anchor Deployment Sound

Anchor installation is a short term activity (hours), with anchoring occurring in soft substrates that would likely produce less sound than the sounds from the vessels deploying the anchors. However, suction anchors require hydraulic pumps for installation. Suction anchors were proposed for installation for the Neptune LNG Deepwater Port, and noise modelling indicated that installation of the suction pile anchors at the Port would produce only low levels of underwater sound with no levels above the 120-dB criterion for continuous sound (Neptune LNG LLC 2007). Modeling for installation of the suction pile anchors was conducted by Jasco, indicating that the 120-dB threshold would not be exceeded and the 90-dB contour would occur only out to 300 to 1,000 feet from the source of the sound. The method for installation was using a submerged pump attached to an ROV (Engineering-Environmental Management Inc. 2006).

HDD Sound

Subsea cable installation would generate sound during HDD. HDD involves drilling below the seafloor, and sound may be generated in the marine environment as the drill head approaches the breakout point underwater. The information that exists about sound that may be generated in the marine environment as the HDD drill head approaches the breakout point underwater is qualitative, and indicates that the sound from the bore hole drilling would be much less than typical work vessels that would be expected to be used for the Project (Gaboury et al. 2008, Navy 2008 *both cited in* NAVFAC 2014).

WEC Operation Sound

During operation, sound may be generated by water flowing past the mooring lines, waves splashing against the WECs and other structures, or by the moving components of the WECs and moorings. Due to the variety and complexity of differing sound sources within an array, it is difficult to model or predict the sound signature (Wilson et al. 2014). Based on underwater sound monitoring, the operational sounds of the test WET-NZ device at PacWave North were within the range of ambient conditions and did not exceed NMFS's 120 dB marine mammal harassment threshold (as discussed below). The maximum SPL attributed to Columbia Power Technologies' 1/7-scale WEC was measured from 116 to 126 dB re: 1 µPa in the integrated bands from 60 Hz to 20 kHz at distances from 10 to 1,500 m from the SeaRay (Bassett et al. 2011). From this, the SPL was estimated to be 145 dB re: 1 µPa at 1 m, and 126 dB re: 1 µPa at 10 m (Thomson et al. 2012, as cited in NAVFAC 2014); in the EA prepared for the Hawaii Wave Energy Test Site, engineers conservatively assumed that a full-sized WEC would be 3-6 dB louder than the 1/7 scale version, and estimated that the maximum SPL for a WEC was between 148 and 151 dB re: 1 µPa at 1 m (NAVFAC 2014). The maximum SPL generated by WECs off the west coast of Sweden was reported at 133 dB re 1 µPa at 20 m with an average of 129 dB re 1µPa (Haikonen et al. 2013). Other analysis suggests that WECs would result in sound only in the range of 75 to 80 dB, with somewhat higher frequencies than light- to normal-density shipping sound (Sound and Sea 2002 *cited in* Navy 2003). Per NMFS's request, to be conservative a source term of 151 dB re: 1 µPa at 1 m was used in this analysis.

Sounds emitted by the WECs, implementing NMFS's practical spreading model with the highest WEC sound source term, would attenuate to 120 dB re: 1 µPa at 125 m. Because of the uncertainty of the WEC type and size that will be deployed at PacWave South, as well as the exact sound signatures, OSU would implement the Acoustic Monitoring Plan (Appendix H) under the Adaptive Management Framework (Appendix J) to detect and, if needed, mitigate unanticipated adverse effects of WEC-related sound (Appendix I).

Effects of Underwater Sound/Vibration on Marine Mammals

Project-related underwater sound and vibration have the potential to adversely affect marine mammals by interfering with communication, prey and predator detection, and migration. The intensity and duration of exposure to underwater noise would vary by Project activity (i.e., installation versus operation), and development stage (i.e., initial build out and full build out scenarios). Sensitivity to sound can vary between marine mammals and responses to sound can be highly variable, depending on the individual hearing sensitivity of the animal, the behavioral or motivational state at the time of exposure, past exposure to the sound which may have caused habituation or sensitization, habitat characteristics, environmental factors that affect sound transmission, and non-acoustic characteristics of the sound source, such as whether it is stationary or moving (NRC National Research Council 2003). Whales migrating past PacWave South may be able detect sounds at considerable distances and may change course to avoid the Project area. To some degree, whales migrating over the OCS are occasionally exposed to elevated sound levels near Newport, and other larger ports along their migration route, as well as passing ships; therefore, it is difficult to predict their response to Project-related sound (Southall 2005), but serious adverse effects are not anticipated. Likewise, seals and sea lions that are habituated to vessel sound from commercial and recreation vessels that frequent the area could be undisturbed by Project vessels because these animals already encounter similar sounds in harbors and nearshore environments.

NMFS has developed revised guidance on sound levels likely to cause injury for marine mammals (NMFS 2016). The NMFS (2016) guidance provides thresholds for injury levels using cumulative sound over a 24 hour period: temporary (TTS) and permanent threshold shift (PTS) onset threshold levels for injury have been identified for low to mid-frequency cetaceans for non-impulse noise (178 and 179 dB re 1 $\mu Pa^2 s$ for TTS and 198 & 199 dB re 1 $\mu Pa^2 s$ for PTS) or phocid and otariid pinnipeds (181 dB & 199 dB re 1 $\mu Pa^2 s$ for TTS and 201 dB & 219 dB re 1 $\mu Pa^2 s$ for PTS). NMFS uses conservative exposure thresholds from broadband sounds that have been shown to cause behavioral disturbance (an adverse effect) 160 dB RMS re: 1µPa for impulsive sound and 120 dB RMS re: 1µPa for non-impulsive sound). None of the Project components or activities are expected to generate sound at levels that could cause injury to marine mammals. However, the sound levels from vessels during installation and operation, from cable laying, and from continuous sounds produced by the various WECs over the 25-year operation of the test center may exceed the 120-dB behavioral disturbance threshold and cause behavioral disruption of marine mammals (NMFS 2012c).

Vessel sound could affect feeding patterns and socialization for marine mammals, but these effects would be short term and temporary (i.e., hours or less as the vessels pass), though periodic over the 25-year license term, and are anticipated to be negligible and similar to what marine mammals already experience along the Oregon Coast. Also, ambient sound levels are also expected to approach 120 dB RMS re: 1µPa; baseline underwater sound monitoring at PacWave South recorded SPLs of between 83 and 116[14] dB RMS re: 1 µPa (Haxel 2019). For example, gray whales, an Oregon Nearshore Strategy and state listed species, are regularly exposed to vessel sound from commercial and recreational fishing and research vessels calling on the Port of Newport. Additionally, sound from Project vessels would likely be partially masked by ambient sound.

Underwater sound that may be generated as the HDD drill head approaches the exit point underwater is qualitative, and would be much less than typical work vessels that would be expected to be used for the Project (Gaboury et al. 2008, Navy 2008 *both cited in* NAVFAC 2014). Cetaceans and pinnipeds are highly mobile and would be expected to avoid the effective range of cable laying operations, thus further reducing potential for exposure to sound generated

[14] A maximum value of 138 dB was measured, but less than 1 percent of the measurements surpassed the 116 dB level (i.e., 99th percentile)(Haxel 2019).

by the dynamic positioning thrusters. Considering the temporary nature of cable laying activities at PacWave South (occurring only during construction), and the low likelihood that most whales would be near the cable route, coupled with the proposed mitigation to further reduce the potential for marine mammals to experience sound exceeding 120 dB, any effects of sound generated during cable installation would be negligible.

Sound generated by operating WECs is expected to be lower than the injury level for cetaceans or pinnipeds (NAVFAC 2014) and is not expected to result in harassment of marine mammals (see Appendix N). According to the analysis conducted in the WETS EA, sound source levels for the WECs range from 126 dB re: 1 µPa at 10 meters (Thomson et al. 2012, as cited in NAVFAC 2014). Using the NMFS practical spreading method with this 10 meter source term, or the same approach used in the WETS EA, the potential harassment area would range from 26 m (81 ft) to 50 m (163 ft). For the WETS EA the harassment area was determined to be roughly the mean of these two distances, or 35 m (115 feet). The higher range of these sound levels would occur during higher sea states, though these conditions would also occur during periods of higher ambient sound, likely resulting in partial or potentially total masking of the WEC-generated sound. Because of uncertainty associated with this new industry and in order to determine the actual sound levels emitted by WECs at the Project, OSU would implement the Acoustic Monitoring Plan (Appendix H) under the Adaptive Management Framework (Appendix J) to detect and, if needed, mitigate any effects of WEC-related sound (Appendix I).

Toothed whales (e.g., porpoises, dolphins, sperm whales, killer whales, and beaked whales), have mostly mid-frequency hearing capabilities (with the exception of harbor porpoises which are high frequency cetaceans) and possible behavior response to non-impulse sound could include moderate changes in speed of travel, direction, or dive profile; cessation or modification of vocal behavior for moderate to extended periods; avoidance of the sound source, and change in group distribution (Southall et al. 2007). The minor increase in travel time for toothed whales to avoid the Project is unlikely to significantly increase an individual's energy budget (NMFS 2013a), plus avoidance would reduce the chance of collision or entanglement with Project structures (discussed below). If displaced from the Project area due to noise, alternative forging and migrating routes are available near the Project. Recent research by Holt et al (2015) found that increased vocalization efforts by marine mammals in noisy habitats, such as areas exposed to regular vessel traffic, can result in measurable increase in metabolic rate and consequently an energetic cost at the individual level.

Baleen whales (e.g., fin, sei, gray, minke, and right whales), like humpback and blue whales, are considered to have low frequency hearing. If exposed, a baleen whale is likely to deflect around the sound instead of continuing in the same direction. The distance moved is expected to depend on the sound level at the time of interaction. Similar to toothed whales, baleen whales could be displaced and precluded from foraging in the Project area or from using it to move between foraging sites.

Pinnipeds have low to mid frequency hearing (Southall et al. 2007). Potential responses to non-impulse sound could include avoidance behavior, and they could be displaced and precluded from foraging in the Project area or from using it to move between foraging sites.

Conversely, the noise levels created by the WECs may not affect marine mammals at all. As noted, baseline underwater sound monitoring at PacWave South recorded SPLs from 83 dB RMS re:1 μPa to 116 dB RMS re:1 μPa (Haxel 2019). If marine mammals choose to avoid the test site, alternative foraging sites and routes are available and the additional distance traveled is unlikely to cause a significant increase in an individual's energy budget. It is likely that continuous, non-impact sound emissions from WEC testing to result in behavioral avoidance and corresponding minor energy cost at the individual level.

Based on the existing information, the likely behavioral responses, even considering potential for repeat exposures of individual whales and pinnipeds to sound from various periodic tests and vessel traffic associated with the Project, both at the site, and between PacWave South and Newport, over the 25-year license term, would not be expected to adversely affect baleen or toothed whales, or pinnipeds.

Effects of Underwater Sound/Vibration on Fish

Depending on the species, and the frequency and sound power level (loudness or amplitude) of the source, sound and vibration can cause stress, behavioral effects such as a startle response or movements away from the source, displacement from preferred feeding or reproduction sites, masking of acoustic communication and ability to find prey or detect predators, reduced growth, altered migration patterns, injury, or even mortality (Slotte et al. 2004, Popper and Hastings 2009, Popper et al. 2014). Underwater sound radiates outward from its origin until the sound pressure waves encounter land mass or attenuate to background levels. Rate of sound attenuation can vary based on sediment type, bottom topography, structures in the water, slope of bottom, temperature gradients, currents, and wave height (WSDOT 2014).

Most fish species can sense and may react to one or two components of sound waves, sound pressure, and/or particle motion. Species that are capable of detecting both sound pressure and particle motion can detect a wider range of frequencies and sounds of lower intensity, while those that can only detect particle motion (e.g., those lacking a swim bladder or those having a swim bladder and hearing structures that are far apart) are less sensitive. Sound and vibration may attract, repel, or otherwise affect fish behaviors (e.g., predator avoidance), depending on the species and the frequency and sound power level (loudness or amplitude) of the sound source.

At very high intensities, the potential effects of sound on fish can include mortality, injury in the form of temporary and permanent hearing damage and tissue damage, and temporary reductions in hearing sensitivity (known as a "temporary threshold shift", or TTS) (Hastings and Popper 2005, Popper and Hastings 2009, Popper et al. 2014). These types of effects are generally related to impulsive sounds, such as the high-level, short-duration sounds of impact pile-driving, explosions, or seismic airguns (Popper et al. 2014). The thresholds for injury resulting from percussive pile driving have been defined as a peak SPL of 206 dB re: 1 μPa and cumulative sound exposure level (SEL_{cum}) of 187 dB re 1 $\mu Pa^2 \cdot s$, by the U.S. Fisheries Hydroacoustic Working Group (FHWG 2009). Fishes near the Project would not be exposed to sound levels that would cause mortality, injury, or TTS, because Project activities would not generate impulsive sounds and the sound levels are expected to remain well below these thresholds for injury.

Sound associated with vessels, cable laying, and continuous sounds from the WECs and other Project infrastructure, could approach or occasionally exceed the threshold for behavioral effects (described below). Potential effects of moderate (e.g., non-injury) anthropogenic noises on fish can include disturbance and deterrence, reduced growth and reproduction, interference with predator-prey interactions, and masking of communication (Slabbekoorn et al. 2010). A reduced ability to avoid predators was shown to occur in Ambon damselfish in response to motorboat noise (Simpson et al. 2015), and reduced forage efficiency was shown to occur by threespine sticklebacks in response to white noise similar to the noise environment in a shoreline area with recreational speedboat activity (Purser and Radford 2011). The threshold for causing temporary behavioral changes (startle and stress) on threatened and endangered fish species, as defined by NMFS and FWS, is 150 dB re 1 μPa RMS (FHWG 2009). There are a number of studies that suggest that Project-related sounds may elicit some behavioral responses by ESA-listed fishes but adverse effects are unlikely; these studies are described below.

Sound levels less than approximately 160 dB are reported to not adversely affect adult fish, including species such as rockfish and rainbow trout (Hastings and Popper 2005; Popper et al. 2014). Based on the measured sound levels of drilling for cable laying in the U.K., avoidance of the sound source by fish was likely but auditory injury was unlikely (Nedwell and Edwards 2004). Rainbow trout exposed to continuous sound (up to 150 dB re: 1 µPa rms) in an aquaculture facility for nine months showed no hearing loss or adverse effects on fish health (Wysocki et al. 2007). A study that exposed juvenile Chinook salmon to simulated tidal turbine sounds at levels of 159 dB re 1 μPa RMS for 24 hours found low levels of temporary tissue damage that had low physiological costs to the fish, and no effects on hearing sensitivity (Halvorsen et al. 2011). This represented a worst-case scenario for temporal exposure, the more likely scenario would be that salmonids, due to their migratory nature, would pass by the turbine and very quickly back into waters with much lower and rapidly declining sound levels, and the risk of tissue damage would be much lower (Halvorsen et al. 2011). A study conducted by

Wahlberg and Westerberg (2005) estimated that Atlantic salmon could detect sound emitted from a wind farm at a distance of 400-500 m, and speculated that they may change their swimming pattern to avoid the source. However, fish could habituate to the continuous sounds of the WECs; in one study comparing effects of intermittent versus continuous sounds, European seabass returned to pre-exposure behaviors more quickly in response to continuous sounds as compared to intermittent sounds of the same intensity (Neo et al. 2014). The migratory nature of many pelagic fish would lower their potential temporal exposure to the continuous sounds of WECs and it is unlikely that the sounds would interrupt their migration path; in one study, the installation of wind farms within the migratory pathway of European silver eel in coastal northern Europe elicited no apparent change in their migration patterns (Andersson et al. 2012). Haikonen et al. (2013) reported that noise generated by WECs off the west coast of Sweden (maximum 133 dB re 1 μPa at 20 m, average 129 dB re 1μPa) was detectable by fish, but not sufficient to alter fish behavior.

Based on the existing information, the short term and temporary sounds from vessels transiting to or from the Project site and within the Project site itself (i.e., hours or less as the vessels pass), and from cable laying during installation and deployment of WECs, as well as from continuous sounds from the WECs, even though they would occur over the 25-year license term, are not likely to adversely fishes for several reasons: the area affected (e.g., up to 125 m around the WECs) would be insignificant compared to the range of most fish species that would pass through the Project area, and, there is similar and abundant habitat available in the surrounding area that they could move to if they are exposed or disturbed by the sounds. In addition, sounds emitted from the WECs or from vessel traffic are unlikely to be significantly greater than existing conditions, given the high level of vessel traffic already present in the vicinity of the Project area in association with the Port of Newport.

The Project is located between two rocky reef areas and approximately 6 nautical miles off the coast of Newport/the entrance to Yaquina Bay. Fish may swim around a WEC or avoid a vessel transiting between the Port of Newport and PacWave South, but there is no basis to expect that noise associated with the Project, including deployment, O&M, retrieval, and environmental monitoring, would affect aggregating fish such as rockfish or green sturgeon, or the migratory path for pelagic fish, such as salmon leaving or returning to natal streams because of the remote offshore location of the Project, the spacing of the WECs, and relatively low levels of noise associated with the Project. Therefore, underwater sound from the Project would not be expected to adversely affect any fish.

Because of the uncertainty associated with the underwater sounds that will be associated with this relatively new industry, if acoustics monitoring (Appendix H) results indicate that the operating WECs exceed an acoustic management or mitigation threshold, adaptive management and mitigation measures to address the unanticipated adverse effects would be implemented by OSU (Appendices I and J).

Effects of Underwater Sound/Vibration on Seabirds

Although intense underwater sound, such as impulses produced by underwater explosions, seismic pulses, sonar, and pile-driving, has the potential to cause injury or mortality to seabirds, sound emitted by the WECs during ordinary operation is expected to be within the range of ambient sound levels; furthermore, it is not expected to produce intense sound at amplitudes capable of causing auditory harm to marine vertebrates (Wilson et al. 2014). Vessel sound could create temporary disturbance to seabirds, but these effects are anticipated to be negligible since they would not rise to the level of causing harm, and would be short term and temporary (i.e., hours). In addition, OSU would implement the Acoustics Monitoring Plan (Appendix H) to detect and, if needed, mitigate any effects of Project-related underwater sound (Appendix J). For these reasons, Project-related underwater sound and vibration is not likely to have significant adverse effect on seabirds.

Effects or Risk of Collision/Entanglement with Project Structures, Entangled Gear, or Service Vessels to Marine Species

Effects or Risk of Collision/Entanglement to Marine Mammals

The CWG was concerned that Project structures, including WECs, mooring lines, subsea floats, marker buoys, and umbilical cables, might possibly pose a risk to whales if they collide with these submerged components or become entangled with debris (e.g., lost fishing gear) if it accumulates at surface or on submerged structures. The estimated number of mooring lines and umbilical cables for each scenario is provided in Table 3-15.

Table 3-15. Estimated number of mooring lines and umbilical cables for Initial Development and Full Build-Out Scenarios.

Build -Out Scenario	No. WECs	No. Anchors/ Mooring Lines Total*	No. Umbilical Cables Total
Initial Development	6	21	6
Full Build Out	20	100	20

* One anchor per mooring line.

In addition, there was concern that whales may possibly collide with vessels visiting the site or transiting between the Port of Newport and PacWave South. The estimated annual number of days during which vessels will be transiting between Newport and PacWave South for the initial development scenario and full build out scenario are shown in Table 3-15. During days when deployment or retrieval activities are occurring, multiple vessels (e.g., up to four vessels) will be at PacWave South and transiting between the Port of Newport and PacWave South, while for other activities (e.g., environmental monitoring or O&M activities), only one vessel may be on site. Therefore, on an annual basis, it is expected that vessels would be transiting between the Port of Newport and PacWave South, and working at PacWave South, during 81 days and 105 days for the initial and full build out scenarios, respectively (Table 3-15). Approximately 33-56 percent of vessel activity will be for required environmental monitoring purposes.

OSU has proposed the following measures to minimize the risk of collision and/or entanglement to marine mammals: minimize vessel strike risk by requiring Project-related vessels to avoid close contact with marine mammals and adhere to NMFS "Be Whale Wise" guidelines, while in transit. OSU has proposed steps to monitor for and remove entangled fishing gear, which would minimize the potential for marine mammals to encounter lost fishing gear at the test site and become entangled. OSU will also comply with current regulations that require marine mammal observers for certain vessel based activity (e.g., sub-bottom profiling and DP vessel activities). To the extent practicable, OSU will direct the WEC testing clients to design and maintain cables and moorings in configurations that minimize the potential for marine mammal or sea turtle entrapment or entanglement and follow the reporting and haulout protocols specified in Appendix I.

Marine mammals offshore of Oregon are exposed to a variety of anthropogenic structures that present collision risk, including moored navigation aids and NOAA oceanographic buoys, as well as moored and moving ships. Marine mammals have evolved to avoid colliding with natural features and to avoid predators, but whale collisions with moored or drifting vessels have been recorded (Nielson et al. 2012). It is possible that sound generated by WECs could result in behavioral avoidance of the WECs, which could therefore have the beneficial effect of reducing the risk of collision (NMFS 2012b and 2012c). There are no data documenting whale collisions with stationary structure (e.g., piers, oil platforms) along the west coast.

Many toothed whales have a well-developed ability to echolocate and avoid structures in the water (Akamatsu et al. 2005), and moorings for WECs would consist of large cables, which are likely to be detected at distances of tens of meters by echolocating toothed whales (Nielsen et al. 2012 *cited in* Benjamins et al. 2014). In a study of finless porpoise, Akamatsu et al. (2005) found that this species inspected a distance of up to 250 feet forward of the animal and swam less than 65 feet without using sonar. The inspection distance was sufficient to provide for a wide safety margin before meeting any risk (Akamatsu et al. 2005). NMFS (2012b) noted that Southern Resident killer whales, which use sonar for hunting and communication, would likely be able to detect and avoid an array of WECs even when they were not making sound. It is expected that this would be true for other toothed whales. Therefore, the risk of collision with

Project structures, for toothed whales in the Project area, even assuming the 25-year project term, would likely be very low.

While odontocetes use echolocation for active detection, most other species rely on hearing or pressure wave detection to detect their surroundings. There is uncertainty regarding the ability of baleen whales (e.g., humpback and blue whales), which do not use sonar, to detect or avoid objects in the water column or on the seafloor. Mooring noise would be relative to current flow, and marine mammals, sea turtles and other species may be able to detect these cues (Bartol and Ketten 2006, Kot et al. 2012, *both cited in* Benjamins et al. 2014). Therefore, the risk of collision with Project structures, for any baleen that occur in the Project area, may be higher than for odontocetes.

Pinnipeds have well-adapted underwater vision (Schusterman and Ballet 1970) and can detect changes in pressure or vibrations in the water through the use of their vibrissae (Dehnhardt et al. 2001, Mills and Renouf 1986). Because of the specialized sensory capabilities of toothed whales (echolocation) and the small size and maneuverability of pinnipeds, it is expected that these species also would be able to detect and avoid underwater structures, such as moorings.

The OSU study involving theodolite monitoring for whales from Yaquina Head in Newport from mid-December 2007 through May 2008 (Ortega-Ortiz and Mate 2008, personal communication with Barbara Lagerquist, Martha Winsor, and Bruce Mate, OSU Marine Mammal Institute, December 1, 2016) reported gray whales were observed offshore of Yaquina Head transiting the area during both southward and northward migrations, and predominantly occurring in parts of the ocean where water depths are between 10 and 70 m. Two minke whales, observed during the end of May 2008, were the only other cetaceans seen during the study (Ortega-Ortiz and Mate 2008). The average distance offshore for gray whales was 3.9 nautical miles during the southbound migration (December 1-February 15; n=58), 2.9 nautical miles during the northbound, phase A migration (February 16-March 31; n=74), and 1.7 miles during the northbound, phase B migration (April 1-June 15; n=38; personal communication with Barbara Lagerquist, Martha Winsor, and Bruce Mate, OSU Marine Mammal Institute, December 1, 2016). Ortega-Ortiz and Mate (2008) noted that gray whales appeared to follow a constant depth (isobath) rather than the shoreline. The Project would be located about 7 miles offshore, which is about 3 miles farther offshore than the average distances detected during the whale observation studies. However, during the 2008 study, gray whales, an Oregon Nearshore Strategy and Stated-listed species, were detected as far offshore as 10.7 miles (shore-based observations from Yaquina Head were limited to 11 miles; Ortega-Ortiz and Mate 2008), so gray whales could still be expected to pass through the Project area.

In 2016, there were reports of 71 entangled whales off the coasts of Washington, Oregon, and California (NOAA 2017). Sixty six of these were off California, though this does not necessarily reflect the location of entanglement, but could instead be the result of higher reporting rates (i.e., more people to report entanglements off the California coast). Sources of entanglement, identified for 29 of the entanglements were as follows: Dungeness crab commercial trap fishery (22), set gillnet and tribal gillnet fishery (2), spot prawn trap fishery (3), and sablefish trap fishery (2) (NOAA 2017).

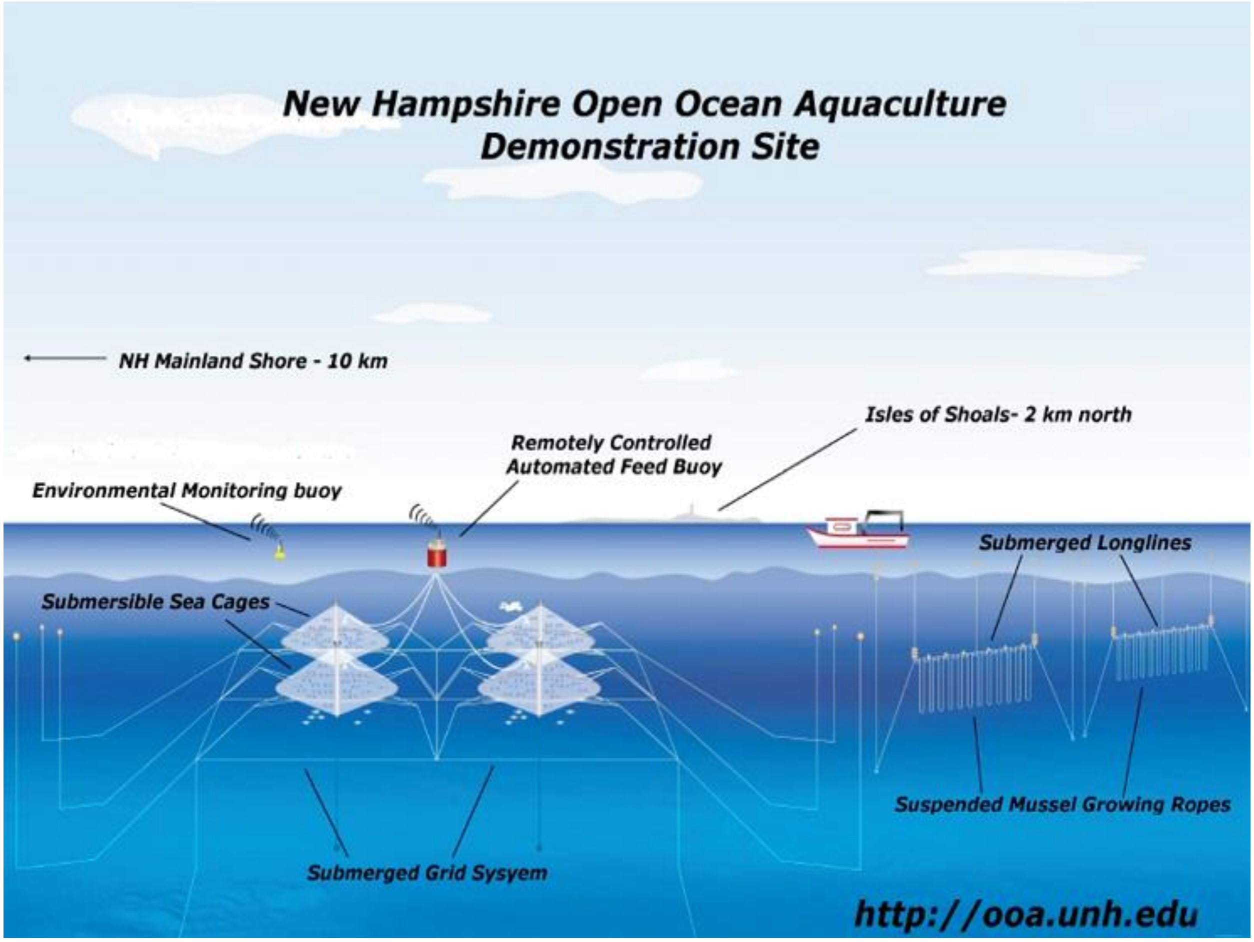
Similarly, an examination of entanglement records from 1990 through 2007 maintained by NMFS Northeast Regional Office showed that, for the 46 confirmed right whale entanglements that occurred during that time period, the whales were entangled in weirs, gillnets, and trailing lines and buoys (NMFS 2009b). In an evaluation of the potential for entanglement of large marine life with marine renewable energy development, Benjamins et al. (2014) report that "the vast majority of reported instances of entanglement ... are associated with ropes forming part of fishing gear. To date, there are few reported cases of marine megafauna becoming entangled in moorings or cables of any kind." Umbilical cables are thought to be less of a concern than mooring lines because power cables have a lower minimum breaking load than mooring lines, as they are not designed to maintain a WEC on station (Harnois et al. 2015).

The Project mooring lines (up to 21 and 100 for the initial development and full build out, respectively; Table 3-15) and the umbilical cables (up to 6 and 20 for the initial development and full build out, respectively) are more substantial than those used for fishing or crab pot lines within which whales have become entangled. Also, the WECs are expected to create substantial tension on the mooring lines. Heavy mooring gear combined with relatively taut mooring lines has been shown to render the potential for entanglement negligible (Wursig and Gailey 2002). Entanglement is unlikely due to the moorings' size and mass regardless of the mooring configuration, though taut mooring systems represented lower relative risk than catenary mooring systems, particularly those using nylon (Benjamins et al. 2014, Harnois et al. 2015). The umbilical cables descending from the WECs to the seafloor would also be substantially taut and relatively rigid. Therefore, it is likely the umbilical cables and mooring lines would act more as structures than as lines and entanglement would be unlikely to occur. In addition, the spacing of the WECs, approximately 50 to 200 m or more apart, would further minimize the potential for collision by providing ample space for marine mammals to pass between the WECs and associated mooring lines and umbilical cables. Tighter WEC spacing would result in a smaller array footprint, yet still allow spacing for larger cetaceans to maneuver between mooring lines; greater WEC spacing would result in a larger array footprint with more room for cetaceans to maneuver between moorings.

The expectation that it would be very unlikely for whales and other marine species to become entangled in the mooring lines or cables is consistent with the "... apparent absence of entanglement records in similar moorings associated with other offshore industries (e.g., oil and gas)", which is the closest parallel to moorings used for marine renewable energy converters

(Benjamins et al. 2014). This has also been confirmed at a NOAA-funded open ocean aquaculture facility located 6 miles off of New Hampshire (Atlantic Marine Aquaculture Center 2008). The facility, which was installed in 1997, covered about 30 acres at depths of 164 feet and had a mooring system comparable to those that would be used at PacWave South (Figure 3-9). Celikkol (1999) evaluated the risk of entanglement and concluded that "the chance of whale entanglement should be considered unlikely to very unlikely" because of the absence of structures that are known to cause entanglement such as slack lines and netting. Monitoring of whales and sea turtles occurred in the project vicinity following deployment of the facility, and fin and humpback whales were observed in the vicinity, but not in the immediate area. Researchers reported in 2006 that "…no incidents related to marine mammals or turtles have occurred at the open ocean aquaculture field site and no impacts have occurred since the beginning of aquaculture activities in 1997" (Atlantic Marine Aquaculture Center 2006)[15]. The findings from the Atlantic Marine Aquaculture Center are relevant to PacWave South because the New Hampshire site occurred at comparable depths (164 ft), comparable distance offshore (6 miles), had a mooring system comparable to those that would be used at PacWave South, and similar species of interest were present (baleen whales [fin and humpback] and sea turtles). However, the netting of the large net pens would likely be harder for a large whale to detect than the more substantial steel of WECs; thus the fact that no impacts were observed during 10 years of monitoring is extremely relevant to evaluating the potential risks of PacWave South.

[15] Prior to 2002, sightings data were obtained from fisherman and personnel associated with the Atlantic Marine Aquaculture Center. In 2001, the database of mammal and sea turtle sightings recorded by onboard naturalists from a local sight-seeing and whale watching commercial operation was obtained and analyzed for species of interest in the project area (Atlantic Marine Aquaculture Center 2002). From 2002 to 2006, marine mammals and sea turtles in the vicinity of the site were monitored by the University of New Hampshire and the Blue Ocean Society for Marine Conservation. From May through late October or November, trained naturalists and interns on whale watch cruises identified and recorded locations and other data on the species sighted (Atlantic Marine Aquaculture Center 2008).



Source: Atlantic Marine Aquaculture Center 2014.

Figure 3-9. NOAA-funded New Hampshire open ocean aquaculture demonstration site.

Observations of whale interactions with moored offshore net pens in Hawaii found a similar lack of effect to marine mammals (Sims 2013). This site is located a half-mile offshore in waters over 200 feet deep, with a sandy bottom and strong currents. Eight submersible net pens, each with a capacity of around 4,000 cubic yards, are centered in the 90-acre lease (e.g., approximately 0.33 nautical miles per side if square). The net pens are tied into a submerged grid anchored by 14 steel embedment anchors and chains, with 14 mooring lines at a 5:1 scope. A series of weights and buoys are attached to the chains to keep them taut, and bridles extend from the mooring grid corners to the net pen rims to hold the net pens in place. Regarding interactions of humpback whales with the farm, which are monitored as part of the Project's Marine Mammal Monitoring Plan, Sims (2013) noted: "There is no definitive pattern of whales avoiding, or being attracted to the cages. Whales are occasionally seen within the lease area. On one instance, the farm workers witnessed a humpback on the surface inside the mooring grid array; the animal appeared to negotiate its path between the net pens and mooring lines with ease." Sims (2013) also reported that bottlenose dolphins frequent the site, and adverse effects have not been observed.

At the Hawaii Wave Energy Test Site (Marine Corps Base Hawaii), researchers evaluated the effects on marine mammals from the shallow-water (water depth of about 30 m) WEC test berth from 2001 to 2003, and in 2011, before and after the first WEC was installed. No marine mammals were seen or heard within 1,640 feet of the anchor or power cable (NAVFAC 2014). It should be noted that Hawaii WETS occurs in shallow water, and is nearer to shore than PacWave South.

Another potential impact that was considered is that lost fishing gear could “travel” with currents, and thus become entangled or fouled on Project structures and infrastructure. Lost fishing gear could include crab pots with float lines, or trawl or other nets, some with flotation devices that could make them more likely to foul or become entangled on Project structures. Marine mammals could become entangled in lost fishing gear if it accumulates at surface or underwater structures (Henkel et al. 2013). OSU would implement the Mitigation for Marine Species Entanglement or Collision (Appendix I), to detect and remove marine debris caught on Project infrastructure to minimize the potential for marine mammals to become entangled.

Summary – Toothed whales use sonar for hunting and communication, and thus would likely be able to detect and avoid an array of WECs, even over the 25 year project term. The large size of the WECs is expected to be readily perceived by an approaching baleen whale. Even though gray whales may be common in the Project area, the risk of a gray whale colliding with a WEC, anchor, or mooring structure is expected to be low, as corroborated by baleen whale interactions with similar projects (Atlantic Marine Aquaculture Center 2008, NAVFAC 2014, Sims 2013). In addition, whales are not known to collide or entangle with taut moorings, which would be used at PacWave South; whale entanglement appears to be associated with fishing gear such as crab pots (especially buoy lines) and lost nets. OSU will implement the Mitigation for Marine Species Entanglement or Collision, to detect and remove marine debris caught on Project infrastructure to minimize the potential for marine mammals to encounter lost fishing gear at the test site and become entangled. OSU will require vessels in transit to/from the Project site to avoid close contact with marine mammals and adhere to NMFS “Be Whale Wise” guidelines to minimize potential vessel impacts to minimize the risk of Project-related vessels colliding with these species. Potential non-strike encounters (e.g., a whale approaching a service vessel that is on site) are expected to be sporadic with transitory behavioral effects and therefore would be insignificant. The small footprint of the Project relative to the surrounding open ocean along the coastline also reduces the likelihood of a collision occurring. OSU would also record sightings of pinniped haul out during vessel-based monitoring and maintenance activities.

Based on the existing information, the potential for collision or entanglement with Project structures or with vessels associated with the Project, both at the site, and between PacWave South and Newport, over the 25-year license term, would not be expected to adversely affect cetaceans.

Effects or Risk of Collision/Entanglement to Seabirds

Seabirds are unlikely to collide with above-surface structures at PacWave South during periods of high visibility and low winds (Camphuysen et al. 2004, Boehlert et al. 2008, Suryan et al. 2012, Henkel et al. 2013). Avoidance rates at wind farms (e.g., avoidance by seabirds of an entire wind farm and of individual wind turbines, used to predict potential collision risk) by many species of seabirds, including terns, divers (loons), cormorants, alcids, gulls, fulmars, and shearwaters, have been estimated at greater than 98 percent (Cook et al. 2012). The avoidance rate estimates are based on surveys conducted when sea conditions and visibility are good (Camphuysen et al. 2004), although seabirds may be more susceptible to collisions with above-surface structures during periods of high winds or poor visibility (e.g., storm conditions, fog, and darkness; Boehlert et al. 2008, Suryan et al. 2012, Henkel et al. 2013). Artificial lighting on WECs may increase the likelihood of collisions for some light-attracted nocturnal seabirds (e.g., shearwaters, petrels, auklets, and murrelets) (Montevecchi 2006, Miles et al. 2010). However, light attraction is not expected to occur due to the environmental measures that would be implemented at PacWave South, such as use of low-intensity flashing lights instead of high-intensity static, white lights on the Project structures and WECs (see discussion of artificial lighting, above).

The presence of seabirds in the Project area and opportunities to encounter Project structures and WECs would likely be highly variable and dependent on factors such as prey availability (Ainley et al. 2009), seasonal migrations, and constraints by distance to breeding colonies. The seabird species likely to occur in the Project area that are most susceptible to colliding with WECs include those known to fly at altitudes of less than 30 m at least some of the time, including alcids (common murres, auklets, puffins), cormorants, storm-petrels, shearwaters, gulls, brown pelicans, and phalaropes (Geo-Marine, Inc. 2011, Suryan et al. 2012, Henkel et al. 2013). Of these species, alcids, gulls, phalaropes, storm-petrels, and cormorants may be most likely to collide with above-surface structures during high winds because they tend to fly at lower altitudes (<10 m), especially during high winds, whereas fulmars, and shearwaters would be less likely to collide with above-surface structures because they fly at higher altitudes when wind speeds increase (Ainley et al. 2015). Scoters and loons also fly at low altitudes but they are unlikely to occur as far offshore as the Project site (Strong 2009, Adams et al. 2014).

Even during times of low visibility or high winds, seabirds are unlikely to collide with above-surface structures of the Project because the likelihood of encountering WECs would be low, given the relatively small area of the above-surface structures (maximum of 20 WECs, and each WEC is expected to extend less than 15 m above water) compared to their available at-sea habitat. Additionally, the WECs would be at least 50 to 200 m or more apart, which would provide ample space for seabirds to maneuver between them.

Pursuit-diving seabirds such as alcids and cormorants, and plunge-diving seabirds such as brown pelicans, gulls, and shearwaters could occur in the vicinity of the WECs and collide with underwater WEC components or become in entangled in marine debris (e.g., lost fishing gear) if it accumulates at underwater WEC components (Henkel et al. 2013), or be crushed or entrapped by moving parts. Some diving seabirds (e.g., cormorants) could attempt to roost or nest on above-water structures (Henkel et al. 2013. Additionally, the diving seabirds likely to occur in the Project area are unlikely to collide with submerged WEC structures, because they are agile swimmers and have high underwater visual acuity (Henkel et al. 2013). Diving birds have to capture highly mobile prey in very low visibility temperate waters along the Pacific Coast with a turbidity range on a large scale of 5-30 m (Secchi depth, Ainley 1977) and on a much smaller scale (i.e., in Monterey Bay) of 3-9 m (Secchi depth, Laird 2006). For example, alcids (e.g., common murres, tufted puffins, and murrelets) are wing-propelled pursuit divers that swim rapidly (approximately 1 m per second) to pursue and capture mobile prey such as schooling fishes, and can veer, turn, and glide underwater (Johnsgard 1987); thus, it is expected that their vision and agility is adequate for navigating around submerged structures. Furthermore, OSU would implement measures to minimize entanglement of lost fishing gear on underwater WEC components (Appendix I), which would minimize the potential for entanglement by diving birds. Therefore, seabirds are not expected to be injured or killed from collision or entanglement with debris or underwater WEC components.

EMF Emissions on Species Sensitive to Electric and Magnetic Fields

Ambient Conditions

Ambient, natural EMF emissions in the ocean come from three sources: the geomagnetic field of the earth, electric fields induced by the movement of charged objects (e.g., currents/waves, organisms) through a magnetic field (i.e., induced electric field, iE), and bioelectric fields produced by organisms (Slater et al. 2010a, Normandeau et al. 2011, Gill et al. 2014, Bedore and Kajiura 2013). EMF includes both the electric field (E-field, measured as the voltage gradient in V/m) and the magnetic field (B-field, measured in tesla [T] or gauss [G]; 10,000G=1T; Slater et al. 2010a).

Wave, tidal, and current motion of seawater, an electrolyte, through the Earth's magnetic field induces electric fields (Slater et al. 2010a). The earth's magnetic fields off Reedsport, Oregon is estimated at 52.2 microteslas (µT) [~52,000 nanoteslas (nT)] and is largely vertical (Slater et al. 2010a). EMF in the ocean at the Reedsport site was modelled by incorporating the influence of ocean conditions (e.g., currents, waves) on the earth's magnetic field. Based on the wave climate at the Reedsport site, at surface (where effects are likely the strongest), electric fields are expected to range from 6 to 216 µV/m, and would be observed between 0.04 and 0.3 Hertz (Hz), with maximum induced magnetic fields due to wave motion ranging from 0.02 to

0.54 nT. The maximum electric fields generated by tidal motion are expected to be 33 μV/m, and the maximum magnetic fields because of tidal sources are expected to be 0.08 nT (Slater et al. 2010a). Coastal currents are expected to generate electric fields up to 22 μV/m, although higher values may be observed, with potential values in extreme current flows of up to 44 μV/m and corresponding estimated magnetic field values would be 0.06 nT (Slater et al. 2010a). Because of the similar levels of the earth's magnetic field, wave climate, tidal motion, and coastal currents at Reedsport and the Project area, it is expected that EMF modeled at Reedsport will be similar to that in the Project area; however, there is uncertainty about the underlying geology at PacWave South that may affect ambient conditions.

Project Generated EMF

EMF transmissions would be generated by the WECs, the umbilical cables (connecting the WECs to the subsea connectors), the hubs and subsea connectors, and the subsea cables to the shore. Each test berth could accommodate a WEC or array of WECs with a maximum capacity, based on cable specifications, of 8 MW (although not all 4 berths could be at capacity at any one time); the capacity of the umbilical cables would correspond with the WECs. The subsea cables would be three-conductor (3C), AC cables, with approximately 70 mm^2 copper conductors bundled together into a typical 3C submarine power cable configuration with a total diameter of approximately 10 cm. Each of these cables is estimated to have a rated capacity of up to 35 kV. Because the power cables would be shielded and armored, they would not emit any electric fields directly; however, electric fields could be induced by the movement of fish and currents through the magnetic fields produced by the cable.

Observations at energized transmission cables indicate rapid dissipation of EMF with distance from the cables. In studies of the Las Flores Canyon submarine power cables (6-7 inch diameter, 36 kV, unburied) that cross the Santa Barbara Channel to oil platforms, EMF (as recorded in μT– a measure of the magnetic field) is reported to dissipate to background levels at a distance of about 1 m from the cable (Love et al. 2015, 2016). Studies of a 33 kV three-conductor buried power cable crossing the River Clwyd in Scotland indicate measureable (nT – 1,000 times smaller than the μT measured by BOEM for the Las Flores Canyon cables) magnetic fields up to 10 m away from the cable (CMACS 2003). Field magnetic profiles of 10 subsea cables, many of which transmit considerably higher voltage than the 36 kV cables at PacWave South, indicate very rapid decay of magnetic field strength moving away from the cable (Normandeau Associates et al. 2011).

As a general rule, the higher the power output from a WEC, the higher the electrical current transmitted through AC cables and hence the stronger the emitted magnetic field and iE-field (Gill 2016). It is notable, however, that there is remarkable consistency among the measured attenuation of AC magnetic fields among 10 different cables (most of them associated with large offshore wind farms) (Normandeau et al. 2011, Bull 2015, Gill 2015). These cables likely carried much larger currents than the proposed Project cables at full build out, all of them were unburied cables, and they all still showed an exponential decline that reached near ambient levels by around 2 m from the cable. Existing information (based on monitoring of EMF at 10 different cables) all showed similar and consistent exponential declines that reached ambient conditions by around 2 m from the cable, and it is expected this to be similar at the Project site (Normandeau et al. 2011, Bull 2015, Gill 2015). From the offshore test site, the majority of the cables would be buried 1-2 m (3-6 feet) below the seafloor, except within the footprint of the test site. Burial of the cable at a depth of 1-2 m will reduce the magnetic field at the seafloor by around 80 percent (Normandeau et al. 2011). Therefore, it is likely that EMF generated by the Project cables will be similar or less than other cables that have been measured, and that EMF generated by power cables above ambient levels would not extend much beyond 1-2 meters. Physical burial of most of the Project cables will additionally minimize any likelihood of exposure.

Models based on fundamental physics have been used to estimate the strength of localized EMF generated by a point source (i.e., an energized WEC; Slater et al. 2010b). Model results indicate that the EMF in the nearshore marine environment decrease rapidly with distance from the source, decreasing to minimum levels of instrumentation detection meters of the WEC (Slater et al. 2010b). Models have also developed to estimate the EMF generated by subsea transmission cables (Slater et al. 2010c, Normandeau et al. 2011). Three-conductor cables can either be individually shielded or have an outer shield encompassing all three conductors (Slater et al. 2010c); the three-conductor with a common shield has the lowest electric and magnetic field strengths compared to individually shielded three-conductor cables (Slater et al. 2010c); this is the type of cable planned for the Project. Modeling results indicate that EMF of the strength that could be detected by species is limited to a distance of much less than 10 m from the cable (Love et al. 2016, Normandeau et al. 2011); field measurements indicate robustness of model results (Slater et al. 2010b and c, Gill et al. 2014, Gill 2016). Because the majority of the subsea cables would be buried, there is little uncertainty related to EMF transmission given our understanding of existing cables and the capability to model EMF. However, there is some uncertainty in applying these results to WECs at PacWave South because specific EMF characteristics of WEC types and subsea connectors are not known. These uncertainties will be addressed in part by the EMF Monitoring Plan (Appendix H), by monitoring EMF production post-installation and comparing with modelled results, and through mitigation (Appendix I) in consultation with appropriate agencies or pursuant to the Adaptive Management Framework (Appendix J).

Electric field detection occurs by fishes with specialized electroreceptors that include electroreceptive elasmobranchs (e.g., sharks, skates, and rays) and holocephalans (e.g., ratfish), and electrosensitive agnatha (e.g., lamprey), acipenseriformes (e.g., sturgeon), and some teleost fish (Normandeau Associates et al. 2011, Gill et al. 2014). Electroreception is used to detect bioelectric fields emitted by prey, detection of mates, and potentially to detect predators, as well as for short and long term movements or migration (Normandeau Associates et al. 2011, Gill et al. 2014). Elasmobranchs and holocephalans are the most electroreceptive marine animals because of specialized electroreceptive organs, the Ampullae of Lorenzini, which can detect very weak electric fields as low as <5-20nV/m (Fisher and Slater 2010, Normandeau Associates et al. 2011, Gill et al. 2014). Elasmobranchs are repelled by strong anthropogenic electric fields (Gill et al. 2014). Electroreceptive teleost fish have a minimum sensitivity level of about 0.01 mV/m (Normandeau Associates et al. 2011) and may respond to strong electric fields 6-15 V/m (Gill et al. 2014).

Some animals use geomagnetic fields to orient during migration; animals that are considered to be capable of this include cetaceans, sea turtles, certain fishes and crustaceans, and mollusks (Gill et al. 2014). Species in the Project area that may be capable of detecting magnetic fields include Dungeness crab, salmonids, sturgeon, and leatherback sea turtles (Normandeau Associates et al. 2011). Fish, in particular salmonids and scombrids (e.g., tuna), have a magnetite receptor system and respond to magnetic fields in the 10-12 µT range (Normandeau Associates et al. 2011). In the laboratory, juvenile salmon, when subjected to the magnetic field intensity and inclination angles similar to those found at the latitudinal extremes of their ocean distribution (northern and southern intensity used in laboratory experiments of 555.5 µT and 444.6 µT), change their orientation (e.g., direction of swimming) and subjecting fish to unnatural pairings of field intensity and inclination resulted in more random orientation (Putman et al. 2014). Dungeness crab have also been examined in the laboratory, and only subtle changes in behavior were observed for relatively high thresholds of B-field (from ~0.05 mT background to 1.0-1.2 mT direct current (DC), considered an upper bound of an anthropogenic source that might be encountered based on reviewed literature; Woodruff et al. 2012).

Multiple projects on the U.S. west coast have evaluated or are evaluating EMF at subsea cables and biotic interactions, indicating very minor, limited interactions. In particular, BOEM has evaluated effects of EMF from power cables by conducting in-situ studies of powered and unpowered cables using SCUBA and ROV surveys (Love et al. 2015, 2016). Results from three years of surveys included:

1. "Researchers did not observe any significant differences in the fish communities living around energized and unenergized cables and natural habitats;
2. They found no compelling evidence that the EMF produced by the energized power cables in this study were either attracting or repelling fish or macro invertebrates;

3. EMF strength dissipated relatively quickly with distance from the cable and approached background levels at about one meter from the cable[16]; and
4. Cable burial would not appear necessary strictly for biological reasons" (BOEM 2016).

These study results are applicable to the Project area because the cables are approximately the same rated voltage; however, the effects at PMEC-SETS would be even less because the subsea cables would be largely buried creating a physical separation from the EMF produced by cables.

The MARS cable, which carries 10,000 volts of electricity directly to a science node for the cabled ocean observing system, is a 52-km (32-mile) DC power and data cable that was plowed in until reaching the shelf break, where it continues unburied to the science node at a depth of 891 m. Evaluations in 2007-2008 and 2010 (37 months post cable installation, Kuhnz et al. 2011) of the cable and biota indicated that abundance of most animals observed did not differ between the area over the cable route and 50 m away. However, in 2008, before the cable was powered, longnose skates were significantly more abundant along a short section at ~300 m depth, near minor (<10 cm) suspensions of the cable above the seafloor (Kuhnz et al. 2011). Longnose skates may have responded to mild electromagnetic fields generated by components of the cable; however, in 2010, when the cable was powered, no significant difference in the abundance of skates was observed near the cable compared to 50 m away (Kuhnz et al. 2011). Field measurements of EMF were not taken (Kuhnz et al. 2011).

The OOI Site-Specific EA (TEC Inc. 2011) provided an assessment of the effects of the power and data cables, buoys, deployment platforms, moorings, junction boxes, and mobile assets (i.e., autonomous underwater vehicles and gliders) on the environment. The approximately 900 km long, 10 kV power and data cable initiates on land at Pacific City, north of Yaquina Bay, to support the offshore OOI project components; the assessment indicated negligible effects of EMF on marine biota, which were attributed to armoring, burial, and lower than background levels of magnetic fields (TEC Inc. 2011).

In response to agency requests, OSU would implement the EMF Monitoring Plan under the Adaptive Management Framework (Appendices H and J, respectively) to detect and, if needed, mitigate any unanticipated adverse effects of EMF emissions from WECs. The objective of the EMF Monitoring Plan is to evaluate the EMF levels produced by the WECs, by using existing models to estimate the expected EMF output of the WECs and validating the model estimates using field measurements. If results of modeling and/or field surveys indicate

[16] EMF readings from a 35- kV unburied AC power cable measured ~110-120 µT at cable surface (Love et al. 2016).

that EMF attributable to the WECs has the potential to elicit a behavioral response from green sturgeon, salmonids or other species of concern (i.e., 3 millitesla, based on Woodruff et al. 2012, Normandeau Associates et al. 2011, Gill 2016, and newer information), and exceeds the mitigation threshold, adaptive management and mitigation measures to address the unanticipated adverse effects would be implemented by OSU (Appendix I).

Summary

EMF emissions from the Project are expected to be minor and limited to the immediate vicinity of the WECs and cables. As described above, previous studies on EMF from subsea cables observed little or no behavior change in invertebrates or fish, and similar lack of responses are expected at PacWave South. However, there is a higher uncertainty about EMF emissions from WECs, which has not been measured. While there is uncertainty about whether electro- and magneto-sensitive species would be capable of detecting EMF emissions from the WECs, as well as the type and degree of these species' responses to EMF from WECs, the proportion of a given population that might be exposed to site-specific EMF generated by the Project is expected to be low for most of these species due to factors such as migratory range and available habitat, and low likelihood of exceeding biologically relevant EMF transmissions from WECs.

Even if individuals encounter and are exposed to magnetic fields, any potential effects are expected to be short term and minor, because of the very localized fields relative to the earth's geomagnetic field potentially being used for navigation; therefore these species are not expected to be affected by EMF. Bottom-oriented fish could be more exposed to EMF from the subsea cables than pelagic fish; however, the cables will be shielded, armored and buried for the most part, limiting exposure to EMF. Based on the low levels of EMF expected, and spatially limited exposure to fishes, it is anticipated that relatively minor, short-term potential effects, if any, could occur, and that the EMF Monitoring Plan (Appendix H) within the Adaptive Management Framework (Appendix J) and implementation of the mitigation measures (Appendix I) should address any potential effects.

Effects on Bats

No bats are expected to be affected by the Project at the test site. Although hoary bats are known to occur offshore during fall migration and could encounter WECs, they would not be expected to collide with the structures given their ability to echolocate and detect structures. Occasionally hoary bats will roost at small islands and rarely at novel plants such as cattails (*Typha* sp.) or anthropogenic structures such as wood towers during migratory periods (D. Johnston, unpublished data). Because the Project provides structure in a marine environment that has little to no other options for temporary roost sites, hoary bats could roost on the WECs or marker buoys rarely, possibly putting them at risk of predation during daylight hours, although they would already be susceptible to predation if flying during the day while at sea. Therefore, no significant impacts on bats are expected in the marine environment.

Effects on Freshwater Fish in Surface Streams

Releases of diesel fuel, lubricants, hydraulic fluid, and other contaminants contained in construction equipment potentially could result in acute negative effects on fish, invertebrates, and instream habitat. In addition, long-term effects could result if a spill were not properly remediated. Potential sources of contaminants would be from the construction equipment itself (lubricating oils and fuel). There is only one fish-bearing stream in the Driftwood Beach State Recreation Site , Friday Creek, which is located at the entrance ofthe site, next to Highway 101. In addition to Friday Creek, two additional fish-bearing streams, Buckley Creek and “Stream 4”, are located along the terrestrial HDD corridor (Figure 3-5). OSU will avoid activities along the terrestrial cable route by using HDD for installation, and by avoiding construction impacts near Friday Creek at the entrance to the Driftwood Beach State Recreation Site (no streams are located at the UCMF site). Implementation of and Erosion and Sedimentation Control Plan will prevent construction related impacts to the stream.

HDD operations could result in inadvertent returns of drilling fluids to a waterway. HDD uses a slurry, composed of a fine clay material such as bentonite, as a drilling fluid. The drilling fluids are non-toxic but aquatic habitats can be temporarily impacted and affect benthic invertebrates, aquatic plants, fish, and fish eggs can be smothered by the fine particles if drilling fluids are discharged to waterways.The depth of the HDD boring operations will be designed so that the engineers determine there is a low risk of inadvertent return of drilling fluids. Inadvertent return during HDD is considered highly unlikely. An HDD Contingency Plan will be developed to minimize the potential for inadvertent return of drilling fluids, provide timely detection, and address potential releases by describing monitoring, containment, response and notification procedures to be implemented by the contractor. Through implementation of construction BMPs, no detrimental effects to freshwater fish are expected from hazardous materials releases.

3.3.3.3 Cumulative Impacts

OSU evaluated whether the following potential effects of the Project could result in cumulative impacts in combination with other current or reasonably foreseeable actions:

- Effects or risk of collision or entanglement with Project structures, entangled gear, or service vessels to marine species;
- Changes to marine community composition and behavior (e.g., use patterns, attraction, and avoidance);
    - Changes in the presence of biofouling species, species interaction, and predator-prey interactions;

    - Effects of pinniped haulout and seabird perching on Project structures;
    - Effects of seabird avoidance of Project area;
    - Effects of artificial lighting;
    - Effects of changes in wave energy to habitat;
- Effects of underwater sound/vibration on marine mammals, fish, and seabirds;
- Effects of EMF emissions on species sensitive to electric and magnetic fields;
- Effects on bats; and
- Effects on freshwater fish in surface waterbodies.

The marine ecosystem in the vicinity of PacWave South is exposed to past and on-going disturbances, such as such as bottom trawling and other types of fishing, deposition of dredged material at the Yaquina Ocean Dredged Materials Disposal Site, and frequent vessel traffic. The Project would vary from these ongoing disturbances because OSU would construct and operate in-water structures. Specifically, effects related to changes in the local marine community resulting from the presence of Project components in an area generally devoid of vertical habitat features; increased opportunity for pinniped haulout and seabird perching; long-term lighting associated with offshore development; and changes to wave energy due to presence of in-water structures would only contribute to cumulative impacts in conjunction with the limited number of small scale off-shore renewable energy projects, such as PacWave North or Camp Rilea.

There is low potential for some low-flying seabird species (e.g., common murres, Cassin’s auklets, rhinoceros auklets, gulls, phalaropes, and cormorants) to collide with above-surface structures or for baleen whales to collide with mooring lines or cables in the water column, especially during periods of higher abundance (e.g., summer and/or fall for seabirds) and during periods of low visibility or high winds. Project design components may reduce the potential for collisions; in particular, the spacing of the WECs would likely be 50 to 200 m or more apart, which should provide ample space for seabirds and marine life to maneuver between them. In addition, the likelihood of seabirds or baleen whales encountering Project structures is low because of the relatively small area of the submerged and above-surface structures (maximum of 20 WECs) compared to the available at-sea habitat.

Of the other past, present, and reasonably foreseeable activities in the area, PacWave North and Camp Rilea could also pose a collision risk to seabirds from above-surface structures or to baleen whales from below-surface structures of WECs. However, PacWave North is 9 miles from the proposed Project and limited to a maximum of two WECs at a time. The potential cumulative impacts of seabird and whale collisions from these two projects are expected to be negligible because of the distance between the projects, the overall low likelihood of collisions at each project, and the small number of WEC`s at each project compared to their available at-sea habitat.

Potential habitat changes (i.e., biofouling) at PacWave South would occur during the same timeframe as PacWave North, and the proposed Camp Rilea Ocean Renewable Energy Project, but would be geographically separated, given that PacWave North is about 9 miles from the proposed Project, and Camp Rilea Project would be about 125 miles away, and Project build out would be phased over the course of several years. Thus, potential cumulative habitat changes are expected to be negligible. The distance between these projects diminishes cumulative impacts due to changes in marine community composition, increased pinniped haulout and seabird perching, artificial lighting, and changes to wave energy.

As discussed above, sound generated by operating WECs is expected to be less than the injury level for cetaceans or pinnipeds, but WEC operation might generate underwater sound exceeding the 120 dB threshold for marine mammal behavioral disturbance within 125 m of a WEC (NAVFAC 2014). Sound from vessels would be localized and would be similar to existing vessel traffic surrounding Yaquina Bay. Sound generated by the proposed OOI are not expected to have any significant impacts on fish and marine mammals because most active acoustics sensors used for monitoring (e.g., acoustic Doppler current profilers) would operate at higher frequencies than those considered audible by fish and marine mammals (e.g., >180 kHz), and for those that operate at lower frequencies (e.g., 2-170 kHz for sensors on autonomous underwater vehicles), fish and marine mammals would not be disturbed due to the low duty cycles of the WECs, the brief period when an individual animal would potentially be within the very narrow beam of the source, and the relatively low source levels (OOI 2011). The distance between the three reasonably foreseeable offshore marine and hydrokinetic energy projects diminishes cumulative impacts due to sound. Thus, potential cumulative impacts from sound are expected to be negligible.

EMF emissions from the Project are expected to be minor and localized, limited to the immediate vicinity of the cables, although EMF emissions from WECs have a greater degree of uncertainty and has not been measured. Previous studies on EMF from subsea cables observed little or no behavior change in fish, and similar lack of responses are expected at PacWave South. PacWave North does not have a cable to shore, so the EMF emissions are limited to the WECs associated with the project. The Camp Rilea project is 125 miles away from PacWave South, and the EMF emissions from this project would also be very minor and localized, with likely no significant impact on fish. EMF from the OOI Project would also not be expected to have any significant impact on fish due to the low voltage transmitted from the cable, the smaller cable size, and the armoring and burying of the cables (OOI 2011). Thus, potential cumulative impacts from EMF emissions are expected to be negligible.

Significant effects on bats at the test site are not expected to occur, nor would they be expected at Camp Rilea because the SurgeWEC™ does not penetrate above the water's surface, nor the OOI project because of the very small size of the buoys.

The terrestrial cable would be installed using HDD from the Driftwood Beach State Recreation Site to the UCMF, which would minimize cumulative impacts to freshwater fish, other aquatic life, and riparian habitat associated with surface waterbodies in the Project area. There is only one fish-bearing stream in the Driftwood Beach State Recreation Site, Friday Creek, which is located at the entrance ofthe site, next to Highway 101. In addition to Friday Creek, two additional fish-bearing streams, Buckley Creek and "Stream 4", are located along the terrestrial HDD corridor (Figure 3-5). OSU will minimimize impacts along the terrestrial cable route by using HDD for installation and construction activities would occur in the parking lot of the Driftwood Beach State Recreation Site, away from Friday Creek. Fish and their habitat would be protected during construction due to avoidance of streams, including installation of the terrestrial transmission cables using HDD, and implementation of BMPs (e.g., development and implementation of an Erosion and Sedimentation Control Plan).

When considered together with other relevant past, present, and reasonably foreseeable actions, Project impacts are not expected to incrementally contribute to collectively significant cumulative adverse effects on the marine or freshwater environment, including marine protected species and sensitive habitats.

3.3.4 Terrestrial Resources

3.3.4.1 Affected Environment

Upland Vegetation and Terrestrial Wildlife

The terrestrial environment in the vicinity of the land-based Project components includes the sandy beach area that would be crossed by the cable, developed recreational area (i.e., Driftwood Beach State Recreation Site) where the HDD conduits would exit via a manhole, the terrestrial habitat under which the cables would extend via HDD from the Driftwood Beach State Recreation Site to the UCMF and potentially from the UCMF to the grid connection point, and a vegetated area where the UCMF would be built.

The upland vegetation communities surrounding these Project components are maritime forest, grass-shrub-sapling/regenerating young forest, coastal dunes, and mixed conifer/ deciduous forest (Kagan et al. 1999). HDR, on behalf of OSU, conducted field surveys in May 2016, June 2017, and February 2019 of the Project area to characterize terrestrial habitat (Appendix C). Forest stands are typically dominated by western hemlock, Sitka spruce, and shore pine with some western red cedar and red alder interspersed. Understories are typically dense with shade-tolerant plants, including evergreen shrubs (e.g., salal, evergreen huckleberry), forbs (e.g., twinflower and false lily-of-the-valley) and ferns (e.g., western sword fern, wood fern, deer fern). The surrounding forest is fairly fragmented due to housing developments and timber harvesting. In general, large tracts of land in Lincoln County are second and third generation woodland, having been logged and replanted over the years (3U Technologies 2013). Intermixed with these habitats are residential housing and associated roads.

Moderately open multi-story forest and wetlands in the area and at the UCMF location may support a number of wildlife species depending on season, species behavior, and specific habitat availability.

Mammal species that could occur in the Project area includes Baird's shrew, black bear, black-tailed deer, bushy-tailed woodrat, California ground squirrel, coast mole, common porcupine, common raccoon, coyote, creeping vole, deer mouse, Douglas' squirrel, fog shrew, house mouse, long-tailed weasel, Pacific shrew, Pacific water shrew, and white-footed vole (OSU and INR 2014). Based on capture records for Lincoln County from Ormsbee et al. (2010) and unpublished acoustic data (ODFW 2015) bat species that could occur in the terrestrial Project area include big brown bat, California myotis, fringed myotis, long-legged myotis, Yuma myotis, little brown bat, long-eared myotis, hoary bat, Townsend's big-eared, and silver-haired bat.

A large number of bird species could occur along the inland cable route; these species include great blue heron, snowy and great egrets, turkey vulture, osprey, bald eagle, Cooper's hawk, sharp-shinned hawk, red-tailed hawk, gulls, band-tailed pigeon, rufous hummingbird, killdeer, red-breasted sapsucker, northern flicker, olive-sided flycatcher, western wood-pewee, willow flycatcher, Pacific-slope flycatcher, gray jay, American crow, common raven, purple martin, tree swallow, black-capped and chestnut-backed chickadees, bushtit, red-breasted nuthatch, brown creeper, Bewick's wren, Pacific wren, golden-crowned kinglet, Swainson's thrush, American robin, wrentit, hermit, black-throated gray, MacGillivray's and Wilson's warblers, common yellowthroat, yellow-breasted chat, spotted towhee, savannah, song, and white-crowned sparrows, black-headed grosbeak, red-winged blackbird, purple and house finches, and house sparrow (Marshall et al. 2006). A complete list of the special-status bird species that could occur in the PacWave South Project area is provided in the Bird and Bat Conservation Strategy (Appendix B).

Amphibians that could occur in the Project area include clouded salamander, ensatina (a salamander), northwestern salamander, Pacific chorus frog, Pacific giant salamander, red-legged frog, roughskinned newt, and southern torrent salamander. Reptiles that could occur in the Project area include common garter snake and northern alligator lizard (OSU and INR 2014).

Typical bird species associated with nearshore waters similar to those of the cable landing site include harlequin duck, surf scoter, white-winged scoter, black scoter, long-tailed duck, red-throated loon, Pacific loon, common loon, red-necked grebe, eared grebe, western grebe, Brandt's cormorant, double-crested cormorant, pelagic cormorant, brown pelican, red-necked phalarope, red phalarope, common murre, pigeon guillemot, Cassin's auklet, rhinoceros auklet, tufted puffin, and gulls (e.g., western, herring, Thayer's, California, glaucous-winged, Bonaparte's, Mew, and Heermann's gulls) (Marshall et al. 2006). Shorebird species likely to occur on wide sandy beaches at the cable landing site include black oystercatcher, semipalmated plover, killdeer, whimbrel, marbled godwit, ruddy turnstone, black turnstone, sanderling, dunlin, least sandpiper, and western sandpiper (Marshall et al. 2006). Other bird species that could occur on the sandy beaches at the cable landing site include brown pelican, great blue herons, snowy, and great egrets, turkey vulture, osprey, bald eagle, and gulls. An inclusive list of the bird species that could occur in the PacWave South nearshore and intertidal waters, and in the beach cable landing area is provided in the Bird and Bat Conservation Strategy (Appendix B).

According to OPRD, the seaside hoary elfin, a rare species of butterfly, is found in Driftwood Beach State Recreation Site, with habitat found throughout the park in upland areas. OPRD reported that recent taxonomic work revealed that the population at Driftwood Beach State Recreation Site may be the only remaining population of the butterfly, because it was found to be distinct from other populations (personal communication with K. Duzik, OPRD, October 29, 2014). This species is ranked as Critically Imperiled in Oregon by the Oregon Biodiversity Center, and the genetically distinct population in Lincoln County is presently the only one of its kind known location in Oregon. This butterfly is associated with its host plant, kinnikinnick (bearberry). During surveys conducted in May 2016 and June 2017, kinnikinnick was document in several locations throughout the terrestrial Project area. All kinnikinnick was found in disturbed areas adjacent to paved areas, on the west side of Highway 101 or adjacent to a dirt road (NW Wenger Lane), on the east side of Highway 101. The majority of kinnikinnick was found within Driftwood Beach State Recreation Site, and was likely previously documented by OPRD studies (see Appendix C).

Wetlands, Riparian, and Littoral Habitat

Wetlands provide a multitude of ecological benefits, providing habitat for fish, wildlife, and a variety of plants. Based on available wetland data from Oregon Wetlands Explorer (ORNHIC and The Wetlands Conservancy 2009), marine tidal wetlands are present on the beach near the terrestrial Project components. The littoral habitat was comprised mainly of broad sandy beach that varies from unvegetated intertidal area to partially vegetated back dunes. ODFW considers coastal dunes a strategy habitat in the Oregon Conservation Strategy (Krutzikowsky et al. 2016). ODFW notes that threats to coastal dunes include beachgrass invasion, increased development, and recreation impacts (Krutzikowsky et al. 2016).

A total of four freshwater wetlands (Wetland C, D, H, and I) were delineated in the terrestrial Project area (i.e., Driftwood Beach State Recreation Site and UCMF) during wetland

and waterway surveys conducted in May 2016 and June 2017 (Figure 3-5; HDR 2017). Wetland C is a 0.11 acre forested wetland, Wetland D is a 0.31 acre scrub-shrub/emergent wetland, Wetland H is a 0.27 acre scrub-shrub/emergent wetland, and Wetland I is a 0.15 acre emergent wetland (HDR 2017, 2019).

In 2019, a wetland and waterway survey was also conducted along the terrestrial HDD corridor, which included an extension of Wetland D as well as three stream features (Buckley Creek, Friday Creek, and "Stream 4). Wetland D, along with the 0.31 acres identified in the previous survey, collectively consisted of 2.93 acres of a forested/scrub-shrub wetland (Figure 3-5) (HDR 2019). Streams are discussed in Section 3.3.2, and a detailed description of each wetland and stream is provided in the Wetland Delineation Report in Appendix C (HDR 2017, 2019).

3.3.4.2 Environmental Impacts Related to Terrestrial Resources

A variety of botanical resources and amphibians, reptiles, mammals, and birds may occur in the terrestrial portion of the Project. Project construction activities have the potential to temporarily displace or disturb wildlife and botanical resources in the immediate vicinity of the Project. Construction of above-ground onshore Project structures, specifically the UCMF, would result in alteration and loss of habitat.

OSU would implement environmental measures as follows to minimize potential effects on terrestrial resources:

- Minimize or avoid terrestrial activities in sensitive ecological areas (e.g., jurisdictional wetlands and nesting areas for listed avian species).
- Use HDD to install the cable conduits under the beach and sand dune habitat
- Use HDD to install the terrestrial cable conduits directly from the Driftwood Beach Recreation Site to the UCMF, and from the UCMF to the Highway 101 grid connection point, minimizing effects to wetlands, streams, and terrestrial habitat.
- Employ environmental measures during installation, operation, and removal to avoid or minimize potential effects to sediment and soils. For example:
    - Minimize disruption of terrestrial geology and soils by maintaining buffers around wetlands to the degree practicable.
    - Develop and implement an Erosion and Sediment Control Plan, and maintaining natural surface drainage patterns.
    - Develop and implement stormwater runoff containment at terrestrial facilities to maintain existing drainage patterns, protect Project-adjacent habitat, and prevent contamination of streams. Develop a stormwater plan that meets all federal and

state legal requirements during site design of the UCMF and associated facilities prior to any construction activities at the site.

- Avoid to the extent practicable, disturbance of snags and of wildlife or legacy trees including live or dead trees that provide benefit to wildlife. If unavoidable, additional pre-construction species specific surveys may be necessary to minimize effects.
- Avoid to the extent practicable, disturbance of forested wetlands.
- Avoid to the extent practicable, disturbance of wetlands and adjacent areas that may provide habitat for turtles, amphibians, and other semi-aquatic wildlife.
- Avoid to the extent practicable, disturbance of riparian wetlands where restoration of natural hydrology may be unsuccessful within a short timeframe. Natural hydrology should be restored after construction is complete, and may require a restoration plan with monitoring until successful restoration can be determined.
- Minimize disturbance of streams that support fish, or are connected to fish-bearing streams. Unavoidable work within or adjacent to fish-bearing streams may be subject to in-water work windows. If terrestrial activities directly or indirectly affect any stream used by anadromous fish or fish listed as threatened or endangered under the federal ESA, consult with NMFS staff to avoid and minimize any potential effects to listed species.
- Avoid to the extent practicable, disturbance of seaside hoary elfin butterfly habitat within and in the vicinity of Driftwood Beach State Recreation Site. The current construction footprint has the Project well within the parking lot boundary of Driftwood, therefore interaction with kinnikinnick will be unlikely. Where unavoidable, species-specific surveys may be necessary on properties outside of Driftwood Beach State Recreation Site but within the construction footprint to determine the extent of occupied habitat and associated mitigation[17].
- Develop a revegetation plan, in consultation with NMFS, ODFW, and appropriate agencies, using native species to the extent practicable for areas disturbed during construction. This plan will include the minimization measures identified in letters commenting on the DLA filed with FERC by NMFS (dated July 18, 2018) and ODFW (dated July 20, 2018) as appropriate.
- Develop measures that will limit the introduction or spread of invasive species, to be included in a construction plan.
- Implement the Environmental Measures section as described in the Bird and Bat Conservation Strategy (Appendix B) to assess, minimize, and avoid impacts to birds and bats; these are annotated below.

[17] For information on survey protocols, see Interagency Special Status/Sensitive Species Program (ISSSSP) 2005.

- No HDD construction equipment or construction activities will occur on Driftwood Beach within suitable snowy plover nesting, roosting, or foraging habitat and is expected to be limited to the Driftwood Beach parking lot, at least 164 feet (50 meters) from any potentially suitable habitat.
- HDD operations in the parking lot will occur during daylight hours, but if lighting is required at night it will be appropriately shielded and directed to minimize artificial light reaching western snowy plover nesting habitat at night. Animal-proof litter receptacles and related signage and coordination will be provided to minimize potential attraction of predators.
- Develop and implement an HDD Contingency Plan to minimize the potential for inadvertent return of drilling fluids, provide timely detection, and address potential releases by describing monitoring, containment, response and notification procedures to be implemented by the contractor.
- If HDD is initiated during the western snowy plover nesting season (March 15 to September 15), prior to operation of the HDD, surveys of suitable nesting habitat will be conducted. If nests are detected, measures specified in the BBCS will be implemented, including noise monitoring and implementation of engineering controls, if appropriate (e.g., install temporary noise barriers such as berms, stockpiles, dumpsters, bins, and/or engineered acoustical barriers).
- Prior to any vegetation clearing that occurs within the nesting season, pre-construction surveys for nesting birds will be conducted by a qualified biologist to ensure that no nests will be disturbed during vegetation clearing.
- To minimize Project-related impacts on non-listed terrestrial nesting birds and avoid the creation of potential conflicts or constraints that the presence of active nests would have on Project activities (vegetation clearing), qualified biologists will remove nest-starts for any birds other than bald eagles or raptors when observed if found within the Project footprint and within 100 feet of a construction zone, and where feasible.
- If an active nest is found sufficiently close to work areas to be disturbed by these activities, the biologist will determine the extent of a construction-free buffer zone to be established around the nest (typically 300 feet for raptors and 100 feet for other species), to ensure that no nests of species protected by the MBTA will be disturbed during Project construction.
- If nesting bald or golden eagles are identified, activities will be restricted near nest sites according to guidelines suggested in the National Bald Eagle Management Guidelines (FWS 2007b).
- If construction activities will not be initiated until after the start of the nesting season, all potential nesting substrates (e.g., bushes, trees, snags, grasses, and other vegetation) that are planned to be removed, will be removed in late winter, prior to the start of the nesting season.

- If necessary, the prescribed no-disturbance nesting buffers may be adjusted to reflect existing conditions including ambient noise, topography, and disturbance with approval of ODFW.
- Conduct preconstruction surveys for roosting bats, and minimize construction impacts from high frequency sound disturbance, night lighting, and air quality degradation near roosts by implementing bat roost buffers, or excluding bats within bat roost buffers, or developing species and equipment specific buffers, use noise controls, and monitor bat roost activity before, during and after construction.
- If lighting is required at the UCMF, it will be appropriately shielded and directed to minimize artificial light attraction and prevent potential injury or mortality to seabirds. To the maximum extent practicable, while allowing for the public safety, low intensity energy saving lighting (e.g., low pressure sodium lamps) will be used, and bright white light will be minimized to the maximum extent practicable.

Oregon's Habitat Mitigation Policy (Oregon Administrative Rules 635-415-0025) describes six habitat categories and mitigation goals. Table 3-16 lists the categories, their mitigation goals and strategies, and the Project habitat found within each category. Table 3-17 indicates the potential for temporary and permanent habitat impacts for each habitat category in the terrestrial portion of the Project area (See Appendix K for a more detailed discussion).

Table 3-16. Habitat categories and mitigation goals and strategies in the Project Area.

Habitat Category	Characteristics	Mitigation Goal	Mitigation Strategy	Habitat Type in Project Area
1	Irreplaceable, essential habitat and limited on a physiographic province or site-specific basis	No loss of habitat quantity or quality	Avoidance	None
2	Essential habitat and limited on a physiographic province or site-specific basis	No net loss of habitat quantity or quality, and provide a net benefit of habitat quality or quantity	Avoidance or in-kind, in-proximity habitat mitigation	Fish bearing streams, wetlands, and habitat important for rare species
3	Essential habitat or important habitat that is limited on a physiographic province or site-specific basis	No net loss of habitat quantity or quality	Avoidance or in-kind, in-proximity habitat mitigation	Older forested areas, wetlands, and dune habitat
4	Important habitat	No net loss in habitat quantity or quality	Avoidance or in-kind or out-of-kind in-proximity or off-proximity habitat mitigation	Beaches, degraded wetlands, and recently disturbed forests.

Habitat Category	Characteristics	Mitigation Goal	Mitigation Strategy	Habitat Type in Project Area
5	Habitat having high potential to become essential or important habitat	Net benefit in habitat quantity or quality	Avoidance or mitigation that contributes to essential or important habitat	Landscaped or maintained areas
6	Habitat that has low potential to become essential or important habitat	Minimize impacts	Actions that minimize direct habitat loss and avoidance of impacts to off-site habitat	Roads and existing rights-of-way, houses, and other paved areas.

Table 3-17. Potential temporary and permanent impacts in the onshore portion of the Project Area.[18]

Feature name	Feature characteristics	Potential for Temporary Impacts	Potential for Permanent Impacts
Habitat Category 2			
Buckley and Friday Creeks	Perennial, fish-bearing streams	No	No
Wetland D	Riparian-forested depressional scrub-shrub emergent wetland, potential habitat for amphibians, supports hydrology of fish-bearing Friday and Buckley creeks	No	No
Roost habitat for bats	Maternity roosting habitat for bats. This habitat type (snags, fallen trees, etc.) is only Habitat Category 2 if there are bats roosting. If no bats are roosting, this area is Habitat Category 4 like surrounding forest type.	Yes	No
Beach habitat for western snowy plovers	Potential roosting, foraging, and nesting habitat for western snowy plover. The beach is only Habitat Category 2 if there are western snowy plovers that occur within 300 feet of construction activities. If no western snowy plovers are on the beach, this beach habitat is Habitat Category 4.	No	No
Habitat Category 3			
Wetland H	Scrub-shrub emergent wetland on north side of NW Wenger Lane	No	No

[18] The assessment of potential impacts and acreages of impact throughout this HMP are based on current construction footprints. Final determination of temporary and permanent impacts and acreages will be provided when final construction plans are available after the FLA is filed.

Feature name	Feature characteristics	Potential for Temporary Impacts	Potential for Permanent Impacts
Wetland I	Emergent wetland on north side of NW Wenger Lane	No	No
Dunes	Dunes adjacent to Driftwood parking lot	No	No
Habitat Category 4			
Disturbed/Shore Pine Forest	Disturbed forest with few or no large trees and shore pine forests within the UCMF property	Yes (<1.1 acres)	Yes (<1.4 acres)
Beach habitat	Foraging and stopover habitat for multiple species	No	No
Habitat Category 5			
Unpaved maintained and landscaped areas	Unpaved maintained and landscaped areas adjacent to Driftwood parking lot and restroom access, and area adjacent to CLPUD's utility pole on Hwy 101	Yes (<0.2 acres)	No
Habitat Category 6			
Paved and dirt roads, rights-of-way, houses, other paved areas	Driftwood access road, parking lot and restroom area, existing NW Wenger Lane and old utility shed on UCMF property	Yes (<1.2 acres)	Yes (<0.04 acres)

A total of four freshwater wetlands and three freshwater streams were delineated within the proposed terrestrial Project area during wetland and waterway surveys (HDR 2017, 2019). The terrestrial cable route, UCMF, and other associated structures have been sited to avoid impacts to wetlands and streams. The terrestrial power cables are proposed to be installed by boring underground (the HDD bore path would have a maximum depth of over 200 feet) to avoid direct impacts to sensitive habitats such as wetlands and streams.

The HDD drill rig would be setup in part of the parking lot of Driftwood Beach State Recreation Site, and each bore would take approximately a month to complete. The terrestrial portion of the cable would be installed in a single underground bore from the beach manholes in the Driftwood Beach State Recreation Site to the UCMF. The entire terrestrial cable route would be about 0.5 miles long. From the UCMF, a cable would also be buried by HDD west to, and under, Highway 101 to the grid connection point with the CLPUD overhead transmission line along the road; for this operation the HDD rig would be set up on the UCMF property. Sound and vibration from HDD and other construction activities could disturb birds in the vicinity of the nearshore (sub-surface) and onshore cable interconnection points during the construction phase of the Project. Nesting and non-nesting birds that could occur near shore include pigeon guillemots, which are known to nest in sandy coastal bluffs; black oystercatchers known to nest on exposed rocky shorelines and reefs; seabirds such as scoters, gulls, loons, and marbled murrelets that may be present in nearshore waters; shorebirds that may be present on the sandy beaches; and nesting or non-nesting songbirds in coastal shrub/pine forest habitats. Effects on non-nesting birds as a result of HDD would be limited to disturbance at the footprint of the drill rig and support equipment in the onshore staging area during the period during which construction is occurring. Noise from HDD is likely to be similar to, and not greater than, the other construction noises associated with the Project, based on measured sounds from a variety of construction equipment (e.g., bulldozers, scrapers, generators, compressors, pumps; CH2M Hill 2008, GEI Consultants 2015), and was estimated at 92 dBA at 15 m (50 ft) for the Deepwater Wind Project (Tetra Tech 2012b). Because the HDD would be operating in the Driftwood Beach State Recreation Site parking lot, effects of sound and vibration from HDD would be lessened, and any effects would be temporary and localized, occurring only during construction. Therefore, HDD drilling is not likely to have significant adverse effects on terrestrial or marine birds.

In their scoping comments and comments on the DLA, OPRD stated that the seaside hoary elfin butterfly is found in Driftwood Beach State Recreation Site, and its habitat is found throughout the park in upland areas. Kinnikinnick was documented in several locations throughout the study area during surveys conducted in May 2016 and June 2017. Kinnikinnick was found in a disturbed area adjacent to a gravel road (NW Wenger Lane) at the UCMF site. The majority of kinnikinnick was found within Driftwood Beach State Recreation Site, and was likely previously documented by studies conducted by Oregon State Parks and Recreation, but that data was not available at the time of the survey. The Project would avoid impacts to hoary elfin butterfly habitat by constructing upland facilities within previously disturbed areas of the park. Likewise, installation of the cables from the Driftwood Beach State Recreation Site to the UCMF, and from the UCMF to the CLPUD grid connection, would likely not impact wildlife habitat because they would be installed underground using HDD, which would avoid vegetation clearing. Similarly, the cable from the UCMF to the CLPUD grid connection would be installed by HDD.

Construction and maintenance activities would temporarily displace any wildlife inhabiting or otherwise using the UCMF site, and these activities could potentially remove or alter wildlife habitat, habitat for special status wildlife species (e.g., state listed, special status species, and species of state management concern) and to cause sound disturbance. Terrestrial special status species that could occur in the area include a number of birds, bats, freshwater turtles, and amphibians. ODFW identified a number of special status bird species that could occur in the terrestrial portion of the Project. Birds are also protected under the MBTA; as noted, a Bird and Bat Conservation Strategy has been prepared that provides environmental measures to mitigate for potential Project effects (Appendix B). Ground disturbing activities could damage special status plants (e.g., Cascade Head catchfly, clover species, Coast range fawn-lily, and early blue violet), if any occur within the construction area. OSU has developed a Habitat Mitigation Plan (Appendix K) to address recommendations by ODFW regarding Oregon's

Habitat Mitigation Policy (Oregon Administrative Rules 635-415) for on-shore habitat impacts; this document does not represent any environmental measures in addition to those proposed above.

Construction activities (e.g., strong lights used for nighttime construction or construction activities that generate high frequency sound) could potentially disturb a bat roost habitat to the point that adult female bats at a maternity roost (i.e., females that are pregnant or are raising young) could abandon the roost and possibly their young. If bats abandon a roost during daylight hours they are subject to predation by raptors, corvids, and other birds. A more detailed discussion of the potential effects is provided in the Bird and Bat Conservation Strategy (Appendix B).

During Project construction, erosion and sediment control measures would be implemented to minimize disturbance of soils and vegetation. Through efforts to avoid and minimize effects to wetlands and streams, OSU would also minimize effects to amphibian state special status species (e.g., western toad and foothill yellow-legged frog). These measures would also reduce the effects to fish located in surface waters. Three species of special status plants have the potential to occur in the Project area: pink sandverbena (federal species of concern), Point Reyes bird’s beak (federal species of concern and Oregon endangered species), and coast range fawn lily (federal species of concern and Oregon threatened species). No populations or individuals of special status plants were observed during surveys conducted between May 31 and June 3, 2016 or between June 21 and June 22, 2017. Additionally, it was determined that no suitable habitat for Point Reyes bird’s beak and coast range fawn lily occurs within the Project area.

Effects of construction activities on terrestrial resources along the terrestrial cable route would be minimized by installing the cable using HDD. Any effects associated with the HDD would be temporary. OSU would conduct pre-construction nesting bird surveys and roosting bat surveys prior to any Project site disturbance, and avoid disturbing nesting birds or roosting bats during the maternity season. Although wildlife would be permanently displaced from the area occupied by the UCMF, there is ample habitat around the proposed UCMF site for wildlife to relocate. Therefore, construction and maintenance activities are not likely to have significant adverse effects on terrestrial birds, bats or other wildlife.

3.3.5 Threatened and Endangered Species

3.3.5.1 Affected Environment

Section 7 of the ESA (19 USC 1536(a)(2)), as amended, requires that any actions authorized, funded, or carried out by a federal agency do not jeopardize the continued existence of a federally listed endangered or threatened species, or result in the destruction or adverse modification of federally listed designated critical habitat. OSU, on behalf of FERC, determined with input from FWS and NMFS that 39 species listed under the ESA may occur in the Project area (Table 3-18). Of these species, critical habitat has been designated within the Project area for only two species: Southern DPS North American green sturgeon and leatherback sea turtle. OSU has prepared a draft BA in consultation with NMFS and FWS for FERC's use in consulting with those agencies pursuant to Section 7 of the ESA, and it is included as Appendix A. This section summarizes information in the draft BA.

Table 3-18. ESA listed species that may occur within the PacWave South Project area.

Common Name	Scientific Name	Federal Status	State Status	Critical Habitat Designated	Critical Habitat in Project Area
Fish					
Chinook salmon[1]	*Oncorhynchus tshawytscha*				
Lower Columbia River Evolutionarily Significant Unit (ESU)		T	NL	Y	N
Upper Columbia River spring-run ESU		E	NL	Y	N
Snake River spring/summer -run ESU		T	T	Y	N
Snake River fall-run ESU		T	T	Y	N
Upper Willamette River spring-run ESU		T	NL	Y	N
California Coastal spring-run ESU		T	NL	Y	N
Sacramento River winter-run ESU		E	NL	Y	N
Central Valley spring-run ESU		T	NL	Y	N
Coho salmon[2]	*O. kisutch*				
Lower Columbia River ESU		T	E	Y	N
Oregon Coast ESU		T	NL	Y	N
Southern Oregon/ Northern California Coast ESU		T	NL	Y	N
Central California Coast ESU		E	NL	Y	N
Steelhead	*O. mykiss*				
Lower Columbia River Distinct Population Segment (DPS)		T	NL	Y	N
Middle Columbia River DPS		T	NL	Y	N

Common Name	Scientific Name	Federal Status	State Status	Critical Habitat Designated	Critical Habitat in Project Area
Upper Columbia River DPS		T	NL	Y	N
Snake River Basin DPS		T	NL	Y	N
Upper Willamette River DPS		T	NL	Y	N
Northern California DPS		T	NL	Y	N
Central California Coastal DPS		T	NL	Y	N
California Central Valley DPS		T	NL	Y	N
South-Central California Coast DPS		T	NL	Y	N
Sockeye salmon Snake River ESU	*O. nerka*	E	NL	Y	N
Chum salmon Columbia River ESU	*O. keta*	T	NL	Y	N
Green sturgeon Southern DPS	*Acipenser medirostris*	T	NL	Y	Y
Eulachon Southern DPS	*Thaleichthys pacificus*	T	NL	Y	N
Reptiles					
Leatherback sea turtle	*Dermochelys coriacea*	E	E	Y	Y
Green sea turtle	*Chelonia mydas*	T	E	Y	N
Loggerhead sea turtle	*Caretta caretta*	T	T	Y	N
Olive (Pacific) Ridley sea turtle Pacific DPS	*Lepidochelys olivacea*	E	T	N	N
Mammals					
Killer whale Southern Resident DPS	*Orcinus orca*	E	NL	Y	N
Humpback whale, Central America DPS/Mexico DPS	*Megaptera novaeangliae*	E	E	N	N
Blue whale	*Balaenoptera musculus*	E	E	N	N
Fin whale	*Balaenoptera physalus*	E	E	N	N
Sei whale	*Balaenoptera borealis*	E	E	N	N
Sperm whale	*Physeter macrocephalus*	E	E	N	N
North Pacific Right Whale	*Eubalaena japonica*	E	E	Y	N
Birds					
Marbled murrelet	*Brachyramphus marmoratus*	T	T	Y	N

Common Name	Scientific Name	Federal Status	State Status	Critical Habitat Designated	Critical Habitat in Project Area
Short-tailed albatross	*Phoebastria albatrus*	E	E	N	N
Western snowy plover	*Charadrius alexandrinus nivosus*	T	T	Y	N
Northern spotted owl	*Strix occidentalis caurina*	T	T	Y	N

Source: Letter from FWS to FERC dated August 1, 2014, letter from NOAA to FERC dated August 4, 2014.
Notes: [1]Based on recoveries of coded wire tagged Chinook salmon (Weitkamp 2010)
[2]Based on recoveries of coded wire tagged coho salmon (Weitkamp and Neely 2002)
E = Endangered, T = Threatened, NL = not listed.

Fish

Federally listed fish in the Project area include five species of anadromous salmonids (i.e., Chinook, coho, chum and sockeye salmon, and steelhead), green sturgeon, and eulachon.

Chinook Salmon

Chinook salmon are the largest of Pacific salmon and historically ranged from southern California (Ventura River) to northern Alaska (Point Hope). Given this widespread geographic distribution, Chinook salmon have developed diverse and complex life history strategies. Chinook salmon can be grouped into two generalized freshwater life history types: "stream-type" and "ocean-type." Stream-type Chinook salmon reside in freshwater for a year or more following emergence, whereas "ocean-type" Chinook salmon migrate to the ocean predominantly within their first year. In addition to differences in freshwater life histories, there appears to be differing ocean use patterns between these stream-type and ocean-type Chinook salmon. Stream-type populations appear to undertake extensive offshore ocean migrations while ocean-type Chinook salmon undertake distinct, coastally oriented, ocean migrations (Good et al. 2005).

Juvenile Chinook salmon exhibit a patchy distribution in U.S. West Coast waters; in pelagic trawl surveys conducted in summer and fall along Oregon and Washington, half of all juvenile salmonids were collected in about 5 percent of the surveys and none were collected in about 40 percent of the surveys (Peterson et al. 2010). In general, salmonids are low in abundance in U.S. West Coast waters when compared to other fishes, as evidenced by: 1) the low numbers of juvenile salmonids captured in directed pelagic surface/ subsurface research trawls relative to other nekton (Brodeur et al. 2004, Brodeur et al. 2005, Fisher et al. 2014, Peterson et al. 2010, Trudel et al. 2009), and by 2) low numbers of adult and subadult salmonids captured as bycatch in midwater trawls (e.g., commercial trawls for whiting, see Lomeli and Wakefield 2014).

Juvenile salmonids are pelagic and typically surface-oriented, most often found in the upper 20 m of the water column (Emmett et al. 2004, Walker et al. 2007, Beamish et al. 2000). Adult coho salmon tend to occur at shallower depths (< 40 m) than adult Chinook salmon (Walker et al. 2007). Juvenile Chinook salmon tend to occur closer inshore than other juvenile salmonid species, generally within the 100 m isobath (Brodeur et al. 2004, Peterson et al. 2010). In fact, subyearling Chinook salmon have been found in the surf zone (Marin Jarrin et al. 2009). Juvenile Chinook salmon tend to be more abundant off Washington in comparison to coastal waters of central and northern Oregon, likely reflecting more favorable habitat in Washington waters with a northwards migration after ocean entry (Bi et al. 2008, Peterson et al. 2010, Trudel et al. 2009).There are eight evolutionarily significant units (ESUs) of federally listed Chinook salmon that could occur in the Project area: Lower Columbia River, Upper Columbia River, Snake River spring/summer, Snake River fall-run, Upper Willamette River, California Coastal, Sacramento River winter-run, and Central Valley spring-run (Table 3-18). Chinook salmon from these ESUs differ in their freshwater spawning and rearing locations, and differ somewhat in their marine distributions (Weitkamp 2010). Oregon Coast Chinook salmon are not listed under the ESA.

Lower Columbia River ESU – NMFS listed Lower Columbia River Chinook salmon as threatened under the ESA in 1999 (70 FR 37160). This ESU includes naturally spawned Chinook salmon originating from the Columbia River and its tributaries downstream of the Hood and White Salmon Rivers, and fish originating from the Willamette River and its tributaries below Willamette Falls.

The predominant life history type for this ESU is the fall run, which consists of an early component that returns to the Columbia River beginning in early to mid-August and spawns within a few weeks (Kostow 1995), and a later returning component, which returns to the Lewis and Sandy rivers (Washington State Department of Fisheries et al. 1993, Kostow 1995). These later fish enter the Columbia River over an extended period of time and spawn from late October through November. Some runs of spring-run Chinook salmon also occur in this ESU on the lower Columbia River and enter freshwater in March and April, well in advance of spawning in August and September (Myers et al. 1998), entering the ocean from May through July (NMFS 2013b). Upon ocean entry, most Lower Columbia River fall Chinook salmon disperse slowly, remaining south of Vancouver Island through autumn (Fisher et al. 2014). The spring-run Chinook salmon become widespread along the coast from summer through autumn, indicating a diversity of dispersal rates (Fisher et al. 2014). Most of the spring-run and fall-run Chinook salmon appear to migrate northward after ocean entry, although a fraction of them migrate south of the Columbia River (Trudel et al. 2009). Designated critical habitat includes the mainstem Columbia River and its tributaries below Hood River (70 FR 52630). Critical habitat includes the mainstem Columbia River and its tributaries below Hood River (70 FR 52630).

Upper Columbia River ESU – In March 1999, the NMFS listed upper Columbia River spring-run Chinook salmon as endangered under the ESA (64 FR 14308). The ESU includes stream-type Chinook salmon spawning above Rock Island Dam and downstream of Chief Joseph Dam, including the Wenatchee, Entiat, and Methow Rivers in Washington. Upon ocean entry in spring, most Upper Columbia River Chinook salmon migrate rapidly northward and by late summer are not found south of Vancouver Island (Fisher et al. 2014). This ESU also includes six artificial propagation programs in Washington. Designated critical habitat includes the Columbia River mainstem and tributaries in Washington (70 FR 52630).

Snake River Spring/Summer-run ESU – NMFS listed Snake River spring/summer-run Chinook salmon as threatened in April 1992 and this status was reaffirmed in 2005 (70 FR 37160– 37204). This ESU includes all naturally spawned populations of spring/summer-run Chinook salmon from the mainstem Snake River, Tucannon River, Grande Ronde River, Imnaha River, Salmon River sub-basins, and 15 artificial propagation programs. Upon ocean entry in spring, most Snake River spring/summer Chinook salmon migrate rapidly northward and by late summer are not found south of Vancouver Island (Fisher et al. 2014), and they do not appear to migrate south of the Columbia River (Trudel et al. 2009). Designated critical habitat includes the Columbia River mainstem and Snake River tributaries (64 FR 57399).

Snake River Fall-run ESU – NMFS listed Snake River fall-run (SRF) Chinook salmon as threatened in April 1992 (57 FR 14653) and this status was reaffirmed in 2003 (70 FR 37160). This ESU includes all naturally spawned populations of fall-run Chinook salmon from the mainstem Snake River and below Hells Canyon Dam and in the Tucannon, Grande Ronde, Imnaha, Salmon, and Clearwater Rivers, as well as four artificial propagation programs. Upon ocean entry from the Columbia River, they migrate both north and south along the coast (Trudel et al. 2009). Designated critical habitat includes the Columbia River mainstem and Snake River tributaries (58 FR 68543).

Upper Willamette River ESU – NMFS listed the Upper Willamette River Chinook salmon as threatened in March 1999 (64 FR 14508), and the threatened status was reaffirmed in June 2005 (70 FR 37160). This ESU includes all naturally spawned populations of spring-run Chinook salmon in the Clackamas River and in the Willamette River, and its tributaries, above Willamette Falls. This ESU also includes seven artificial propagation programs (79 FR 20802). Upper Willamette River Chinook salmon typically exhibit an ocean-type life history and enter the Columbia River estuary at a younger age; they are smaller in size than other salmon that rear longer in streams (Bottom et al. 2005). Upon ocean entry, most Upper Willamette River Chinook salmon become widespread along the coast from summer through autumn, indicating a diversity of dispersal rates (Trudel et al. 2009, Fisher et al. 2014). Critical habitat includes the Columbia River mainstem, the Willamette River and its eastside tributaries above Willamette Falls (70 FR 52630).

California Coastal ESU – The California Coastal ESU, which includes all Chinook salmon naturally reproduced in streams between Redwood Creek in Humboldt County, California, south to the Russian River, Sonoma County, was federally listed as threatened in 1999 (64 FR 50394). Critical habitat was designated in 2005 and consists of river reaches from Redwood Creek to the Russian River (70 FR 52488). Critical habitat does not extend into the open ocean and does not include the Project area. The California Coastal ESU includes 15 independent populations of fall-run and 6 independent populations of spring-run Chinook salmon (NMFS 2011e).

Sacramento River Winter-run ESU – The Sacramento River winter-run ESU was federally listed as threatened in 1989 (54 FR 32085), and reclassified as endangered in 1994 (59 FR 440). It was also listed as endangered by the State of California in 1989. This ESU includes all naturally spawned populations of winter-run Chinook salmon in the Sacramento River and its tributaries in California. Critical habitat was designated in 1993 and includes the Sacramento River from Keswick Dam, Shasta County, to Chipps Island at the westward margin of the Sacramento-San Joaquin Delta; all waters from Chipps Island west to the Carquinez Bridge; San Pablo Bay west of the Carquinez Bridge; and San Francisco Bay from San Pablo Bay to the Golden Gate Bridge (58 FR 33212). Critical habitat does not extend into the open ocean and does not include the Project area. Chinook salmon in this ESU enter the Sacramento River in the winter and spawn in the summer (Quinn 2005). No other Chinook salmon populations have a similar life history pattern, and DNA analysis indicates substantial genetic differences between winter-run and other Chinook salmon in the Sacramento River. Chinook salmon from this ESU are the ocean-type race, and they migrate to the ocean in winter or spring after 5 to 9 months of freshwater residence. Juvenile Chinook salmon from the Sacramento and San Joaquin rivers in the Central Valley were more abundant along the Oregon coast north of Cape Blanco than in northern California during surveys conducted in the summer, which indicates that they likely migrate north during their ocean phase (Brodeur et al. 2004). Thus, Sacramento River winter-run Chinook salmon could occur in the Project area.

Central Valley Spring-run ESU – The Central Valley spring-run ESU was federally listed as threatened in 1999 and includes all naturally spawned populations of spring-run Chinook salmon in the Sacramento River and its tributaries in California, including the Feather River and the Feather River Hatchery spring-run Chinook program (64 FR 53094). Critical habitat was designated in 2005 and consists of the Sacramento River and its tributaries in California (70 FR 52488). Critical habitat does not extend into the open ocean and does not include the Project area.

Chinook salmon from this ESU are the ocean-type race, returning to freshwater in spring or summer and spawn in the fall, and the juveniles migrate to the ocean in spring. Juvenile Chinook salmon from the Sacramento and San Joaquin rivers in the Central Valley were more abundant along the Oregon coast north of Cape Blanco than in northern California during surveys conducted in the summer, which indicates that they likely migrate north during their ocean phase (Brodeur et al. 2004). However, these salmon are likely stream-type Chinook salmon that undertake extensive offshore migrations and return to freshwater in the fall, and would not include salmon from this ESU. Therefore, Chinook salmon from this ESU may be unlikely to occur in the Project area

Coho Salmon

Coho salmon are a widespread Pacific salmon species that inhabit most major river basins in western Oregon. Coho salmon typically exhibit a three year life history, divided between 18 months in freshwater and 18 months in saltwater phases. In freshwater, coho salmon spawn and rear in small streams with stable gravels and complex habitat features, such as backwater pools, beaver dams, and side channels. Marine survival and growth of coho salmon are linked to food availability, environmental conditions, and stressors present in the nearshore environment.

Juvenile coho salmon disperse from their natal streams to coastal waters; their ocean distribution changes with time, with juveniles typically moving northward or farther offshore (Brodeur et al. 2004). Ocean dispersal rates for yearling Columbia River coho salmon averaged between 3.2 and 6.6 km/d (Fisher et al. 2014). Juvenile salmonids are pelagic and typically surface-oriented, most often found in the upper 20 m of the water column (Emmett et al. 2004, Walker et al. 2007, Beamish et al. 2000). Adult coho salmon tend to occur at shallower depths (< 40 m) than adult Chinook salmon (Walker et al. 2007).

In general, juvenile salmonids are low in abundance in U.S. West Coast waters when compared to other fishes, as evidenced by the low numbers of juvenile salmonids captured in directed pelagic surface/subsurface research trawls relative to other nekton (Brodeur et al. 2004, Brodeur et al. 2005, Fisher et al. 2014, Peterson et al. 2010). Juvenile coho salmon exhibit a patchy distribution in U.S. West Coast waters; in pelagic trawl surveys conducted in summer and fall along Oregon and Washington, half of all juvenile salmonids were collected in about 5 percent of the surveys and none were collected in about 40 percent of the surveys (Peterson et al. 2010). Juvenile coho salmon occur in coastal waters, usually further offshore than juvenile Chinook salmon (Brodeur et al. 2004, Peterson et al. 2010). Juvenile coho salmon tend to be more abundant off Washington in comparison to coastal waters of central and northern Oregon, likely reflecting more favorable habitat in Washington waters (Bi et al. 2008, Peterson et al. 2010). Data from coded-wire tag recaptures suggest that juvenile coho salmon generally migrate northward from point of ocean entry (Morris et al. 2007).

There are four coho salmon ESUs that could occur in the Project area: the Lower

Columbia River, the Oregon Coast, the Southern Oregon/Northern California Coast, and the Central California Coast ESU.

Lower Columbia River ESU – NMFS listed the lower Columbia River coho salmon as threatened under the ESA in June 2005 (70 FR 37160). This ESU includes all naturally spawned populations of coho salmon from Columbia River tributaries below the Klickitat River on the Washington side and below the Deschutes River on the Oregon side (including the Willamette River as far upriver as Willamette Falls), as well as coastal drainages in southwest Washington between the Columbia River and Point Grenville. Critical habitat has been proposed for lower Columbia River coho salmon and includes Columbia River tributaries between the Cowlitz and Hood rivers (78 FR 2726). Upon ocean entry, most Lower Columbia River coho salmon become widespread along the coast from summer through autumn, indicating a diversity of dispersal rates (Fisher et al. 2014).

Oregon Coast ESU – In February 2008 (73 FR 7816), NMFS listed the Oregon Coast coho salmon ESU as threatened. The ESU includes all naturally spawned populations of coho salmon in Oregon coastal streams south of the Columbia River and north of Cape Blanco, including the Cow Creek coho hatchery program. Critical habitat is designated for most coastal streams in Oregon that currently, or historically, support coho salmon (64 FR 24049). Near the Project area, the Yaquina and Alsea rivers, and Thiel, Beaver, and Hill creeks are designated as critical habitat.

Southern Oregon / Northern California Coast ESU – Coho salmon from the Southern Oregon/Northern California Coast ESU were listed as threated by NMFS in 1997 (62 FR 24588) and reconfirmed in 2005 (76 FR 35755). This ESU includes naturally spawned coho salmon originating from coastal streams and rivers between Cape Blanco, Oregon, and Punta Gorda, California, plus coho salmon from three artificial propagation programs. Southern Oregon/Northern California coast coho salmon can occur in ocean waters from California to British Columbia, but they primarily occur off the California coast (Weitkamp and Neely 2002). Critical habitat was designated in 1999 (64 FR 24049) and revised in 2008 (73 FR 7816), and the closest designated rivers to the Project are the Chetco, Illinois, and Rogue rivers in Curry County, Oregon.

Central California Coast ESU – Coho salmon from the Central California Coast ESU were listed as threatened by NMFS in 1996 (61 FR 56138) and upgraded to endangered in 2005 (70 FR 37160). It was also listed as endangered by California in 2002. This ESU includes all coho salmon naturally spawned coho salmon from rivers south of Punta Gorda in Humboldt County, California (70 FR 37160, 77 FR 19552). Coho salmon from this ESU can occur in ocean waters from California to British Columbia, but they primarily occur off the California coast (Weitkamp and Neely 2002). Critical habitat was designated in 1999 and consists of accessible reaches of all rivers (including estuarine areas and tributaries) between Punta Gorda and the San Lorenzo River (64 FR 24049). Critical habitat does not extend into the open ocean and does not include the Project area.

Steelhead

Steelhead are rainbow trout that exhibit an anadromous life history pattern. By migrating to the ocean, steelhead grow to much larger sizes than their resident rainbow trout cohorts. Anadromous steelhead and resident rainbow trout can be considered to be from the same population, as “anadromous parents can produce resident offspring and resident parents can produce anadromous offspring” (LCFRB 2010). This adaptive life history makes steelhead flexible to changing habitat conditions. Also, unlike other Pacific salmonids, they can spawn more than one time.

After emergence, young steelhead rear in freshwater streams for 1 to 4 years before out migrating to the ocean. After reaching the ocean in the spring, juvenile steelhead tend to move offshore quickly rather than use nearshore waters like other salmon. For example, Daly et al. (2014) captured tagged juvenile steelhead that migrated greater than 55km offshore of the Columbia River within 3 days. While as sea, steelhead are found in pelagic waters of the Gulf of Alaska principally within 10 m of the surface, though they sometimes travel to greater depths (Light et al. 1989).

There are nine DPSs of steelhead that may occur in the Project area.

Lower Columbia River DPS – Listed as threatened in 1998, the lower Columbia River DPS includes naturally spawned steelhead originating Columbia River tributaries between the Cowlitz and Wind Rivers in Washington and the Willamette and Hood Rivers in Oregon (76 FR 50448). Excluded are steelhead in the upper Willamette River basin above Willamette Falls (which are included in the upper Willamette River DPS) and steelhead from the Little White Salmon and Big White Salmon Rivers, Washington (which are part of the Middle Columbia River DPS). Critical habitat is designated for lower Columbia River DPS steelhead and includes the Columbia River and tributaries between Cowlitz and Hood Rivers (70 FR 52630).

Middle Columbia River DPS – Steelhead from the middle Columbia River ESU were first listed as threatened 1999 (64 FR 14517), and this listing status was later confirmed in 2005 (76 FR 50448). This inland steelhead DPS occupies the Columbia River basin and tributaries from above (and excluding) the Wind River in Washington and the Hood River in Oregon upstream to, and including, the Yakima River in Washington. Steelhead of the Snake River basin are excluded from this DPS. Critical habitat is designated in Columbia River tributaries (70 FR 52630).

Upper Columbia River DPS – NMFS listed upper Columbia River steelhead threatened in 2009 (62 FR 43937). This inland steelhead DPS occupies the Columbia River basin upstream from the Yakima River, Washington, to the U.S./Canadian border. The principal tributary rivers include the Wenatchee, Entiat, Okanogan, and Methow Rivers. Critical habitat is designated in Columbia River tributaries in Washington (70 FR 52630).

Snake River Basin DPS – The NMFS listed steelhead trout from the Snake River Basin as threatened in 1997 (62 FR 43937) and reaffirmed this status in 2006 (71 FR 834). This inland steelhead DPS includes fish originating from the Snake River basin of southeast Washington, northeast Oregon, and northwest Idaho. Sockeye are dependent on lakes for part of their life history. Critical habitat is designated in Snake River tributaries in northeast Oregon and central Idaho (70 FR 52630).

Upper Willamette River DPS – Listed as threatened by NMFS in 2006 (71 FR 834), this DPS includes naturally spawned anadromous winter-run steelhead originating below natural and manmade impassable barriers from the Willamette River and its tributaries upstream of Willamette Falls to and including the Calapooia River. Critical habitat includes Willamette River tributaries upstream of Willamette Falls (70 FR 52630).

Northern California Steelhead DPS – This DPS was federally listed as threatened in 2000 and includes all naturally spawned steelhead populations below natural and manmade impassable barriers in coastal rivers, from Redwood Creek in Humboldt County, California, south to, but not including, the Russian River (65 FR 36074). Critical habitat was designated in 2005 and consists of river reaches between Redwood Creek south to Point Arena on the Mendocino coast (70 FR 52488). Critical habitat does not extend out into the open ocean and does not include the Project area. This DPS contains both winter and summer steelhead populations.

Central California Coastal Steelhead DPS – This DPS was federally listed as threatened in 1997 and includes all naturally spawned steelhead populations below natural and manmade impassable barriers in California streams from the Russian River south to Aptos Creek and in the drainages of San Francisco, San Pablo, and Suisun bays, excluding the Sacramento-San Joaquin River Basin (62 FR 43937). Critical habitat was designated in 2005 and consists of accessible river reaches of the Russian River south to Aptos Creek, and the drainages of San Francisco, San Pablo, and Suisun bays and their tributaries (70 FR 52488). Critical habitat does not extend out into the open ocean and does not include the Project area.

California Central Valley Steelhead DPS – This DPS was federally listed as threatened in 1998 and reaffirmed in 2006, and includes all naturally spawned steelhead populations below natural and manmade impassable barriers in the Sacramento and San Joaquin rivers of California and their tributaries, excluding steelhead from San Francisco and San Pablo Bays and their tributaries (71 FR 834). Critical habitat was designated in 2005 and consists of accessible river reaches of the Sacramento River and San Joaquin Rivers and their tributaries (70 FR 52488). Critical habitat does not extend out into the open ocean and does not include the Project area. This DPS contains winter and summer steelhead populations.

South-Central California Coast Steelhead DPS – This DPS was listed as threatened by NMFS in 1998 (63 FR 13347). This DPS includes all naturally spawned steelhead originating below natural and manmade impassable barriers from the Pajaro River to (but not including) the Santa Maria River in California. Critical habitat for the South-Central California steelhead was designated in 2005 and includes accessible river reaches from the Pajaro River to (but not including) the Santa Maria River (70 FR 52488).

Sockeye Salmon

Sockeye salmon are a widely distributed and abundant Pacific salmon species; however, the number of sockeye originating from the Snake River has dramatically declined and NMFS listed Snake River sockeye salmon as endangered in 1991 (56 FR 58619), confirming the listing in 2005 (70 FR 37160). The ESU includes all anadromous and residual sockeye salmon from the Snake River basin, Idaho, as well as artificially propagated sockeye salmon from the Redfish Lake captive propagation program. NMFS designated critical habitat for Snake River sockeye in 1993. Critical habitat includes the mainstem of the Columbia River and Snake River tributaries (58 FR 68543).

According to NMFS (2015b), "sockeye salmon enter the ocean and immediately begin migrating north, as no sockeye from the Columbia River have been caught south of the river's mouth in 16 years of sampling in the Northern California Current." Therefore, it is unlikely that sockeye salmon would occur in the ocean habitat near the Project area.

Chum Salmon

Historically, over a million chum salmon returned to the Columbia River each year. Today, Columbia River chum salmon returns are limited to a few thousand fish in a few lower Columbia River tributaries (e.g., Grays River, Washington; NMFS 2011). NMFS listed the Columbia River chum salmon as threatened 1999 (64 FR 14508) and reaffirmed this status in June 2005 (70 FR 37160). Chum salmon are rare in Columbia River tributaries in Oregon. NMFS designated critical habitat for chum salmon in 2005. The critical habitat includes the Columbia River (in Clatsop, Columbia, Multnomah, and Hood River counties) and a few other lower Columbia River tributaries (70 FR 52630).

Chum salmon have a short freshwater residence time and rear in estuaries prior to entering the ocean. Chum salmon are present in the Columbia River estuary following emergence as early as mid-January through mid-July, with the peak in abundance between mid-April and mid-May as they migrate seaward. Chum salmon juveniles may remain in the coastal area longer than other salmon before moving offshore to feed in pelagic ocean environments (Beamish et al. 2005). However, adult chum salmon are unlikely to occur in the Project area, because it is at the southern end of their range. Juveniles could occur in the Project area based on surveys along the Oregon coast (Brodeur et al. 2007, Fisher et al. 2007), but they generally migrate northward after ocean entry from the Columbia River (Beamish et al. 2005).

Green Sturgeon

NMFS listed the southern DPS of North American green sturgeon as threatened in 2006 (71 FR 17757). This DPS is defined as green sturgeon originating from the Sacramento River basin and from coastal rivers south of the Eel River in California.

Green sturgeon is a long-lived (up to 70 years), anadromous fish species that occurs along the Eastern Pacific Coast from the Bering Sea south to Ensenada, Mexico, although their consistently inhabited range is much smaller, primarily concentrating in the coastal waters of Washington, Oregon, and Vancouver Island (Huff et al. 2012). They spend most of their lives in coastal marine waters, coastal bays, and estuaries along the Pacific coast. Juveniles inhabit bays and estuaries for 1 to 4 years before traveling to the ocean. They spend about 15 years at sea before returning to spawn in their natal freshwater habitat, and spawn every 2 to 4 years thereafter (Moyle 2002). They spend summers in coastal waters typically <100 m deep along California, Oregon, and Washington, migrate north in the fall to as far as southeast Alaska, and then return in the spring (Erickson and Hightower 2007, Lindley et al. 2008). They occur on the bottom, although they can forage throughout the water column, feeding on benthic invertebrates and small fishes (Radtke 1966, Israel and Klimley 2006).

Green sturgeon are known to occur in the vicinity of and in the Project area based on trawl bycatch (Erickson and Hightower 2007, Al-Humaidhi et al. 2012) and coastal tracking of tagged fish (Erickson and Hightower 2007, Lindley et al. 2008, Huff et al. 2011, Lindley et al. 2011, Huff et al. 2012, Henkel 2017). They migrate and forage in coastal waters and in estuaries along the coast as well as in the Project area (Lindley et al. 2011, Huff et al. 2011). Models predict green sturgeon to have a high probability of presence in the Project area during all seasons (Huff et al. 2012) and occur at the same depths as the Project (Erickson and Hightower 2007, Huff et al. 2011). Close to the Project area, tagged green sturgeon spend longer durations in highly complex seafloor habitats (e.g., boulders) and tend to occur at depths of 20-60 m (Huff et al. 2011). Based on a telemetry study near Reedsport, Oregon, green sturgeon most commonly occurred at depths of 50-70 m and were associated with flat, soft bottom habitat lacking high-relief habitat (Payne et al. 2015), which is similar to the depth and habitat type of the Project site. In addition, some sturgeon used the coastal waters near the mouth of the Umpqua River for extended periods of time (e.g., months), while others moved through the area quickly. It was thought that the coastal waters may represent an important feeding area for green sturgeon, likely because the river plume contributes to food resource availability in the adjacent coastal waters (Payne et al. 2015). Tagged green sturgeon also occur at PacWave South and PacWave North, based on lines of 8 acoustic receivers placed at PacWave North (1 line) and PacWave South (2 lines) between October 2015-January 2016, and April-October 2016 (Henkel 2017). Similar to Payne et al. (2015), most sturgeon moved through quickly (days) whereas others remained for longer periods (weeks or months) (Henkel 2017). When comparing the first set (Year 1) and the second set (Year 2), there were fewer unique green sturgeon in Year 2 (n=85 versus n=115 in Year 1) with fewer detections (pings) per sturgeon (n=245.8 versus n=1535.9 in Year 1), and shorter durations (half the time, average 19 days versus 38 days in Year 1) of each sturgeon's presence in the array, despite the longer duration of receiver deployment in Year 2 (Henkel 2017). However, despite differences in the number of sturgeon detected between the years, within each deployment period similar numbers of green sturgeon were seen at both PacWave North and PacWave South (Henkel 2017).

In October 2009, NMFS designated all nearshore waters to a depth of 60 fathoms (360 feet or 110 m) offshore Oregon as critical habitat for the southern DPS of the green sturgeon (74 FR 52300; Figure 3-10). This critical habitat includes the Project area.

Figure 3-10. Southern DPS green sturgeon critical habitat (74 FR 52300).

The applicable[19] primary constituent elements essential for the conservation of the Southern DPS of green sturgeon are (74 FR 52300):

- For estuarine habitats
  - Food resources - Abundant prey items within estuarine habitats and substrates for juvenile, subadult, and adult life stages.
  - Water flow - Within bays and estuaries adjacent to the Sacramento River (i.e., the Sacramento-San Joaquin Delta and the Suisun, San Pablo, and San Francisco bays), sufficient flow into the bay and estuary to allow adults to successfully orient to the incoming flow and migrate upstream to spawning grounds.
  - Water quality - Water quality, including temperature, salinity, oxygen content, and other chemical characteristics, necessary for normal behavior, growth, and viability of all life stages.
  - Migratory corridor - A migratory pathway necessary for the safe and timely passage of Southern DPS fish within estuarine habitats and between estuarine and riverine or marine habitats.
  - Depth - A diversity of depths necessary for shelter, foraging, and migration of juvenile, subadult, and adult life stages.
  - Sediment quality - Sediment quality (i.e., chemical characteristics) necessary for normal behavior, growth, and viability of all life stages.

- For nearshore coastal marine areas
  - Migratory corridor - A migratory pathway necessary for the safe and timely passage of Southern DPS fish within marine and between estuarine and marine habitats.
  - Water quality - Nearshore marine waters with adequate dissolved oxygen levels and acceptably low levels of contaminants (e.g., pesticides, organochlorines, elevated levels of heavy metals) that may disrupt the normal behavior, growth, and viability of subadult and adult green sturgeon.
  - Food resources - Abundant prey items for subadults and adults, which may include benthic invertebrates and fishes.

A draft recovery plan was developed for green sturgeon (NMFS 2018) indicating that ocean energy projects are a “potential” risk factor for which future research was recommended. Specific concerns include potential exposure to EMF which could cause direct mortality, habitat loss, or migration, feeding, or habitat impacts.

[19] Not including PCEs for freshwater riverine systems.

Eulachon

Eulachon (commonly called smelt, candlefish, or hooligan) are a small, anadromous fish endemic to the eastern Pacific Ocean, ranging from northern California to southwest Alaska and into the southeastern Bering Sea. Eulachon leave saltwater to spawn in their natal streams late winter through early summer. During spawning, they release eggs over sandy river bottoms. Shortly after hatching, the larvae are carried downstream and dispersed by estuarine and ocean currents (WDFW and ODFW 2001). Winchuck, Chetco, Pistol, Rogue, Elk, Sixes, Coquille, Coos, Siuslaw, Umpqua, and Yaquina rivers; and Hunter, Euchre, Tenmile (draining Tenmile Lake), and Tenmile (near Yachats, Oregon) creeks are Oregon drainages that are reported to support eulachon spawning (Gustafson et al. 2010), as well as several tributaries to the Columbia River (ODFW and WDFW 2014).

Juveniles are reported to rear in nearshore marine waters. Eulachon spend most of their life in the ocean and grow up to 12 inches in length and return to spawn at age 3 to 5 years (WDFW and ODFW 2001).

NMFS listed eulachon as federally threatened in 2010 (75 FR 13012). NMFS designated freshwater rivers and associated estuaries in California, Oregon, and Washington as critical habitat for eulachon in 2011. In Oregon, critical habitat includes the Columbia River, Tenmile Creek, and Umpqua River (76 FR 65324). Eulachon are also an Oregon Conservation Strategy species and a candidate for listing in the State of Washington.

Marine Reptiles

Based on the Biological Opinion for PacWave North and NMFS scoping comments on the Project, four sea turtle species may occur in the Project area. OSU commenced initial site characterization studies in 2013, which include recording opportunistic sightings of sea turtles in the Project area during sampling cruises. To date, OSU has not observed any sea turtles in the Project area.

Leatherback Sea Turtle

The leatherback sea turtle was listed as endangered in 1979 (35 FR 8491). It has the widest distribution of all sea turtles, nesting on beaches in the tropics and sub-tropics and foraging in sub-polar waters. Following nesting, leatherbacks migrate along the west coast of North America from Mexico to Alaska. The leatherback is the most frequently observed sea turtle along the West Coast. However, sightings are still infrequent and this species is typically seen miles off the coast (FERC 2010).

Leatherbacks have been seen near Oregon from commercial seiners in pelagic areas, miles offshore, and along the continental slope (NMFS and FWS 1998). During the Oregon and Washington Marine Mammal and Seabird Survey, observers documented 16 leatherback turtles: five were located offshore of northern Oregon along the continental slope and 11 were off the coast of Washington (Bruggeman et al. 1992). Tagged leatherback turtles have been observed offshore of the Oregon coast (TOPP 2010).

The number of leatherback sea turtles in the Pacific Ocean is sizeable but declining, according to the latest status review (NMFS and FWS 2013). In the eastern Pacific, major nesting beaches are found in Costa Rica, Mexico, and Nicaragua. Based on nest counts in these areas, there are about 1,000 breeding females (NMFS 2013c). Although, populations estimates from index surveys, such as nest counts, are somewhat unreliable because females may breed at different beaches each year.

On January 26, 2012, NMFS designated critical habitat in the Pacific Ocean off areas of Washington, Oregon, and California (77 FR 4170; Figure 3-11). The area designated includes the offshore waters between Cape Flattery, Washington, and the Umpqua River (Winchester Bay), Oregon, out to the 2,000-m depth contour, and an similar area offshore California (44 FR 17710). NMFS identified one PCE) that is essential for the conservation of leatherback sea turtle: "the occurrence of prey species, primarily scyphomedusae of the order Semaeostomeae (*Chrysaora*, *Aurelia*, *Phacellophora* and *Cyanea*), of sufficient condition, distribution, diversity, abundance and density necessary for growth and success of leatherback sea turtles." This PCE is to ensure that ample prey species are available for leatherback sea turtles during their long migrations. The Project area occurs within designated critical habitat.

NMFS inquired, if given the 25 year duration of the Project and the likely occurrence of El Niño or warm water currents off the coast of Oregon, leatherback occurrence would be more likely in the Project area. NMFS and FWS (2013) state in their Five Year Review, "climate change is likely to increase abundance and change the distribution of jellyfish, a major food source for leatherbacks." More specifically, during El Niño events the redistribution of primary prey (the jellyfish *Chrysaora fuscescens*) show a "poleward and offshore re-distribution" (NMFS 2010a). In discussing *C. fuscescens* distribution off of central California, Lenarz et al (1995) states, "the distribution of the medusae towards the north is consistent with northward advection, but it should be noted that concentrations did not increase off Point Reyes during Niño years." Compared to other leatherback turtle populations, leatherbacks found along the west coast embark on trans-ocean migrations to forage on jellyfish at fixed or recurrent productive areas. Presumably, leatherbacks are still able to exploit prey-concentrating hydrographic features during Niño periods, as otherwise, leatherbacks would not have developed a migratory life history strategy.

Hypothetically climate change may shift leatherback distribution or migration timing as leatherbacks follow redistribution of their prey (NMFS 2012c). Relative to the Project area, there are no field data that leatherback turtle occurrence at PacWave South would be significantly altered during unusual climate events.

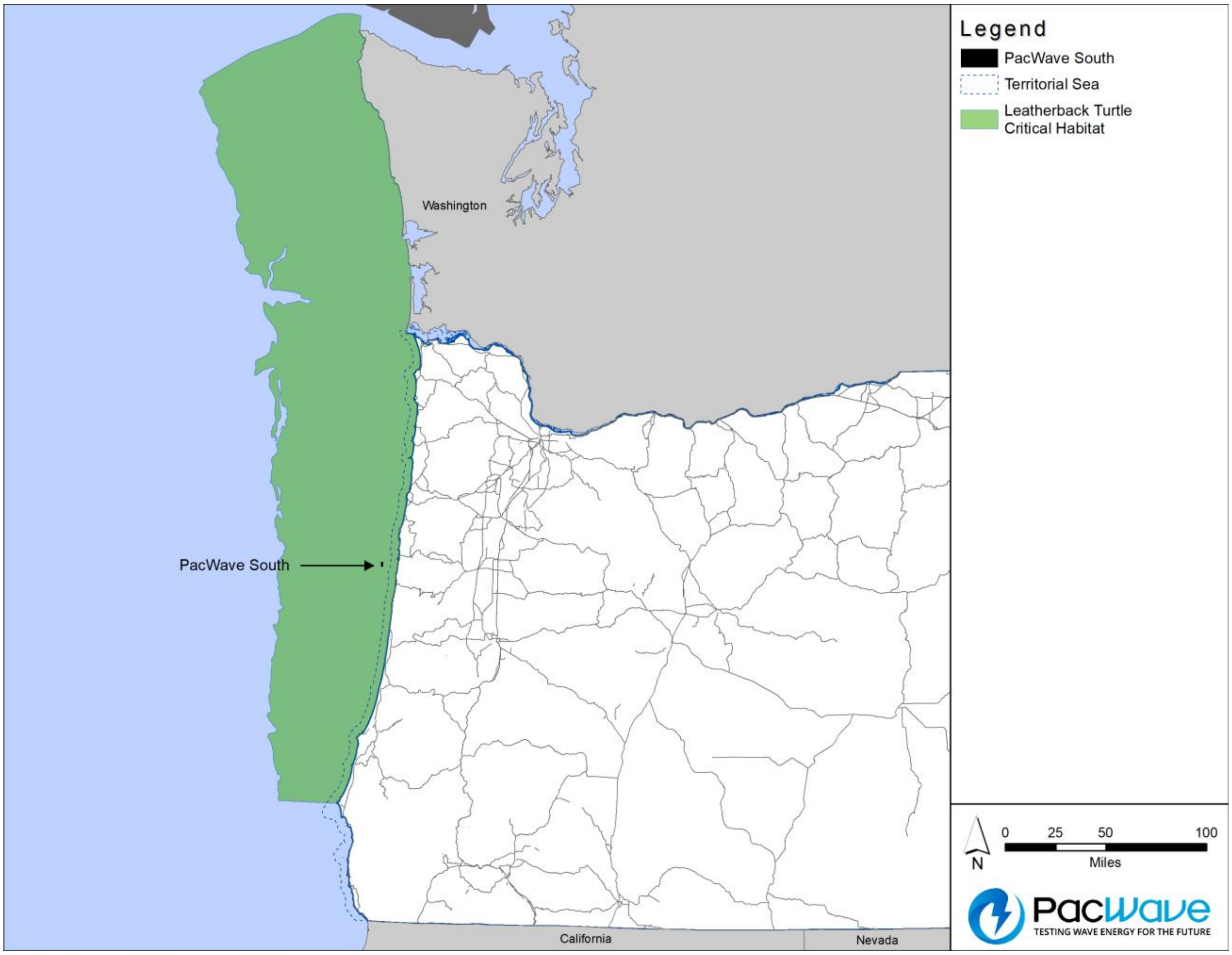


Figure 3-11. Leatherback sea turtle designated critical habitat (44 FR 17710).

Green Sea Turtle

The green sea turtle was listed as endangered in 1978 (43 FR 32800). This species inhabits warm coastal waters and is rarely observed off the coastline of Washington, Oregon, or California (NMFS 2012c). It is not known to nest on the West Coast, and the primary area of observations is in marine waters south of San Diego, California (FERC 2010). Critical habitat for the green sea turtle has only been designated only in the Atlantic Ocean (63 FR 46693).

Loggerhead Sea Turtle

The loggerhead sea turtle is listed as threatened both federally (43 FR 32800) and by the state of Oregon. Loggerhead nesting primarily occurs in the western Atlantic and Indian Oceans, and this species is not known to nest on the U.S. West Coast. Loggerheads have been documented off the U.S. West Coast and southeastern Alaska. In the Eastern Pacific, this species is primarily found south of Point Conception, which is the northern boundary of the Southern California Bight. In Oregon and Washington, loggerhead records have been kept since 1958, with nine strandings recorded over approximately 54 years, which equates to less than one stranding every 6-years (NMFS 2013c). NMFS has designated critical habitat for this species, but only in the Atlantic Ocean (79 FR 39855).

Olive Ridley Sea Turtle

The olive ridley sea turtle is thought to once have been the most abundant sea turtle, worldwide, but it was listed endangered in 1979 (43 FR 328200). This species nests in Central America, and individuals have been documented as far north as southern Oregon (FERC 2010). However, olive ridley sea turtles are rarely observed in the West Coast Exclusive Economic Zone (EEZ) (NMFS 2012c). This species is primarily pelagic, feeding on mid-water organisms, though it has been found in coastal areas. There are no apparent migration corridors for olive ridley sea turtles (FERC 2010). NMFS has not designated critical habitat for this species.

Marine Mammals

Three federally listed marine mammals (humpback, Southern Resident killer, and blue whales) are known or likely to occur within the Project area. Three other marine mammals (fin, sei, and sperm whales) could occur as transients but are primarily associated with deeper water, farther from the coast.

Southern Resident Killer Whale

NMFS listed Southern Resident killer whales as endangered in 2005 (70 FR 69903). The current population for Southern Resident killer whales is 75 animals (census count occurs every year), divided between three pods (J, K, and L pods) that mainly reside in waters around the Puget Sound (Center for Whale Research 2019). As such, NMFS designated intercoastal waters of Puget Sound as critical habitat in 2006 (71 FR 69054) but a 12 month finding in 2015 determined it was necessary to revise designated critical habitat and expand this designation to include inhabited marine waters along the U.S. West Coast that constitute essential foraging and winter areas (80 FR 9632). They mainly occur in the coastal waters of southern Vancouver Island and Washington, but two pods (K and L pods) have been sighted as far south as Monterey Bay, California (Carretta et al. 2009, 2015).

In describing the likelihood of Southern Resident killer whale to occur at PacWave North, NMFS (2012a) states “we have limited fine-scale information about Southern Resident foraging habits and space use along the Oregon coast, and do not have information specific to the Project area [but] Southern Residents are likely to occur…given their general tendency to occupy nearshore coastal waters when foraging, which is consistent with nearshore sightings off the Oregon coast (i.e., near Depoe Bay, Yaquina Bay, and the mouth of the Columbia River).” Surveys from aircraft conducted offshore of northern California, Oregon, and southern Washington in 2011 and 2012 detected few killer whales (total of 12 individuals), and these were reported at deeper depths (100-2,000 m depth) than the Project area (Adams et al. 2014). However, killer whale vocalizations were detected on seven days in April, May, and June 2014 by an acoustic lander deployed inshore of the test site and on three days in July and August 2015 by the acoustic mooring at PacWave South (Haxel 2019), which indicates their presence in the Project area. During vessel-based, standard-line transect surveys conducted from October 2013 to September 2015 (a total of 37 cruises) in the Project area, a total of 4 killer whales was observed (Henkel et al. 2019). These surveys indicate that small numbers of killer whales could occur at the test site. Autonomous monitoring with passive acoustic recorders from Cape Flattery, Washington to Pt. Reyes, California (including off Newport, Oregon) indicated the greatest frequency of detections off the Columbia River and Westport, which was likely related to the presence of their most commonly consumed prey, Chinook salmon (Hanson et al. 2013). Based on recent findings, Southern Resident killer whale fecundity is highly correlated with the abundance of Chinook salmon, in particular the stocks from Fraser River, Puget Sound, and the Columbia River (Ward et al. 2009, Ford et al. 2016, Hansen et al. 2010, NOAA and WDFW 2018). Climate change is projected to cause a decline in Chinook abundance (Munoz et al. 2014, Lacy et al. 2017). Viability models suggest that prey limitation is the most important factor affecting population growth for Southern Resident killer whale, and that in order to meet recovery targets through prey management, Chinook salmon abundance would have to be sustained near the highest levels since the 1970s (Lacy et al. 2017). Southern Resident killer whales may occur in the Project area, but likely in small numbers and at low frequency.

Humpback Whale

NMFS listed humpback whales as endangered in 1970 (35 FR 18319); the Mexico distinct population segment (DPS) is listed as “threatened” and the Central America DPS as ‘endangered’ (effective October 11, 2016; 81 FR 62259). In 2015, NMFS proposed to divide the humpback whales into 14 distinct population segments (DPSs), remove the current species-level listing and in its place list two DPSs as endangered and two DPSs as threatened (80 FR 22304). The remaining 10 DPSs are not proposed for listing based on their current status. Two of DPSs that are in U.S. waters that would remain listed under NMFS’s status review are the West North Pacific and Central America DPSs. The humpback whale is a highly-migratory marine mammal that ranges along the West Coast and worldwide. In the North Pacific, humpback whales migrate between feeding areas in the Bering Sea and wintering designations off Mexico, Central America, Hawaii, southern Japan, and the Philippines (Carretta et al. 2009). Humpback whales are commonly observed off the California, Oregon, and Washington coasts during the spring, summer, and fall months (NMFS 2012c). Past (Green et al. 1992) and recent (Tynan et al. 2005) studies noted summer concentrations of humpback whales in upwelled waters over Heceta Bank (about 15-30 miles off the Oregon Coast in Lincoln and Lane counties), where whales presumably gathered for feeding opportunities and preferred sea surface salinity.

Surveys from aircraft conducted offshore of northern California, Oregon, and southern Washington in 2011 and 2012 frequently detected humpback whales (114 sightings of 264 total individuals), although most were reported in waters having deeper depths (100-2,000 m depth) than the Project area, with the exception of higher densities reported inshore at focal areas located both south and north of the Project area (Adams et al. 2014). During surveys conducted offshore of Oregon from 1991 to 2008, humpback whales were observed near the Oregon coast (Carretta et al. 2015), and would be expected to occur at PacWave South. OSU detected humpback whales vocalizations during underwater noise monitoring at the "nearshore" sampling site east of the Project site (Haxel 2019), and a total of 20 humpback whales was observed during vessel-based, standard-line transect surveys conducted from October 2013 to September 2015 (a total of 37 cruises) in the Project area (Henkel et al. 2019).

Blue Whale

Blue whales were designated as endangered in 1970 (35 FR 62919), but critical habitat has not been designated for the species. Blue whales are the largest whale with worldwide distribution, but they are rarely sighted off the coast in Oregon's coastal waters. Blue whales are often concentrated near continental shelf breaks downstream of upwelling centers where krill are concentrated, but overall their distribution is more offshore than coastal (NMFS 2014). The offshore waters of Washington, Oregon, and California are thought to be important feeding areas for blue whales in the summer and fall (Carretta et al. 2009). Surveys from aircraft conducted offshore of northern California, Oregon, and southern Washington in 2011 and 2012 detected a few blue whales (10 sightings of 16 total individuals), most of which were in inner shelf waters (0-100 m depths) offshore of Oregon (Adams et al. 2014). OSU did not detect blue whales during vessel-based, standard-line transect surveys conducted from October 2013 to September 2015 (a total of 37 cruises) in the Project area (Henkel et al. 2019). NMFS (2012a) concluded that the occurrence of blue whales in the PacWave North project areas would be rare. NOAA did not identify the Project area as a "biologically important area" for blue whale feeding (Calambokidis et al. 2015). NMFS noted that OSU has not provided evidence to support the assertion that the same likelihood of occurrence would be true at PacWave South, which is farther from shore. It should be noted that PacWave South is located 4 nautical miles further offshore than PacWave North. However, given that whale surveys from 1991-2008 were conducted out to 300 nautical miles offshore (Carretta et al. 2015), PacWave South is only 1 percent further offshore than PacWave North (Figure 1-1) within that survey corridor, and it is expected that whale observations and conclusions at PacWave North would be relevant to PacWave South. It is expected that blue whales could occur in the Project area, though rarely.

Fin Whale

Fin whales are listed as endangered (35 FR 8491), but critical habitat has not been designated for the species. Fin whales occur in the major oceans of the world and tend to be more abundant in temperate and polar waters. NMFS recognizes three populations in the United States, including one that is found in waters off California, Oregon, and Washington. In its Biological Assessment of dredged materials disposal near Yaquina Bay, the EPA (2011) cites historical whaling records that note fin whales were harvested off the Oregon coast. However, fin whales are thought to prefer deeper waters than occur in the Project area. For example, Tyan et al. (2005) sighted fin whales in >2,000 m of water off the coast of Coos Bay during their linear transect surveys out to 150 km offshore from Newport, Oregon, to Crescent City, California. Surveys from aircraft conducted offshore of northern California, Oregon, and southern Washington in 2011 and 2012 only detected fin whales (6 sightings of 13 total individuals) at depths of >200 m (Adams et al. 2014). In shipboard surveys conducted off Oregon from 1991-2008, all but one fin whale were found much further offshore than PacWave South (Carretta et al. 2015). OSU only detected one fin whale during vessel-based, standard-line transect surveys conducted from October 2013 to September 2015 (a total of 37 cruises) in the Project area (Henkel et al. 2019). It is expected that fin whales could occur in the Project area, though rarely (Henkel et al. 2019, Carretta et al. 2015).

Sei Whale

Sei whales are large baleen whales that occur in subtropical and tropical waters to subpolar waters around the world and into the higher latitudes. NMFS listed sei whales as endangered in 1970 (35 FR 18319). Critical habitat has not been designated for the species. Sei whales in the eastern North Pacific (east of 180°W longitude) are considered a separate stock. They are predominately distributed over continental slopes, shelf breaks, and deep ocean basins situated between banks (NMFS 2011). They are rarely found off the Washington, Oregon, and California coasts; when observed, individuals are in oceanic waters, much further offshore than where PacWave South is located (Carretta et al. 2015). Surveys out to a distance of 300 nautical miles in 2005 and 2008 resulted in an abundance estimate of 126 sei whales off of Washington, Oregon, and California (Carretta et al. 2015). Surveys from aircraft conducted offshore of northern California, Oregon, and southern Washington in 2011 and 2012 did not detected any sei whales (Adams et al. 2014). OSU did not detect any sei whales during vessel-based, standard-line transect surveys conducted from October 2013 to September 2015 (a total of 37 cruises) in the Project area (Henkel et al. 2019). Therefore, sei whales are not expected to be encountered in the Project area because the species occurs in much deeper waters farther offshore.

Sperm Whale

Sperm whales are the largest of the toothed whales and are found in deep waters throughout the world's oceans. NMFS listed sperm whales as endangered in 1970 (35 FR 18319). Critical habitat has not been designated for the species. Sperm whales primarily prey on other deep water species, like squid, and are rarely found in waters less than 300 m deep (NMFS 2013c). Sperm whales are present the Pacific Ocean off of Oregon and Washington most of the year, except mid-winter, when they migrate farther south (NMFS 2010b). Based on surveys out to a distance of 300 nautical miles from 1991 to 2008, sperm whales are found in oceanic waters offshore of Oregon, much further offshore than where PacWave South is located, and their abundance ranged between 2,000 and 3,000 animals (Carretta et al. 2015). Surveys from aircraft conducted offshore of northern California, Oregon, and southern Washington in 2011 and 2012 only detected sperm whales (2 sightings of 3 total individuals) at depths of >200 m (Adams et al. 2014). OSU did not detect any sperm whales during vessel-based, standard-line transect surveys conducted from October 2013 to September 2015 (a total of 37 cruises) in the Project area (Henkel et al. 2019). Sperm whales are therefore not expected to occur in the Project area (NMFS 2012c).

North Pacific Right Whale

Eastern North Pacific Right whales have historically occurred along the West Coast and have been reported as far south as central Baja California in the eastern North Pacific, as far south as Hawaii in the central North Pacific, and as far north as the sub-Arctic waters of the Bering Sea and sea of Okhotsk (NMFS 2017). Migration patterns of the North Pacific right whale are unknown, although it is assumed the whales spend the summer in far northern feeding grounds and migrate south to warmer waters, such as southern California, during the winter. However, Shelden (2006, as cited in NMFS 2017) suggests that records of right whales in southern California and Hawaii likely represent vagrant individuals. Since 1950, there have been at least 3 sightings from Washington coast, fourteen from California coast, two from Baja California, Mexico, and three from Hawaii (Brownell et al. 2001); sightings are extremely rare (NMFS 2017). The western Gulf of Alaska and the southeastern Bering Sea are both frequently used areas primarily in the 50-100m isobaths (NMFS 2017). There are no reliable estimates of current abundance however, the Eastern Pacific population is likely to be very small, and has been estimated to consist of approximately 30 individuals (Wade et al. 2011).

Birds

Marbled Murrelet

The FWS listed marbled murrelet as threatened in 1992 (57 FR 45328). Marbled murrelets occur in Alaska, British Columbia, Washington, Oregon, and California. Although only a small percentage of the population (2 percent) occurs in Washington, Oregon, and California, this area represents 18 percent of the species' linear coastal range and likely supported far greater murrelet numbers historically (McShane et al. 2004). Population declines have been attributed to forest fragmentation and loss of nesting habitat from the harvest of old-growth coniferous forests, and from mortality associated with gillnet fisheries and oil pollution. Critical habitat has been revised several times since the first designation in 1996, with the most recent designation in 2011 (76 FR 61599). There is no critical habitat in the Project area, because critical habitat was designated to protect inland nesting habitat (Figure 3-7). The species is also listed as threatened by the State of Oregon.

Marbled murrelets nest on naturally occurring branch platforms high in old-growth coniferous trees (Nelson 1997). They fly between coastal/ocean habitat where they feed and inland nesting habitat (Miller et al. 2002). At-sea abundance has been strongly correlated with inland areas containing contiguous old-growth forest (Miller et al. 2002). In Oregon, the at-sea density of marbled murrelets during the breeding season is highest in the nearshore waters of central Oregon between Reedsport and Newport (e.g., 9-50 murrelets/km^2; Strong 2009, Suryan et al. 2012), which is directly offshore from large tracts of inland nesting habitat. At sea, they forage on small schooling fishes and large pelagic crustaceans (euphausiids, mysids, amphipods), and occur primarily in very nearshore waters (<1.5 km from shore; Sealy 1974, Strachan et al. 1995, Strong 2009). Peak densities of murrelets in Oregon occur between 300 and 1,000 m from shore, and they are rare but consistently present beyond 4 km from shore (Strong 2009). They most often feed as singles or in pairs, although they do occur in loose aggregations (tens to hundreds of birds) where prey is concentrated (Sealy 1975, Carter and Sealy 1990, Strachan et al. 1995). There is some evidence that they occur farther offshore over the continental shelf during the non-breeding season (Suryan et al. 2012), thus it is possible that they are more likely to occur in the Project area from fall through spring. Adult murrelets molt two times per year, and they are flightless for one to two months during the fall (October-November), during which time they remain on the water and do not fly to inland nesting areas (Carter and Stein 1995).

During vessel-based, strip transect surveys conducted from May 2013 to October 2015 (a total of 44 cruises) in the Project area, a total of 35 marbled murrelets were observed, primarily concentrated shoreward of the test site and adjacent nearshore waters near the mouth of the Yaquina Bay, with the exception of a couple of murrelet observations just north and west of the test site (Porquez 2016, Suryan and Porquez 2016). These surveys indicate that occurrences would likely be limited to occasional occurrences of 1-2 murrelets at the test site, but that they would be expected to occur along the subsea cable route and vessel route between Yaquina Bay and the test site.

The mixed conifer/deciduous forest in the terrestrial Project area does not contain suitable nesting habitat for marbled murrelets. However, murrelets could fly over or through the mixed conifer/deciduous forest in the terrestrial Project area as they fly between at-sea and inland nesting habitats.

Short-tailed Albatross

The short-tailed albatross was federally listed as endangered in 2000 (65 FR 46643). Critical habitat has not been designated for the species. The species is also listed as endangered by the State of Oregon. The short-tailed albatross was once an abundant species, numbering more than a million birds. The species was decimated by feather hunting and egg exploitation at the turn of the 20th century and by the late 1940s was thought to be extinct. Through intense management efforts, the population has now reached an estimated 4,354 individuals and is currently undergoing very high population growth (5-9 percent per year), mainly due to high survivorship, translocation of chicks and use of social attraction to establish a new colony, and reduction of bycatch in commercial fishing (FWS 2014a). This species is now showing up in the northwest Hawaiian Islands in double-digit numbers during the breeding season, and has bred on Midway Atoll (American Bird Conservancy 2012, FWS 2014a). Current potential threats to the short-tailed albatross include breeding colony habitat degradation due to volcanic activity, typhoons, flash floods, erosion, and invasive species; contaminants; plastics ingestion; and bycatch in commercial fisheries; and offshore wind energy development (FWS 2014a).

With the exception of Hawaii, the short-tailed albatross nests exclusively on small volcanic islands in Japan. The breeding season lasts about eight months and occurs in October-June (FWS 2008). During the non-breeding season (summer), they range along the Pacific Rim from southern Japan to northern California, primarily along the continental shelf margins. Based on satellite tracking of 99 individuals between 2002 and 2012, juveniles generally range in shallower, nearer-to-shore waters than adults (e.g., <200 m depth), and are more likely than adults to occur off the west coast of U.S. and Canada (Suryan et al. 2006, 2007, and 2008, Suryan and Fischer 2010, Deguchi et al. 2012, Yamashina Institute for Ornithology and Oregon State University, unpublished data, as cited in FWS 2014a).

The short-tailed albatross is still quite rare off the U.S. West Coast, with 14 records in Oregon waters (most of them <10 years old) accepted by the Oregon Bird Records Committee (OBRC; Marshall et al. 2006, OBRC 2016). During vessel-based, strip transect surveys conducted from May 2013 to October 2015 (a total of 44 cruises) in the Project area, a total of 41 black-footed albatrosses (used as a proxy for short-tailed albatross due to similar habitat use) was observed, primarily concentrated beyond 20 km from shore, with the exception of one sighting near the test site about 16 km from shore (Porquez 2016, Suryan and Porquez 2016). In addition to the extreme rarity of this species off the Oregon coast, these surveys indicate that occurrence of the short-tailed albatross at the test site is highly unlikely and would likely be limited to rare occasional occurrences, if at all, even as the population continues to grow.

Western Snowy Plover

The western snowy plover was federally listed as threatened in 1993 due to loss of nesting habitat and declines in breeding populations (58 FR 12864). Critical habitat was revised in 2012 and there are critical habitat units in California, Oregon, and Washington (77 FR 36728); however, there is no critical habitat designated in the Project area. The main threats to the species include habitat loss and degradation from human disturbance, urban development, introduced beachgrass (*Ammophilia* spp.), and expanding predator populations (FWS 2007a). The species is also listed as threatened by the State of Oregon.

The western snowy plover nests on sand spits, dune-backed beaches, beaches at creek and river mouths, and salt pans at lagoons and estuaries from southern Washington to Baja California (FWS 2007a). They feed on invertebrates in wet sand within the intertidal zone, and dry sand above high tide, on salt pans, spoil sites, and along the edges of salt marshes, salt ponds, and lagoons. The breeding season occurs from March through September: FWS (2007a) Recovery Plan for the Pacific Coast Population of the Western Snowy Plover, indicates "on the Oregon coast nesting may begin as early as mid-March, but most nests are initiated from mid-April through mid-July (Wilson-Jacobs and Meslow 1984); peak nest initiation occurs from mid-May to early July (Stern et al. 1990). In Oregon, hatching occurs from mid-April through mid-August, with chicks reaching fledging age as early as mid- to late May. Peak hatching occurs from May through July, and most fledging occurs from June through August." Nests were observed at various points along the beach between the mouth of the Alsea Bay to Seal Rock, which includes the cable landing site at Driftwood Beach State Recreation Site; five nests were observed near Driftwood Beach State Recreation Site in 2017 (Lauten et al. 2017), and four nests were observed in 2018 (Taylor 2018). Some plovers remain in their coastal breeding areas year-round while others migrate south or north for winter, and most inland-nesting snowy plovers migrate to the coast for the winter (FWS 2007a). They could be found wintering at any beach with suitable habitat along the Oregon coast, including the shore cable landing area. Winter surveys were conducted at South Beach State Park in Newport (approximately 9.5 miles north of the Driftwood Beach State Recreation Site) in 1991-1994, 2001-2003, and in 2007, and no plovers were reported (FWS 2010); however, winter surveys observed plovers there in 2015, 2016, 2017, and 2018 (FWS 2018).

A Habitat Conservation Plan prepared by the Oregon Parks and Recreation Department covering incidental take of western snowy plover included Lincoln County in its “covered lands”, allowing recreation and beach management activities with minimal protection (50-m radius fenced area) of nests (ICF International 2010). Therefore, small numbers of this species could winter or nest in the vicinity of the shore cable landing area.

Northern Spotted Owl

The northern spotted owl was federally listed as threatened in 1990 due to habitat loss from timber harvest (55 FR 26114). The main threats to this species are past and current habitat loss, and competition from the barred owl. Critical habitat was designated in 1992 and revised in 2008 and 2012 and there are critical habitat units in California, Oregon, and Washington (77 FR 71875); however, there is no critical habitat designated in the Project area. The species is also listed as threatened by the State of Oregon.

Northern spotted owl nesting, roosting, and foraging habitat occurs in structurally complex, older coniferous forests (FWS 2011). Important habitat features include a moderate to high canopy closure (60 to 90 percent); multilayered, multi-species canopy with large overstory trees; a prevalence of large trees with various deformities (large cavities, broken tops, mistletoe infections, and other evidence of decadence); presence of large snags; accumulations of fallen trees and other woody debris on the ground; and sufficient open space below the canopy for spotted owls to fly (Thomas et al. 1990). Spotted owls spend most of the day roosting in trees; they forage at night between sunset and sunrise, although they may also forage opportunistically during the day (Forsman et al. 1984, Sovern et al. 1994). Spotted owls exhibit high site fidelity, generally retaining the same breeding territories from year to year (Forsman et al. 2002). Courtship behavior begins in February or March, and eggs are typically laid in late March or April (Forsman et al. 1984, FWS 2011). Nests are usually found in old-growth coniferous trees (i.e., exceeding 200 years), and Douglas fir is the most common nest tree species (Forsman et al. 1984, LaHaye and Gutierrez 1999). Northern spotted owls could occur in the mixed conifer/deciduous forest near the terrestrial portion of the Project, although it would be unlikely given that the surrounding forest is fairly fragmented due to housing developments and timber harvesting.

Essential Fish Habitat

The PFMC manages, under federal FMPs, four groups of fished species along the West Coast of the United States: (1) groundfish, (2) salmon, (3) highly migratory species, and (4) coastal pelagic species. The groundfish FMP includes more than 80 species of fish, and the salmon FMP includes all species of salmon occurring along the west coast of the United States that are commercially fished, including Chinook, coho, and pink salmon. The highly migratory species FMP includes the tunas, some shark species, and billfish. The coastal pelagic FMP includes five taxa: northern anchovy, market squid, Pacific sardine, Pacific (chub) mackerel, and jack mackerel.

Pursuant to the Magnuson-Stevens Act, EFH has been designated for each of these groups, and all waters within and adjoining the Project area constitute EFH for these groups. Specifically, EFH has been designated as follows (PMFC 2013):

- *Groundfish* - Water depths less than or equal to 3,500 m (11,483 feet) to the mean higher high water level or the upriver extent of saltwater intrusion, defined as upstream and landward to where ocean-derived salts measure less than 0.5 parts per thousand during the period of average annual low flow; seamounts in depths greater than 3,500 m (11,483 feet) as mapped in the EFH assessment GIS data; and areas designated as HAPC not already identified by the above criteria.
- *Salmon* - All waters of the United States between the Canadian border and the Mexican border and out 200 miles (370 km) to the western extent of the Exclusive Economic Zone.
- *Pelagic* - All waters of the United States from the Canadian border to the Mexican border and out 200 miles (370 kilometers) to the western extent of the Exclusive Economic Zone.
- *Highly migratory species* - Varies by species.

The PFMC has designated rocky reef habitats as HAPCs, which are distinct subsets of EFH. As noted previously, the proposed cable route aims to bypass the rocky geology associated with the South Reef near the Project area, as the reef supports sensitive environmental resources and could pose risks to cable survivability.

3.3.5.2 Environmental Impacts Related to Threatened and Endangered Species, Critical Habitat, and Essential Fish Habitat

In general, Project construction and operation could expose some threatened and endangered species to habitat alteration, underwater sound, and EMFs. This section evaluates the effects on threatened and endangered species, critical habitat, and EFH. As FERC’s non-federal representative for carrying out informal consultation pursuant to Section 7 of the ESA, OSU has been working with NMFS and FWS in evaluating effects to the 39 threatened and endangered species that may occur in the Project area (Table 3-18). Of these species, critical habitat has been designated within the Project area for two species: Southern DPS North American green sturgeon and leatherback sea turtle. The draft BA, developed in consultation with NMFS and FWS, is included as Appendix A.

Fish

Threatened and endangered fish species that are likely to occur near PacWave South and which could be affected by the Project include Chinook salmon, coho salmon, steelhead, green sturgeon, and eulachon. In addition, critical habitat for the southern DPS of North American green sturgeon includes the Project area. Potential effects during construction and operation of the Project on these species and green sturgeon critical habitat include effects caused by habitat alteration, underwater sound, and exposure to EMFs. To minimize effects to ESA-listed fish, OSU would implement environmental measures as follows:

- Bury subsea cables at a depth of 1-2 meters, to the maximum extent practicable, to minimize the amount of habitat conversion (soft bottom to hard structure) from laying exposed cable on the seafloor. In areas where a cable cannot be buried or persistently becomes unburied, that portion of the cable will be on the seafloor and will be protected by split pipe, concrete mattresses or other cable protection systems.
- Implement the EMF Monitoring Plan (Appendix H) to measure Project-related EMF emissions. Based on monitoring results, implement the specified measures to mitigate for potential adverse effects (Appendix I).
- Implement the Organism Interactions Monitoring Plan to track changes to pelagic and demersal fish and invertebrates (particularly Dungeness crab) that might be attracted to the installed components or affected due to the potential for reduced fishing pressure, as well as biofouling on the anchors/WECs (Appendix H).
- To the maximum extent practicable, bury subsea cables and utilize appropriate shielding on subsea cables and umbilicals, and other electrical infrastructure to minimize EMF emissions.

The probability of occurrence of the ESA-listed fishes in the Project area is likely low, based on research and regional bycatch data, and because these fish are also migratory, they are unlikely to remain in the Project area but rather move through on a transitory basis.

Habitat Alteration

As discussed in greater detail in Sections 3.3.3.2 and 3.3.2.2 and the draft BA, potential stressors related to habitat alteration are:

- Suspended sediment during installation and redeployments;
- Disturbance of the benthic community from Project structures;
- Changes to marine community composition and behavior (e.g., use patterns, attraction, and avoidance); and
- Potential effects of toxic substances introduced by the Project on water quality.

Suspended sediment resulting from cable laying, subsea connector installation, and anchor installation/removal at PacWave South, is expected last for minutes or tens of minutes. Suspended sediment during cable laying is expected to dissipate quickly and not reach levels that would harm ESA-listed salmonids (Newcombe and Jensen 1996), and salmonids, eulachon, and green sturgeon would likely move away from the area of disturbance.

As noted in Section 3.3.3.2, effects to the benthic community from Project structures may include direct effects, such as burial of the cable and the presence of Project components on the seafloor and indirect effects, such as scour associated with the anchors. The total area of benthic habitat disturbed at the test site would be very small relative to the range of and available marine habitat and prey for the ESA-listed fishes (particularly for the highly migratory salmonids and green sturgeon), and minor in comparison to surrounding available habitat (about 0.1 percent of the Project area [2 acres] for direct effects to the seafloor from the maximum footprint of the anchors and about 3 percent [48 acres] of the Project area for indirect effects to the seafloor at full build out). Effects at PacWave South are expected to be minimized given that anchor installation/removal is not likely to occur more than once a year in a berth and anchors may be deployed for multi-year periods.

Potential changes to marine community composition and behavior as a result of WEC structures introduced to the marine environment could include changes in the marine community, forage opportunities, and predator/prey abundances. In general, although there is uncertainty about the degree to which marine animals may be attracted to WEC structures, there is no data that suggest that there would be any significant adverse effects to individuals or populations (Copping et al. 2016). Because of the small size of the Project, it is not anticipated that the addition of Project structures to the marine environment would represent a significant change to marine habitat above existing conditions, and the probability of the ESA-listed fishes encountering and being affected by Project structures is generally low. The ESA-listed fishes are not anticipated to be attracted to or associate regularly with the structures; therefore, they would not be expected to be at increased risk of predation by predatory fishes, seabirds, or pinnipeds, even if those predators associate with the structures.

There are two pathways that the Project could contaminate the water quality in the Project area: antifouling paints, and accidental spills of hazardous materials (e.g., fuel) from vessels during construction and operation. Contaminants could affect ESA-listed fish through direct mortality at high levels of exposure, or cause sublethal effects such as compromised immune response, increased susceptibility to pathogens, reduced reproductive success and reduced growth rates at lower concentrations. This potential effect is covered in Section 3.3.2.2, and it was concluded that toxic substances are not expected to adversely affect any aquatic resources or marine life that could be in the Project area. Spill control and response measures proposed by OSU would greatly reduce the likelihood that a spill of hydraulic fluids or other petroleum-based contaminants would be large enough to adversely affect more than a few individual fish, or to affect habitat function. Occurrence of the ESA-listed fish is likely to be low and/or short-term/transitory in the Project area, thus their potential exposure to toxic substances, if they are released, would likely be very low. In addition, the location of PacWave South in the open ocean further minimizes the likelihood of impacts, because any minor effects on water or sediment quality would quickly dissipate.

The terrestrial cable would be installed via HDD, and would consequently avoid impacts to freshwater fish. As noted in Section 3.3.3.2 (Environmental Impacts Related to Aquatic Resources), potential effects on ESA-listed freshwater fish in surface waterbodies in the Project area include effects from potential hazardous materials release from the construction equipment itself (lubricating oils and fuel) or inadvertent returns of drilling fluids to a waterway from HDD operations. However, there are only three fish-bearing streams in the Project area, which will be avoided entirely. The depth of boring operations will be designed so that the engineers determine there is a low risk of inadvertent return of drilling fluids and an HDD Contingency Plan will be developed to minimize the potential for inadvertent return of drilling fluids, provide timely detection, and address potential releases by describing monitoring, containment, response and notification procedures to be implemented by the contractor. Through implementation of construction BMPs, no detrimental effects to freshwater fish are expected from hazardous materials releases.

Underwater Sound

The primary sources of Project-related underwater sound would be from vessels at PacWave South and transiting between Newport and the site, cable laying, and from WECs and associated Project structures. The threshold for causing temporary behavioral changes (startle and stress) on threatened and endangered fish species, as defined by NMFS and FWS, is 150 dB re: 1 μPa RMS (FHWG 2009); Project associated sounds could approach or occasionally exceed the threshold for behavioral effects. Potential effects of moderate (e.g., non-injury) anthropogenic noises on fish can include disturbance and deterrence, reduced growth and reproduction, interference with predator-prey interactions, and masking of communication (Slabbekoorn et al. 2010). Based on the existing information, the short term and temporary sounds from vessels transiting to or from the Project site and within the Project site itself (i.e., hours or less as the vessels pass), and from dynamic positioning vessels for cable laying during installation and deployment of WECs, as well as from continuous sounds from the WECs, even though they would occur over the 25-year license term, are not likely to adversely affect ESA-listed fishes for several reasons: these species are not particularly sensitive to sound; the area affected (e.g., up to 125 m around the WECs) would be insignificant compared to the range of these species, particularly for the highly migratory green sturgeon and salmonids; and there is similar and abundant habitat available in the surrounding area that they could move to if they are exposed or disturbed by the sounds. ESA-listed salmon, green sturgeon, or eulachon may swim around a WEC or avoid a vessel transiting between the Port of Newport and PacWave South, but there is no basis to expect that noise associated with the Project, including deployment, O&M, retrieval, and environmental monitoring, would affect aggregating green sturgeon or the migratory path for salmonids leaving or returning to natal streams because of the offshore location of the Project, the spacing of the WECs, and relatively low levels of noise associated with the Project. All of the listed fish are highly mobile and migratory, and individual fishes are unlikely to remain in the Project area and be continually or repeatedly exposed to this stressor. Because of the uncertainty associated with the underwater sounds that will be associated with this relatively new industry, if monitoring results (Appendix H) indicate that the operating WECs exceed an acoustic management or mitigation threshold, adaptive management and mitigation measures to address the unanticipated adverse effects would be implemented by OSU (Appendices I and J).

EMF

As discussed in Section 3.3.3.2, evaluations of marine animal interactions with subsea cables have provided understanding that EMF produced by WECs and their subsea cables are in the magnitude of the sensitivity ranges of many marine animals; however, the ability to detect EMF does not necessarily translate to an effect or an impact on individuals, populations, or ecosystems (Normandeau et al. 2011, Gill et al. 2014). Most effects are assumed to be minor and limited to a close distance (meters), with the exception of elasmobranchs that are considered to be the most vulnerable because of their high sensitivity and use of EMF for important behaviors (e.g., prey detection) (Normandeau et al. 2011, Gill et al. 2014).

Recent studies have indicated that EMF from subsea cables has not affected fish (BOEM 2016, Kuhnz et al. 2011, Love et al. 2016, Kogan et al. 2006, see Section 3.3.3.2). Studies of unenergized and energized unburied subsea cables have found no differences in fish communities (BOEM 2016, Love et al. 2016). Although sturgeon can locate prey using electroreception and are more bottom-oriented, there is no compelling evidence that the EMF produced by energized power cables either attracts or repels electro-sensitive species including elasmobranchs (Love et al. 2016).

EMF emissions from the Project are expected to be minor and limited to the immediate vicinity of the cable. However, there is higher uncertainty about EMF emissions from WECs, which has not been measured. Potential effects of EMF on green sturgeon, ESA-listed salmonids, and eulachon are uncertain but could include minor indirect effects such as altered behavior and migration at the Project. However, all of the listed fish are highly mobile and migratory, and therefore exposure to EMF is unlikely due to the very small spatial scale of the Project relative to the area within which these species migrate and feed.

Measures would be taken at PacWave South to minimize and avoid exposure of marine animals to EMF; for example, subsea cables would be shielded, armored, and buried to minimize the amount of EMF exposure to marine animals. To manage uncertainties and understand the magnitude and extent of Project-related perturbations of the natural EMF background, OSU would implement the EMF Monitoring Plan under the Adaptive Management Framework (Appendices H and J, respectively) to detect and, if needed, mitigate any effects of Project-related EMF emissions (Appendix I).

Critical Habitat

As noted in Section 3.2.1, the primary constituent elements that are essential for the conservation of the North American green sturgeon, southern DPS in coastal marine areas are: migratory corridors that allow for the safe and timely passage between estuarine and marine habitats; water quality with adequate dissolved oxygen levels and acceptably low levels of contaminants; and adequate food resources including benthic invertebrates and fish. The primary constituent elements in estuarine habitats include migratory corridors, water quality, and adequate food resources, as well as a diversity of depths and adequate sediment quality (74 FR 52300). Potential stressors from the Project – habitat alteration, underwater sound, and EMF emissions – are not expected to adversely affect these primary constituent elements. As discussed above, the Project is not expected to affect green sturgeon movement. Water and sediment quality is not likely to be adversely affected because measures would be implemented to prevent the releases of hazardous materials and chemicals. Habitat alteration could affect prey resources of green sturgeon, mainly by providing habitat for reef-associated invertebrates and fish that could serve as prey resources for green sturgeon, but this would be a potentially beneficial, not adverse, effect. Any effect on the primary constituent elements in coastal marine areas would be minor or even negligible, even considering repeated disturbances over the life of the Project, given the small total footprint of the seafloor structures (about 2 acres) relative to the size of the marine portion of green sturgeon critical habitat (7.3 million acres). Even the total direct (Project components on the seafloor) and indirect disturbance (seafloor potentially affected by scour) surface area, which is anticipated to be approximately 21,214 ft^2 per anchor, results in only approximately 48 acres, or 3 percent of the total Project site being potentially affected during full build out (see Section 3.3.3.2, *Effects of Benthic Community from Project Structures*). The Project would not affect migratory corridors, depths or food resources in estuarine habitat. Therefore, the Project would not adversely affect any of these primary constituent elements and would not adversely modify critical habitat for green sturgeon.

Marine Reptiles

Green, loggerhead, and olive Ridley turtles have been observed in waters off the Oregon coast, but their presence is associated with unusual oceanic conditions (Henkel et al. 2014). Due to their rare occurrence near PacWave South, green, loggerhead, and olive Ridley turtles are unlikely to be exposed to Project effects. For the PacWave North Project, NMFS noted that leatherback sea turtles were not anticipated to forage or spend extended amounts of time in the Project area (NMFS 2012c), and OSU expects that the same is true for PacWave South. It should be noted that NMFS's conclusions for PacWave North were specific to a smaller project and a shorter deployment time. Nonetheless, OSU expects that the same is true for PacWave South, and this is corroborated by a satellite tracking study completed by Benson et al. (2011) that reported no use of the Project area or vicinity by leatherback sea turtles, rather most occurrences in Oregon waters were farther offshore or concentrated offshore of the mouth of the Columbia River.

Potential stressors that may affect marine turtles include underwater sound, collision or entanglement with submerged structures, and entanglement with debris (e.g., lost fishing gear) if it accumulates on surface or submerged structures, and toxic effects from accidental release of oil/toxic substances. This potential effect of toxic substances is covered in Section 3.3.2.2, and it was concluded that toxic substances are not expected to adversely affect any aquatic resources or marine life that could be in the Project area. Accidental release of oil or toxic substances is unlikely to occur because OSU will develop and implement an Emergency Response and Recovery Plan that includes spill prevention and control protocols to minimize the potential for and, if needed, respond to accidental release of oils and toxic chemicals into the marine environment.

Underwater Sound

Sound associated with vessels, cable laying, and continuous (non-impulsive) sounds from the WEC operations, could cause leatherback sea turtles to startle and move away from the Project area to the surrounding similar habitat. However, unlike marine mammals, sea turtles do not appear to vocalize or use sound for communication, but sound may be used to navigate, locate prey, avoid predators, and be important for general environmental awareness (Dow Piniak et al. 2012). Sea turtles, in general, appear to have a relatively narrow, low-frequency range of hearing sensitivity, and respond to low frequencies between 250 and 1,000 Hz (Bartol and Ketten 2006). Juvenile loggerhead sea turtles respond behaviorally to sounds in the low frequency range of 200-700 Hz (Lavendar et al. 2012), and leatherback sea turtles hatchlings respond to stimuli between 50 and 1,200 Hz, with maximum sensitivity at 100-400 Hz (Dow Piniak et al. 2012). Data are lacking regarding sea turtle response to continuous sounds, but it is assumed that sea turtles may exhibit avoidance behavior when exposed to high amplitude, low frequency sound (e.g., Lenhardt 1994, Bartol 2008, Popper et al. 2014). McCauley et al. (2000) did observations of sea turtles in cages and concluded that sound from airguns louder than 166 dB re 1 mPa RMS increased their swimming activity, and louder than 175 dB re 1m Pa RMS caused erratic behavior. They also estimated an alert behavior at a distance of 2 km from the sound source and escape behavior at a distance of 1 km. Other than installation of the cables using a dynamic positioning vessel (if used) over a period of about 30 days, Project activities are not expected to reach such sound levels, nor would they be impulsive sounds, but they could reach levels that result in minor behavioral responses (startle, avoidance), based on evidence from studies on the response to continuous sounds by fish (Popper et al. 2014). However, because leatherback sea turtles are rare in the action area, the likelihood of exposure to Project-related underwater sound is remote.

Effects or Risk of Collision/Entanglement

Leatherback sea turtles are expected to be rare in the Project area. Leatherback sea turtles also are unlikely to collide with WECs or mooring lines, because the WECs would be widely spaced (50 to 200 m or more apart), which would provide ample space for sea turtles to pass between the devices and associated mooring lines and umbilical cables, even if their maneuverability is reduced from being in colder water temperatures. Also, mooring lines and umbilical cables would have little slack and would not form loops, which could entangle turtles. There is a slight risk that turtles could be entangled in lost fishing gear caught on Project structures or mooring lines, but OSU would implement measures to detect and remove lost fishing gear to minimize this risk. Therefore, leatherback sea turtles are not expected to be exposed to collisions or entanglement.

Critical Habitat

NMFS identified one PCE essential to the conservation of leatherback sea turtles in marine waters of the U.S. West coast: occurrence of prey species of sufficient condition, distribution, diversity, and abundance to support individual as well as population growth, reproduction, and development (77 FR 4170). The proposed listing identified eight groups of activities that may have the potential to affect this PCE: pollution from point sources, runoff from agricultural pesticide use, oil spills, power plants, desalination plants, tidal energy projects, wave energy projects, and liquid natural gas projects (NMFS 2009b).

NMFS noted that possible impacts to features of the leatherback critical habitat include disturbance to their primary prey species, jellyfish, during the benthic polyp stage (77 FR 4170). Like most attached organisms, jellyfish polyps prefer to grow on hard substrates. It is therefore unlikely the Project site is habitat for the benthic stage of jellyfish. At PacWave North, OSU found little fouling of concrete block anchors deployed for over two years at the site, and therefore, it can be expected that the introduction of hard structure (e.g., anchors) at PacWave South would not provide substrate for polyps. Little effect on their prey is expected, although, it should be noted that NMFS's conclusions for PacWave North were specific to a shorter deployment time. As noted above, the disturbance to the seafloor by the Project would be short term and temporary, occurring during installation activities. Therefore, the Project would not affect leatherback prey species condition, distribution, diversity, or abundance.

Marine Mammals

As with the other aquatic animals discussed above, ESA-listed marine mammals in the Project area would potentially be exposed to underwater sound, collision or entanglement risk, EMF, and toxic effects from accidental release of oil/toxic substances. Marine mammals are not known to be adversely affected by EMF (NMFS 2012c), and are therefore unlikely to be affected by Project-related EMF emissions. The potential effect of toxic substances is covered in Section 3.3.2.2, and it was concluded that toxic substances are not expected to adversely affect any aquatic resources or marine life that could be in the Project area. Accidental release of oil or toxic substances is unlikely to occur because OSU will develop and implement an Emergency Response and Recovery Plan that includes spill prevention and control protocols to minimize the potential for and, if needed, respond to accidental release of oils and toxic chemicals into the marine environment.

Although sei and sperm whales have been observed off the coast of Oregon, they are associated with deeper water than the Project site and are unlikely to be exposed to Project effects.

To minimize effects to marine mammals, OSU would implement the following environmental measures and studies:

- Entangled fishing gear
    - Conduct opportunistic visual observations from the water surface in the portions of the test site which are being visited to conduct operations, maintenance, or environmental monitoring work and review any underwater visual monitoring conducted for other purposes to detect entangled fishing gear that has the potential to increase the risk of marine species entanglement. The licensee will ensure that surface observations occur during all visits to the Project test site, and at least once per quarter each year for the duration of the license (Appendix I).
    - Annually following the peak storm season and period of maximum activity for the Dungeness crab fishery, the licensee shall conduct surface surveys of active WEC berths during the spring season (mid-March through mid-June), or the earliest possible time after that period that avoids jeopardizing human safety, property or the environment.
    - Conduct annual subsurface surveys of moorings and anchor systems using ROV or other appropriate techniques with approval by NMFS concurrent with spring

(mid-March through mid-June) monitoring under the Organism Interactions Monitoring Plan (Appendix H).
    - If entangled fishing gear or marine mammal (or sea turtle) stranding, entanglements, impingements, injuries or mortalities are detected, implement the specified measures to minimize risk of marine mammal entanglement and to make every effort to return the fishing gear to the owners (Appendix I).
- Require vessels in transit to/from the Project site to avoid close contact with marine mammals and sea turtles and adhere to NMFS "Be Whale Wise" guidelines to minimize potential vessel impacts to marine mammals.
- Comply with current regulations that require marine mammal observers for certain vessel based activity (e.g., sub-bottom profiling).
- Require WEC testing clients to keep their equipment in good working order to minimize sound due to faulty or poorly maintained equipment.
- Implement the Acoustics Monitoring Plan (Appendix H) to quantify sound levels using field measurements and validated sound propagation models. Based on monitoring results, implement specified measures to mitigate for potential adverse effects (Appendix I).
- Minimize construction activities during key gray whale migration periods, to the extent possible.
- For use of DPVs or other equipment that may exceed NMFS's published threshold for injury
    - Avoid use of these vessels to the maximum extent practicable during Phase B gray whale migration (April 1-June 15). If these construction activities are proposed during this migration period, the licensee will consult with ODFW regarding the timing of such activities including cable-laying in state waters.
    - With technical assistance from NMFS, establish and carry out the following actions and protocols necessary to maintain an appropriate acoustic zone of influence in accordance with NMFS's published harassment threshold (120 dB re: 1 μPa) during DPV operations to minimize behavioral disturbance and protect marine resources
        - Post qualified marine mammal observers during daylight hours.
        - The licensee will conduct dynamic positioning (DP) activities during daylight hours when feasible to ensure observations may be carried out.
        - DP for cable laying may occur during all hours; however, DP start up for cable laying will only occur during daylight hours.
        - The licensee will carry out the ramp-up procedures that are specified in Appendix I, which may be modified by agreement of the licensee and NMFS.
    - Implement such additional measures as may be imposed pursuant to a Marine Mammal Protection Act authorization.

- Make opportunistic visual observations of pinnipeds in the portions of the test site which are being visited to conduct operations, maintenance, or environmental monitoring work. If pinnipeds are observed to be hauled out on Project structures, the licensee will follow the reporting and haulout protocols specified in Appendix I.
- To the extent practicable, direct the WEC testing clients to design and maintain cables and moorings in configurations that minimize the potential for marine mammal or sea turtle entrapment or entanglement and follow the reporting and haulout protocols specified in Appendix I.

Underwater Sound

The primary sources of Project-related underwater sound would be from vessels at PacWave South and transiting between Newport and the site during Project construction and WEC and mooring installation, maintenance, and removal; cable laying; and operation of the WECs. Most of the sound pressure produced by vessels during construction, monitoring, or maintenance activities would attenuate to below background levels a short distance from the vessel, and sound associated with vessels would be temporary and of short duration (NMFS 2012c). As described above, underwater noise levels of up to 180 dB RMS are expected within 1 meter of the dynamically positioned vessel that would be used for cable laying operations. ESA listed species of whales are not expected to occur within 1 meter of the dynamically positioned vessel and thus, no whales are expected to be exposed to injurious levels of underwater noise from the dynamically positioned vessel. None of the Project components or other activities are expected to generate sound at levels that could cause injury. However, the sound levels from vessels during installation and operation, from cable laying, dynamic positioning vessels, and from non-impulsive sounds produced by WECs over the 25-year operation of the test center is not expected to result in harassment of marine mammals (see Appendix N). Nearly all of the ambient sounds at PacWave North were reported at 84-117 dB RMS re:1 μPa (Haxel 2016), and 83-116 dB RMS at PacWave South (Haxel 2019). During higher sea states, both WEC and ambient noise levels would be expected to increase concurrently, likely resulting in partial or total masking of the WEC generated sound. OSU has proposed mitigation measures that are expected to minimize to discountable levels the risk that marine mammals would be exposed to sound exceeding 120 dB, and adverse effects are therefore not likely to occur.

Whales could be displaced from foraging in the Project area or from using it to move between foraging sites. However, the Project area is not known to be an important foraging area for any of the ESA-listed whales, with the possible exception of humpback whales where the Project site is 0.2% of the feeding Biologically Important Area, and there is similar habitat in the surrounding area that would serve as alternate foraging areas for these species if they are displaced. Any disruption or delay in foraging would be temporary and persist only as long as it took for the whale to swim away from the noisy area (under an hour).

Because of uncertainty associated with this new industry and in order to determine the actual sound levels emitted by WECs at the Project, OSU would implement the Acoustic Monitoring Plan (Appendix H) under the Adaptive Management Framework (Appendix J) to detect and, if needed, mitigate any effects of Project-related sound (Appendix I); therefore, project-related sound would not significantly impair essential life functions (i.e., foraging, migration, rearing), or impair the health, survivability, or reproduction of individual whales, and is therefore not expected to rise to levels constituting harassment.

Collision/Entanglement Risk

As discussed in the Section 3.3.3.2 and in the draft BA (Appendix A), Southern Resident killer whales use sonar for hunting and communication, and thus would likely be able to detect and avoid an array of WECs, even over the 25-year Project term. The large size of the WECs is expected to be readily perceived by an approaching humpback, blue or fin whale. Even though humpback whales may be common in the action area, the risk of a humpback whale colliding with a WEC, anchor, or mooring structure is expected to be low, as corroborated by similar projects (Sims 2016, Atlantic Marine Aquaculture Center 2008, NAVFAC 2014). The risk of a blue or fin whale colliding with a WEC, anchor, or mooring structure is expected to be very low because both species typically occur further offshore (Caretta et al. 2015) and in deeper water (Adams et al. 2014) in Oregon than where PacWave South would be located. In addition, whales are not known to collide or entangle with taut moorings, which would be used at PacWave South; whale entanglement appears to be associated with fishing gear such as crab pots (especially buoy lines) and lost nets. OSU would conduct opportunistic surface observations at least quarterly to detect and remove marine debris from the Project (Appendix I), review results of Organism Interactions Monitoring Plan (Appendix H) for lost fishing gear, and remove detected lost fishing gear to minimize potential risk of marine mammal entanglement.

Vessel strikes are so unlikely for any of the ESA-listed marine mammals as to be discountable. OSU would minimize the risk of Project-related vessels colliding with these species by requiring vessels to avoid close contact with marine mammals and sea turtles and adhere to NMFS “Be Whale Wise” guidelines. Potential non-strike encounters (e.g., a whale approaching a service vessel that is on site) are expected to be sporadic with transitory behavioral effects and therefore would be insignificant. The small footprint of the Project relative to the surrounding open ocean along the coastline also minimizes the likelihood of a collision occurring.

Birds

OSU would implement the Environmental Measures section as described in the Bird and Bat Conservation Strategy (Appendix B) to minimize impacts on seabird species, including species listed under the ESA. These are annotated below:

- Conduct opportunistic visual observations from the water surface in the portions of the test site, that are being visited to conduct operations, maintenance, or environmental monitoring work, and review any underwater visual monitoring conducted for other purposes, to detect derelict gear that has the potential to increase the risk of marine species entanglement. If monitoring shows that derelict gear has become entangled or collected on any Project structure, the risk that it poses will be assessed based on type of gear, and the derelict gear will be removed as soon as is practicable while avoiding jeopardizing human safety, property or the environment, as described in Appendix I.
- Conduct opportunistic visual observations in the portions of the WEC test site during vessel-based visits for operations, maintenance or environmental monitoring work, to detect and document any instances of seabird perching.
- Use low-intensity flashing lights and bird-friendly wavelengths on the Project structures to minimize seabird attraction and follow the specifications for Project lighting developed in consultation with the FWS and U.S. Coast Guard.
- Minimize lighting (e.g., use low intensity, bird-friendly wavelengths, shielded lighting not providing upward-pointing light or light directed at the sea surface) used at night by service and support vessels to reduce the potential for seabird attraction.
- Require vessel operators to follow FWS instructions regarding appropriate handling and release of seabirds in the event of seabird fallout.
- Require vessel operators to remain 500 feet away from seabird colonies during the nesting season to minimize disturbance to nesting seabirds.
- Develop and implement an Emergency Response and Recovery Plan (Appendix G).
- No HDD construction equipment or construction activities will occur on Driftwood Beach within suitable snowy plover nesting, roosting, or foraging habitat and is expected to be limited to the Driftwood Beach parking lot, at least 164 feet (50 meters) from any potentially suitable habitat.
- HDD operations in the parking lot will occur during daylight hours, but if lighting is required at night it will be appropriately shielded and directed to minimize artificial light reaching western snowy plover nesting habitat at night. Animal-proof litter receptacles and related signage and coordination will be provided to minimize potential attraction of predators.
- Develop and implement an HDD Contingency Plan to minimize the potential for inadvertent return of drilling fluids, provide timely detection, and address potential

releases by describing monitoring, containment, response and notification procedures to be implemented by the contractor.

- If HDD is initiated during the western snowy plover nesting season (March 15 to September 15), prior to operation of the HDD, surveys of suitable nesting habitat will be conducted. If nests are detected, measures specified in the BBCS will be implemented, including noise monitoring and implementation of engineering controls, if appropriate (e.g., install temporary noise barriers such as berms, stockpiles, dumpsters, bins, and/or engineered acoustical barriers). If lighting is required at the UCMF or construction site at night, it will be appropriately shielded and directed to minimize artificial light attraction and prevent potential injury or mortality to seabirds. To the maximum extent practicable, while allowing for the public safety, low intensity energy saving lighting (e.g., low pressure sodium lamps) will be used, and bright white light will be minimized to the maximum extent practicable.

In addition, the spacing of the WECs would likely be at least 50 to 200 m or more apart, which should provide ample space for seabirds to maneuver between them.

Marbled Murrelet

Potential effects of the Project on marbled murrelets would be similar to those that may occur for other alcids (see Section 3.3.3), such as collision with above-surface structures or submerged structures, entanglement with debris (e.g., lost fishing gear) if it accumulates at surface or underwater structures, attraction to operational lighting on service and supply vessels or navigational aid lighting on Project structures, sound and vibration emitted from the WECs during ordinary operation or during HDD, and fouling of feathers and toxic effects from accidental release of oil/toxic substances. Unlike other alcids, marbled murrelets fly between coastal/ocean habitat and inland nesting habitat in old growth forests (Miller et al. 2002), making them potentially susceptible to impacts from terrestrial construction activities as well.

<u>Effects or Risk of Collision/Entanglement</u> - Marbled murrelets are unlikely to collide with submerged structures, become in entangled in marine debris (e.g., lost fishing gear) if it accumulates at surface or on submerged structures, or become entrapped or crushed by moving parts, because pursuit-diving seabirds such as marbled murrelets are agile swimmers and have high underwater visual acuity (Henkel et al. 2014). Alcids are wing-propelled pursuit divers that swim rapidly (approximately 1 m per second) to pursue and capture mobile prey such as schooling fishes, and can veer, turn, and glide underwater (Johnsgard 1987); thus, it is expected that their vision and agility is adequate for navigating around submerged structures. Furthermore, OSU would implement monitoring to detect and remove marine debris from Project structures, which would minimize the potential for murrelets and other seabirds to become entangled in marine debris at the surface or submerged portions of WEC moorings.

Marbled murrelets reach peak densities at 300-1,000 m from shore and are rarely observed seaward beyond 4 km (Strong 2009), and were not observed at the test site during boat surveys conducted from May 2013 to October 2015 (a total of 44 cruises) in the Project area (Porquez 2016, Suryan and Porquez 2016). Therefore, presence of this species in the test site and exposure to risk of collision/entanglement from the WECs and Project structures would likely be rare and limited to few individual birds. An analysis of the potential effects on marbled murrelets at a proposed wave park 4.6 km offshore of Reedsport, Oregon, found a low likelihood of collisions with above-surface and submerged structures at the park due to the low density of marbled murrelets at that distance from shore, the spacing between the WECs (approximately 100 m apart), and the relatively small area encompassed by the WECs (Kropp 2013). Similarly, due to the expected low density of murrelets in the test site area, and the relatively small area of the submerged and above-surface structures (maximum of 20 WECs with a maximum height of 10-12 m above the water surface) compared to their available at-sea habitat, the likelihood of marbled murrelets encountering PacWave South and colliding with Project structures is very low. The spacing of WECs 50 to 200 m or more apart should provide ample space for marbled murrelets to maneuver between them, further reducing the potential for collisions.

Effects of Artificial Lighting - Phototactic seabirds have been shown to be highly attracted to artificial light in the marine environment; typical sources of light include boats, lighthouses, oil and gas platforms, coastal resorts, and commercial fishery operations. Continuous high-intensity white lighting is more likely to attract seabirds than lower-intensity, colored lights and those that flash at intervals (Montevecchi 2006, Poot et al. 2008). Nocturnal seabirds are most susceptible to light attraction in cloudy, foggy, or hazy conditions, in light rain, and when the moon is absent or obscured. Immature and nonbreeding nocturnal seabirds tend to be more attracted to light than breeding adults (Montevecchi 2006, Miles et al. 2010). However, the minimization measures including use of shielded, low-intensity flashing lights on the WECs, and minimizing nighttime vessel lighting during installation and maintenance activities would likely prevent attraction to artificial lighting and potential injury or mortality to murrelets. The potential effects on marbled murrelets from vessel lighting are expected to be short-term and intermittent, limited to installation of the WECs and during periodic maintenance and repair activities. For these reasons, there is little risk to marbled murrelets as a result of artificial lighting.

Effects of Underwater Sound - Underwater sounds generated by the Project may be similar to, or masked by, ambient underwater sounds in the Project area, which are reported to be higher than the typical deep ocean sound found in the northeast Pacific Ocean (Haxel et al. 2011), likely due to wave activity and existing vessel traffic. The presence of marbled murrelets in the test site area and exposure to underwater sound and vibration emitted by the WECs during ordinary operation would likely be rare and limited to few individual birds. Some birds could be exposed to underwater sound and vibration from service and support vessels in nearshore waters as they transit between Yaquina Bay and the test site, as a small number of birds (<10 total) were observed in this area during boat surveys conducted from May 2013 to October 2015 (Porquez 2016). Some birds could also be exposed to underwater sound and vibration emitted from HDD and the dynamic positioning thrusters during cable lay, as a small number of birds (<10) were observed in this area during boat surveys (Porquez 2016).

The threshold for underwater sounds to result in injury to marbled murrelets is 202 dB SEL (SAIC 2011), and 150 dB rms for behavioral effects such as flushing and avoidance of the area (FWS 2014b). None of the Project components or activities are expected to generate sound at levels that could cause injury to marbled murrelets. Underwater sound emitted by the WECs during ordinary operation is expected to be within the range of ambient sound levels, and thus is not expected to interfere with or disrupt normal behavior. Vessel sound throughout the life of the Project could cause short-term, temporary behavioral disturbances (i.e., minutes per trip) to marbled murrelets as the vessels transit through nearshore waters. During cable lay operations at the beginning of the Project, and during installation of individual WECs throughout the Project, sound from a vessel with dynamic positioning thrusters could also cause short-term, temporary behavioral disturbances. Because Project associated sounds would not result in injury or mortality and may only result in short-term temporary behavioral disturbances, there is little risk to individuals or the population of marbled murrelets as a result of exposure to sound and vibration from the Project.

Effects of Toxic Releases - Accidental release of oil or toxic substances is unlikely to occur because OSU will develop and implement an Emergency Response and Recovery Plan that includes spill prevention and control protocols to minimize the potential for and, if needed, respond to accidental release of oils and toxic chemicals into the marine environment.

Effects of Terrestrial Activities - The mixed conifer/deciduous forest in the terrestrial Project area does not contain suitable nesting habitat for marbled murrelets. However, murrelets could fly over or through the mixed conifer/deciduous forest in the terrestrial action area as they fly between at-sea and inland nesting habitats. However, they are unlikely to be affected by sound and human disturbance (e.g., movement of equipment and personnel) during construction activities given that these activities would occur in the Driftwood Beach State Recreation Site parking lot where disturbance from vehicles and human activity is already present, and at the UCMF, which is adjacent to Highway 101, and therefore near disturbance from vehicles and human activity. In addition, inland flights occur around sunrise and sunset, which is outside of the typical construction schedule. No effects to marbled murrelets are expected to occur as a result of terrestrial construction activities.

There is no proposed or designated critical habitat for marbled murrelets in the Project area, thus Project activities would have no effect on critical habitat for this species.

Short-tailed Albatross

Potential effects of the Project on short-tailed albatross would be similar to those that may occur for other seabirds (see 3.3.3), such as collision with above-surface structures of WECs, and fouling of feathers and toxic effects from accidental release of oil/toxic substances. This species is also attracted to boat activity (Hyrenbach 2001), so they could be attracted to Project-related service and support vessels, or possibly to WECs. However, attraction to boat activity or to WECs is not likely to result in any adverse effects such as increased energy expenditure, given their ability to fly short distances with little energy cost (Sachs et al. 2012), or collisions with vessels, given that vessel collision is not mentioned in the Recovery Plan as a threat to the species despite their frequent attraction to vessels (FWS 2008). Accidental release of oil or toxic substances and harm to short-tailed albatross is unlikely to occur because OSU will develop and implement an Emergency Response and Recovery Plan that includes spill prevention and control protocols to minimize the potential for and, if needed, respond to accidental release of oils and toxic chemicals into the marine environment.

Currently, short-tailed albatross are extremely rare along the Oregon coast; thus the species is unlikely to occur in the Project area. Therefore, effects on the species are considered unlikely in the short term. However, more short-tailed albatrosses may occur in Oregon waters in the future if the population of this species continues to increase, which could make individuals more likely to be affected by the Project.

If short-tailed albatross do become more common in Oregon waters in the future, the likelihood of albatrosses occurring in the test site and being affected by WECs or vessels is still very low. During boat surveys conducted from May 2013 to October 2015 (a total of 44 cruises), black-footed albatrosses (used as a proxy for short-tailed albatross due to similar habitat use) were primarily concentrated beyond 20 km from shore, westward of the test site (Porquez 2016, Suryan and Porquez 2016). If they did occur at the test site the likelihood of encountering Project structures would still be low due to the relatively small area of the above-surface structures (maximum of 20 WECs, maximum height of 10-12 m above the water surface) compared to their available at-sea habitat. Although albatrosses are known to fly altitudes of less than 30 m some of the time, they tend to fly at higher altitudes when wind speeds increase (Ainley et al. 2015), which would reduce their likelihood of collision with WECs at higher wind speeds. In lower wind speeds, when they are more likely to fly in the path of WECs, the lower wind speeds makes them more able to maneuver and avoid colliding with the structures. Additionally, the spacing of the WECs (50 to 200 m or more apart) should provide ample space for short-tailed albatrosses to maneuver between them. For these reasons, it is extremely unlikely that short-tailed albatrosses would be affected by the Project. There is no proposed or designated critical habitat for short-tailed albatross; thus, the Project would have no effect on critical habitat for this species.

Western Snowy Plover

Western snowy plovers could use the beach near the proposed cable landing site for nesting, wintering, foraging, and roosting. Western snowy plovers are known to occur on the sandy beaches along the central Oregon coast, and nesting was documented along the beach between the mouth of Alsea Bay to Seal Rock, to the south and the north of Driftwood Beach State Recreation Site in 2017 (L. Hillman, Oregon Parks and Recreation Department, pers. comm. 2017).

Snowy plovers that occur on the beach within the action area could potentially be affected by installation of the cables where they come ashore at Driftwood Beach State Recreation Site. Potential effects on plovers will largely or entirely be avoided by the use of HDD to install the cables from the onshore cable landing (beach manholes) at Driftwood Beach State Recreation Site parking lot, 50-100 ft under the beach and dunes, and beneath the seafloor to about the 10-m isobath, a distance of about 0.6 nautical miles. The onshore cable landing installation will occur over a period of 6 to 8 months. All activities and equipment associated with the onshore cable landing will be limited to the parking lot at least 150 ft from any potentially suitable nesting or foraging habitat (for reference, Oregon Parks and Recreation Department establishes a 164-foot radius roped buffer around plover nests [ICF International 2010a], and Oceano Dunes State Vehicular Recreation Area in California prohibits parking and camping within 100 ft of posted nesting areas [California State Parks 2017]). No HDD, equipment, personnel, or activities will occur on the beach; however, resource agency staff have raised concerns that human activity at the Driftwood Beach State Recreation Site parking lot associated with the Project could attract predators (e.g., common ravens) to anthropogenic food sources, and with inadvertent return of drilling fluid at the beach.

Anthropogenic food sources are unlikely to increase because it is anticipated that vehicular access to Driftwood Beach State Recreation Site to would be prohibited to the public during construction activities. The parking lot is a busy public access point to the beach; therefore, any snowy plovers that nest or forage on the nearby beach would likely already be habituated to human disturbance.

Human activity at the Driftwood Beach State Recreation Site parking lot associated with the Project construction could result in additional disturbance to nesting western snowy plovers, in the form of increased light at night, and the potential to increase risk of predation due to a anthropogenic food sources associated with poorly contained refuse or debris (because Driftwood Beach State Recreation Site is already used by visitors, food sources are already likely present, but construction at the parking lot could potentially introduce food sources). Operations at the parking lot are proposed during daylight hours, but if lighting is required at night it will be appropriately shielded and directed to minimize artificial light reaching western snowy plover nesting habitat at night. To minimize and mitigate for human debris and food waste, animal-proof litter receptacles will be provided to the Park, along with signage, to notify construction crews and visitors after construction is completed about the importance of litter removal to wildlife. Construction crews will receive guidance that includes the need to keep the parking lot and surrounding area clean of litter and food waste. For these reasons, there is little risk to individuals or the population of western snowy plovers as a result of terrestrial operations at the Driftwood Beach State Recreation Site.

Inadvertent return of drilling fluids would not affect nesting and foraging habitat for western snowy plover because the depth of boring operations at 50-100 ft below the dunes and beach should curtail the risk of inadvertent return of drilling fluids to the beach. Regardless, a HDD Contingency Plan will be developed to minimize the potential for inadvertent return of drilling fluids, provide timely detection, and address potential releases by describing monitoring, containment, response and notification procedures to be implemented by the contractor. The contingency plan will rely on beach access for containment response and monitoring, if necessary, to occur from existing vehicle access points such as Quail Street, approximately 1.32 miles north of the Driftwood Beach State Recreation Site.

The HDD rig is likely to be the loudest equipment used during operations from the Driftwood Beach State Recreation Site parking lot (Tetra Tech 2013). Sound emitted from the HDD rig is not likely to affect plovers on the beach because the HDD rig will be operated in the of the Driftwood Beach State Recreation Site parking lot at least 300 ft from any potential nesting or foraging habitat for snowy plovers. At a distance of 300 ft, and assuming no deflection or masking of the noise, the sound pressure levels of the HDD rig (the maximum sound pressure level of a HDD rig at 50 ft is estimated at 92 dBA [TetraTech 2012]) would be reduced by 40 percent to 76 dBA from the levels at the source. Blocking and deflection due to the elevational difference (Harmelink and Hajek 1973), estimated to be 40 ft, between plover habitat and the location of the HDD, and deflection and absorption due to dune vegetation (Huddart 1990, Fang and Ling 2003, van Renterghem et al. 2012, 2015) will further reduce HDD noise in plover habitat. Acoustic shadows created by temperature differences between the ground surface and near-ground atmosphere (West et al. 1989), late in the day, are expected to further ameliorate noise from the drill rig.

Masking of HDD noise is also expected to be substantial due to heavy surf and strong onshore winds. Auditory perception is dependent, in part, on filtering background noise: near-constant ambient noise is expected to largely or completely mask those associated with the HDD rig.

Surf contributes substantially to ambient noise (e.g., Cato 2012), and surf-generated noise scales roughly with the square of the wave height (Deane 2000). Bathymetry affects surf-generated noise, influencing source level densities as well as the sound spectra (Fabre and Wilson 1997). While these studies refer to the noise underwater due to breaking waves, these sounds are also audible on the beach, in air. Bolin and Åbom (2010) recorded sound pressure levels in air ranging from 60 dB at 0.4 m wave height to 78 dB at 2.0 m wave height in the Baltic Sea, and Tollefsen and Byrne (2011) recorded comparable levels across a similar range of surf heights. Ocean waves (i.e., not surf or breaking waves, *sensu* Bascom 1980) are regularly recorded offshore of the Project site (NDBC, Station 46098)[20] that suggest local surf conditions, and thus surf-generated noise, regularly exceed these levels. The average wave height at sea exceeds 2 meters offshore of the Project area and rarely falls below 1 meter, even in the summer; these wave heights translate to surf of comparable or greater size, depending largely on their period (Bascom 1980).

Wind-dependent noise is correlated with wind speed (Wenz 1962), and local wind conditions indicate that this is likely to be a substantial contributor to ambient noise. An average wind speed near 10 knots and the onshore direction of the prevailing winds[21] are expected to combine to further limit sound propagation from the HDD rig towards plover habitat (Tanaka and Shiraishi 2008, Oshima and Li 2013).

Thus, the sound pressure level of a HDD rig (Engineering Page 2017) diminishes rapidly with distance from the source, and these estimates are expected to be an overestimation due to strong onshore winds, elevational differences between the sound source and plover habitat, and the effects of intervening vegetation. Ambient noise from the surf zone and strong winds that are common along the coastline of Oregon is expected to be high, masking HDD rig noise in western snowy plover habitat. Ambient noise in the surf zone has not been measured at Driftwood Beach State Recreation Site; however, surf noise would be expected to exceed 60 dBA at wave heights above 1 m (Bolin and Åbom 2010, Tollefsen and Byrne 2011), and the surf at Driftwood Beach is expected to be considerably greater. Noise is considered significant if it increases background noise by more than 10 dBA above background (ICF International 2010b), and HDD noise levels within potential snowy plover habitat are unlikely to exceed this value. For these reasons, there is little risk to individuals or the population of western snowy plover as a result of onshore cable installation or due to sound from HDD.

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[20] National Data Buoy Center, Station 46098 – OOI Waldport Offshore, www.ndbc.noaa.gov, accessed March 24, 2018.

[21] Winds measured at Station NWPO3 off Newport, Oregon, http://www.ndbc.noaa.gov/view_climplot.php?station=nwpo3&meas=ws (accessed March 24, 2018)

If HDD occurs outside of the nesting season (September 16-March 14), but then extends into the nesting season, any western snowy plovers that initiate nesting near the parking lot while HDD is ongoing, are assumed to be undisturbed by the HDD, assuming there is no significant change in Project operations after nesting is initiated. However, if HDD is initiated within the nesting season (March 15-September 15), prior to operation of the HDD, surveys of suitable nesting habitat will be conducted within 600 ft of the HDD rig for signs of nesting western snowy plovers (eggs or chicks) following the *Western Snowy Plover Breeding Window Survey Protocol* (Elliott-Smith and Haig 2007). If no nests are detected, HDD can proceed. If nests are detected, then noise monitoring will be conducted to evaluate the sound levels within the nesting habitat. Noise monitoring includes evaluating existing ambient noise levels prior to start of HDD (7-14 days), during calm wind and ocean conditions (e.g., <10 mph winds, seas <1.5 m) and at windy, high wave conditions (e.g., >15 mph winds, seas >2 m). After HDD is initiated, additional sound monitoring may be conducted at calm conditions and windy, high wave conditions, 50 ft from the HDD rig (to determine if sound levels cited and analyzed in the BA, 92 dBA, are accurate), and at 300 ft from the HDD rig in snowy plover nesting habitat. If sound levels produced by the HDD rig are greater than 10 dBA above ambient conditions at 300 ft in either calm or windy conditions, then engineering controls will be implemented to minimize HDD-related operational noise (e.g., install temporary noise barriers such as berms, stockpiles, dumpsters, bins, and/or engineered acoustical barriers). Specialized panels that absorb and deflect sound when effectively positioned around noise generating areas are commercially available, and are advertised by some companies (e.g., http://www.drillingnoisecontrol.com/panels.html. The effectiveness of noise reducing measures will be tested upon deployment to verify that they reduce noise to less than 10 dBA above ambient conditions at 300 ft. For these reasons, there is little risk to individuals or the population of western snowy plovers as a result of onshore cable installation or due to sound from HDD.

There is no proposed or designated critical habitat for western snowy plover in the Project area, nor in Lincoln County; thus, the Project would have no effect on critical habitat for this species.

Northern Spotted Owl

Northern spotted owls could occur in the mixed conifer/deciduous forest in the terrestrial portion of the Project, although it would be unlikely given that the surrounding forest is fairly fragmented due to housing developments and timber harvesting. The terrestrial cable would be installed from the Driftwood Beach State Recreation Site to the UCMF using HDD, thereby negating potential impacts from installation of the terrestrial cable. There is no critical habitat for northern spotted owls in the Project area; thus, the Project would have no effect on critical habitat for this species.

Essential Fish Habitat

Potential effects to EFH may include 1) changes in the marine and freshwater fish and invertebrate communities, 2) changes to predator/-prey interactions, 3) EMF effects, and 4) the effects of underwater sound/vibration. However, as described above and in section 3.3.3.2, OSU anticipates that the Project would have only minor and localized effects on the local marine and freshwater fish and invertebrate communities and thus on EFH.

As detailed in Section 3.3.3.2 (*Effects on Benthic Community from Project Structure*), the installation of the subsea cables, subsea connectors, and anchors would result in both temporary and long-term alteration of benthic habitat in the Project area, potentially affecting groundfish EFH. Suction caisson, embedment, and plate anchors, if used, would be placed into and under the seafloor, and therefore would have no footprint on the seafloor other than the mooring line extending from the anchor under the seafloor up to the WEC. The maximum footprint of the other types of anchors would be 19,068 ft^2 (0.4 acres) for the initial development and 90,800 ft^2 (2 acres) for the full build out (Table 2-1), which is approximately 0.1 percent of the total Project site surface area (1,695 acres). The estimates are based on exclusive use of large 34-ft-diameter gravity anchors; however, other types of smaller anchors will likely be used for some of the WECs, and shared anchors may be used for some WECs when feasible, so the actual seafloor footprint is expected to be considerably smaller than these estimates. Once an anchor is removed, the local benthic habitat would likely return to normal within months.

Installation of the buried portions of the four subsea cables and single auxiliary cable (from the offshore test site to the seaward end of the HDD bores) by jet plow in individual trenches would result in a temporary disturbance of the sand bottom and could displace or cover benthic and infaunal organisms.

Mobile invertebrates (e.g., crabs), fish species that feed on or near the bottom (e.g., green sturgeon), and species that shelter on the bottom at times would likely move away from the immediate vicinity of the anchors and cable and move to nearby areas during deployment and removal activities (Roegner and Fields 2015). While these activities would result in short-term benthic habitat disturbance, benthic fauna (e.g., polychaetes, clams, and amphipods) that inhabit the area are likely to be adapted to dynamic ecosystems and likely would be unaffected by sediment burial. The total area of benthic habitat disturbed at the test site would be very small relative to the range of and available marine habitat and prey for EFH fishes, and minor in comparison to surrounding available habitat (about 0.1 percent of the Project area [2 acres] for direct effects to the seafloor from the maximum footprint of the anchors and about 3 percent [48 acres] of the Project area for indirect effects [scour] to the seafloor at full build out). Effects at PacWave South are expected to be minimized given that anchor installation/removal is not likely to occur more than once a year in a berth and anchors may be deployed for multi-year periods.

Effects of habitat alteration associated with the presence of these Project components would be insignificant, due to the relatively small Project footprint and prevalence of unconsolidated sand habitat offshore of Oregon.

Fish would likely avoid the Project area during construction activities, moving to abundant similar habitat that is adjacent to the Project area. During the scoping process, PFMC raised concerns on impacts the Project may have on Seal Rock Reef, specifically along the habitat interfaces where fish species often congregate. PMFC suggested that the subsea cable route avoid rocky reef habitat, canopy kelp, and seagrass HAPCs. OSU has addressed this concern by selecting the cable route to avoid reefs and other hard substrate to the greatest extent possible. Therefore, the Project would not affect HAPC, including Seal Rock Reef or the associated habitat interfaces where fish congregate.

As detailed in Section 3.3.3.2 (*Changes in the Presence of Biofouling Species, Species Interactions, and Predator-Prey Interactions*), the introduction of Project-related structures could result in localized habitat changes as the hard structures are colonized ("biofouled") by algae and invertebrates, such as barnacles, mussels, bryozoans, corals, tunicates, and tube-dwelling worms and crustaceans, termed "biofouling" (Boehlert et al. 2008). Project structures at or near the bottom (e.g., anchors) may also act as an artificial reef and provide habitat for structure-oriented fishes, such as rockfish (Danner et al. 1994, Love and Yoklavich 2006, Kramer et al. 2015), potentially affecting groundfish EFH. Attraction to Project structures could alter the fish species composition in and around the Project area, and may also affect predator/prey interactions (Wilhelmsson and Langhamer 2014). Some fish are also known to associate with or aggregate at floating objects (Castro et al. 2002, Nelson 2003), so Project structures in the water column and at the surface (e.g., WECs, marker buoys and mooring lines) and any associated biofouling could act as FADs and attract pelagic fishes through visual and/or olfactory cues (Dempster and Kingsford 2003), potentially affecting coastal pelagic EFH.

Fish attracted to Project components on the seafloor (e.g., anchors) could include the deep rocky reef (>25 m depth) associated fish species and groundfish EFH. The Project structures could provide additional habitat, enhanced forage opportunities, or expose some of these fish species to increased predation by predatory fishes, seabirds, or marine mammals. However, most of these reef fish species are also known to occur at the bottom and midwater structures of oil platforms offshore of southern and central California (Casselle et al. 2002, Love et al. 2010), and negative population-level effects on reef-associated species at these oil platforms have not been reported. In fact, the oil platforms contribute to rockfish productivity and have some of the highest secondary production per unit area of any marine habitat studied globally (Claisse et al. 2014). The Project would not be expected to have a population-level impact on rocky reef fishes due to the small overall footprint and low density of WECs;

moreover, the offshore oil platform studies suggest that artificial structure does not negatively affect rocky reef fishes.

Typical FAD-associated fish species are tropical or subtropical, and do not occur in the Project area. In temperate ocean waters of California, Oregon, and Washington, fish associations with midwater and surface structures were generally limited to some species of pelagic juvenile rockfish, which have been reported at various structures such as attached kelp (Matthews 1985, Bodkin 1986, Gallagher and Heppell 2010), floating kelp (Mitchell and Hunter 1970, Boehlert 1977), oil platforms (Love et al. 2010, 2012), vertical structures of docks and pilings (Gallagher and Heppell 2010), and "SMURFs" (Ammann 2004, Caselle et al. 2010, Woodson et al. 2012, Jones and Mulligan 2014). None of the studies of fish assemblages at these structures reported juvenile or adult salmonids. Due to the small Project footprint and low likelihood a FAD effect (as discussed above), the proposed action is not expected to have an adverse effect on EFH for coastal pelagic, salmon groundfish or highly migratory species.

As detailed in Section 3.3.3.2 (*Effects of Underwater Sound/Vibration on Fish*), temporary sound associated with Project construction and operations (i.e., WEC installation, maintenance, and removal), as well as the WECs themselves during operation, would generate underwater sound that could potentially affect EFH for groundfish, salmon, coastal pelagics, and highly migratory species. Measurements taken at PacWave North indicate ambient underwater SPLs between 84 to 117 dB RMS re:1 µPa, with a mean level of 101 dB RMS re:1 µPa, and at PacWave South ambient underwater SPLs were between 83 and 116 dB RMS re:1 µPa, with 50th percentile of 101 dB RMS re:1 µPa (Haxel 2019). Sound from vessel types that would be used for Project installation, operations and maintenance would not exceed 130 to 160 dB (re: 1 µPa) over a frequency range of 20 Hz to 10 kHz, except for the dynamic positioning cable laying vessel, which could create sound levels of 180 dB re:1 µPa at 1 m (NMFS 2015).

It is expected that a low level of additional sound could be produced by the WECs based on measurements taken at existing WECs deployments. The maximum SPL for Columbia Power Technologies' 1/7-scale WEC was estimated at 146 dB re: 1 µPa at 1 m, and 126 dB re: 1 µPa at 10 m (Thomson et al. 2012, as cited in NAVFAC 2014). In the EA prepared for the Hawaii Wave Energy Test Site, engineers conservatively assumed that a full-sized WEC would be 3-6 dB louder than the 1/7 scale version, and estimated that the maximum SPL for a WEC would be 148-151 dB re: 1 µPa at 1 m (NAVFAC 2014). Other analysis suggests that WECs would result in sound only in the range of 75 to 80 dB, with somewhat higher frequencies than light- to normal-density shipping sound (Sound & Sea Technology 2002 cited in Department of the Navy 2003). Per NMFS request, to be conservative a source term of 151 dB re: 1 µPa at 1 m was used in this analysis. Implementing NMFS practical spreading model with the highest WEC sound source term, sound levels of WECs would attenuate to 120 dB re: 1 µPa at 125 m. OSU would implement the Acoustic Monitoring Plan (Appendix H) under the Adaptive Management

Framework (Appendix J) to detect and, if needed, mitigate any effects of Project-related sound (Appendix I). Therefore, acoustic emissions from Project vessels and WECs are unlikely to adversely affect EFH.

As detailed in Section 3.3.3.2 (*Effects of EMF Emissions on Species Sensitive to Electric and Magnetic Fields*), the subsea cables, umbilicals, subsea connectors, and WECs would produce EMF that could potentially affect EFH for highly migratory species, coastal pelagics, groundfish, and salmon. As described above, studies on EMF from subsea cables observed little or no behavior change in fish, or effects on species composition, or attraction or repulsion by electro-sensitive species (BOEM 2016, Kuhnz et al. 2011, Love et al. 2016, Kogan et al. 2006), and similar responses are expected at PacWave South. In addition, the levels of EMF are expected to be low and would be minimized through armoring and subsea cable shielding and burial. Because the cables would be buried 1-2 m (3-6 ft) below the seafloor, the physical separation will greatly reduce the amount of EMF exposure to marine animals (around 80 percent [Normandeau et al. 2011]). The magnetic field at the seafloor by would be expected to reach ambient conditions about 2 m above the seafloor (Normandeau et al. 2011, Bull 2015, Gill 2015). To manage uncertainties and understand the magnitude and extent of Project-related EMF emissions relative to the natural EMF background, OSU would implement the EMF Monitoring Plan under the Adaptive Management Framework (Appendices H and J, respectively) to detect and, if needed, mitigate any effects of Project-related EMF emissions (NNMREC 2015b). Consequently, EMF emissions from the Project are not expected to adversely affect EFH.

As detailed in Section 3.3.3.2 (*Effects on Freshwater Fish in Surface Streams*), the terrestrial cable would be installed via HDD; therefore, avoiding impacts to EFH located in stream. Potential effects to EFH in surface waterbodies in the Project area could occur from the release of potential hazardous materials from the construction equipment itself (lubricating oils and fuel) or inadvertent returns of drilling fluids to a waterway from HDD operations. However, there are only three fish-bearing stream in the Project area, which will be avoided entirely. The depth of boring operations will be designed so that the engineers determine there is a low risk of inadvertent return of drilling fluids and an HDD Contingency Plan will be developed to minimize the potential for inadvertent return of drilling fluids, provide timely detection, and address potential releases by describing monitoring, containment, response and notification procedures to be implemented by the contractor. Therefore, terrestrial construction activities are not expected to adversely affect EFH.

3.3.5.3 Cumulative Impacts

Past and on-going uses of the Project area, such as commercial fishing, dredge material disposal, testing of WECs at PacWave North, development and operation of the Camp Rilea Ocean Renewable Energy Project, and the OOI Project may have a small negative cumulative effect on federally listed species, designated critical habitat, and EFH. As described above, PacWave South would affect a relatively small area of the OCS and avoid areas of HAPCs. Therefore, the Proposed Action would result in insignificant or discountable impacts to threatened and endangered species, and EFH, and it would not result in the destruction or adverse modification of critical habitat for Southern DPS North American green sturgeon and leatherback sea turtle, the two species for which critical habitat has been designated within the Project area.

NMFS (2010) identified actions to improve the potential for recovery of green sturgeon, including determining if EMF produced by offshore energy projects alters green sturgeon migration patterns. The migration of green sturgeon from spawning habitats in California along the coast to overwintering grounds off British Columbia has been documented (Lindley et al. 2008) and recent observations of tagged green sturgeon off the Oregon Coast both at Reedsport and PacWave South and PacWave North, indicate that some individual sturgeon migrate quickly whereas other individuals can remain in an area for longer periods of time (Payne et al. 2015, Henkel 2017). A concern is that green sturgeon migration rate (speed of migration) could be delayed by EMF emitted from subsea cables that transmit power from multiple offshore wave and wind projects to the coast, because these cables cross green sturgeon migration corridors as well as designated critical habitat. PacWave South would be the first grid-connected wave energy project on the West Coast, although Camp Rilea would require cables to transmit power from offshore WECs to shore. In addition, scientific research projects such as the Ocean Observatory Initiative's Endurance Array off Oregon also requires cable to transmit data to shore and to transmit power to the nodes. When NMFS designated critical habitat for green sturgeon in 2009 (74 FR 52300), all proposed "alternative energy hydrokinetic projects" in coastal marine waters within 60 fathom (about 109 m) depth were considered, and all those projects have been abandoned. The effect on migration from four projects off Oregon is unlikely to significantly delay migration of green sturgeon to overwintering habitats to the north or return migration south to spawning habitats in California because EMF from subsea cables has not been shown to affect marine life (BOEM 2016).

The terrestrial cable would be installed using HDD from the Driftwood Beach State Recreation Site to the UCMF, which would avoid cumulative impacts to EFH in surface waterbodies in the Project area. There are only three fish-bearing stream identified in the Project area, which will be avoided entirely. EFH would be protected during construction due to use of HDD to install the terrestrial cable and implementation of other BMPs (e.g., implementing and Erosion and Sedimenatation Control Plan).

3.3.6 Recreation, Ocean Use and Land Use

3.3.6.1 Affected Environment

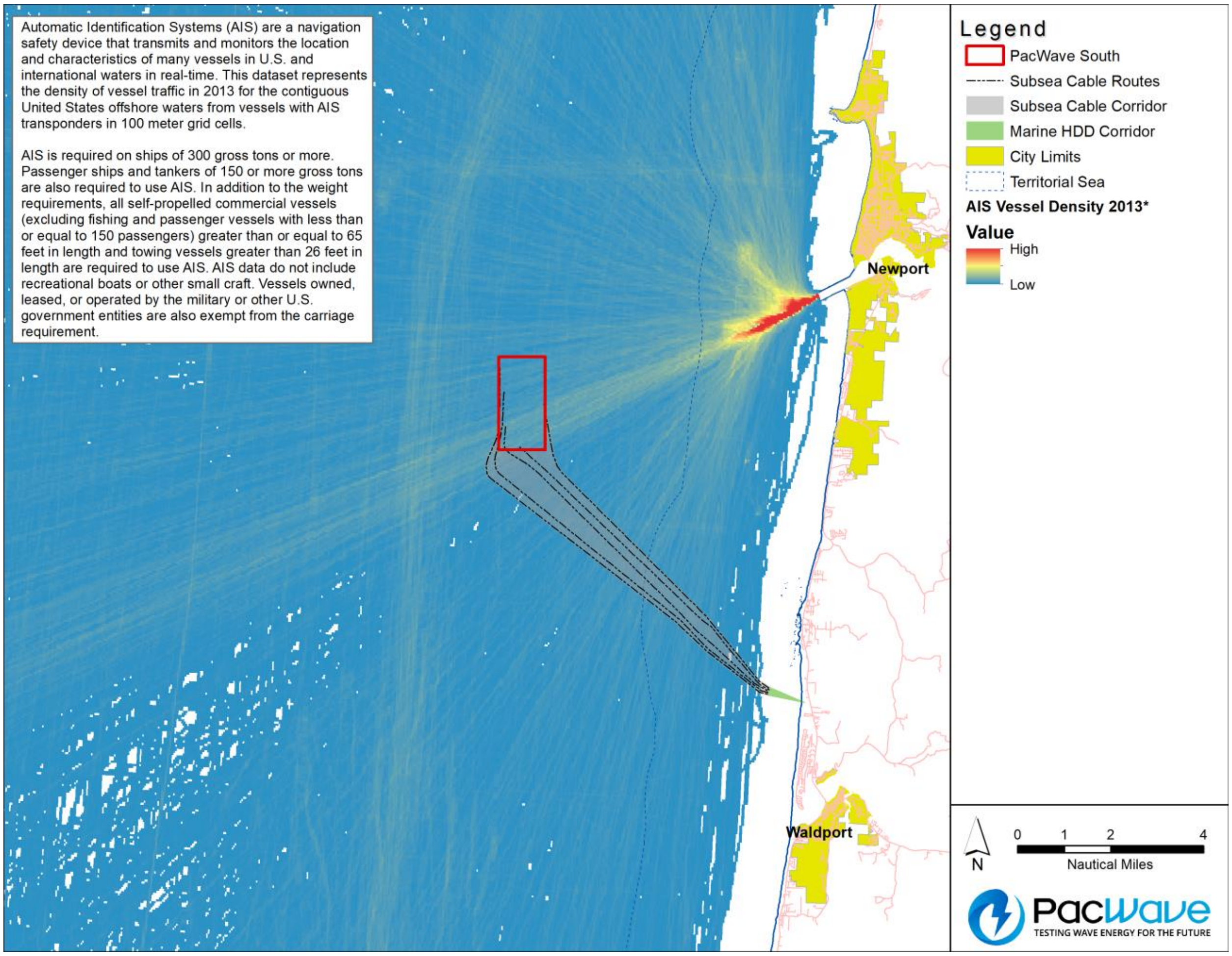
Commercial and sport fishing, fish processing, shipping, tourism, recreation, and lumber and wood processing are major industries in this area (Oregon Public Ports Association 2014). Below, the following primary uses of the Project area are discussed:

- Navigation;
- Commercial fishing;
- Recreation; and
- Land use.

Navigation

Waters in the vicinity of the Project are used by a variety of recreational, charter, and commercial boats. Vessel traffic is often concentrated near the mouth of the Yaquina River and near the Port of Newport (Figure 3-12). The Yaquina River supports commercial traffic, primarily fishing vessels, research vessels from NOAA and OSU, and occasional lumber cargo vessels. To avoid conflicts between commercial crab fishermen and ocean going tugs that are towing barges, the Washington Sea Grant program helped broker an agreement that provided navigable towboat and barge lanes through the crabbing grounds between Cape Flattery and San Francisco. Based on the Washington Sea Grant Tow Lane Charts, PacWave South would be located in the southern corner of the existing tow lane off the coast of Newport; however, OSU has been working with the crabbers and tow boat operators and has secured a provisional agreement to adjust the tow lanes so they avoid PacWave South.

The USACE maintains the Yaquina Bay federal navigation channel to federally authorized depths by periodically removing naturally occurring sedimentary material. Material removed from this area has been placed at one of the two USACE designated Ocean Dredged Material Disposal Sites (North and South) located off the coast of Newport in the Yaquina Bay area (USACE 2012). The Ocean Dredged Material Disposal Sites are located about 6 nautical miles northeast of PacWave South and about 10 nautical miles north of the subsea cable route.



Source: NOAA Office of Coastal Management, available via the Marine Cadastre (www.MarineCadastre.gov).

Figure 3-12. Vessel traffic in PacWave South and vicinity.

Commercial Fishing

The Port of Newport is one of 23 port districts established by the state of Oregon (FCS Group 2014). The natural harbor of Yaquina Bay provides a protected haven for commercial fishing vessels, and the Port provides a number of support facilities for the local fleet and the locally-based distant water fleet (commercial fishing boats that spend much of the year in waters off the coast of Alaska), including moorage, space for suppliers and services, fuel, and other essentials. The Port also leases space to seafood processors (FCS Group 2014).

The North Shore Development Area of the Port is Newport's working waterfront, which includes a 214-slip marina that is used primarily by commercial fishermen and the Newport-based distant water fleet (Port of Newport 2013). In addition to these and other amenities, there is over 240 feet of floating moorage for boat maintenance, and a 220-foot fixed moorage that contains four hoists of varying capacities, enabling vessels to perform gear changes, off-load fish product, and do other maintenance or repair work (Port of Newport 2013).

In 2000, the most recent year for which data are available, 393 commercially registered vessels (residents and non-residents) delivered landings to Newport. The vessels participated in the following fisheries: 17 in the coastal pelagic fishery, 99 in the crab fishery, 179 in the groundfish fishery, 180 in the highly migratory species fishery, 181 in the salmon fishery, 2 in the shellfish fishery, 38 in the shrimp industry, and 106 in other fisheries (NOAA 2007). (Note: some vessels participate in multiple fisheries.)

In 2000, Newport residents owned 90 commercial vessels, which participated in the following fisheries: one in the coastal pelagic fishery, 35 in the crab fishery, one in the highly migratory species fishery, 56 in the salmon fishery, 11 in the shellfish fishery, 37 in the shrimp fishery, and 41 in other fisheries (NOAA 2007). In 2018, about 124.8 million pounds of commercially harvested fish and shellfish were processed at the Port in Newport, equating to over $62.4 million dollars. The highest landings were for hake, rockfish, pink shrimp, Dungeness crab, sablefish, flatfish, albacore tuna, Chinook salmon, and hagfish: hake accounted for approximately 66 percent of the total landings with an estimated worth of $7.2 million dollars, followed by pink shrimp, which accounted for approximately 9 percent of the total landing and an estimated worth of $8.8 million dollars (ODFW 2019).

Commercially important species are caught with a variety of techniques, such as traps (e.g., Dungeness crab), long-lines (e.g., sablefish), pole-and-line (e.g., albacore tuna), trolling (salmon) and trawling at different locations within the water column (e.g., mid-water trawls for Pacific whiting and bottom trawls for groundfish species). While some species are landed only seasonally (e.g., albacore tuna, salmon), others are landed fairly consistently throughout the year (e.g., shortspine thornyhead; ODFW 2017). There has been a developing commercial purse seine fishery for market squid off coastal Oregon, with landings in recent years in Newport (ODFW 2019).

Recreation

In a statewide survey, Lincoln County ranked as the most visited county for "non-consumptive ocean recreation" in Oregon (Surfrider Foundation et al. 2011). In 2010, Oregon residents took an estimated 27 million trips to the coast, 88 percent for recreation. A random sample of 4,000 residents found that over 80 percent had visited the Oregon coast at least once in the past 12 months. The most popular activities were shore-based. Wildlife viewing activities such as exploring tide pools and going on whale watching tours were popular with nearly a third of respondents. Ocean-based activities such as surfing, kayaking, and boating had been conducted by two to eight percent of respondents. Participation in these activities appears to be increasing (Dean Runyan Associates 2016, Surfrider Foundation et al. 2011).

Seal Rock is a popular vacation destination with a 5-mile stretch of beach along Oregon's scenic Pacific Coast Highway (Greater Newport Chamber of Commerce 2009). Seal Rock State Park provides access to tide pools as well as ocean views and a sandy beach. In Seal Rock, the viewpoint known by the residents as Elephant Rock is a large landmark formed by seismic activity in the 1700s, and is a popular spot for onlookers to view wildlife and coastal storms. Rocks located off the coast of Seal Rock are part of the Oregon Islands National Wildlife Refuge (FWS 2014c). Another popular recreational site in Seal Rock is Quail Street Beach, which is a relatively secluded beach with tide pools and other unique features.

The Driftwood Beach State Recreation Site is located about 2 miles south of the village of Seal Rock between Highway 101 and the ocean. It is known for its accumulation of driftwood that has washed up during heavy surf, and sand sculptures formed by strong winds and waves. The park is approximately 29 acres and offers beach access as well as picnicking and fishing opportunities. It is open year round and annual day use attendance of the park is estimated to be approximately 145,500 (Oregon Parks and Recreation Department 2014). OPRD and NPS have indicated that a portion of the Driftwood Beach State Recreation Site is subject to the requirements of 6(f) of the Land and Water Conservation Fund Act (LWCF). Section 6(f) of the LWCF contains provisions to protect Federal investments and the quality of the assisted resources. Any site that has been acquired, developed, or improved with funds from the LWCF grant program must be open to the public and maintained for public outdoor recreation (OPRD 2018). Where a non-recreation, non-public use will temporarily or permanently "convert" LWCF Section 6(f) park land, the state is required to consult with NPS, evaluate the resource impacts associated with the loss of public park and recreation opportunities and, if deemed necessary, provide replacement park land and recreation opportunities. OSU is currently coordinating with OPRD and NPS regarding the impacts of the Project on the LWCR Section 6(f) park land and the appropriate mitigation to satisfy the requirements of LWCF Section 6(f)(3). Figure 3-13 shows coastal beach access sites and Oregon State Parks in the vicinity of the Project area.

Popular marine recreational activities in the area include fishing, swimming, surfing, boating, and whale watching. Sport fishing occurs in rivers, estuaries, and off shore areas throughout the Oregon coast by various trip types, including by shore, pier, small craft, and charter boat. Over the last decade, the State of Oregon has had a highly significant decline in the number of boat registrations and use days, which is consistent with the national trend. While recreational vessel registrations have declined in the State, the charter industry has shown steady growth over the same period. The Central Oregon Coast hosts over 22 percent of fishing guides in the state. In 2008, there were 15 charter vessels operating out of Newport (FINE 2008). Typically, charters operate year-round, weather permitting, with most of their business generated during from May to September.

In the City of Newport, which is located approximately 10 miles north of Seal Rock, marinas provide boat slips, fuel docks, boat ramps, parking, and a boat wash areas (FCS Group 2014). On average, 9,500 recreational fishing boats were launched per year at the Port of Newport from 2005 to 2007 (FINE 2008). In the City of Waldport, which is 8 miles south of Seal Rock, the Port of Alsea Marina includes a public boat ramp and 25 moorage slips. The Oregon Marine Board estimates that there were 13,782 boating related trips in the Alsea Bay and Alsea River during 2011 (FCS Group 2014).

The recreational fishery targets primarily five species or species groups in ocean waters off the coast of Lincoln County; these include salmon, groundfish, Dungeness crab, albacore tuna, and halibut (FINE 2008). Coho salmon fishing was traditionally the backbone of the recreational fishery off of Lincoln County, which changed in the 1980s when restrictive harvesting regulations were placed on the fishery. Accordingly, the salmon fishery began to focus primarily on the Chinook salmon rather than coho salmon. The majority of Chinook salmon are caught from May to mid-September outside of state waters.

Groundfish, Pacific halibut, and albacore tuna became more popular recreationally as restrictions were imposed on other species. There is a major recreational groundfish fishery located about 3 miles off of Lincoln County. Interest in recreational fishing for halibut has been growing (FINE 2008).

Land Use

Land ownership in Lincoln County includes areas managed by federal and state agencies, local municipalities, and private entities. Figure 3-13 shows land ownership in the Project area. The Lincoln County Department of Planning and Development is responsible for the administration of land use planning, which is administered through the locally adopted comprehensive land use plan. Along the coastline of Seal Rock, the land is zoned for residential and public facility uses. Driftwood Beach State Recreation Site is identified as a public facility surrounded by lands designated for rural residential uses. The terrestrial portion of the Project area in Driftwood Beach State Recreation Site is a state park administered by the Oregon Parks and Recreation Department in the state of Oregon. Land surrounding the Driftwood Beach State Recreation Site is owned by private entities.

Jurisdiction over the ocean is shared by state and federal governments. The state owns the ocean floor from shore to 3 nautical miles (the Territorial Sea). The federal government owns the seafloor, resources, and uses across the continental shelf and slope beyond the Territorial Sea. Oregon asserts its interests, but not ownership, in ocean resources in this area (Oregon DLCD 2001).

In Oregon, the public owns the beach up to the ordinary high tide line, but any beach above that is usually part of the adjoining upland property owner. Regardless, the public has a perpetual easement to use the dry sand beaches (even those privately owned) up to the statutory vegetation line or the line of established upland shore vegetation, whichever is more inland. This is set out in the Oregon Beach Bill, which guarantees the public unobstructed use of dry sand beaches, even those that are privately owned. The public rights under the beach bill are managed and protected by the OPRD. The OPRD is responsible for managing and making permitting decisions for activities and improvements on the ocean shore. The DSL shares jurisdiction over beaches in managing the beds and banks of state waters and is responsible for managing the seafloor within 3 nautical miles of the shoreline (Oregon DLCD 2001). Figure 3-13 shows public access to the shore in the Project area.

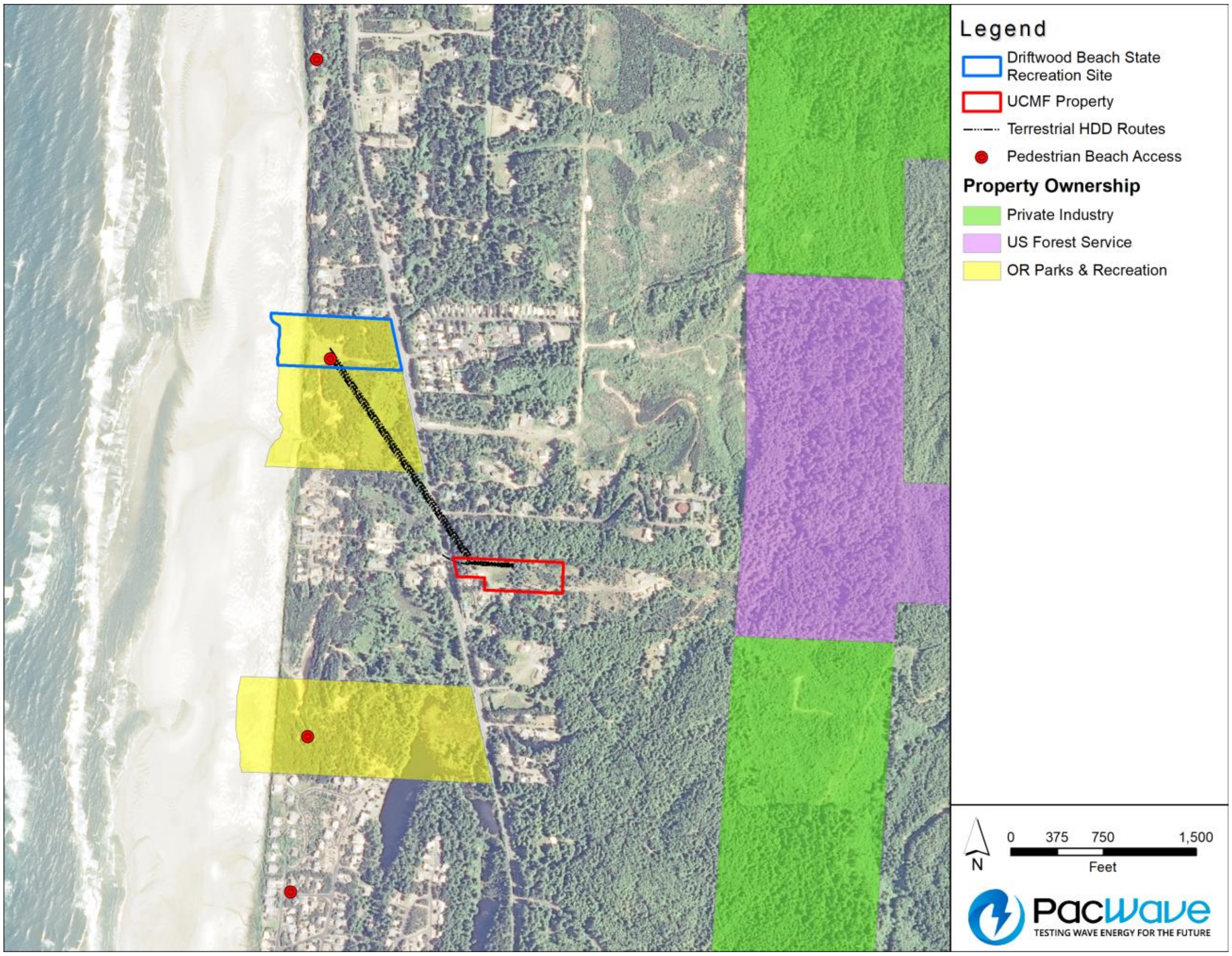


Figure 3-13. Land ownership and coastal access sites in the vicinity of PacWave South.

3.3.6.2 Environmental Impacts Related to Recreation, Ocean Use, and Land Use

This section evaluates the following potential effects on recreation and land use:

- Effects to navigation;
- Effects to commercial and recreational crabbing and fishing;
- Effects of Project land-based structures and facilities on recreational qualities and uses of state park lands; and
- Effects of recovery/clean-up activities associated with spills or other emergencies on coastal recreation.

OSU proposes to construct and operate the Project with the following environmental measures to avoid and minimize potential impacts.

Ocean Use and Recreation

- Mark Project structures with appropriate navigation aids, as required by the USCG.
- Avoid, to the extent practicable, anchoring in areas known to contain hard substrate or rocky reef habitats as identified by available seafloor mapping.
- Conduct outreach to inform mariners of Project structures or activities to be avoided in the area (e.g., Notice to Mariners, flyers posted at marinas and docks).
- Install subsurface floats at sufficient depth to avoid potential vessel strike.
- Work cooperatively with commercial, charter and recreational fishing entities and interests to avoid and minimize potential space-use conflicts with commercial and recreational interests during construction and operation.
- Bury submarine cables 1 to 2 m deep where feasible to minimize interactions with fishing gear and anchors.

Terrestrial Use and Recreation

- Use HDD to install the terrestrial cable conduits directly from the Driftwood site to the UCMF, and from the UCMF to the Highway 101 grid connection point, thus minimizing effects to adjacent landowners and traffic along Highway 101.
- If acceptable to OPRD, develop and install an interpretive display describing PacWave South in the Driftwood Beach State Recreation Site. OSU would work with OPRD to develop a plan regarding the interpretive display.
- Comply with all state and local permitting requirements for all construction work.
- Use construction fencing to isolate work areas from park lands.
- Although non-project related vehicular access to the Driftwood Beach State Recreation Site would be prohibited during construction, OSU would arrange the construction work

area to maintain pedestrian public beach access, to the extent safe and practicable and with concurrence of OPRD. OSU would coordinate with the OPRD to mitigate impacts to public access and use of Driftwood Beach State Recreation Site.

- Construction work areas or staging areas should be sited on other disturbed areas if practicable.

Effects to Navigation

No navigational closures are anticipated for the Project (i.e., no exclusion zones). However, the Project would increase the volume of marine traffic (e.g., construction and maintenance vessels), which in turn, could present navigation hazards to other users. A number of vessels, including tugs, installation vessels, and other workboats would be employed during construction, maintenance, and removal of the Project. This would require multiple trips from the Newport or other ports to the Project site to install the WECs, anchors, and moorings. Despite this increase in vessel activity, Project-related vessel traffic is not anticipated to affect navigation because the vessels used for the Project would be similar to other boats found along the coast, and usage would be intermittent.

There is the potential that passing vessels could collide with the WECs deployed at PacWave South. Operation of the Project would result in the long-term deployment of WECs (e.g., a WEC may be deployed for 3-5 years). The WECs could pose a navigational hazard while stationary or if dislodged from a mooring. USCG Local Notice to Mariners would be requested to inform mariners traveling in the vicinity of Project structures or activities to be avoided (e.g., during deployment of Project infrastructure and WECs). Navigational markers and lighting would be used to identify navigational hazards.

The Project would be located in the southern corner of an existing tow lane off the coast of Newport; however, OSU has been working with the crabbers and tow boat operators and has a provisional agreement to realign the tow lanes to avoid PacWave South.

As noted in Section 2.6.1, OSU selected the Project site after an extensive public outreach program as part of the technical evaluation of candidate sites. The Ports of Newport and Toledo, FINE, and the public at large were heavily involved with this process, and this site was selected to minimize potential effects to ocean users, including to navigation.

In the unlikely event that a WEC has a catastrophic emergency and separated from its mooring, the WEC would be a navigational hazard. OSU will require that each WEC be equipped with AIS equipment to allow for monitoring of its location. In such an event, OSU would implement the Emergency Response and Recovery Plan to coordinate with agencies and retrieve the WEC.

On May 6, 2016, OSU submitted a draft Navigational Safety Risk Assessment to the USCG for its review (updated version in Appendix E). This assessment considered environmental factors, vessel fleet characteristics, routes, and waterway characteristics in the vicinity if the Project, and concluded that the introduction of the WECs in the Project area will not significantly affect navigation safety. While the assessment acknowledged there is the potential for some increased risk during inclement weather or periods of reduced visibility, sufficient mitigating factors exist to substantially reduce the risk. Specifically:

- The proposed lighting and marking of the structures, outreach to mariners, and other risk mitigations factors listed above, as well as a proactive approach in adhering to the navigation rules by construction and service vessels, should serve to mitigate the additional risk to navigational safety caused by additional structures and vessels in the waterway.
- The WECs may cause some limited obstruction of views of the coastline or other navigational features, but this will be restricted to the immediate Project vicinity and the WECs will create multiple points of reference for visual navigation.
- The WECs are not expected to cause any interference with communications, radar, or sonar.
- In-air and underwater noise levels during installation and operation of the WECs will not cause increased health and safety risk nor adversely affect passing vessels, aids to navigation, or sonar in the Project area.
- No adverse effects on navigational systems from EMF are anticipated to occur due to the near ambient levels and the rapid dissipation of EMF generated by the Project.

Effects to Commercial and Recreational Crabbing and Fishing

Project construction could result in short-term, temporary displacement of fisheries, for example, while the DP vessel or barge is laying the subsea transmission cables, and when WECs are being deployed. Once the subsea cables are laid and buried, they are unlikely to have any effect on fisheries. The presence of the WECs and moorings would result in some reduction of the area available for commercial and recreational crabbing and fishing. Entanglement of commercial and recreational fishing gear with the Project could occur, especially with salmon trollers and Dungeness crab fishermen. The area where fishing could be affected is the 2 square nautical mile area 6 nautical miles off Newport, Oregon where WECs, moorings, and anchors will be deployed, and represents a fairly small area when considering the vast surrounding open ocean habitat. The WECs, moorings, and anchors would have a very limited effect on surface fisheries (e.g., albacore), but risk of gear entanglement would increase with deeper troll (salmon) and crab trapping fisheries, and likely entirely limit commercial trawling fisheries (e.g., pink shrimp). Purse seine fisheries, such as for market squid, could also be limited due to gear interactions with WECs and moorings. Lights used for navigation purposes would not focus downward but horizontally, so they would not affect species that may be attracted to downward bright lighting (e.g., squid). As discussed in Section 3.3.3.2, Project anchors are likely to act as artificial reefs and attract rockfish and other groundfish to bottom structure (e.g., lingcod), and potentially increase fishing opportunities for these species.

To minimize the effects of the Project on commercial and recreational crabbing and fishing, OSU consulted with FINE and other stakeholders as part of the outreach efforts and site selection process (see Section 2.6.1). OSU is also proposing the environmental measures listed above to minimize effects to these groups.

During severe storm conditions, strong wind and waves may cause crab pots to move, and they could drift into the Project site and become entangled in mooring systems. Nevertheless, the overall potential impact on commercial and recreational fishing from the Project is expected to be minor because of the small Project footprint of compared to the surrounding area open for fishing. Furthermore, OSU would periodically search for and remove entangled gear from the Project and, if possible, return the gear to the owner. Also, if the Project structures attract fish, it is likely recreational fishers would use the surrounding area, so the actual impact on recreational fishing would be minor and potentially positive.

The selection of the Project site was based on a combination of community input and preferred site criteria, including physical and environmental characteristics, subsea and terrestrial cable route options, port and industry capabilities, potential impacts to existing ocean users, permitting considerations, stakeholder participation in the proposal process, and support of the local fishing communities. Since identifying the PacWave South study area off the coast of Newport, OSU has continued to maintain ongoing communication and coordination with the local community and with the fishing industry in particular.

Effects of Project Land-Based Structures and Facilities on Recreational Qualities and Uses of State Park Lands

The land-based structures and facilities associated with the Project could result in temporary effects to the recreational qualities and usage of Driftwood Beach State Recreation Site during Project construction. Following construction, the proposed terrestrial Project components would be underground and would not affect the recreational qualities and usage of Driftwood Beach State Recreation Site. OSU's plan to develop and install an interpretive display, if acceptable to and in coordination with OPRD, describing PacWave South in the parking lot would enhance the recreational qualities of the site by heightening Project awareness and appreciation by beach visitors. In addition, OSU would implement the following measures to minimize construction effects to the state park lands: (1) use HDD to install the terrestrial cable conduits directly from Driftwood Beach State Recreation Site to the UCMF, and from the UCMF to the Highway 101 grid connection point, thus minimizing effects to traffic and Highway 101, (2) comply with all state and local permitting requirements for construction work, (3) use construction fencing to isolate work areas from park lands, and (4) site construction work and staging areas on disturbed areas if practicable. Additionally, although non-project related vehicular access to the Driftwood Beach State Recreation Site would be prohibited during construction, OSU would arrange the construction work area to maintain pedestrian public access, to the extent safe and practicable with concurrence of OPRD. OSU would coordinate with OPRD to mitigate impacts to public access and use of the Driftwood Beach State Recreation Site.

The UCMF compound would consist of an approximately three buildings and a parking/laydown area. The existing gravel lane (NW Wenger Lane) would be paved to accommodate semi-truck access to the UCMF. The entire area of the UCMF compound will be approximately 1.2 acres. The UCMF would be located on private property and would not be visible from the Driftwood Beach State Recreation Site or other state park lands.

Effects of Recovery/Clean-Up Activities Associated with Spills or Other Emergencies on Coastal Recreation

Vessels used for the construction, operation, and maintenance of the Project would contain fuel, hydraulic fluid, and other potentially hazardous materials. Also, while WECs are designed for survivability at sea and to minimize the potential for leaks of hydraulic fluid, they do contain fluids toxic to marine life, such as hydraulic fluid. In the unlikely event that a spill occurred from a vessel or from a WEC (e.g., if a WEC broke free of its mooring and washed ashore), subsequent recovery and clean-up activities could affect coastal recreation.

As noted in Section 3.3.2.2, OSU would implement the following measures to minimize the potential for an environmental spill:

- Mark Project structures with appropriate navigation aids, as required by the USCG;
- Conduct outreach to inform mariners of Project structures or activities to be avoided in the area (e.g., Notice to Mariners, flyers posted at marinas and docks);
- Install subsurface floats at sufficient depth to avoid potential vessel strike;
- Develop and implement an Emergency Response and Recovery Plan (Appendix G) with spill prevention, response actions, and control protocols, as well as and provisions for recording types and amounts of hazardous fluids contained in WECs and other Project components.
- Work cooperatively with commercial, charter and recreational fishing entities and interests to avoid and minimize potential space-use conflicts with commercial and recreational interests during construction and operation; and

- Require all Project vessel operators to comply with an Emergency Response and Recovery Plan (Appendix G) for installation and maintenance of Project facilities.

Also, the Project's location approximately 6 nautical miles off the coast of Newport, on the OCS in the open ocean, further minimizes the likelihood of impacts, because any minor effects to water quality or sediment disturbance would quickly dissipate.

In the unlikely event that a WEC has a catastrophic emergency and washed washes ashore, OSU would implement the Emergency Response and Recovery Plan. By preparing for such a scenario, and having a plan in place to respond, OSU would minimize the effects to coastal recreation users of recovery and clean-up activities.

3.3.6.3 Cumulative Impacts

Construction and operation of the Project would result in obstacles (e.g., WECs and moorings) to navigation and commercial and recreational crabbing and fishing. The overall Project area under the initial development scenario (6 WECs) and the full build out scenario (20 WECs) represents a small area of the OCS approximately 6 nautical miles offshore, relative to the area available to commercial and recreational crabbers and fishermen. Given that the only other planned or existing ocean energy projects offshore of Oregon are PacWave North, and the Camp Rilea Ocean Energy project, located 9 and 100 miles from PacWave South, respectively, the development of the PacWave South Project would contribute a negligible cumulative effect on navigation and commercial and recreational crabbing and fishing.

3.3.7 Cultural Resources

OSU is in the process of completing cultural resources investigations for the Project to identify historic properties and assess effects to historic properties that may occur as a result of Project activities. This section details the efforts conducted thus far.

3.3.7.1 Affected Environment

This section describes the results of efforts undertaken thus far to identify historic properties that may be affected by Project activities. It has been organized into the following parts: 1) Project APE, 2) cultural history, 3) existing information, 4) consultation efforts, and 5) results and status of cultural resources investigations undertaken for the Project.

Project APE

As described in Section 1.3.6, the Project must comply with Section 106 of the NHPA which requires federal agencies to take into account the effects of their undertakings on historic properties. Pursuant to the applicable regulations guiding Section 106 of the NHPA which can be found at 36 CFR 800, the APE for an undertaking is determined in consultation with the SHPO and is defined as the geographic area or areas within which an undertaking may directly or indirectly cause alterations in the character or use of historic properties, if any such properties exist. The APE for this Project is defined as all lands and facilities located within or outside of the Project where historic properties may be affected by Project activities. HDR submitted a letter dated August 8, 2016 on behalf of OSU to the Oregon SHPO proposing the APE for both marine and terrestrial components of the Project, and outlining proposed methods for identifying cultural resources within the APE. In a letter dated August 25, 2016 the SHPO concurred with the proposed APE boundaries and the proposed cultural resources identification methods. Since this time, OSU has refined the proposed Project layout and subsequently, both the terrestrial and marine portions of the APE have changed slightly compared to what SHPO concurred with. A letter describing the newly proposed APE and requesting concurrence on the appropriateness of the new APE was submitted to SHPO on May 17, 2019, and OSU is awaiting a response. . The revised APE includes the following:

- The marine portion of the APE:
  - The 2 square nautical mile test site (where the WECs would be deployed) and a slight buffer around the test site to accommodate construction activities.
  - An approximately 8.25-nautical-mile long subsea cable route (Figure 3-14). As shown in Figure 3-14, the APE does not include the area nearshore where the cable will be deployed well beneath the seafloor using HDD.
- The terrestrial portion of the APE (Figure 3-15), which is comprised of two discontiguous areas:
  - The area surrounding the Driftwood Beach State Recreation Site parking lot and access road where the five beach manholes measuring approximately 10 ft. deep, 10 ft. wide, and 10 ft. long would be constructed and would contain the splicing of the subsea cables to the terrestrial cables. This area will capture all construction work areas, the access corridor, and staging needed to install the manholes and splice the cables. As shown in Figure 3-15, the APE does not include the area where the terrestrial cable will be installed using HDD.
  - The area surrounding the UCMF compound, which consists of a 1.2 acre compound with three buildings and a parking area, as well as an access road, and CLPUD tie-in on the west side of Highway 101. The APE established around the UCMF compound encompasses associated areas needed for staging and access during construction of the UCMF.

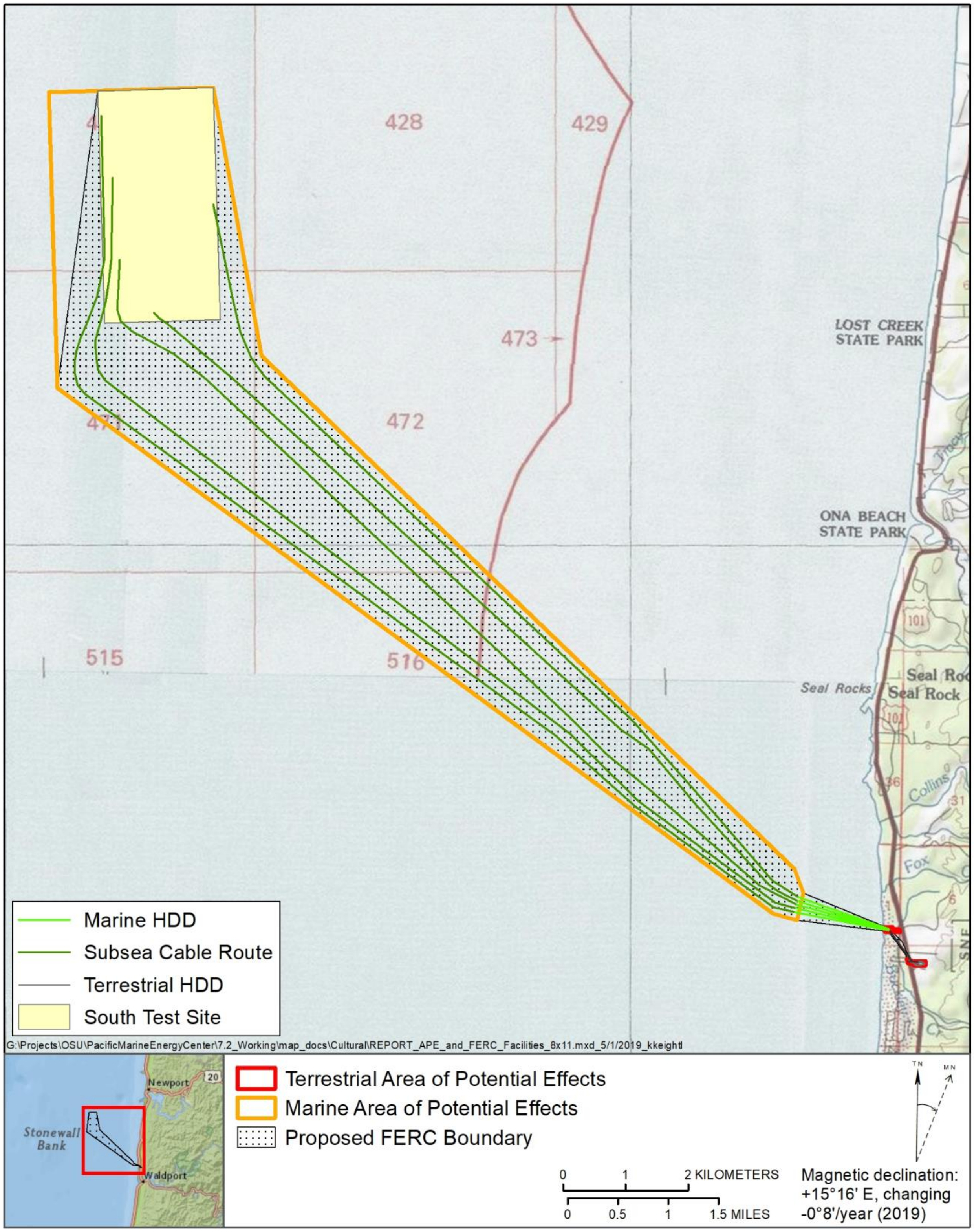


Figure 3-14. PacWave South Project area and corresponding Area of Potential Effect.

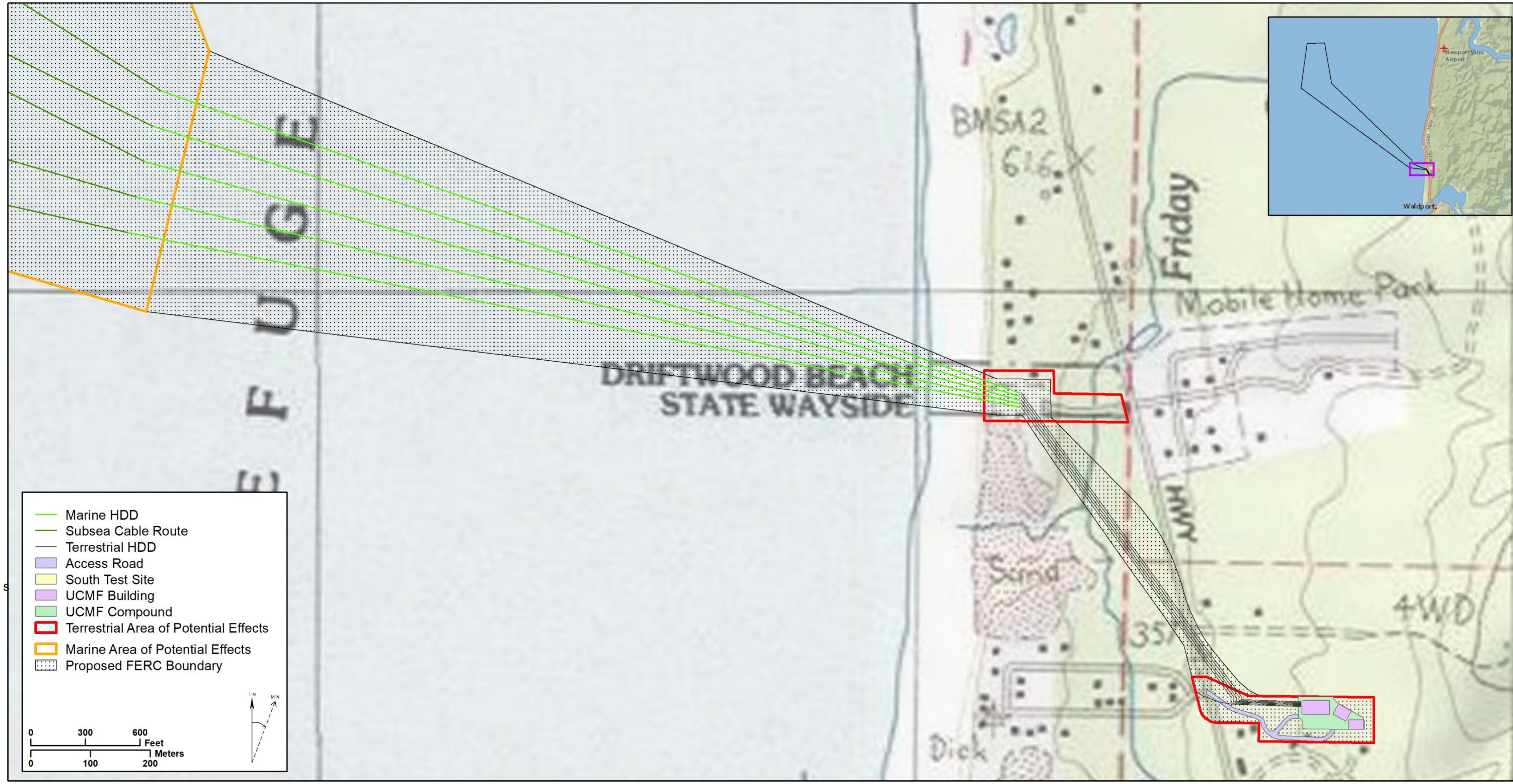


Figure 3-15. Terrestrial area of PacWave South and corresponding proposed Area of Potential Effects.

Cultural History of the Project Vicinity

The APE is a part of the Pacific Northwest Coast Culture Area that extends from Yakutat Bay, Alaska to Cape Mendocino, California (Aikens et al. 2011). The biotic potential of the marine and terrestrial food sources is enormous, and as such prehistoric populations along the coast were often dense and sedentary (Aikens et al. 2011). The Pacific Northwest Coast Culture Area has been characterized as being similar in fishing and hunting technology, with similar aspects of religion and art as well, suggesting extensive contact, trade and shared information within this culture area (Aikens et al. 2011). However, even though there are many similarities, there are many local variations including language (Aikens et al. 2011).

Permanent settlements were common in this culture area, and on the southern Oregon coast single family homes were prevalent and “houses were square to rectangular in form, with a gabled or shed roof” (Aikens et al. 2011). Village communities were often found along shared river courses consisting of one to many houses (Aikens et al. 2011). Many sites along the Oregon coastline are later in time with up to 90 percent falling within the last 1,500 years (Aikens et al. 2011). High energy waves, tectonic uplift, and rising sea levels all may be contributing factors to explain the rarity of early sites along the coast (i.e., they have been eroded away and/or have been inundated) (Aikens et al. 2011).

There are three distinct cultural periods along the coast of Oregon. The Pre-Marine Culture (9,000-2,000 B.C.) is characterized by early projectile points that are probably from people that occupied the interior and were not marine based (Ross 1990). The Early Marine and Riverine Cultures (3,000 B.C. to 500 A.D.) utilized bone tools almost exclusively with few examples of stone tools (Ross 1990). Bone harpoons with unilateral barbs, antler-tine flake tools and wedges were most common (Ross 1990). Late Marine Cultures (500 to 1856 A.D.) had a more robust assemblage of artifacts and commonly made concave base, triangular, and tanged projectile points (Ross 1990). Bow and arrow technology probably reached the Oregon coast around 500 to 900 A.D. and in response the morphology of projectile points changed (Ross 1990). Other parts of their assemblage covered drills, hammerstones, pestles, scrapers, heavy choppers, net sinkers, bifaces, pipes, bowls, bone needles, awls, pendants, fish lures, composite harpoon heads, and gaming pieces, all a part of the Late Marine Culture (Ross 1990).

The Alsea Bay and river that are adjacent to the City of Waldport are named after the Alsea people who inhabited the area at the time of historic contact (Minor 2008). The Alsea spoke a dialect of the Alsean language family that was shared with the Yaquina, who lived around Yaquina Bay to the north (Minor 2008, Thompson and Kinkade 1990, Zenk 1990).

The Alsea village *lku ·huyu·*, meaning "where one goes down to the beach" is located where Waldport is now built (Minor 2008, Zenk 1990). The Alsea were peripherally associated with a regional socio-economic network called "Greater Lower Columbia" that was centered on the lower Columbia River (Minor 2008). Participation in this network was evidenced by head flattening as a sign of free birth (Minor 2008).

After historic contact the territory of the Alsea and Yaquina were allocated as part of the Siletz or Coast Reservation established in 1855, which included 125 miles of coast line (Minor 2008). By December 21, 1865 an executive order was issued that opened the Alsea and Yaquina estuaries to pioneer settlement (Minor 2008, Beckham 1990). The Alsea and Yaquina were subsequently forced to relocate to the Siletz Reservation. The first population density estimations of the Alsea, Yaquina, and Siuslaw of the central Oregon coast totaled 6,000 people (Minor 2008, Mooney 1928). By 1900 only a dozen survivors were reported to be living at the Siletz Reservation (Minor 2008).

Lincoln County, where the Project APE is, was formed on February 20, 1893 as a split from Benton and Polk Counties (Moe 1993). The first county seat was located in Toledo, but moved to Newport in 1952 (Moe 1993). Lincoln County incorporates 53 miles of coastline and travels inland between 14 and 22 miles with a total coverage of 998 square miles. The major cities from the north to the south are Lincoln City, Newport, Waldport, and Yachats. Waldport is the closest city to the Project APE. Settlement in the Waldport area began in the 1870s. In 1884 a saw mill was built taking advantage of the wide Alsea Bay and river to float logs down as a natural flume (Moe 1993). Early German homesteaders named Waldport as a combination of the words wald meaning forest in German and the English word port (Moe 1993). The City was chartered in 1890 and incorporated in 1911. Waldport received electricity in 1926 from a water wheel that was placed in Eckman Creek which was later upgraded to a turbine that was turned by water fed through a 30 inch wooden penstock (Griswold 1993).

Improvements to the road network allowed for mail to be delivered from Waldport to Florence starting in 1897 (Hays 1976). By the 1930s a bridge was built from Waldport across Alsea Bay (Moe 1993). This bridge was just one of many commissioned for the Oregon Coast Highway a project which was completed in 1936 (Blakely 2014). The United States Government intended the Oregon Coast Highway to eventually be part of a highway that would extend from Canada to Mexico (Blakely 2014). The Oregon Coast Highway was later renamed Highway 101 when the bridge across the Columbia River was completed on July 29, 1966 and a continuous highway from Canada to Mexico was finally united (Blakely 2014).

Early Homesteaders to Lincoln County were German immigrants that often lived in close proximity to one another (Hays 1976). One of these families, the Ludeman family, built a saw mill powered by a water wheel (Hays 1976). This saw mill cut most of the wood to build and fix bridges within the county, and gave the family the money to venture into a cannery that they built a quarter mile east of Waldport (Hays 1976). This cannery employed Chinese workers to operate the day to day activities (Hays 1976). Logging and fishing were the most important industries in the county from the late nineteenth to the mid-twentieth century as evidenced by the large number of sawmills, grist mills, and canneries in the county during this time period (Moe 1993, Hay 1976). Today, these industries are still important but tourism is now the largest industry in the county.

Existing Information

This section describes the results of a review of previously recorded cultural resources, previously conducted cultural resources investigations, and historical features identified on historic maps. The area reviewed includes the APE and a 1.0-mile buffer around the APE. The purpose of this review of existing information is to: 1) identify any previously recorded cultural resources within the APE so they can be revisited during fieldwork conducted for the Project, 2) identify the types and density of resources found in the vicinity of the APE to better understand the types and density of resources that might be encountered within the APE, and 3) identify historical features shown on historic maps of the area, evidence of which might still be within the APE and can be field checked.

Using information obtained from the online Oregon SHPO databases, previously recorded cultural resources and previously conducted cultural resources investigations within a 1.0 mile radius of the APE were identified and reviewed. Four previous cultural resources investigations have taken place within 1.0 mile of the APE, one of which occurred within the APE (Table 3-19). These investigations occurred between 1976 and 2006, and were conducted prior to a variety of different undertakings, to include sewer/water utility improvements and culvert repairs. Additionally, one investigation represents an archaeological inventory of state parks and was not conducted prior to a specific undertaking, but was conducted simply to inventory archaeological resources on state parks.

Table 3-19. Previous cultural resources investigations within 1.0 mile of the APE.

Count	SHPO ID #	Year	Prepared By	Report Name and Description	Within Project APE (Yes/No)
1	20418	2006	T. Cabebe, Q. Winterhoff, K. Wendland, S. Henrikson	Archaeological Survey of Forty-Nine (49) Culverts and Seven (7) Staging Areas in Region 2 for the Oregon Department of Transportation	No

Count	SHPO ID #	Year	Prepared By	Report Name and Description	Within Project APE (Yes/No)
2	19806	2004	G.L. Tasa, J.A. Knowles, J. Peterson	*Archaeological Resource Evaluation of Area 1 and Area 4, Oregon State Parks, 2003/2004 Surveys; Volumes I and II*. Driftwood Beach State Park. Pedestrian survey of 49 parks within the Area 1 and 4 management units of the Oregon State Park and Recreation system. A total 5,393.36 acres were surveyed and 37 new sites and 56 previously identified sites were observed and documented.	Yes
3	27034	1997	R. Minor, K.A. Toepel	Archaeological Survey for the Seal Rock Water District System Improvements Project (Phase 3), Lincoln County, Oregon. Pedestrian survey of a 40 acre area near Seal Rock. No sites, Historical Sites or isolates were found.	No
4	248	1976	D.R. Brauner	The archeological reconnaissance of the Proposed Newport to Waldport and Waldport To Yachats sewer systems, Lincoln county, Oregon.	No

Based on information obtained from the online Oregon SHPO databases, there is one previously recorded site located within 1.0 mile of the APE (see Table 3-20). The site is a prehistoric shell midden named Collins Creek Shell Midden and it is located almost 1.0 mile north of the APE. While the depth of the site is unknown the surface of the site has a dense concentration of shell, fire cracked rock, and charcoal. The Collins Creek Shell Midden is identified as unevaluated for listing on the NRHP. No historic built environment resources were found to have been previously recorded within 1.0 mile of the APE.

Table 3-20. Previously recorded cultural resources within 1.0 mile of the Project APE.

Trinomial or Resource Name	Temp No. or Agency No.	Recorder and Year Recorded	Description	NRHP Evaluation[1]	Within Project APE (Yes/No)
35LNC80	LNCUO952	Erlandson 1995	**Prehistoric.** Dense Shell midden deposits with shell, fire cracked rock, and charcoal.	U	No

[1] NRHP eligibility status is based on that provided by the Oregon State Historic Preservation Office's online database; U = Unevaluated.

The 1874 General Land Office (GLO) plat showing Township 13 South, Range 12 West does not show any historic roads, homes or other cultural features within a 1.0 mile radius of the APE or within the APE itself. The 1922 Waldport, Oregon 1:62,500 scale USGS topographic quadrangle shows four unimproved roads, one light duty road, six structures, and one school within a 1.0 mile radius of the APE, of which, two unimproved roads fall within the APE. The 1942 Waldport, Oregon 1:62,500 scale USGS topographic quadrangle shows Highway 101, three light duty roads, one unimproved road, Smithy Ranch, and seven structures within a 1.0 mile radius of the APE, of which, Highway 101 falls within the APE.

NOAA nautical charts and GIS data indicate that shipwrecks are in the area of the Yaquina jetty and elsewhere within the Newport South Quadrangle area (between Newport and Seal Rock), but do not occur in the Project APE (3U Technologies 2013).

Section 106 Consultation Efforts

Consultation with Native American tribes and other interested parties is required under Section 106 of the NHPA and is the responsibility of the lead federal agency. For the Project, FERC is the lead federal agency. However, the lead federal agency can designate other parties as unofficial representatives for carrying out informal consultation efforts. This section describes consultation efforts conducted thus far and proposed consultation efforts to be undertaken in the future.

OSU sent a copy of the NOI/PAD to a representative of the Confederated Tribes of Siletz Indians and to the Confederated Tribes of Grand Ronde Tribal Historic Preservation Office via an email dated April 21, 2014. FERC sent consultation letters to the Confederated Tribes of Siletz Indians and to the Confederated Tribes of Grand Ronde on April 24, 2014 inviting these groups to participate in the consultation process for the Project licensing. The Confederated Tribes of Siletz Indians is a member of the CWG and has participated in CWG meetings. In a notice dated May 27, 2014, FERC designated OSU as FERC's non-federal representative for carrying out informal consultation, pursuant to Section 106 of the NHPA. The Confederated Tribes of Siletz Indians and to the Confederated Tribes of Grand Ronde were copied on the August 8, 2016 letter submitted to the SHPO by OSU proposing the APE for both marine and terrestrial components of the Project, and outlining proposed methods for identifying historic properties within the APE. In a letter dated August 25, 2016 the SHPO concurred with the proposed APE boundaries and proposed methods for historic properties identification. Via a letter dated September 29, 2016, HDR on behalf of OSU, notified these tribes and SHPO of the cultural resources inventory to be conducted by HDR for the terrestrial portion of the Project APE. Following completion of the cultural resources inventory of the terrestrial portion of the APE, a report documenting the results of the inventory was submitted to the Confederated Tribes of Siletz Indians, the Confederated Tribes of Grand Ronde, and appropriate agencies on February 19, 2018 for a 30-day review period. Only one response was received, which was from Sam Willis, the Coastal Region Archaeologist with the Oregon Parks and Recreation Department, who provided comments on the report. Accordingly, the report was revised to address these comments and submitted to the SHPO on June 11, 2018 for review and concurrence on the report findings. In a letter dated July 6, 2018, the SHPO concurred that a good faith effort for the terrestrial portion of the Project had been completed and that this portion of the Project will likely have no effect on any significant archaeological objects or sites. OSU filed copies of the terrestrial report and SHPO's concurrence letter with FERC on August 8, 2018. OSU also sent a copy of the DLA to the tribes on April 23, 2018.

Since 2018, the Project footprint has been refined. Accordingly, OSU has modified both the marine and terrestrial portions of the APE to reflect the new area in which the Project could affect historic properties. A letter describing the newly proposed APE and requesting concurrence on the appropriateness of the new APE was submitted to SHPO on May 17, 2019. No response from SHPO has yet been received. The collection of cultural resources field data for the marine portion of the APE was completed at the beginning of 2019. The review and assessment of these data in regards to historic properties identification and the potential for the marine portion of the Project to affect historic properties has been completed and documented in a study report that is included in Appendix O of this APEA.

The marine study report will be sent to the Confederated Tribes of Siletz Indians, the Confederated Tribes of Grand Ronde, and appropriate agencies for a 30-day review period by July 2019. After which, any comments received will be addressed and the report will then be submitted to SHPO for review and concurrence on the findings of the marine investigation. A finding of effects to historic properties for the Project in its entirety will also be determined and provided to tribes, agencies, and SHPO concurrently with the marine study report for review. Concurrence on the finding of effects for the Project will be sought from SHPO. Following these consultation efforts, the final Section 106 consultation materials, including the marine study report and finding of effects assessment will be filed with FERC. OSU expects to file the final Section 106 consultation materials with FERC by December 31, 2019.

Results and Status of Cultural Resources Investigations Undertaken for the Project

In 2014, OSU conducted geophysical surveys at the proposed test site and subsea cable routes (i.e., the marine portion of the APE). Surveys included: (1) a high-resolution chirp multibeam sonar survey producing detailed bathymetry and backscatter coverage of the test site and potential cable routes, (2) a chirp sub-bottom survey, (3) a boomer seismic survey, and (4) a magnetometer survey. OSU conducted additional geophysical and geotechnical surveys in 2018 at PacWave South test site and within the subsea cable corridor (Appendix M). As described above, the review and assessment of these data in regards to historic properties identification and the potential for the marine portion of the Project to affect historic properties has been completed and documented in a study report. The marine study assessed the following data sets to identify cultural resources that could be potentially affected by the project: 1) GIS modeling to predict the location of submerged precontact sites; 2) a review of previously identified archaeological resources (e.g., shipwrecks); 3) sidescan sonar and magnetometry signal data were examined to look for evidence of large precontact sites expressed at or near the surface of the seafloor and for magnetic anomalies that might represent the remains of historic shipwrecks; and 4) marine cores were collected and analyzed in order to facilitate groundtruthing of the range of variation seen in subbottom profiler geophysical signatures in areas with possible archaeological interest. The marine study did not identify the presence of any cultural resources within the marine portion of the APE and concluded that these data suggest that the project is not expected, nor likely to negatively affect submerged and/or buried cultural resources within the marine portion of the APE. No cultural resources were identified, therefore, no historic properties have been identified within the marine portion of the APE. However, these findings have not yet been reviewed by participating tribes, agencies, or SHPO, and are therefore not yet considered final. The study report will be sent to the Confederated Tribes of Siletz Indians, the Confederated Tribes of Grand Ronde, and appropriate agencies for a 30-day review period by July 2019. After which, any comments received will be addressed and the report will then be submitted to SHPO for review and concurrence on the findings of the marine investigation. Once the report is finalized, it will be filed with FERC.

In September 2017, a pedestrian survey (using 15 - 30 meter apart transects), augmented with subsurface probing, was conducted across the terrestrial portion of the APE. No historic or prehistoric cultural resources were encountered. As described above, a cultural resources inventory report was prepared documenting these efforts and findings and submitted to Native American tribes, agencies, and SHPO for review. SHPO concurred with the report findings and the final report and associated consultation materials were filed with FERC.

It is anticipated that the cultural resources inventory report documenting the investigation of the marine portion of the APE will be finalized and filed with FERC by December 31, 2019. Finalization of this report will include acquiring SHPO concurrence on a finding of effect for the entire undertaking (i.e., the Project licensing), as required for Section 106.

3.3.7.2 Environmental Impacts Related to Cultural Resources

The proposed Project may affect cultural resources that are listed on or eligible for listing on the NRHP (i.e., historic properties). The effect may be direct (e.g., result of ground disturbing activities), indirect (e.g., indirectly providing access to a historic property), or cumulative (e.g., caused by a Project activity in combination with other non-Project activities).

Section 106 of the NHPA requires a determination as to whether or not a federal undertaking (in this case FERC licensing of the Project) will affect historic properties, and if there is an adverse effect, Section 106 requires resolution of that adverse effect. Adverse effects are activities that may alter those characteristics of a historic property that contribute to its NRHP eligibility in a manner diminishing the integrity of the property's location, design, setting, materials, workmanship, feeling, or association.

At this time, no historic properties have been identified within the APE and therefore, no impacts to historic properties have been identified. However, should historic properties be identified in the Project APE, OSU would either modify the Project to exclude the historic property from the Project APE or would develop a Historic Properties Management Plan to consider and manage identified and potential historic properties throughout the life of the FERC license. If no historic properties are identified within the Project APE and it is determined that the Project will have no effect on historic properties, OSU will move forward with Project construction and operations with an understanding that should any previously unidentified cultural resources be identified during the course of construction and operations OSU will consult with FERC to determine the best course of action pursuant to Section 106 of the NHPA.

3.3.8 Aesthetic Resources

3.3.8.1 Affected Environment

The Oregon Central Coast stretches 60 miles from Yachats up to Lincoln City and includes Waldport, Seal Rock, and Newport, which contains a variety of aesthetic resources including the ocean, rock formations, beaches, dunes, and dense forest. In addition to recreational and natural resources, the OPRD oversees the protection of scenic resources along the coast. Permits are required for construction or alteration, vehicle use, signs, salvage, and driftwood removal in the ocean shore area (OPRD 2014). Highway 101, which is a National

Scenic Byway, runs along the upland shoreline near the terrestrial portions of the Project area (National Scenic Byways Program 2010). In this area of the coast, Highway 101 offers intermittent ocean views to motorists.

There are a variety of aesthetic resources in Driftwood Beach State Recreation Site, and the beach is known to accumulate driftwood that has washed up during heavy surf, as well as sculptures that are formed by strong winds and waves.

3.3.8.2 Environmental Impacts Related to Aesthetic Resources

Views along the Oregon coast are valued by both residents and tourists. This section evaluates the following potential effects on aesthetic resources:

- Effects of WECs and navigational lighting on the aesthetic/visual experience from of viewers on shore.
- Effects of land-based Project structures and facilities on viewers in state park lands.

The Project would be located 6 nautical miles from shore in the ocean where no anthropogenic structures exist; consequently, the WECs could impact aesthetics from shore. WECs deployed at PacWave South would comply with USCG requirements for navigational marks and lighting (e.g., low-intensity flashing lights).

Portions of the Project potentially visible from shore would include the parts of the WECs that would be above the water surface during clear days and navigational lighting during clear nights. OPT’s PB150, an example of a point absorber WEC, would extend about 30 feet above the water. For a person standing on shore, 5.6 nautical miles from the Reedsport OPT Wave Park, OPT determined that a PowerBuoy would appear to be 0.6 mm, at arm’s length (Reedsport OPT Wave Park, LLC 2010). This is comparable to viewing from the closest location from shore, which is approximately 6 nautical miles. An oscillating water column WEC would be a larger structure than a point absorber (estimated to extend about 35 feet above the water surface), but would similarly appear very small when viewed from shore. Lights and navigation aids would be visible at some distance, but are necessary for maritime safety. The range of visibility would vary depending on time of day and weather conditions.

All land-based Project components in Driftwood Beach State Recreation Site, including the terrestrial cables, would be located underground and would therefore not affect the aesthetics of the area. Construction of these facilities would affect the aesthetics in isolated areas, but this would be a temporary alteration.

The UCMF compound would be paved and fenced and would cover approximately 1.2 acres. The site would include three, one-story buildings and a parking/laydown area. The existing gravel lane (NW Wenger Lane) would be paved to accommodate semi-truck access to the UCMF. After construction, the UCMF and the five manholes in the parking lot of Driftwood Beach State Recreation Site would be the only visible terrestrial component of the Project. The UCMF would be on a private property set back from Highway 101. During construction, activities associated with installation of the underground cable would be visible to recreational users in the Driftwood Beach State Recreation Site. However, these activities and effects would be temporary.

3.3.9 Socioeconomics

3.3.9.1 Affected Environment

The terrestrial portion of the Project would be located in Seal Rock, Lincoln County. Seal Rock is a relatively small coastal town located in central Oregon between the popular coastal cities of Newport and Waldport. Newport is located approximately 10 miles north of Seal Rock. Waldport is located on the Alsea River and Alsea Bay, 8 miles south of Seal Rock.

The unincorporated town of Seal Rock (zip code 97376) has a population of 1,301 (USCB 2016a). Waldport is larger than Seal Rock with an area of 3 square miles and a population of 2,081. Newport has an area of 9 square miles and a population of 10,268 (Table 3-21). In October 2016, the seasonally adjusted unemployment rate was 5.9 percent in Lincoln County, 5.4 percent in Oregon, and 4.9 percent nationally (Bureau of Labor Statistics 2016).

Table 3-21. Project area demographic information.

Demographic	Lincoln County	Newport*
2015 Estimated Population	47,038	10,268
Land area (square miles)	979.77	9.05
Persons per square mile, 2010	47.0	1,103.6
Median household income, 2008-2012	$42,429	$40,448
Persons below poverty level, 2008-2012 (percent)	18.8%	18.5%

* No demographic data available for Seal Rock. Source: U.S. Census Bureau 2016a.

Historically, Oregon was dependent on its timber, agriculture, and fishing industries to generate wealth in the state by exporting products to other states and countries. In the 1980s there was a large shift from traditional resource extraction sectors to a high-tech sector, especially near Portland, Oregon (FCS Group 2014). In Lincoln County, principal industries remain more traditional and include fishing, tourism, government, services, retail, and forest products (Lincoln County 2014).

Although Oregon's export mix has changed over the years, the ports have continued to support commerce and economic activity (FCS Group 2014). Oregon is one of the most trade dependent states in the nation and economic activity in other countries helps drive the state's economy. For example, the value of exports from Oregon to foreign countries was $20.08 billion in 2015 (USCB 2016b). The state's largest trading partners are China, Canada, Malaysia, Japan, and South Korea. However, Oregon's trade with other U.S. states far exceeds its trade with foreign nations (Oregon Secretary of State 2014).

In addition to serving as state, national and international transportation gateways, the 23 ports in Oregon provide other commercial, economic, and recreational services to residents and businesses in Oregon and elsewhere (Oregon Public Ports Association 2014). The Port of Newport District is located on the central coast at the junction of US 20 and Highway 101. It is a major economic hub in the area.

The Port District's facilities are divided into two distinct development areas, the North Shore Development Area and the South Beach Development Area. The North Shore Development Area is Newport's working waterfront where the commercial fishing fleet is based, including local fishing fleets and the Newport-based distant water fleet (commercial fishing boats that spend much of the year in waters off the coast of Alaska; FCS Group 2014).

The South Beach Development Area is primarily of facilities designed to support recreational fishing and tourism. The South Beach Marina provides moorage for 450 recreational vessels and other amenities. The South Beach Development Area is home to the Marine Science Cluster, which includes the OSU Hatfield Marine Science Center and the new NOAA Pacific Coast Marine Operations Center for its fleet of research ships (FCS Group 2014).

The Port of Alsea District is located on Alsea Bay at Waldport on the Oregon coast, near the junction of Highway 101 and Oregon Highway 34 and serves as a recreation and tourism destination for the area around Waldport. The Port of Alsea offers a number of amenities for local fisherman and tourists, including sport fishing docks and a boat launch. In addition, the Port leases land to restaurant and retail shop businesses, as well as a kayak rental establishment. The annual economic impacts of the Port of Newport and Alsea are identified in Table 3-22.

Table 3-22. Annual economic impacts of the Ports of Newport and Alsea (FCS Group 2014).

Economic Impact	Port of Newport	Port of Alsea
Total Port-related Oregon employment	3,089	89
Oregon output (gross sales)	$389 M	$7.35 M
Oregon GDP	$207 M	$4.08 M
Oregon labor income	$124 M	$2.55 M
Annual local and state of Oregon tax revenue/payments	$21 M	$526 K
Annual federal tax revenue/payments by Oregon enterprises/employees	$28 M	$555 K

Source: FCS Group 2014.

The commercial fishing industry affects the local economy through increases in personal income from harvesting and processing, as well as by providing support to local industries and businesses. The Newport area also is positively affected by the distant water fleet, which uses Newport as a home port as well as for repairs and/or provisions. In 2018, about 124 million pounds of commercially harvested fish and shellfish were processed at the port in Newport, equating to over $62 million dollars (ODFW 2019) (Table 3-23). As described in Section 3.3.6, the highest landings were for hake, pink shrimp, Dungeness crab, sablefish, rockfish, sole, albacore tuna, Chinook salmon, and hagfish (ODFW 2019).

Table 3-23. 2018 Pounds and values of commercially caught fish and shellfish landed in Newport.

Month*	Million Pounds	Million Dollars**
January	2.6	5.3
February	6.3	15.7
March	2.3	5.2
April	1.8	2.6
May	7.5	3.6
June	20.9	5.0
July	21.3	7.4
August	26.2	6.9
September	22.2	5.1
October	10.0	3.1
November	2.1	0.1.2
December	1.0	0.6
Total	124.8	62.4

Source: ODFW 2019.
*Landings by month reflect the date of purchase by the dealers and may not necessarily indicate the date the fish were caught.
**Value based on the ex-vessel price per pound paid to fisherman.

In addition to the commercial fishing fleet, the Port's operations involve four sport fishing markets, including ocean charters, ocean and freshwater private trailerable boats, ocean and freshwater private moored boats, and bank and pier pole and shellfish anglers. Over the last decade, the state has seen a significant decline in the number of boat registrations and use days, both on an absolute and a per capita basis, which is consistent with the national trend. While recreational vessel registrations have declined, the charter industry has grown steadily and the Central Oregon Coast accounts for over 22 percent of fishing guides in the state (Port of Newport 2013).

Sport fishing is a major contributor to the local economy. For example, in 2010 the regional economic impact of saltwater sport fishing trips on the Oregon coast was estimated at $822 thousand for salmon and $3.5 million for species including bottom fish, halibut, and tuna.[22] Travel generated expenditures for fishing in Lincoln County was estimated at over $32 million for fishing and almost $7.7 million for shellfish fishing in 2008. Local recreation expenditures (i.e., lodging, meals) accounted for an additional $3.5 million in activity in the County (Port of Newport 2013).

3.3.9.2 Environmental Impacts Related to Socioeconomic Resources

This section evaluates the following potential effects on socioeconomic resources:

- Effects of the Project on recreational and commercial crabbing and fishing;
- Effects of the Project and potential navigation restrictions on marine transportation; and
- Effects of local, state, and regional economic benefits resulting from the development and presence of the Project.

Effects of the Project on Recreational and Commercial Crabbing and Fishing

Entanglement of commercial and recreational fishing gear with the Project could occur, especially with regard to the equipment used by salmon trollers and Dungeness crab fishers. To minimize the effects of the Project on commercial and recreational fishing, OSU consulted with FINE and other stakeholders as part of the outreach efforts and site selection process (See Section 2.6.1). OSU would: (1) work cooperatively with commercial, charter and recreational fishing entities and interests to avoid and minimize potential space-use conflicts during

[22] This estimate includes charters, private boats, and bank access to ocean and estuary sites. Expenditures on capital items, such as boats, vehicles to pull boats, and second homes, are not included.

construction and operation, (2) where feasible, bury submarine cables 1 to 2 m deep to minimize interactions with fishing gear and anchors, and (3) engage with the fishing community to inform mariners traveling in the vicinity of Project structures or activities to be avoided. This would include requesting the USCG to issue a Notice to Mariners and working with appropriate parties to post Project information flyers at marinas and docks.

During severe storm events, strong wind and waves may cause crab pots to drift and become entangled in the WEC mooring lines. Nevertheless, the overall potential impact on commercial and recreational fishing from the Project is expected to be minor because of the small Project footprint relative to the surrounding open ocean. If the surface equipment attracts fish, it is likely that recreational fishers would use the area near PacWave South for recreational fishing, so the actual impact on recreational fishing would be minor or potentially positive.

The selection of the Project site was based on a combination of preferred site criteria and community input, including impacts to existing ocean users and support of the local fishing communities. Since identifying the Project study area off the coast of Newport, OSU has continued to maintain ongoing communication and coordination with the local community, and with the fishing industry in particular.

Effects of the Project and Potential Navigation Restrictions on Marine Transportation

As mentioned in Section 3.3.6.2, no navigational closures are anticipated for the Project (i.e., no exclusion zones), and OSU would implement a variety of measures to minimize potential effects to marine navigation, including the following: (1) mark Project structures with appropriate navigation aids, as required by the USCG, (2) conduct outreach to inform mariners of Project structures or activities to be avoided in the area (e.g., Notice to Mariners, flyers posted at marinas and docks), (3) develop and implement an Emergency Response and Recovery Plan, and (4) install subsurface floats at sufficient depth to avoid potential vessel strike.

A number of vessels, including tugs, installation vessels, and other workboats would be employed during construction, maintenance, and removal of the Project. These vessels would make multiple trips from the Newport or other ports to the Project site to install the WECs, anchors, and moorings. However, Project-related vessel traffic is not anticipated to affect navigation because the vessels used for the Project would be similar to existing boating traffic along the coast and their usage would be intermittent.

USCG Local Notice to Mariners would be requested for the deployment of in-water infrastructure and equipment associated with the Project. USCG-compliant navigational markers and lighting would be used to identify navigational hazards. While the Project is located near a tow lane, as noted in Section 2.6.1, OSU selected the Project site after an extensive public outreach program to gain broad support for the selected site as part of the technical evaluation of candidate sites. The Ports of Newport and Toledo, FINE, and the public at large were involved with this process.

In the unlikely event that a WEC had a catastrophic emergency and washed ashore, OSU would implement the Emergency Response and Recovery Plan. OSU will require that each WEC be equipped an AIS system to allow for monitoring of its location.

OSU submitted a draft Navigational Safety Risk Assessment to the USCG for its review. This assessment considered environmental factors, vessel fleet characteristics, routes, and waterway characteristics in the vicinity if the Project, and concluded that the introduction of the WECs in the Project area will not significantly affect navigation safety (Appendix E).

In conclusion, the presence of the WECs and associated construction and service vessels would not affect marine transportation in the Project area, the Ports of Newport or Toledo, or along the Oregon Coast.

Effects of Local, State, and Regional Economic Benefits Resulting from the Development and Presence of the Project

The Federal Energy Policy Act of 2005 encourages the development of renewable energy resources, including wave energy, to reduce the country's dependence on foreign oil and other hydrocarbon energy sources. The State of Oregon has also implemented a number of initiatives to encourage the development of wave and other types of renewable energy projects, including the Oregon Wave Energy Trust and the Oregon Renewable Portfolio Standard. OSU does not propose any measures related to economic development.

In evaluating the feasibility of wave energy projects, the Electric Power Research Institute (EPRI) stated that the development of wave energy projects would result in a number of public benefits including job creation (construction, operation, and maintenance of wave energy projects), economic development, and increased energy self-sufficiency (EPRI 2011).

For the construction of OPT's first planned WEC in Oregon, OPT estimated that deployment of the single WEC would create 30 jobs for workers at the facility where the WEC was being fabricated, and that the deployment of the planned additional nine WECs (the Reedsport OPT Wave Park) would provide employment for an additional 180 skilled workers for seven months. OPT estimated that project deployment would result in six new local jobs while helping maintain 10 to 12 existing jobs and creating $1 million in wages to the local economy. During operation of the 10-WEC project, OPT estimated that the project would support eight full-time employees, while periodic maintenance would create temporary positions for about five additional workers (Reedsport OPT, LLC 2010, FERC 2010).

In its EA for the Reedsport OPT Wave Park, FERC (2010) described findings of the report to the Oregon Wave Energy Trust (EcoNorthwest 2009), which estimated multiplier effects for constructing and operating a 7 to 10 MW wave research and development facility on the Oregon Coast. EcoNorthwest estimated that this type of project would create total construction employment for 45 workers, and that operation of the facility would create 40 direct jobs and another 51 jobs associated with facility and employee spending for goods and services (FERC 2010).

While the extent of the PacWave South contribution to employment in the region is not known, one can conclude that construction and operation of the Project would result in employment and related worker earnings. The Project would attract test clients to the area, which would generate business for hotels, restaurants, and other local businesses. In addition, promotion of the marine renewable energy converter market off the coast of Oregon could lead to future projects elsewhere in the region, which could result in subsequent jobs.

3.3.9.3 Cumulative Impacts

The potential for the following potential effects of the Project to result in cumulative impacts in combination with other current or reasonably foreseeable actions were evaluated:

- Effects of the Project on recreational and commercial crabbing and fishing;
- Effects of the Project and potential navigation restrictions on marine transportation; and
- Effects of local, state, and regional economic benefits resulting from the development and presence of the Project.

As noted in Section 3.3.6.4, construction and operation of the Project would result in obstacles (e.g., WECs and moorings) to navigation and commercial and recreational crabbing and fishing. The overall Project area of the initial development scenario (6 WECs) and the full build out scenario (20 WECs) represents a small area of the OCS approximately 6 miles offshore, relative to the area available to commercial and recreational crabbers and fishermen. Given that the only other planned or existing ocean energy projects offshore of Oregon are PacWave North and the Camp Rilea Ocean Energy projects, located 9 and 100 miles from PacWave South, respectively, the development of the PacWave South Project would have a negligible cumulative effect on navigation, and commercial and recreational crabbing and fishing.

As noted above, the development and operation of the Project would contribute to the growth of various industries related to, or that would support, ocean energy. Thus, it is expected that there would be a small positive cumulative effect to the economy from the Project, in combination with the PacWave North and Camp Rilea projects.

3.4 NO-ACTION ALTERNATIVE

Under the no-action alternative, the Project would not be constructed. There would be no changes to the physical, biological, or cultural resources of the area, and electrical generation from the Project would not occur. The benefits associated with the Project, including generation, testing, and development of wave energy converters, would not occur. The power that would have been developed from a renewable resource would likely be replaced by nonrenewable fuels.

4.0 DEVELOPMENTAL ANALYSIS

4.1 POWER AND ECONOMIC BENEFITS

Experts have estimated that the potential for clean, renewable energy generated from wave energy resources could be approximately equal to all the power generated by hydroelectric facilities in 2015 (EPRI 2011, U.S. Energy Information Administration [EIA] 2016). According to the Energy Information Agency, 336 terawatt-hours (TWh) were generated at conventional hydroelectric facilities in the U.S. during 2015 (EIA 2016). Cumulative generation from all sources in the U.S. during 2015 was 4,090 TWh. Conventional hydroelectric power represented approximately 8 percent of generation (EIA 2016). EPRI estimated that the total potential wave energy for the United States is 2,640 TWh per year, with 590 TWh of that occurring on the West Coast (Washington, Oregon, and California) (EPRI 2011). Ocean energy has the potential to be highly predictable, adding a reliable and renewable source of energy to Oregon’s and the nation’s existing energy portfolio.

The Federal Energy Policy Act of 2005 encourages the development of renewable energy resources, including wave energy, to reduce the country’s dependence on foreign oil and other hydrocarbon energy sources. The State of Oregon has also implemented a number of initiatives to encourage the development of wave and other types of renewable energy projects, including the Oregon Wave Energy Trust and the Oregon Renewable Portfolio Standard.

PacWave South would produce up to 20 MW of power and serve as an integrated test center to evaluate the performance of commercial scale WECs. OSU believes that once the Project develops, the capital costs of wave energy would become more competitive with traditional generation. Promotion of the marine renewable energy converter market off the coast of Oregon could lead to future projects elsewhere in the region, which could result in subsequent jobs. An established wave energy generation industry has the potential to create jobs for thousands of skilled workers, driving economic development along the Oregon coast.

4.2 COMPARISON OF ALTERNATIVES

4.2.1 No-Action Alternative

Under the no-action alternative there would not be a grid-connected wave energy test facility to facilitate industry commercialization and fully reap the benefits of this clean, renewable energy resource. The no-action alternative would not produce renewable energy and would not provide economic benefits through job creation on the Oregon coast. More importantly, the future incorporation of wave energy into the power grid would be hindered by the limited advancements in wave energy converter technology.

4.2.2 Proposed Action

OSU proposes to construct and operate an offshore test site composed of four test berths that could collectively support the testing of up to 20 WECs. Research into, and testing of WECs is needed to advance the development of marine renewable energy technologies by providing facilities for full-scale, open-ocean testing of WECs, thereby reducing the time and costs associated with siting individual grid-connected projects. The Project will build on the body of knowledge of the environmental effects of wave energy projects to support larger commercial projects. OSU considers the responsible investigation of clean, reliable, local wave energy to be important in planning for future energy resource needs.

Upon completion of the installation of 20 WECs, the maximum installed capacity would be 20 MW, and would generate from 150 kilowatts (kW) to 2 MW per WEC. Overall, the average annual Project cost is estimated be more expensive than alternative power. However, it is important to note, the primary purpose of PacWave South is to serve as a test facility designed for developers of WECs who would contract with OSU to use these test facilities. The generation of power for transmission to the grid would be a secondary purpose and would be focused on testing the integration of power from the test units onto the distribution grid. OSU believes that once the Project develops, the capital costs of wave energy would become more competitive with traditional generation.

4.3 COST OF ENVIRONMENTAL MEASURES

The estimated cost for pre-installation environmental studies already completed, planned, or in progress is approximately $2 million. These studies included acoustic Doppler current profiling, wave modeling and far field effects analysis, underwater acoustics studies, aquatic species studies, marine mammal studies, oceanographic/ bathymetrical/benthic studies, and terrestrial and cultural resources studies.

As part of this Project, the OSU proposes to undertake certain measures designed to gather environmental and operational data regarding the operation of the WECs. This information will be utilized to evaluate the effects of the Project and individual WECs and may result in modifications to the Project’s operations. Due to the nature of the Project as a test site, many of the proposed monitoring plans are being applied to wave energy technology for the first time, making precise estimates for the overall cost of each plan extremely difficult. However, OSU estimates that the total annual cost to conduct the activities described in the proposed monitoring plans will be approximately $500,000 per year. Specific costs of proposed environmental measures are provided below in Table 4-1.

Table 4-1. Estimated costs of proposed environmental measures.

Proposed Environmental Measures	Capital Cost (2019$)	Annual Cost (2019$)	Levelized Annual Cost (2019$)[f]
General Environmental Measures			
1. Implement the Adaptive Management Framework (Appendix J) in conjunction with specific PM&E measures to evaluate study results, identify any Project effects, and implement and/or modify response actions (Appendix I) in consultation with key agency stakeholders.	$0	$50,000	$63,502
2. Beginning five years and six months after deployment of the first WEC at the Project, and recurring every five years thereafter, the licensee shall file with FERC a Five Year Report and provide copies to BOEM, NMFS, FWS, and ODFW. Contents of the report are further described in Appendix I, Protection, Mitigation, and Enhancement Measures.	$0	$25,000	$31,751
3. Employ periodic, routine inspection and maintenance methods to ensure structural integrity of Project components (Appendix F, Operation and Maintenance Plan).	$0	$0[b]	$0[b]
4. Develop and implement the Emergency Response and Recovery Plan (Appendix G).	$0	$0[a]	$0[a]
Geologic and Soil Resources Measures			
5. Use HDD to install the terrestrial cables under the nearshore and intertidal habitat (to approximately the 10-m isobath) to minimize substrate disturbance. Use HDD to install the cables in up to five bores, from the beach manholes at the Driftwood Beach State Recreation Site to the UCMF, and from the UCMF to the Highway 101 grid connection point, to minimize habitatdisturbance.	$0[c]	$0	$0
6. Follow best practices during installation, operation, and removal activities to avoid or minimize potential effects to sediment, including: 6a. Minimize the time that the seafloor is disturbed and sediment is dispersed and the associated effects by completing cable laying and other construction activities during appropriate construction windows and within one construction season to the extent practicable.	$0[c]	$0	$0
6b. Develop and implement an Erosion and Sediment Control Plans, where appropriate, to minimize effects of ground-disturbing activities associated with installation of the terrestrial cables and/or other terrestrial construction.	$0	$0[b]	$0[b]
7. Implement the Benthic Sediments Monitoring Plan (Appendix H) to evaluate effects on benthic habitat from anchors, WECs, and other equipment during operation, maintenance, and monitoring activities. Based on monitoring results, implement the specified measures to mitigate for potential adverse effects (Appendix I).	$0	$0[d]	$0[d]
8. Project components in the estuarine environment should not bottom out so as to prevent nearshore/estuarine habitat effects.	$0	$0	$0

Proposed Environmental Measures	Capital Cost (2019$)	Annual Cost (2019$)	Levelized Annual Cost (2019$)[f]
9. To the extent possible, minimize frequency of anchor installation/removal cycles and reuse installed anchors.	$0	$0	$0
Water Resources			
10. Follow industry best practices and guidelines[e] for antifouling applications (e.g., TBT-free) on Project structures such as marker buoys, subsurface floats, and WECs.	$0	$0[b]	$0[b]
11. Develop and implement an Emergency Response and Recovery Plan (Appendix G) with spill prevention, response actions, and control protocols, as well as and provisions for recording types and amounts of hazardous fluids contained in WECs and other Project components.	$0	$0[b]	$0[b]
12. Require all vessel operators to comply with an Emergency Response and Recovery Plan (Appendix G) for installation and maintenance of Project facilities.	$0	$0[b]	$0[b]
13. Prepare waste management, hazardous material, and spill prevention plans, as appropriate, for onshore Project facilities.	$0	$0[b]	$0[b]
14. Minimize storage and staging of WECs outside of existing dock, port, or other marine industrial facilities.	$0	$0[b]	$0[b]
15. Require that all Project chartered or contracted vessels comply with all current federal and state laws and regulations regarding aquatic invasive species management.	$0	$0[b]	$0[b]
16. Develop and implement an HDD Contingency Plan to minimize the potential for inadvertent return of drilling fluids, provide timely detection, and address potential releases by describing monitoring, containment, response and notification procedures to be implemented by the contractor.	$0[c]	$0	$0
Aquatic Resources and Threatened and Endangered Species – General			
17. Bury subsea cables at a depth of 1-2 meters, to the maximum extent practicable, to minimize the amount of habitat conversion (soft bottom to hard structure) from laying exposed cable on the seafloor. In areas where a cable cannot be buried or persistently becomes unburied, that portion of the cable will be on the seafloor and will be protected by split pipe, concrete mattresses or other cable protection systems.	$0[c]	$0	$0
18. To the maximum extent practicable, utilize shielding on subsea cables, umbilicals, and other electrical infrastructure to minimize EMF emissions.	$0[c]	$0	$0
19. Implement the EMF Monitoring Plan (Appendix H) to measure Project-related EMF emissions. Based on monitoring results, implement the specified measures to mitigate for potential adverse effects (Appendix I).	$0	$0[d]	$0[d]
20. In the event of an emergency in which fish or wildlife are being killed, harmed, or endangered by Project facilities or operations in a manner that was not anticipated, OSU will notify agencies with	$0	$0[a]	$0[a]

Proposed Environmental Measures	Capital Cost (2019$)	Annual Cost (2019$)	Levelized Annual Cost (2019$)[f]
regulatory authority as soon as possible and take action to promptly minimize the impacts of the emergency, including implementing any guidance pursuant to agency legal authorities, as outlined in Appendix I.			
Aquatic Resources and Threatened and Endangered Species – Fish and Invertebrates			
21. Implement the Organism Interactions Monitoring Plan to track changes to pelagic and demersal fish and invertebrates (particularly Dungeness crab) that might be attracted to the installed components or affected due to the potential for reduced fishing pressure, as well as biofouling on the anchors/WECs (Appendix H).	$0	$0[d]	$0[d]
22. Develop cable routes that avoid crossing areas with rocky reef and hard substrate to the maximum extent practicable to protect sensitive habitat features.	$0[c]	$0	$0
23. Develop and implement an anchoring plan or protocol for any Project vessels that may anchor at the Project site, that: • Avoids anchoring in known rocky reef or hard substrate habitats to the maximum extent practicable; and • Minimizes the use of anchors within the Project area wherever practicable by combining onsite activities.	$0	$25,000	$31,751
Aquatic Resources and Threatened and Endangered Species – Marine Mammals			
24. Entangled Fishing Gear 24a. Conduct opportunistic visual observations from the water surface in the portions of the test site which are being visited to conduct operations, maintenance, or environmental monitoring work and review any underwater visual monitoring conducted for other purposes to detect entangled fishing gear that has the potential to increase the risk of marine species entanglement. The licensee will ensure that surface observations occur during all visits to the Project test site and at least once per quarter each year for the duration of the license.	$0[c]	$0	$0
24b. Annually following the peak storm season and period of maximum activity for the Dungeness crab fishery, the licensee shall conduct surface surveys of active WEC berths during the spring season (mid-March through mid-June), or the earliest possible time after that period that avoids jeopardizing human safety, property, or the environment.	$0	$0[d]	$0[d]
24c. Conduct annual subsurface surveys of moorings and anchor systems using ROV or other appropriate techniques with approval by NMFS concurrent with spring (mid-March through mid-June) monitoring under the Organism Interactions Monitoring Plan (Appendix H).	$0	$0[d]	$0[d]

Proposed Environmental Measures	Capital Cost (2019$)	Annual Cost (2019$)	Levelized Annual Cost (2019$)[f]
24d. If entangled fishing gear or marine mammal (or sea turtle) stranding, entanglements, impingements, injuries, or mortalities is detected, implement the specified measures to minimize risk of marine mammal entanglement and to make every effort to return the fishing gear to the owners (Appendix I).	$0	$50,000	$63,502
25. Require vessels in transit to/from the Project site to avoid close contact with marine mammals and sea turtles and adhere to NMFS "Be Whale Wise" guidelines to minimize potential vessel impacts to marine mammals.	$0	$0	$0
26. Comply with current regulations that require marine mammal observers for certain vessel-based activity (e.g., sub-bottom profiling).	$0	$0	$0
27. Require WEC testing clients to keep their equipment in good working order to minimize sound due to faulty or poorly maintained equipment.	$0	$0	$0
28. Implement the Acoustics Monitoring Plan (Appendix H) to quantify sound levels using field measurements and validated sound propagation models. Based on monitoring results, implement specified measures to mitigate for potential adverse effects (Appendix I).	$0	$0[d]	$0[d]
29. Minimize construction activities during key gray whale migration periods, to the extent possible.	$0[c]	$0	$0

30. For use of DPVs or other equipment that may exceed NMFS's published threshold for injury
• Avoid use of these vessels to the maximum extent practicable during Phase B gray whale migration (April 1-June 15). If these construction activities are proposed during this migration period, the licensee will consult with ODFW regarding the timing of such activities including cable-laying in state waters.
• With technical assistance from NMFS, establish and carry out the following actions and protocols necessary to maintain an appropriate acoustic zone of influence in accordance with NMFS's published harassment threshold (120 dB re: 1 µPa) during DPV operations to minimize behavioral disturbance and protect marine resources.
  ○ Post qualified marine mammal observers during daylight hours.
  ○ The licensee will conduct dynamic positioning (DP) activities during daylight hours when feasible to ensure observations may be carried out.
  ○ DP for cable laying may occur during all hours; however, DP start up for cable laying will only occur during daylight hours.
  ○ The licensee will carry out the ramp-up procedures that are specified in Appendix I, which may be modified by agreement of the licensee and NMFS.
	$0	$0[b]	$0[b]

Proposed Environmental Measures	Capital Cost (2019$)	Annual Cost (2019$)	Levelized Annual Cost (2019$)[f]
• Implement such additional measures as may be imposed pursuant to a Marine Mammal Protection Act authorization.			
31. Make opportunistic visual observations of pinnipeds in the portions of the test site which are being visited to conduct operations, maintenance, or environmental monitoring work. If pinnipeds are observed to be hauled out on Project structures, the licensee will follow the reporting and haulout protocols specified in Appendix I.	$0	$0[d]	$0[d]
32. To the extent practicable, direct the WEC testing clients to design and maintain cables and moorings in configurations that minimize the potential for marine mammal or sea turtle entrapment or entanglement and follow the reporting and haulout protocols specified in Appendix I.	$0	$0	$0
Aquatic Resources and Threatened and Endangered Species – Seabirds			
33. Implement the Environmental Measures section as described in the Bird and Bat Conservation Strategy (Appendix B) to assess, minimize, and avoid impacts to birds, these are annotated below:			
33a. Conduct opportunistic visual observations from the water surface in the portions of the test site that are being visited to conduct operations, maintenance, or environmental monitoring work, and review any underwater visual monitoring conducted for other purposes, to detect derelict gear that has the potential to increase the risk of marine species entanglement. If monitoring shows that derelict gear has become entangled or collected on any Project structure, the risk that it poses will be assessed based on type of gear, and the derelict gear will be removed as soon as is practicable while avoiding jeopardizing human safety, property, or the environment, as described in Appendix I.	$0	$0[d]	$0[d]
33b. Conduct opportunistic visual observations in the portions of the WEC test site during vessel-based visits for operations, maintenance, or environmental monitoring work, to detect and document any instances of seabird perching.	$0	$0[d]	$0[d]
33c. Use low-intensity flashing lights and bird-friendly wavelengths on the Project structures to minimize seabird attraction and follow the specifications for Project lighting developed in consultation with the FWS and U.S. Coast Guard.	$0	$0[b]	$0[b]
33d. Minimize lighting (e.g., use low intensity, bird-friendly wavelengths, shielded lighting not providing upward-pointing light or light directed at the sea surface) used at night by service and support vessels to reduce the potential for seabird attraction.	$0	$0[b]	$0[b]
33e. Require vessel operators to follow FWS instructions regarding appropriate handling and release of seabirds in the event of seabird fallout.	$0	$0	$0

Proposed Environmental Measures	Capital Cost (2019$)	Annual Cost (2019$)	Levelized Annual Cost (2019$)[f]
33f. Require vessel operators to remain 500 feet away from seabird colonies during the nesting season to minimize disturbance to nesting seabirds.	$0	$0	$0
33g. Develop and implement an Emergency Response and Recovery Plan (Appendix G).	$0	$0[a]	$0[a]
Terrestrial Resources			
34. Minimize or avoid terrestrial activities in sensitive ecological areas (e.g., jurisdictional wetlands and nesting areas for listed avian species).	$0[c]	$0	$0
35. Use HDD to install the cable conduits under the beach and sand dune habitat.	$0[c]	$0	$0
36. Use HDD to install the terrestrial cable conduits directly from the Driftwood site to the UCMF, and from the UCMF to the Highway 101 grid connection point, minimizing effects to wetlands, streams, and terrestrial habitat.	$0[c]	$0	$0
37. Employ environmental measures during installation, operation, and removal to avoid or minimize potential effects to sediment and soils. For example: • Minimize disruption of terrestrial geology and soils by maintaining buffers around wetlands to the degree practicable. • Develop and implement Erosion and Sediment Control Plans and maintaining natural surface drainage patterns. • Develop and implement stormwater runoff containment at terrestrial facilities to maintain existing drainage patterns, protect Project-adjacent habitat, and prevent contamination of streams. Develop a stormwater plan that meets all federal and state legal requirements during site design of the UCMF and associated facilities prior to any construction activities at the site.	$0[c]	$0	$0
38. Avoid to the extent practicable, disturbance of snags and of wildlife or legacy trees including live or dead trees that provide benefit to wildlife. If unavoidable, additional pre-construction, species-specific surveys may be necessary to minimize effects.	$0[c]	$0	$0
39. Avoid to the extent practicable, disturbance of forested wetlands.	$0[c]	$0	$0
40. Avoid to the extent practicable, disturbance of wetlands and adjacent areas that may provide habitat for turtles, amphibians, and other semi-aquatic wildlife.	$0[c]	$0	$0
41. Avoid to the extent practicable, disturbance of riparian wetlands where restoration of natural hydrology may be unsuccessful within a short timeframe. Natural hydrology should be restored after construction is complete and may require a restoration plan with monitoring until successful restoration can be determined.	$0[c]	$0	$0

Proposed Environmental Measures	Capital Cost (2019$)	Annual Cost (2019$)	Levelized Annual Cost (2019$)[f]
42. Minimize disturbance of streams that support fish, or are connected to fish-bearing streams. Unavoidable work within or adjacent to fish-bearing streams may be subject to in-water work windows. If terrestrial activities directly or indirectly affect any stream used by anadromous fish or fish listed as threatened or endangered under the federal or state ESA, consult with NMFS/FWS staff to avoid and minimize any potential effects to listed species.	$0[c]	$0	$0
43. Avoid to the extent practicable, disturbance of seaside hoary elfin butterfly habitat within and in the vicinity of Driftwood Beach State Recreation Site. The current construction footprint has the Project well within the parking lot boundary of Driftwood, therefore interaction with kinnikinnick will be unlikely. Where unavoidable, species-specific surveys may be necessary on properties outside of Driftwood Beach State Recreation Site but within the construction footprint to determine the extent of occupied habitat and associated mitigation[23].	$0[c]	$0	$0
44. Develop a revegetation plan, in consultation with NMFS, ODFW, and appropriate agencies, using native species to the extent practicable for areas disturbed during construction. This plan will include the minimization measures identified in letters commenting on the DLA filed with FERC by NMFS (dated July 18, 2018) and ODFW (dated July 20, 2018) as appropriate.	$0[c]	$0	$0
45. Develop measures that will limit the introduction or spread of invasive species, to be included in a construction plan.	$0[c]	$0	$0
46. Implement the Environmental Measures section as described in the Bird and Bat Conservation Strategy (Appendix B) to assess, minimize, and avoid impacts to birds and bats; these are annotated below. • No HDD construction equipment or construction activities will occur on Driftwood Beach within suitable snowy plover nesting, roosting, or foraging habitat and is expected to be limited to the Driftwood Beach parking lot, at least 164 feet (50 meters) from any potentially suitable habitat. • HDD operations in the parking lot will occur during daylight hours, but if lighting is required at night it will be appropriately shielded and directed to minimize artificial light reaching western	$0[c]	$0	$0

[23] For information on survey protocols, see Interagency Special Status/Sensitive Species Program (ISSSSP) 2005.

Proposed Environmental Measures	Capital Cost (2019$)	Annual Cost (2019$)	Levelized Annual Cost (2019$)[f]
snowy plover nesting habitat at night. Animal-proof litter receptacles and related signage and coordination will be provided to minimize potential attraction of predators. • Develop and implement an HDD Contingency Plan to minimize the potential for inadvertent return of drilling fluids, provide timely detection, and address potential releases by describing monitoring, containment, response and notification procedures to be implemented by the contractor. • If HDD is initiated during the western snowy plover nesting season (March 15 to September 15), prior to operation of the HDD, surveys of suitable nesting habitat will be conducted. If nests are detected, measures specified in the BBCS will be implemented, including noise monitoring and implementation of engineering controls, if appropriate (e.g., install temporary noise barriers such as berms, stockpiles, dumpsters, bins, and/or engineered acoustical barriers). • Prior to any vegetation clearing that occurs within the nesting season, pre-construction surveys for nesting birds will be conducted by a qualified biologist to ensure that no nests will be disturbed during vegetation clearing. • To minimize Project-related impacts on non-listed terrestrial nesting birds and avoid the creation of potential conflicts or constraints that the presence of active nests would have on Project activities (vegetation clearing), qualified biologists will remove nest-starts for any birds other than bald eagles or raptors when observed, if found within the Project footprint and within 100 feet of a construction zone and where feasible. • If an active nest is found sufficiently close to work areas to be disturbed by these activities, the biologist will determine the extent of a construction-free buffer zone to be established around the nest (typically 300 feet for raptors and 100 feet for other species), to ensure that no nests of species protected by the MBTA will be disturbed during Project construction. • If nesting bald or golden eagles are identified, activities will be restricted near nest sites according to guidelines suggested in the National Bald Eagle Management Guidelines (FWS 2007). • If construction activities will not be initiated until after the start of the nesting season, all potential nesting substrates (e.g., bushes, trees, snags, grasses, and other vegetation) that are planned to be removed, will be removed in late winter, prior to the start of the nesting season. • If necessary, the prescribed no-disturbance nesting buffers may be adjusted to reflect existing conditions including ambient noise, topography, and disturbance with approval of ODFW. • Conduct preconstruction surveys for roosting bats, and minimize construction impacts from high frequency sound disturbance, night lighting, and air quality degradation near roosts by			

Proposed Environmental Measures	Capital Cost (2019$)	Annual Cost (2019$)	Levelized Annual Cost (2019$)[f]
implementing bat roost buffers, or excluding bats within bat roost buffers, or developing species and equipment specific buffers, use noise controls, and monitor bat roost activity before, during and after construction. • If lighting is required at the UCMF, it will be appropriately shielded and directed to minimize artificial light attraction and prevent potential injury or mortality to seabirds. To the maximum extent practicable, while allowing for the public safety, low intensity energy saving lighting (e.g., low pressure sodium lamps) will be used, and bright white light will be minimized to the maximum extent practicable.			
Recreation, Ocean Use, and Land Use			
47. Mark Project structures with appropriate navigation aids, as required by the USCG.	$0	$0[b]	$0[b]
48. Avoid, to the extent practicable, anchoring in areas known to contain hard substrate or rocky reef habitats as identified by available seafloor mapping.	$0	Cost above in Item 23	Cost above in Item 23
49. Conduct outreach to inform mariners of Project structures or activities to be avoided in the area (e.g., Notice to Mariners, flyers posted at marinas and docks).	$0	$10,000	$12,700
50. Install subsurface floats at sufficient depth to avoid potential vessel strike.	$0	$0[b]	$0[b]
51. Work cooperatively with commercial, charter and recreational fishing entities and interests to avoid and minimize potential space-use conflicts with commercial and recreational interests during construction and operation.	$0	$50,000	$63,502
52. Bury submarine cables 1 to 2 m deep where feasible to minimize interactions with fishing gear and anchors.	$0	$0[b]	$0[b]
Recreation, Ocean Use, and Land Use – Terrestrial Use and Recreation			
53. Use HDD to install the terrestrial cable conduits directly from the Driftwood site to the UCMF, and from the UCMF to the Highway 101 grid connection point, thus minimizing effects to adjacent landowners and traffic along Highway 101.	$0[c]	$0	$0
54. If acceptable to OPRD, develop and install an interpretive display describing PacWave South in the Driftwood Beach State Recreation Site. OSU would work with OPRD to develop a plan regarding the interpretive display.	$25,000	$0	$1,058
55. Comply with all state and local permitting requirements for all construction work.	$0[c]	$0	$0
56. Use construction fencing to isolate work areas from park lands.	$0[c]	$0	$0
57. Although non-Project related vehicular access to the Driftwood Beach State Recreation Site would be prohibited during construction, OSU would arrange the construction work area to maintain	$0[c]	$0	$0

Proposed Environmental Measures	Capital Cost (2019$)	Annual Cost (2019$)	Levelized Annual Cost (2019$)[f]
pedestrian public beach access, if safe and practicable. OSU would coordinate with OPRD to minimize impacts to public access and use of Driftwood Beach State Recreation Site.			
58. Construction work areas or staging areas should be sited on other disturbed areas if possible.	$0[c]	$0	$0
Socioeconomic Resources – Included above under Recreation, Ocean Use and Land Use			

[a] No costs estimated since costs would be dependent on the frequency and nature of any unplanned events that occur.

[b] Cost to implement this environmental measure is included in Project operations and maintenance costs that OSU has estimated to be approximately $4 million annually (2019$).

[c] Cost to implement this environmental measure is included in Project construction capital costs that OSU has estimated to be approximately $55 million (2019$).

[d] Costs to implement this environmental measure is included in Project monitoring costs that OSU has estimated to be approximately $500,000 annually (2019$).

[e] Industry standards are sometimes published in written documents (e.g., the International Cable Protection Committee's cable recommendations available at https://www.iscpc.org/publications/recommendations/) or in manufacturer guidelines (e.g., for a vessel anchor, providing the recommended ratio of water depth to anchor line paid out). These standards are sometimes required as a condition of insurance or warranty. In other cases, industry standards represent unpublished best practices commonly implemented by a particular industry and that evolve over time.

[f] Levelized annual costs is calculated based on the annualized cost of the capital expenditures divided by 30 years.

5.0 CONCLUSIONS AND RECOMMENDATIONS

5.1 COMPARISON OF ALTERNATIVES

As discussed in Section 2.1 and 3.4, if PacWave South is not developed (No-Action Alternative), the minor environmental effects associated with construction and operation of the proposed Project would not occur. Electrical generation from the ocean resources of Oregon would not occur, and the power that would have been generated from this renewable technology would continue to be provided to residents and businesses in Oregon through a mix of standard hydropower, natural gas, and other resources. The Project would not be available to advance the development of marine renewable energy technologies and evaluate the potential environmental effects of these technologies.

5.2 COMPREHENSIVE DEVELOPMENT AND RECOMMENDED ALTERNATIVE

Sections 4(e) and 10(a)(1) of the FPA require the Commission to give equal consideration to the power development purposes and to the purposes of energy conservation, the protection, mitigation of damage to, and enhancement of fish and wildlife, the protection of recreational opportunities, and the preservation of other aspects of environmental quality. Any license issued shall be such as in the Commission's judgment will be best adapted to a comprehensive plan for improving or developing a waterway or waterways for all beneficial public uses.

PacWave South would serve as an integrated test center to evaluate the performance of commercial scale or near-commercial scale WECs. As a secondary benefit, the Project would provide electricity to the Oregon coast region. This Project would specifically support the mission, vision, and goals of the DOE Office of Energy Efficiency and Renewable Energy Water Power Technologies Office to improve performance, lower costs, and accelerate deployment of innovative technologies for clean, domestic power generation from resources such as hydropower, waves, and tidal power technologies.

The successful development of PacWave South would create the potential for an emergent renewable energy industry segment to bring clean, competitively priced electricity to commercial and residential consumers in Oregon and other coastal U.S. states. From its contribution to a diversified generation mix and the potential for displacement of non-renewable fossil-fueled generation, the Project will help meet a need for renewable, emission free, and environmentally responsible energy in Oregon.

OSU proposes to construct and operate the Project as proposed in this document and to implement the following environmental measures:

General

- Implement the Adaptive Management Framework (Appendix J) in conjunction with specific PM&E measures to evaluate study results, identify any Project effects, and implement and/or modify response actions (Appendix I) in consultation with key agency stakeholders.
- Beginning five years and six months after deployment of the first WEC at the Project, and recurring every five years thereafter, the licensee shall file with FERC a Five Year Report and provide copies to BOEM, NMFS, FWS, and ODFW. Contents of the report are further described in Appendix I, Protection, Mitigation, and Enhancement Measures.
- Employ periodic, routine inspection and maintenance methods to ensure structural integrity of Project components (Appendix F, Operation and Maintenance Plan).
- Develop and implement the Emergency Response and Recovery Plan (Appendix G).

Geologic and Soil Resources

- Use HDD to install the cables under the nearshore and intertidal habitat (to approximately the 10-m isobath) to minimize substrate disturbance.
- Use HDD to install the terrestrial cables in up to five bores, from the beach manholes at the Driftwood Beach State Recreation Site to the UCMF property, and from the UCMF to the Highway 101 grid connection point, to minimize habitat disturbance.
- Follow best practices during installation, operation, and removal activities to avoid or minimize potential effects to sediment, including:
    - Minimize the time that the seafloor is disturbed and sediment is dispersed and the associated effects by completing cable laying and other construction activities during appropriate construction windows and within one construction season to the extent practicable.
    - Develop and implement an Erosion and Sediment Control Plan, where appropriate, to minimize effects of ground disturbing activities associated with installation of the terrestrial cables and/or other terrestrial construction
- Implement the Benthic Sediments Monitoring Plan (Appendix H) to evaluate effects on benthic habitat from anchors, WECs, and other equipment during operation, maintenance and monitoring activities. Based on monitoring results, implement the specified measures to mitigate for potential adverse effects (Appendix I).
- Project components in the estuarine environment should not bottom out so as to prevent nearshore/estuarine habitat effects.
- To the extent practicable, minimize frequency of anchor installation/removal cycles and reuse installed anchors.

Water Resources

- Follow industry best practices and guidelines[24] for antifouling applications (e.g., TBT-free) on Project structures such as marker buoys, subsurface floats and WECs.
- Develop and implement an Emergency Response and Recovery Plan (Appendix G) with spill prevention, response actions, and control protocols, as well as and provisions for recording types and amounts of hazardous fluids contained in WECs and other Project components.
- Require all vessel operators to comply with an Emergency Response and Recovery Plan (Appendix G) for installation and maintenance of Project facilities.
- Prepare waste management, hazardous material, and spill prevention plans, as appropriate, for onshore Project facilities.
- Minimize storage and staging of WECs outside of existing dock, port or other marine industrial facilities.
- Require that all Project chartered or contracted vessels comply with current federal and state laws and regulations regarding aquatic invasive species management.
- Develop and implement an HDD Contingency Plan to minimize the potential for inadvertent return of drilling fluids, provide timely detection, and address potential releases by describing monitoring, containment, response and notification procedures to be implemented by the contractor.

Aquatic Resources and Threatened and Endangered Species

General

- Bury subsea cables at a depth of 1-2 meters, to the maximum extent practicable, to minimize the amount of habitat conversion (soft bottom to hard structure) from laying exposed cable on the seafloor. In areas where a cable cannot be buried or persistently becomes unburied, that portion of the cable will be on the seafloor and will be protected by split pipe, concrete mattresses or other cable protection systems.
- To the maximum extent practicable, utilize shielding on subsea cables, umbilicals, and other electrical infrastructure to minimize EMF emissions.

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[24] Industry standards are sometimes published in written documents (e.g., the International Cable Protection Committee's cable recommendations available at https://www.iscpc.org/publications/recommendations/) or in manufacturer guidelines (e.g., for a vessel anchor, providing the recommended ratio of water depth to anchor line paid out). These standards are sometimes required as a condition of insurance or warranty. In other cases, industry standards represent unpublished best practices commonly implemented by a particular industry and that evolve over time.

- Implement the EMF Monitoring Plan (Appendix H) to measure Project-related EMF emissions. Based on monitoring results, implement the specified measures to mitigate for potential adverse effects (Appendix I).
- In the event of an emergency in which fish or wildlife are being killed, harmed or endangered by Project facilities or operations in a manner that was not anticipated, OSU will notify agencies with regulatory authority as soon as possible and take action to promptly minimize the impacts of the emergency, including implementing any guidance pursuant to agency legal authorities, as outlined in Appendix I.

Fish and Invertebrates

- Implement the Organism Interactions Monitoring Plan to track changes to pelagic and demersal fish and invertebrates (particularly Dungeness crab) that might be attracted to the installed components or affected due to the potential for reduced fishing pressure, as well as biofouling on the anchors/WECs (Appendix H).
- Develop cable routes that avoid crossing areas with rocky reef and hard substrate to the maximum extent practicable to protect sensitive habitat features.
- Develop and implement an anchoring plan or protocol for any Project vessels that may anchor at the Project site, that:
    - Avoids anchoring in known rocky reef or hard substrate habitats to the maximum extent practicable; and
    - Minimizes the use of anchors within the Project area wherever practicable by combining onsite activities.

Marine Mammals

- Entangled fishing gear
    - Conduct opportunistic visual observations from the water surface in the portions of the test site which are being visited to conduct operations, maintenance, or environmental monitoring work and review any underwater visual monitoring conducted for other purposes to detect entangled fishing gear that has the potential to increase the risk of marine species entanglement. The licensee will ensure that surface observations occur during all visits to the Project test site, and at least once per quarter each year for the duration of the license.
    - Annually following the peak storm season and period of maximum activity for the Dungeness crab fishery, the licensee shall conduct surface surveys of active WEC berths during the spring season (mid-March through mid-June), or the earliest possible time after that period that avoids jeopardizing human safety, property or the environment.

  - Conduct annual subsurface surveys of moorings and anchor systems using ROV or other appropriate techniques with approval by NMFS concurrent with spring (mid-March through mid-June) monitoring under the Organism Interactions Monitoring Plan (Appendix H).
  - If entangled fishing gear or marine mammal (or sea turtle) stranding, entanglements, impingements, injuries or mortalities are detected, implement the specified measures to minimize risk of marine mammal entanglement and to make every effort to return the fishing gear to the owners (Appendix I).
- Require vessels in transit to/from the Project site to avoid close contact with marine mammals and sea turtles and adhere to NMFS "Be Whale Wise" guidelines to minimize potential vessel impacts to marine mammals.
- Comply with current regulations that require marine mammal observers for certain vessel based activity (e.g., sub-bottom profiling).
- Require WEC testing clients to keep their equipment in good working order to minimize sound due to faulty or poorly maintained equipment.
- Implement the Acoustics Monitoring Plan (Appendix H) to quantify sound levels using field measurements and validated sound propagation models. Based on monitoring results, implement specified measures to mitigate for potential adverse effects (Appendix I).
- Minimize construction activities during key gray whale migration periods, to the extent possible.
- For use of Dynamic Positioning Vessels or other equipment that may exceed NMFS's published threshold for injury:
  - Avoid use of these vessels to the maximum extent practicable during Phase B gray whale migration (April 1-June 15). If these construction activities are proposed during this migration period, the licensee will consult with ODFW regarding the timing of such activities including cable-laying in state waters.
  - With technical assistance from NMFS, establish and carry out the following actions and protocols necessary to maintain an appropriate acoustic zone of influence in accordance with NMFS's published harassment threshold (120 dB re: 1 μPa) during DPV operations to minimize behavioral disturbance and protect marine resources:
    - Post qualified marine mammal observers during daylight hours.
    - The licensee will conduct dynamic positioning (DP) activities during daylight hours when feasible to ensure observations may be carried out.
    - DP for cable laying may occur during all hours; however, DP start up for cable laying will only occur during daylight hours.
    - The licensee will carry out the ramp-up procedures that are specified in Appendix I, which may be modified by agreement of the licensee and NMFS.

    - Implement such additional measures as may be imposed pursuant to a Marine Mammal Protection Act authorization.
- Make opportunistic visual observations of pinnipeds in the portions of the test site which are being visited to conduct operations, maintenance, or environmental monitoring work. If pinnipeds are observed to be hauled out on Project structures, the licensee will follow the reporting and haulout protocols specified in Appendix I.
- To the extent practicable, direct the WEC testing clients to design and maintain cables and moorings in configurations that minimize the potential for marine mammal or sea turtle entrapment or entanglement and follow the reporting and haulout protocols specified in Appendix I.

Seabirds

- Implement the Environmental Measures section as described in the Bird and Bat Conservation Strategy (Appendix B) to assess, minimize, and avoid impacts to birds, these are annotated below:
    - Conduct opportunistic visual observations from the water surface in the portions of the test site that are being visited to conduct operations, maintenance, or environmental monitoring work, and review any underwater visual monitoring conducted for other purposes, to detect derelict gear that has the potential to increase the risk of marine species entanglement. If monitoring shows that derelict gear has become entangled or collected on any Project structure, the risk that it poses will be assessed based on type of gear, and the derelict gear will be removed as soon as is practicable while avoiding jeopardizing human safety, property, or the environment, as described in Appendix I.
    - Conduct opportunistic visual observations in the portions of the WEC test site during vessel-based visits for operations, maintenance or environmental monitoring work, to detect and document any instances of seabird perching.
    - Use low-intensity flashing lights and bird-friendly wavelengths on the Project structures to minimize seabird attraction and follow the specifications for Project lighting developed in consultation with the FWS and U.S. Coast Guard.
    - Minimize lighting (e.g., use low intensity, bird-friendly wavelengths, shielded lighting not providing upward-pointing light or light directed at the sea surface) used at night by service and support vessels to reduce the potential for seabird attraction.
    - Require vessel operators to follow FWS instructions regarding appropriate handling and release of seabirds in the event of seabird fallout.
    - Require vessel operators to remain 500 feet away from seabird colonies during the nesting season to minimize disturbance to nesting seabirds.

  - Develop and implement an Emergency Response and Recovery Plan (Appendix G).

Terrestrial Resources

- Minimize or avoid terrestrial activities in sensitive ecological areas (e.g., jurisdictional wetlands and nesting areas for listed avian species).
- Use HDD to install the cables under the beach and sand dune habitat.
- Use HDD to install the terrestrial cables directly from the Driftwood site to the UCMF, and from the UCMF to the Highway 101 grid connection point, minimizing effects to wetlands, streams, and terrestrial habitat.
- Employ environmental measures during installation, operation, and removal to avoid or minimize potential effects to sediment and soils. For example:
  - Minimize disruption of terrestrial geology and soils by maintaining buffers around wetlands to the degree practicable.
  - Develop and implement an Erosion and Sediment Control Plan, and maintaining natural surface drainage patterns.
  - Develop and implement stormwater runoff containment at terrestrial facilities to maintain existing drainage patterns, protect Project-adjacent habitat, and prevent contamination of streams. Develop a stormwater plan that meets all federal and state legal requirements during site design of the UCMF and associated facilities prior to any construction activities at the site.
- Avoid to the extent practicable, disturbance of snags and of wildlife or legacy trees including live or dead trees that provide benefit to wildlife. If unavoidable, additional pre-construction species specific surveys may be necessary to minimize effects.
- Avoid to the extent practicable, disturbance of forested wetlands.
- Avoid to the extent practicable, disturbance of wetlands and adjacent areas that may provide habitat for turtles, amphibians, and other semi-aquatic wildlife.
- Avoid to the extent practicable, disturbance of riparian wetlands where restoration of natural hydrology may be unsuccessful within a short timeframe. Natural hydrology should be restored after construction is complete, and may require a restoration plan with monitoring until successful restoration can be determined.
- Minimize disturbance of streams that support fish, or are connected to fish-bearing streams. Unavoidable work within or adjacent to fish-bearing streams may be subject to in-water work windows. If terrestrial activities directly or indirectly affect any stream used by anadromous fish or fish listed as threatened or endangered under the federal ESA, consult with NMFS staff to avoid and minimize any potential effects to listed species.
- Avoid to the extent practicable, disturbance of seaside hoary elfin butterfly habitat within and in the vicinity of Driftwood Beach State Recreation Site. The current construction

footprint has the Project well within the parking lot boundary of Driftwood, therefore interaction with kinnikinnick will be unlikely. Where unavoidable, species-specific surveys may be necessary on properties outside of Driftwood Beach State Recreation Site but within the construction footprint to determine the extent of occupied habitat and associated mitigation[25].

- Develop a revegetation plan, in consultation with NMFS, ODFW, and appropriate agencies, using native species to the extent practicable for areas disturbed during construction. This plan will include the minimization measures identified in letters commenting on the DLA filed with FERC by NMFS (dated July 18, 2018) and ODFW (dated July 20, 2018) as appropriate.
- Develop measures that will limit the introduction or spread of invasive species, to be included in a construction plan.
- Implement the Environmental Measures section as described in the Bird and Bat Conservation Strategy (Appendix B) to assess, minimize, and avoid impacts to birds and bats; these are annotated below.
    - No HDD construction equipment or construction activities will occur on Driftwood Beach within suitable snowy plover nesting, roosting, or foraging habitat and is expected to be limited to the Driftwood Beach parking lot, at least 164 feet (50 meters) from any potentially suitable habitat.
    - HDD operations in the parking lot will occur during daylight hours, but if lighting is required at night it will be appropriately shielded and directed to minimize artificial light reaching western snowy plover nesting habitat at night. Animal-proof litter receptacles and related signage and coordination will be provided to minimize potential attraction of predators.
    - Develop and implement an HDD Contingency Plan to minimize the potential for inadvertent return of drilling fluids, provide timely detection, and address potential releases by describing monitoring, containment, response and notification procedures to be implemented by the contractor.
    - If HDD is initiated during the western snowy plover nesting season (March 15 to September 15), prior to operation of the HDD, surveys of suitable nesting habitat will be conducted. If nests are detected, measures specified in the BBCS will be implemented, including noise monitoring and implementation of engineering controls, if appropriate (e.g., install temporary noise barriers such as berms, stockpiles, dumpsters, bins, and/or engineered acoustical barriers).

[25] For information on survey protocols, see Interagency Special Status/Sensitive Species Program (ISSSSP) 2005.

- Prior to any vegetation clearing that occurs within the nesting season, pre-construction surveys for nesting birds will be conducted by a qualified biologist to ensure that no nests will be disturbed during vegetation clearing.
- To minimize Project-related impacts on non-listed terrestrial nesting birds and avoid the creation of potential conflicts or constraints that the presence of active nests would have on Project activities (vegetation clearing), qualified biologists will remove nest-starts for any birds other than bald eagles or raptors when observed if found within the Project footprint and within 100 feet of a construction zone, and where feasible.
- If an active nest is found sufficiently close to work areas to be disturbed by these activities, the biologist will determine the extent of a construction-free buffer zone to be established around the nest (typically 300 feet for raptors and 100 feet for other species), to ensure that no nests of species protected by the MBTA will be disturbed during Project construction.
- If nesting bald or golden eagles are identified, activities will be restricted near nest sites according to guidelines suggested in the National Bald Eagle Management Guidelines (FWS 2007b).
- If construction activities will not be initiated until after the start of the nesting season, all potential nesting substrates (e.g., bushes, trees, snags, grasses, and other vegetation) that are planned to be removed, will be removed in late winter, prior to the start of the nesting season.
- If necessary, the prescribed no-disturbance nesting buffers may be adjusted to reflect existing conditions including ambient noise, topography, and disturbance with approval of ODFW.
- Conduct preconstruction surveys for roosting bats, and minimize construction impacts from high frequency sound disturbance, night lighting, and air quality degradation near roosts by implementing bat roost buffers, or excluding bats within bat roost buffers, or developing species and equipment specific buffers, use noise controls, and monitor bat roost activity before, during and after construction.
- If lighting is required at the UCMF, it will be appropriately shielded and directed to minimize artificial light attraction and prevent potential injury or mortality to seabirds. To the maximum extent practicable, while allowing for the public safety, low intensity energy saving lighting (e.g., low pressure sodium lamps) will be used, and bright white light will be minimized to the maximum extent practicable.

Recreation, Ocean Use, and Land Use

Ocean Use and Recreation

- Mark Project structures with appropriate navigation aids, as required by the USCG.
- Avoid, to the extent practicable, anchoring in areas known to contain hard substrate or rocky reef habitats as identified by available seafloor mapping.
- Conduct outreach to inform mariners of Project structures or activities to be avoided in the area (e.g., Notice to Mariners, flyers posted at marinas and docks).
- Install subsurface floats at sufficient depth to avoid potential vessel strike.
- Work cooperatively with commercial, charter and recreational fishing entities and interests to avoid and minimize potential space-use conflicts with commercial and recreational interests during construction and operation.
- Bury submarine cables 1 to 2 m deep where feasible to minimize interactions with fishing gear and anchors.

Terrestrial Use and Recreation

- Use HDD to install the terrestrial cable conduits directly from the Driftwood site to the UCMF, and from the UCMF to the Highway 101 grid connection point, thus minimizing effects to adjacent landowners and traffic along Highway 101.
- If acceptable to OPRD, develop and install an interpretive display describing PacWave South in the Driftwood Beach State Recreation Site. OSU would work with OPRD to develop a plan regarding the interpretive display.
- Comply with all state and local permitting requirements for all construction work.
- Use construction fencing to isolate work areas from park lands.
- Although non-project related vehicular access to the Driftwood Beach State Recreation Site would be prohibited during construction, OSU would arrange the construction work area to maintain pedestrian public beach access, if practicable. OSU would arrange the construction work area to maintain pedestrian public beach access, if practicable. OSU would coordinate with the OPRD to mitigate impacts to public access and use of Driftwood Beach State Recreation Site.
- Construction work areas or staging areas should be sited on other disturbed areas if practicable.

Socioeconomic Resources

See Recreation, Ocean Use, and Land Use measures.

Cultural Resources

At this time, no historic properties have been identified within the APE and therefore, no impacts to historic properties have been identified. However, should historic properties be identified in the Project APE, OSU would either modify the Project to exclude the historic property from the Project APE or would develop a Historic Properties Management Plan to consider and manage identified and potential historic properties throughout the life of the FERC license. If no historic properties are identified within the Project APE and it is determined that the Project will have no effect on historic properties, OSU will move forward with Project construction and operations with an understanding that should any previously unidentified cultural resources be identified during the course of construction and operations OSU will consult with FERC to determine the best course of action pursuant to Section 106 of the NHPA.

In conclusion, OSU recommends licensing PacWave South as proposed for a term of 25 years. OSU believes the public benefits of the proposed action outweigh those of the no-action alternative. Given the growing national and regional energy demands and limitations in supply, OSU recommends that testing and development of new wave energy technologies be encouraged and promoted to increase domestic renewable energy production and to work to address climate change.

5.3 UNAVOIDABLE ADVERSE EFFECTS

The Project would be relatively small, consisting of approximately six WECs during the initial development scenario and 20 WECs for the full build-out scenario, and given the location about 6 nautical miles offshore, the overall scale of any adverse effects are expected to be minor. The footprint of the anchors, even under full build out and using the largest types of anchors, would be about 2 acres total, spread out over the deployment area. Unavoidable adverse effects to on the benthic community include placement of anchors on a small area of the seafloor and burial of the subsea cables, which could kill some slow-moving infaunal or benthic species, and would temporarily displace some marine organisms.

The Project would be located about 3 miles or farther offshore than the average distance gray whales were observed during a monitoring study (Ortega-Ortiz and Mate 2008). However, gray whales were detected as far offshore as 11 miles (Ortega-Ortiz and Mate 2008), so gray whales, as well as other whale species, would be expected to be passing through PacWave South. However, no whale collisions have been detected during operations at PacWave North or at similar Projects, such as the Hawaii Wave Energy Test Site and open ocean aquaculture facilities located off of Hawaii and New Hampshire (Section 3.3.2). Lost fishing gear could become entangled on Project components; OSU will implement the Organism Interactions Monitoring Plan to detect and remove marine debris at the Project, which would minimize the potential for marine mammals to encounter lost fishing gear at the test site and become entangled. Because of the low risk of potential Project effects and implementation of comprehensive mitigation measures designed to further minimize the potential for any adverse effects, NMFS has determined that construction and operation of the Project is not expected to result in take of marine mammals (see Appendix N).

WECs would appear very small when viewed from shore. Lights and navigation aids would be visible at some distance, but are necessary for maritime safety, and the range of visibility would vary depending on time of day and weather conditions.

5.4 RECOMMENDATIONS OF FISH AND WILDLIFE AGENCIES

Where FPA Section 10(j) fish and wildlife recommendations are submitted, the Commission is required to make a determination that the recommendations of the federal and state fish and wildlife agencies are consistent with the purpose and requirements of Part I of the FPA and applicable law. Section 10(j) states that whenever the Commission believes that a fish and wildlife agency recommendation may be inconsistent with the purposes and requirements of the FPA or other applicable law, the Commission and the agency shall attempt to resolve any such inconsistency, giving due weight to recommendations, expertise, and statutory responsibilities of such agency.

NMFS and FWS submitted comments and preliminary Section 10(j) recommendations dated July 18, 2018 and July 24, 2018, respectively. These preliminary Section 10(j) recommendations are consistent with the PM&E measures proposed by OSU in this application. For more information, OSU's responses to each of these agency recommendations are set forth in Appendix L-1.

ODFW submitted comments and preliminary Section 10(j) recommendations dated July 20, 2018. ODFW had previously indicated its agreement with the CWG work products, including the proposed PM&E measures, through a consensus decision made by the CWG on May 15, 2017. During that decision making process, and as allowed by the CWG communications protocol and noted in Table 1-4, ODFW identified just two outstanding disagreements regarding the proposed PM&E measures and indicated that the agency would address these issues through preliminary 10(j)s:

(1) the potential for EMF impacts from unshielded underwater hubs/connectors (see Appendix L-1, ODFW 4); and
(2) reducing response timeframes for exceedance of acoustic thresholds (see Appendix L-1, ODFW 8).

However, ODFW's preliminary recommendations requested additional modifications or additions that are not consistent with the agreed-upon PM&Es being proposed by OSU, including but not limited to measures regarding: gray whale migration (see Appendix L-1 at ODFW 7); enlarging the AMC's authority (see Appendix L-1 at ODFW 20); the timing of development of the HDD Contingency Plan (see Appendix L-1 at ODFW 22); marking of certain marine equipment (see Appendix L-1 at ODFW 24 and 39); contents of WEC client O&M plans (see Appendix L-1 at ODFW 25); use, removal and recovery of anchors (see Appendix L-1 at ODFW at 30 and 33); and fish attraction and entrainment (see Appendix L-1 at ODFW 46, 47 and 48). The additional measures and changes sought by ODFW are not necessary or consistent with the FPA for the reasons described in Appendix L-1, and should not be incorporated into FERC's EA or final license terms.

In addition, ODFW indicated it would need to review a final project footprint and OSU agreed to consult with ODFW in its development of the Habitat Mitigation Plan (HMP) in the months following agreement to CWG work products. ODFW submitted comments and recommendations regarding terrestrial Project components and the HMP while that consultation was ongoing (see Appendix L-1 at ODFW 9, 10, 11, 12, 13, 14, 26e, 27, 59). OSU has incorporated ODFW's comments into the FLA and the HMP attached as Appendix K and requests that FERC approve the HMP as proposed, without modification.

5.5 CONSISTENCY WITH COMPREHENSIVE PLANS

Section 10(a)(2) requires FERC to consider the extent to which a Project is consistent with federal or state comprehensive plans for developing or conserving a waterway. No inconsistencies with these plans were found.

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6.0 FINDING OF NO SIGNIFICANT IMPACT

To be completed by FERC.

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APPENDICES

APPENDIX A

Draft Biological Assessment

PACWAVE SOUTH

DRAFT BIOLOGICAL ASSESSMENT

FERC PROJECT NO. 14616

APPLICANT:

OREGON STATE UNIVERSITY
CORVALLIS, OREGON

MAY 2019

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1.0 INTRODUCTION

Oregon State University (OSU) is planning to file an application with the Federal Energy Regulatory Commission (FERC) for an original license for the installation and operation of the PacWave South (Project; formerly known as Pacific Marine Energy Center South Energy Test Site [PMEC-SETS], a grid-connected wave energy test facility (FERC Project No. 14616). The Project would be located in the Pacific Ocean, approximately 6 nautical miles off the coast of Newport, Oregon on the Outer Continental Shelf (OCS) and would occupy an area of approximately 2 square nautical miles (1,695 acres) (Figure 1-1). The Project would support up to 20 commercial-scale wave energy converters (WECs) and transfer power to a grid connection point with the Central Lincoln People's Utility District (CLPUD) in Lincoln County, Oregon. The Project could generate up to 20 megawatts (MW) that would travel through four individually buried subsea cables running from the test site to a terrestrial cable connection point at Driftwood Beach State Recreation Site in Seal Rock, Lincoln County, Oregon and then about 0.5 miles to the east and south to a newly built grid connection point with CLPUD (Figure 1-2). The portion of the OCS where the test site would be located is federal land administered by the Bureau of Ocean Energy Management (BOEM). The subsea cables would cross Oregon's territorial seas. The terrestrial components of the Project would be sited on state, county, and privately-owned lands. The Project would serve as an integrated test center. As a grid-connected test facility, PacWave South would provide U.S. and international developers, clients, utilities, and researchers with the opportunity to:

- Optimize WECs and arrays to increase their energy capture, improve their survivability and reliability, and decrease their levelized cost of energy;
- Refine deployment, recovery, operations, and maintenance procedures;
- Collect interconnection and grid synchronization data; and
- Gather information about potential environmental effects, and economic and social benefits.

FERC's issuance of a license for the PacWave South Project is a federal action that "may affect" species listed or critical habitat designated pursuant to the Endangered Species Act (ESA) and, therefore, requires consultation under Section 7 of the ESA. A federal agency may designate a non-federal representative to conduct informal consultation or prepare a draft biological assessment to assess the effects of a proposed federal action on listed species. On May 27, 2014, FERC designated OSU as its non-federal representative for ESA consultation for the licensing of the PacWave South Project. Consistent with this designation, OSU has developed this draft Biological Assessment (BA) to evaluate potential effects on species listed as endangered or threatened under the ESA. This draft BA also incorporates an evaluation of the potential effects of the Project on Essential Fish Habitat (EFH), in compliance with the Magnuson-Stevens Fishery Conservation and Management Act (Magnuson-Stevens Act).

Research and testing of WECs is needed to advance the development of marine renewable energy technologies. This Project would specifically support the mission, vision, and goals of the U.S. Department of Energy's (DOE) Office of Energy Efficiency and Renewable Energy Water Power Technologies Office to improve performance, lower costs, and accelerate deployment of innovative technologies for clean, domestic power generation from resources such as hydropower, waves and tidal power technologies by providing facilities for developers of WEC technology to conduct full-scale, open-ocean testing of WECs, thereby reducing the time and costs associated with siting individual grid-connected projects. Renewable energy test facilities, like PacWave South, can support the development of new technologies and help displace non-renewable, fossil fuel-fired generation and contribute to a diversified mix of energy generation. OSU believes that once the Project develops, the capital costs of wave energy would become more competitive with traditional generation sources. Testing conducted at PacWave South would advance the development of WEC technologies, and further the nation's efforts to reduce its greenhouse gas emissions, diversify its energy supply, provide cost-competitive electricity to key coastal regions, and stimulate revitalization of key sectors of the economy.

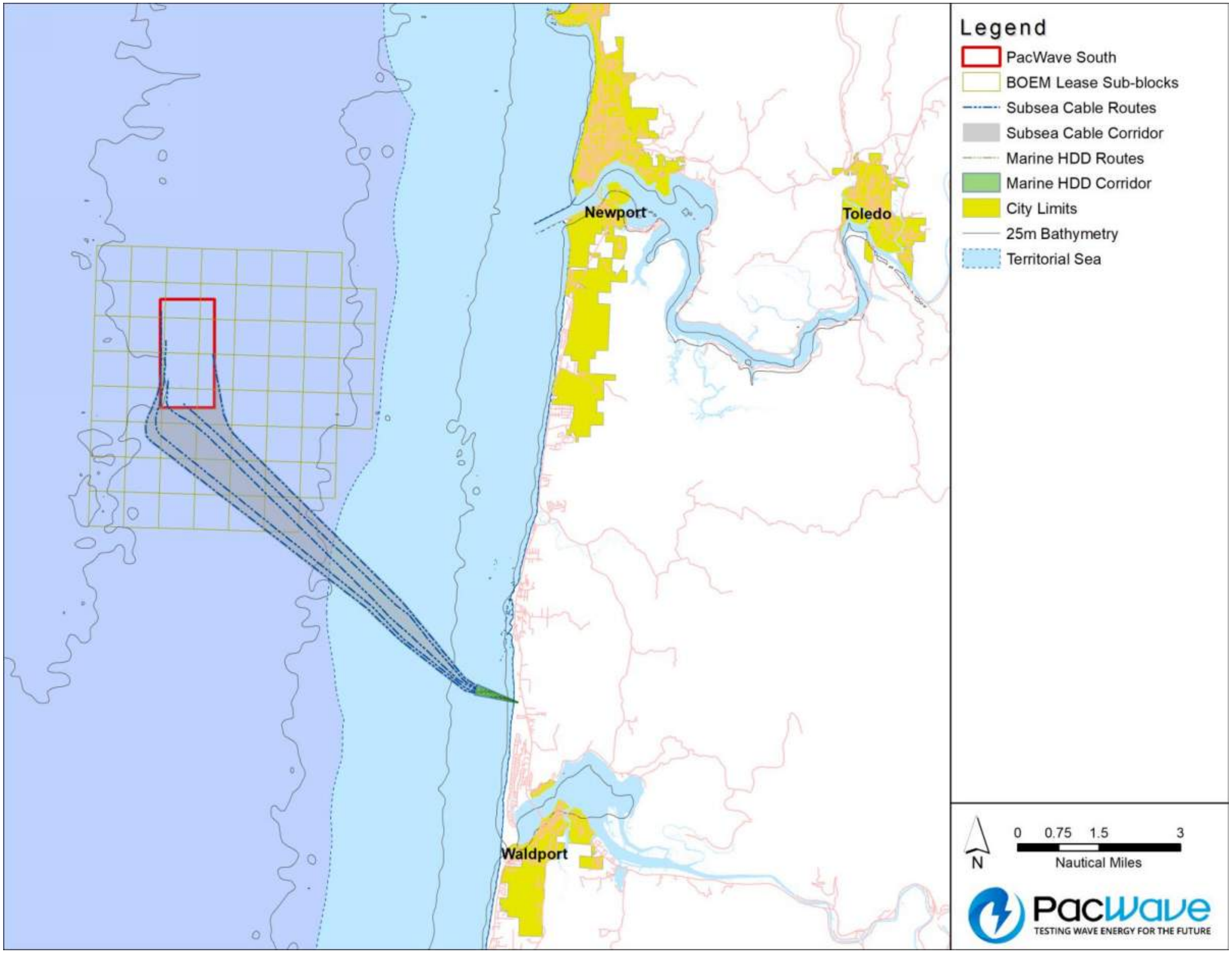

Figure 1-1. Marine area of PacWave South.

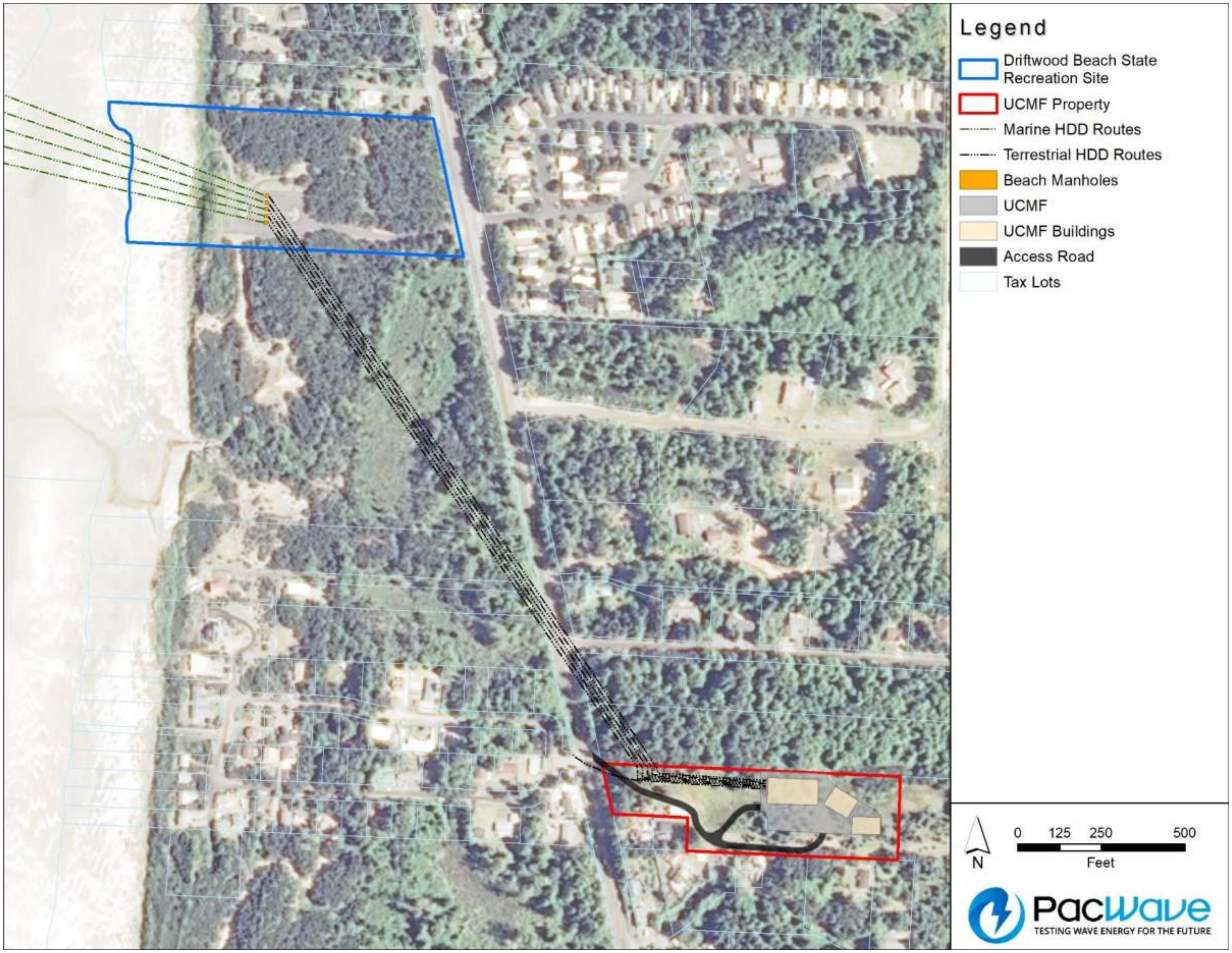

Figure 1-2. Terrestrial area of PacWave South.

1.1 BACKGROUND

FERC, under the authority of the Federal Power Act (FPA), may issue licenses for terms of up to 50 years for the construction, operation, and maintenance of non-federal hydroelectric projects. OSU is requesting a 25-year license to construct and operate the Project. Under Section 7 of the ESA, federal agencies are required to ensure that their actions are not likely to jeopardize the continued existence of endangered or threatened species or result in the destruction or adverse modification of the critical habitat of such species. In this case, issuance of a license for the construction and operation of PacWave South requires FERC to consult with the U.S. Fish and Wildlife Service (FWS) and the National Marine Fisheries Service (NMFS) regarding potential effects of the Project on federally listed or proposed endangered or threatened species and their designated critical habitat.

In a notice dated May 27, 2014, FERC designated OSU as its non-federal representative for carrying out informal consultation pursuant to Section 7 of the ESA. OSU determined with input from NMFS and FWS that 39 fish, reptile, and marine mammal, and bird species listed under the ESA may occur in the action area. Critical habitat has been proposed or designated for 32 of these species, though the only designated critical habitats that overlap the Project footprint are for green sturgeon and leatherback sea turtle. FWS identified four federally listed bird species under its jurisdiction that may occur in the vicinity of the Project (letter from FWS to FERC dated August 1, 2014 and subsequent discussions). Through interagency meetings related to the FPA licensing process, OSU has been coordinating with NMFS, FWS, and other resource agencies to identify potential Project effects, the likelihood of harm from those effects on ESA-listed species and their habitats, and the need for measures to mitigate or monitor species' interactions with Project components.

OSU has conducted site characterization studies at PacWave South in 2013, 2014, and 2015, evaluating sediment and macrofauna, crabs, reefs, sea birds, and marine mammals in support of defining the environmental baseline conditions of the action area (see Section 3.0). Some of the information gathered from these studies, such as benthic data, may also serve as "pre-installation" data against which post-installation data would be compared to evaluate Project effects. In addition to site specific surveys, OSU has been conducting ongoing environmental studies at the nearby (approximately 8 nautical miles) PacWave North[1] (formerly known as the Pacific Marine Energy Center North Energy Test Site [PMEC-NETS]) since 2009; where applicable, information collected at PacWave North was used to inform assessment of environmental baseline of the action area (Figure 1-3). During Project operation, OSU will implement monitoring programs for acoustics, benthic, and electromagnetic fields to confirm

[1] PacWave North is an existing wave energy test facility developed by OSU in 2012. The facility, which is north of the proposed PacWave South site, is not grid connected and is not part of the PacWave South license application.

assumptions on level and durations of effects, and modify actions as needed in consultation with appropriate agencies or pursuant to the Adaptive Management Framework.

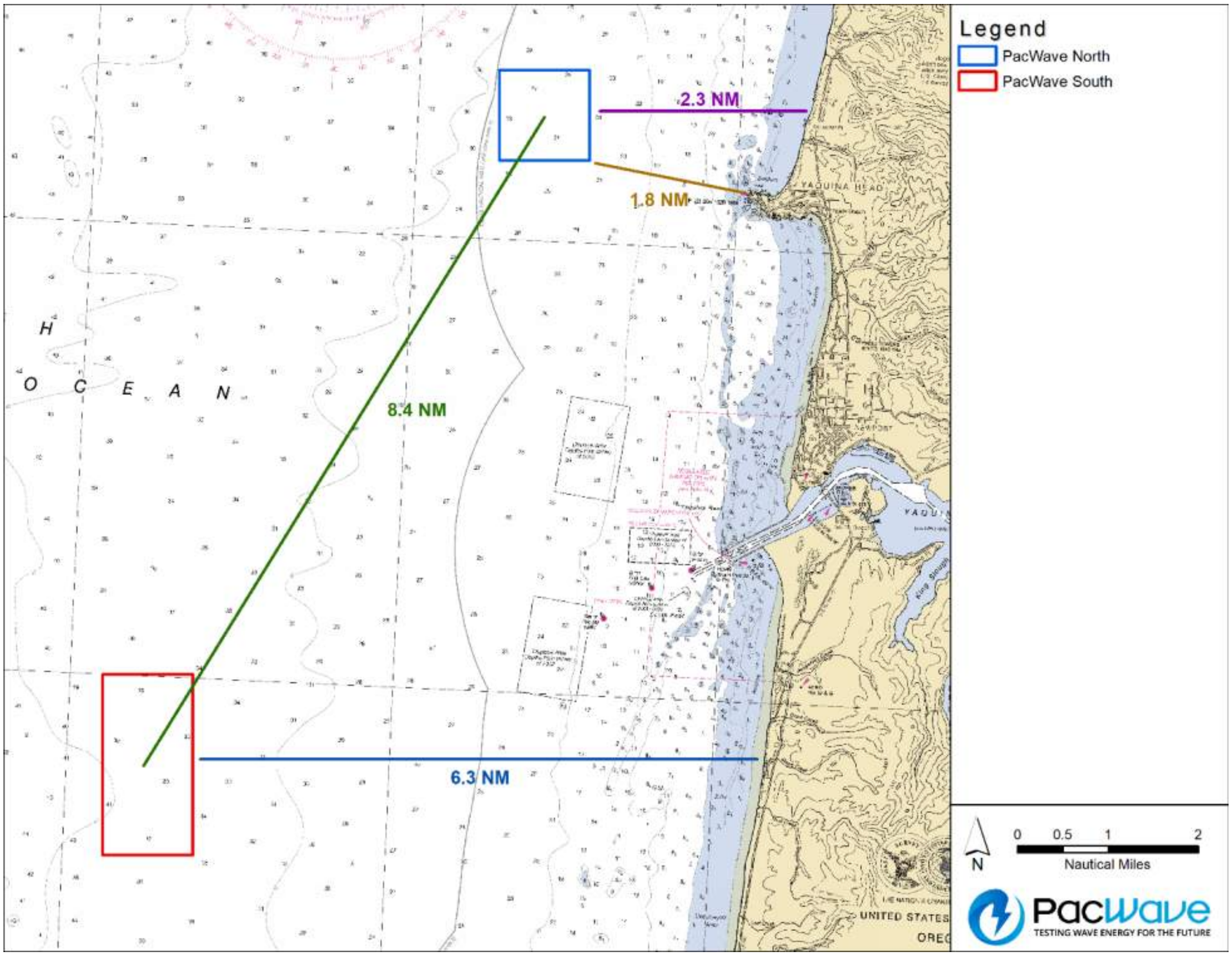

Figure 1-3. Location of PacWave South, relative to PacWave North.

1.2 CONSULTATION HISTORY

In conjunction with the community site selection process, OSU began engaging with both FERC and BOEM in fall 2012 to share information about the Project and help prepare for the regulatory process. OSU held conference calls with each agency individually to share initial information about the Project, followed by a conference call with FERC and BOEM to discuss the licensing and leasing processes. In January 2013, OSU formed an advisory team comprised of federal and state agencies involved in the PacWave South authorization process, including NMFS and FWS, as well as non-governmental organizations representing stakeholder interests, to collectively explore the Project and identify key regulatory and environmental considerations, including potential impacts to ESA-listed species and critical habitat. In 2014, this group was designated as the Collaborative Workgroup (CWG).

A primary focus of the CWG was on how the Project would meet regulatory standards and undertake approval processes under the FPA and other federal and state approvals. As part of these efforts, OSU and other members of the CWG agreed that the Alternative Licensing Process (ALP) would be the most appropriate FPA licensing process for PacWave South because it would allow the CWG members to work cooperatively toward the ultimate OSU licensing proposal. As a requirement of FERC's alternative procedure, a Communications Protocol was established to guide the CWG's consensus-based collaborative process. Additional details about the establishment of the CWG, as well as the process used to develop and reach consensus, are provided in the Request to Use the ALP and the associated Communications Protocol that were filed with FERC with the Pre-Application Document (PAD) in April 2014. In a notice dated May 27, 2014, FERC designated OSU as its non-federal representative for carrying out informal consultation pursuant to Section 7 of the ESA. NMFS identified 35 federally listed species under its jurisdiction that may occur within the vicinity of the Project (letter from NMFS to OSU dated May 22, 2015), including six species of whales, four species of sea turtles, 23 species of salmonids, one species of sturgeon, and one species of smelt (eulachon). Critical habitat has been proposed or designated for 32 of these species, though the only designated critical habitats that overlap the Project footprint are for green sturgeon and leatherback sea turtle. FWS identified four federally listed bird species under its jurisdiction that may occur in the vicinity of the Project (letter from FWS to FERC dated August 1, 2014 and subsequent discussions). Through interagency meetings related to the FPA licensing process, OSU has been coordinating with NMFS and other resource agencies to identify potential Project impacts, the likelihood of harm from those impacts on ESA-listed species and their habitats, and the need for measures to mitigate or monitor species' interactions with Project components.

A draft preliminary draft environmental assessment (PDEA) was developed and sent to NMFS and other resource agencies on March 24, 2015. Among other things, the draft PDEA analyzed potential effects of the Project on threatened and endangered species and their habitats. Comments were received from NMFS on May 22, 2015, and OSU incorporated those comments in the PDEA and this BA as appropriate. In addition to engaging one-on-one with interested parties, OSU has held a number of meetings with NMFS and other agencies and stakeholders since January 2013. On September 4, 2015, the OSU team shared with NMFS an example analysis of "Changes to Marine Community Composition and Behavior" from the draft BA to allow NMFS to review for general organization and level of analysis. On October 8, 2015, NMFS provided feedback and OSU incorporated this feedback into the draft BA. The revised draft BA was sent to NMFS for its review on January 7, 2016, and OSU met with NMFS to discuss NMFS's comments on the draft BA on February 2, 2016. NMFS provided additional comments to OSU on February 3, 2016.

OSU met with FWS to discuss development of the draft BA on April 13, 2016. The draft BA was sent to FWS on September 13, 2016, and FWS provided its comments to OSU on

October 7, 2016. OSU also met with FWS a number of times in 2017 and 2018 to discuss potential effects to ESA-listed bird species.

A revised Draft BA was included as an Appendix to the April 2018 DLA, which was distributed by OSU to NMFS, FWS and other CWG parties on April 20, 2018. NMFS provided comments on the Draft BA in letters dated July 18, 2018 and September 10, 2018. FWS provided comments in a letter dated July 24, 2018. This Draft BA has been revised to address the agencies' comments, as appropriate (see Appendix L of the Applicant Prepared Environmental Assessment [APEA]).

2.0 PROPOSED ACTION

OSU would construct and operate an offshore wave energy test site composed of four test berths that could collectively support the testing of up to 20 WECs, and associated moorings, anchors, subsea connectors and hubs, subsea power and communication cables, and onshore facilities. The PacWave South test site would occupy approximately 2 square nautical miles in federal waters about 6 nautical miles off the coast of Newport, Oregon. Water depths at PacWave South range from 65 to 79 m mean lower low water (MLLW) and OSU expects types of deep water WECs (described in more detail below) to be tested at the site; however, it would not be feasible to test medium to shallow water or shoreline-based WECs at this site. OSU would oversee and manage all activities, and clients deploying WECs at PacWave South would be subject to test center protocols and procedures.

The Project site was selected in consultation with Fishermen Involved in Natural Energy (FINE), a committee established by Lincoln County to ensure the fishing community was represented in discussions about offshore renewable energy in the region. FINE identified a 6 square nautical mile area off the coast of Newport that the fishermen felt would be both a suitable and acceptable area within which to locate PacWave South based on their extensive knowledge of the local marine environment. It was also a site FINE felt would have minimal effects on other ocean users. Based on the area identified by FINE, OSU submitted a research lease application to BOEM. OSU subsequently conducted site-specific surveys and gathered information from agencies and stakeholders to characterize the physical and biological conditions of the area and used this information to select a 2 square nautical mile test site. The coordinates for the corners of the 2 square nautical mile Project site are below:

NW:	44° 35' 00.00"N	124° 14' 30.00"W
NE:	44° 35' 02.75"N	124° 13' 06.17"W
SE:	44° 33' 02.75"N	124° 12' 58.51"W
SW:	44° 33' 00.00"N	124° 14' 22.41"W

Primary Project components include WECs, marker buoys, anchors and mooring systems, support buoys and instrumentation, subsea connectors and hubs, subsea transmission and auxiliary cables, and an utility connection and monitoring facility (UCMF) to transfer power to the grid. The WECs, support buoys, anchors and mooring systems, and subsea connectors and hubs would be located in the test berths. From the subsea connectors, the subsea cables would transmit medium voltage alternating current (AC) power and data from the PacWave South test berths to shore. Around the 10-m (33 ft) isobath (i.e., depth contour), each subsea cable would enter a dedicated conduit, installed by horizontal directional drilling (HDD), running to an onshore cable landing point, or "beach manhole". Each of the five beach manholes would consist of an approximately 10 x 10 x 10 ft buried concrete splice vault. Within the beach manholes, the subsea cables would be connected to terrestrial cables, which would connect to an onshore UCMF. The cable conduits between the beach manholes and the UCMF would be installed by HDD. Cable conduits would also be buried by HDD from the UCMF, across the UCMF property to the grid connection point with the CLPUD overhead distribution line along Highway 101.

2.1 ACTION AREA

The Project site includes a 2 square nautical mile (1,695 acres) WEC deployment area located in federal waters about 6 nautical miles off the coast of Newport, Oregon; buried subsea cables from the test site to a terrestrial cable connection point at Driftwood Beach State Recreation Site in Seal Rock, Lincoln County, Oregon; terrestrial cables installed with HDD from the Driftwood Beach State Recreation Site parking lot directly to the UCMF property on the east of Highway 101; and from the UCMF, an additional conduit would also be buried by HDD west to, and under, Highway 101 to the grid connection point with the CLPUD overhead distribution lines along the road (Figure 1-1). The total distance of the terrestrial cables would be about 0.5 miles. The terrestrial portions of the Project would cross under a beach and dune system, wetlands and the highway, and would be located on upland areas east of the beach within the Driftwood Beach State Recreation Site and on the UCMF property east of the highway (Figure 1-2).

For purposes of ESA Section 7 consultations, *action area* is defined as all areas to be affected directly or indirectly by the federal action and not merely the immediate area involved in the action (50 CFR § 402.02). The action area is further defined as the geographic extent of the potential physical, biological, and chemical effects of the Project above the baseline conditions. For this Project, the action area is defined as the following:

- the Project site (described above);
- the acoustic environment around the WEC deployment area to a distance of 125 m (410 ft);
- a vertical and horizontal distance of 3 m beyond each subsea cable during installation; and
- the vessel traffic corridor between the Project site and the primary staging point, Port of Newport.

A distance of 125 m from the WEC deployment area is the distance over which anticipated operational noise levels would attenuate to the marine mammal harassment threshold of 120 decibels (dB) 1 µPa[2]. A distance of 3 m around each subsea cable is the furthest distance

[2] As discussed in the APEA, the maximum noise output for a WEC was calculated as being 151 dB 1 µPa at 1 m. Implementing the NMFS practical spreading model (e.g., 15*Log(R1/R2)) where R1 = 1 m and R2 = 125 m, WEC sound levels would attenuate by 31 dB, and results in an operational sound level of 120 dB 1 µPa at 125 m from the WEC.

that any physical disturbance to the sediment would be expected, and benthic changes from installation are expected to be measurable. It is anticipated that EMF emissions from the Project will be reduced to ambient levels within 10 m of the Project components.

2.2 PROJECT FACILITIES

2.2.1 Wave Energy Converters

WEC technology is expected to evolve over the duration of the Project's FERC license and various types of WECs would be tested. To accommodate near-term and long-term industry needs, OSU surveyed and interviewed WEC technology developers to ascertain what types of WECs could be reasonably expected to be deployed at PacWave South, based on the location of the test site (e.g., water depth and wave resources) and present state of technology. Based on this research, the following WEC types are expected to be tested (singly or in arrays) at PacWave South (Figure 2-1):

- **Point absorbers:** floating or submerged structures with components at or near the ocean surface that capture energy from the motion of waves, which drives a generator. Point absorbers may be fully or partly submerged.
- **Attenuators:** structures that respond to the curvature of the waves rather than the wave height. These WECs may consist of a series of semi-submerged sections linked by hinged joints. As waves pass along the length of the WEC, the sections move relative to one another. The wave-induced motion of the sections is captured and used to drive a generator.
- **Oscillating water columns (OWC):** structures that are partially submerged and hollow (i.e., open to the sea below the water line), enclosing a column of air above the water. Waves cause the water under the device to rise and fall, which in turn compresses and decompresses the air column above. This air is forced in and out through a turbine, which usually has the ability to rotate regardless of the direction of the airflow (i.e., a bi-directional turbine).
- **Hybrids:** WEC types that use two or more of the above-listed technology types. For example, some WECs that are the relative size and shape of a point absorber may generate power through movements that resemble an attenuator. Another example is a class of WECs with moving masses that are internal to a hull with no external moving parts exposed to the ocean. An example of this technology is the Vertical Axis Pendulum, which consists of a structural hull that contains all moving parts; inside, a pendulum rotates and converts the kinetic energy of the ocean waves into electrical power.

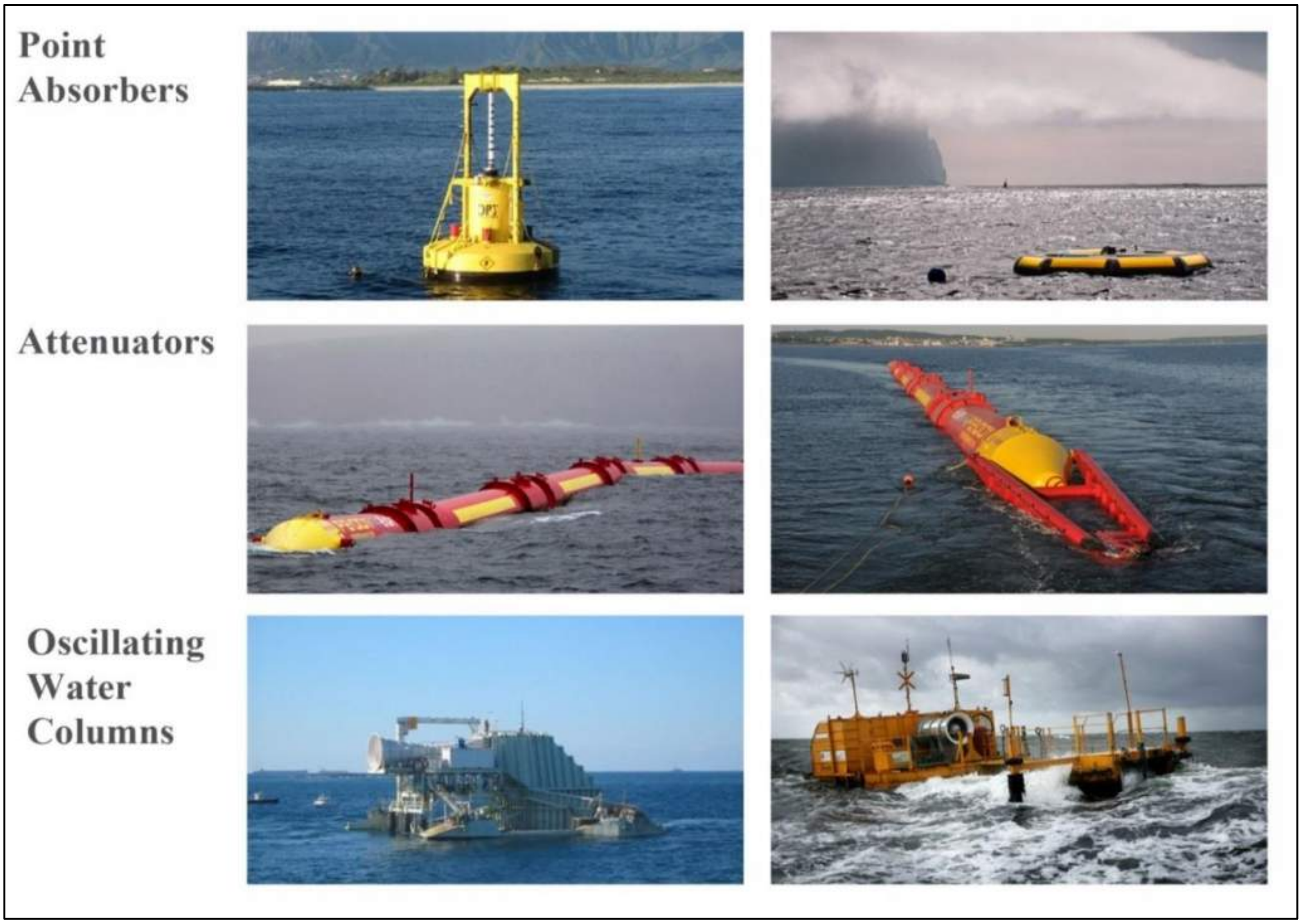

Figure 2-1. Examples of different types of WECs.

To allow for the testing of arrays of WECs, PacWave South could accommodate the deployment of up to 20 WECs (total) at one time. However, OSU expects that the number of WECs deployed at PacWave South would vary throughout the license term and that fewer WECs would likely be deployed in the initial years of operation (i.e., the five years or so). To evaluate the true range of potential effects that the Project might have over a 25-year license term, this APEA evaluates both an initial development scenario and a full build out scenario, as follows:

- *Initial Development Scenario* (Figure 2-2) – 6 WECs consisting of:
  - Berth 1 = 1 point absorber;
  - Berth 2 = 1 OWC;
  - Berth 3 = 1 attenuator; and
  - Berth 4 = 3 point absorbers with shared anchors.
- *Full Build Out Scenario* (Figure 2-3) – 20 WECs consisting of:
  - Berth 1 = array of 5 point absorbers;
  - Berth 2 = array of 5 OWCs;
  - Berth 3 = array of 5 point absorbers; and
  - Berth 4 = array of 5 attenuators.

WECs would likely be deployed 50 to 200 m or more apart from each other within a berth[3] (Figures 2-4 and 2-5). The PacWave South would have a maximum installed capacity of 20 MW. The rated capacity of individual WECs would vary, and preliminary estimates range from 150 kW to 2 MW per device. Based on these estimates, the installed capacity for the initial development scenario is expected to range from 750 kW to 10 MW, and the installed capacity for the full build out scenario is expected to range from 10 to 20 MW. Because the rated capacity of WECs would vary depending on the units installed for testing at the site at any given time, the average power output from PacWave South would also vary during the term of the FERC license. Accordingly, the characterization of power and generation produced by the proposed PacWave South Project would similarly vary with time, including the average capacity factor, availability, and value of installed capacity.

Supporting buoys and instrumentation would also be used to gather data on site conditions and support testing operations. This equipment would likely be similar to those previously deployed at OSU's nearby PacWave North.

[3] The referenced distance refers to the separation of the WECs; the moorings may be located closer to each other.

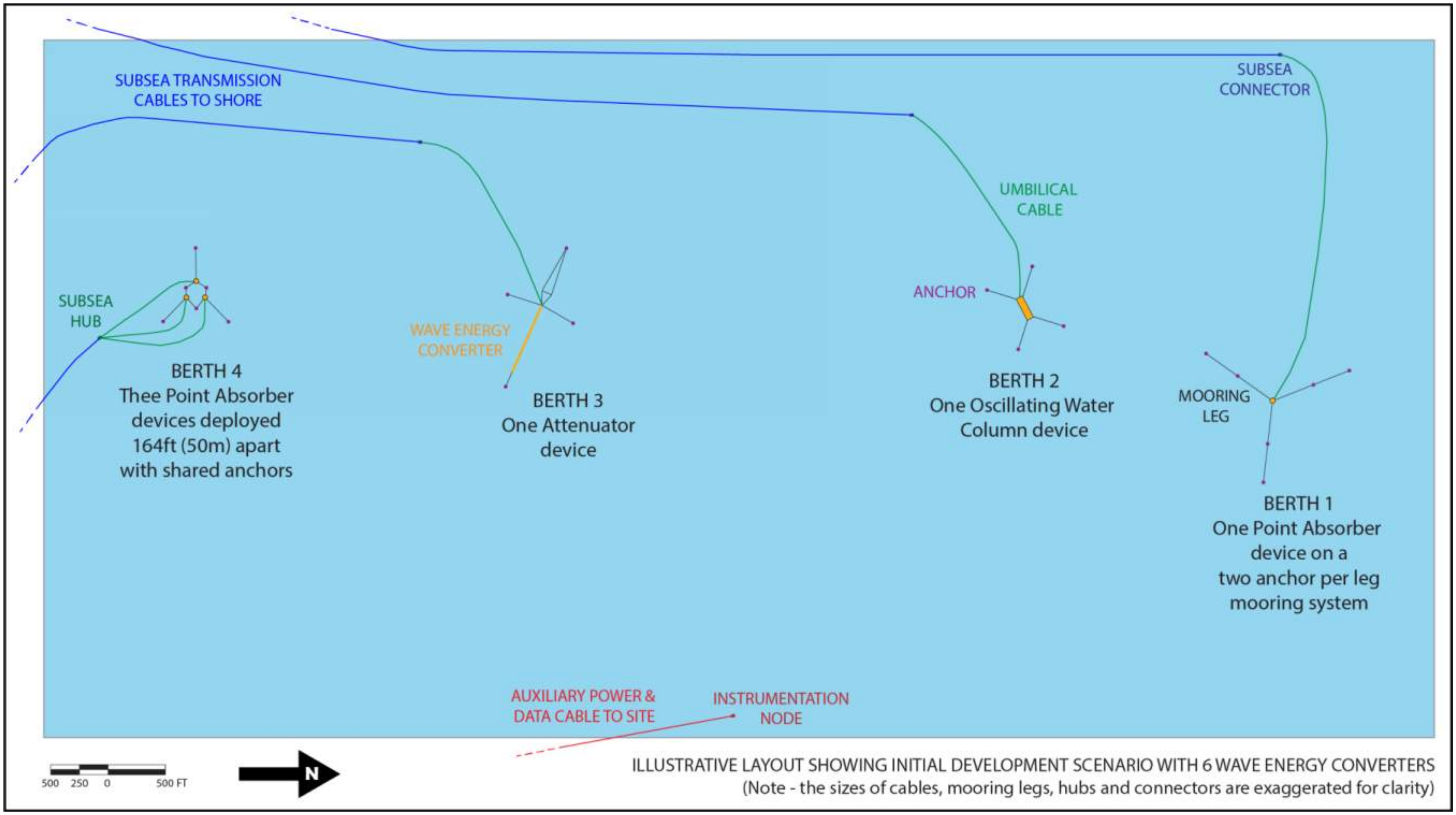

Figure 2-2. Illustrative test berth configuration for the initial development scenario. Note, actual deployment would vary.

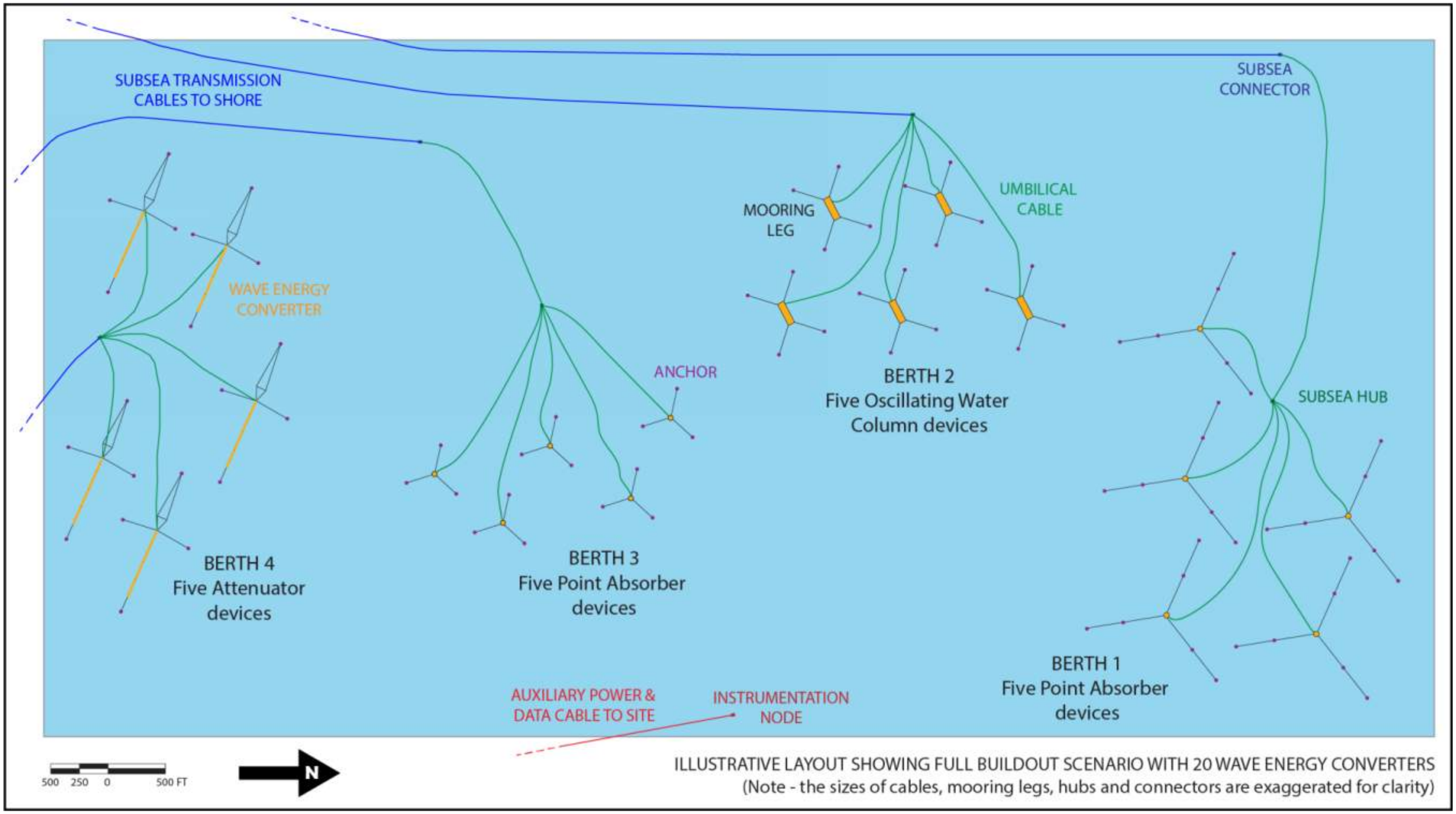

Figure 2-3. Illustrative test berth configuration for the full build out of scenario. Note, actual deployment would vary.

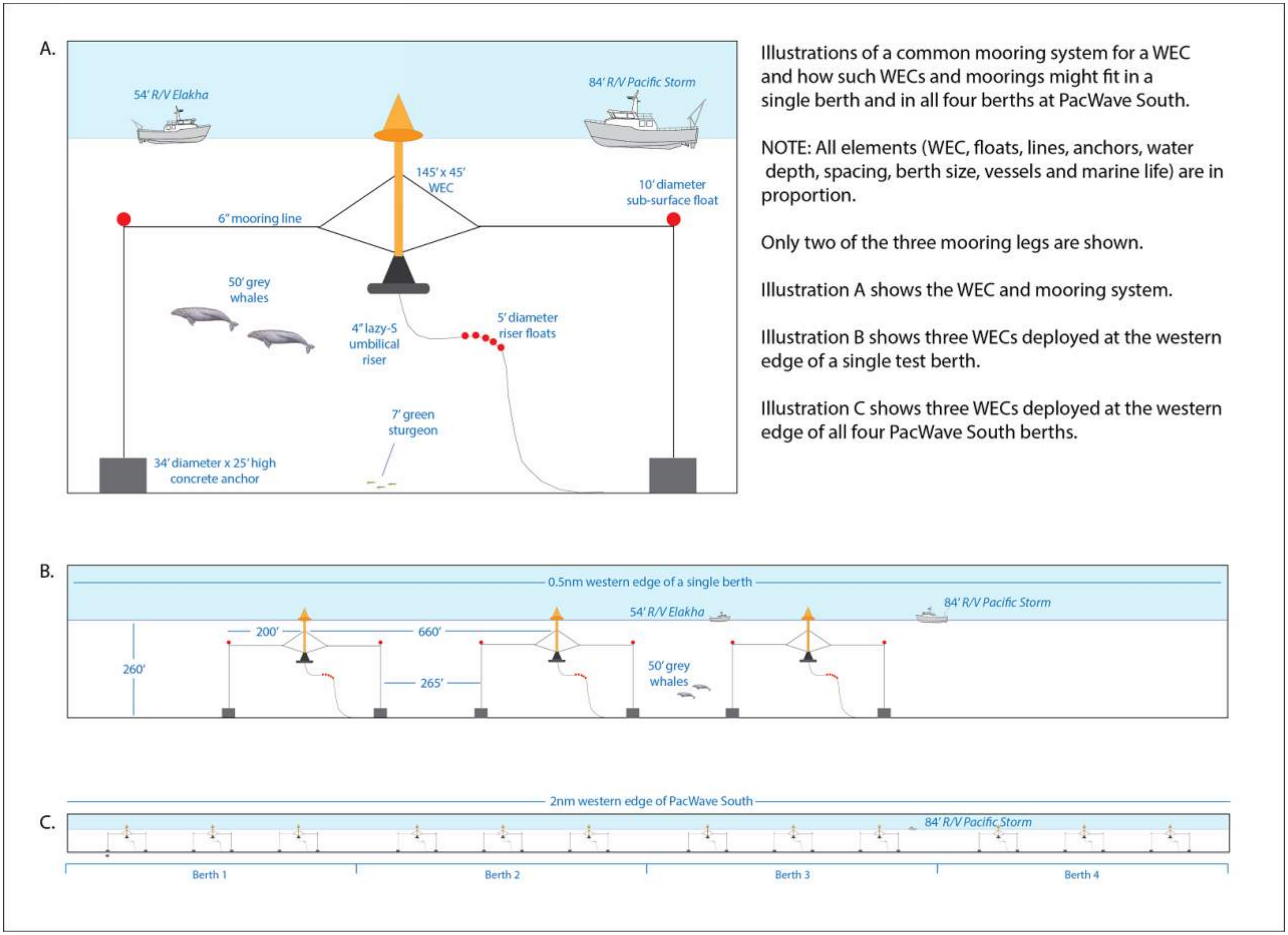

Figure 2-4. Scale drawing of WECs at 200 m spacing (660 ft).

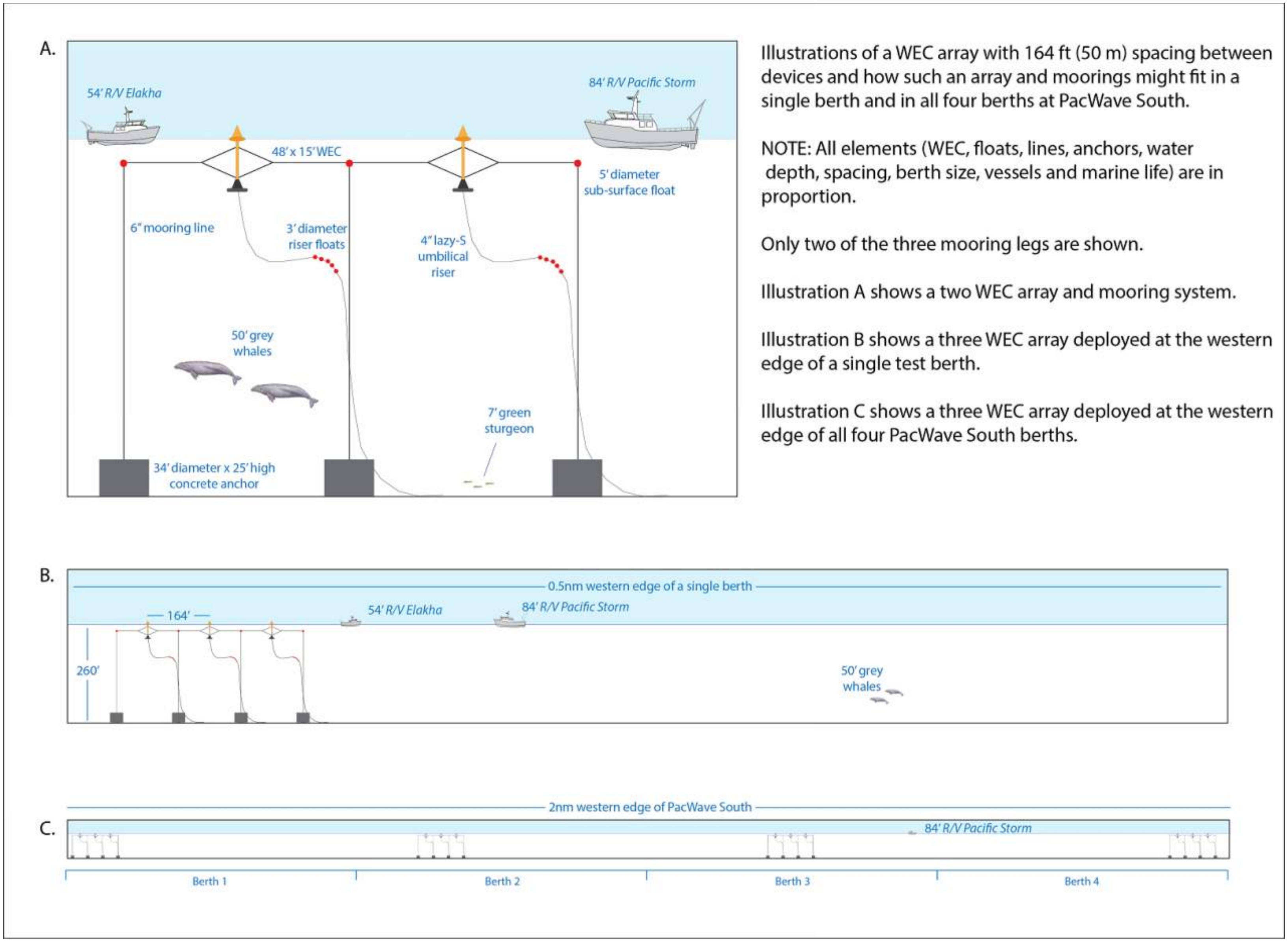

Figure 2-5. Scale drawing of WECs at 50 m spacing (164 ft).

2.2.2 Anchors and Mooring Systems

The specific anchor types and mooring configurations at PacWave South would vary based on the specific WECs deployed. However, because the physical and environmental conditions within the test site are relatively uniform, the general types of anchoring and mooring systems would not vary substantially. Furthermore, the anchors and mooring systems used at PacWave South would be the same as or similar to those commonly used for other applications in the marine environment. An Oregon Wave Energy Trust (OWET)-funded report, titled *Advanced Anchoring and Mooring Studies,* describes common types and features of mooring systems (Sound & Sea Technology 2009).

Results of the OSU survey of WEC technology developers indicate that anchoring systems used at PacWave South would likely include gravity anchors, drag embedment anchors, suction anchors, and plate anchors (Figure 2-6). In some cases, a combination of anchor types might be used. The survey results also show that anchors would likely consist of steel, concrete, or a mixture of the two. All concrete anchors would be fully cured prior to deployment.

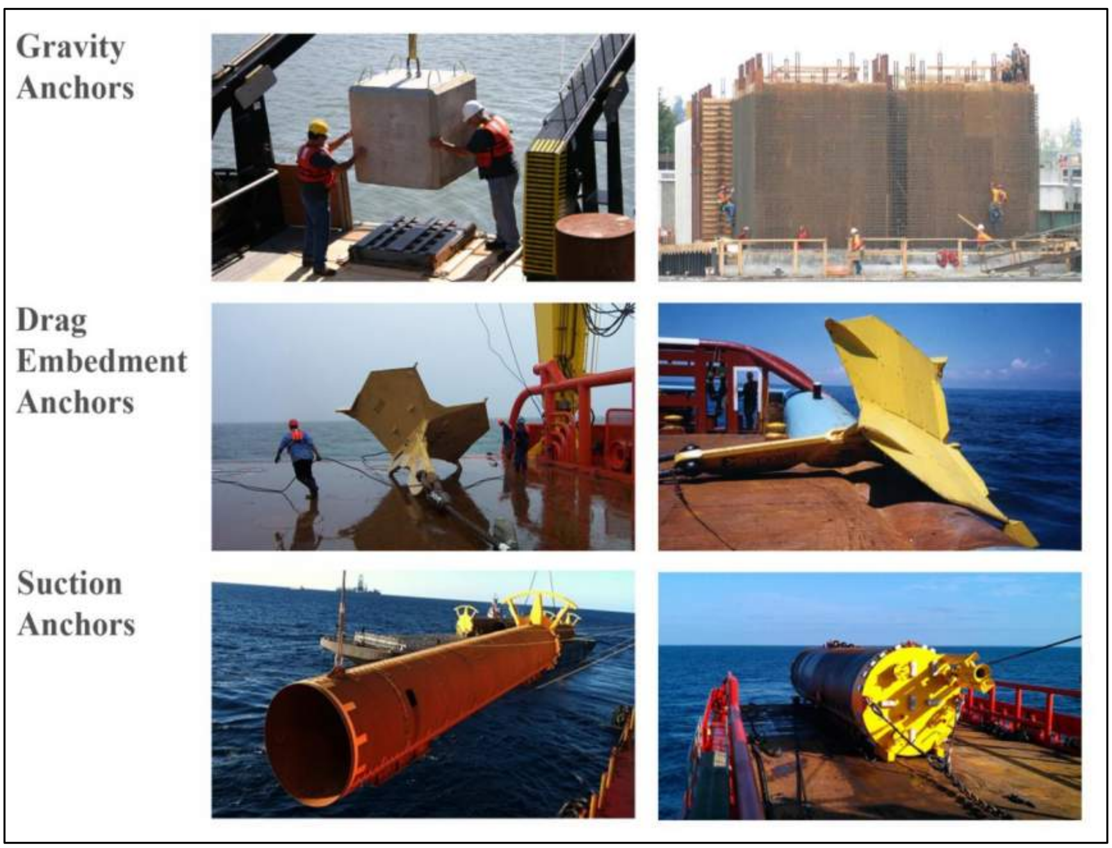

Figure 2-6. Examples of different anchor types.

The maximum estimated area covered by the anchors (i.e., the anchor footprint) under the initial and full build out scenarios are provided in Table 2-1. The estimates are based on exclusive use of 34-ft diameter cylindrical gravity anchors as these represent the largest anchors that might be expected to be used at PacWave South; however, other types of smaller anchors would likely be used for many of the WECs, and shared anchors may be used for some WECs when feasible. Therefore, the actual seafloor anchor footprint is expected to be considerably smaller than the estimates in Table 2-1.

Table 2-1. Estimated maximum anchor footprints for initial development and full build-out scenarios by berth.

Scenario	WEC Type	No. WECs	Total No. Anchors	Maximum Seafloor Anchor Footprint (ft^2)*
Initial Development				
Berth 1	Point absorber	1	6	5,448
Berth 2	OWC	1	4	3,632
Berth 3	Attenuator	1	4	3,632
Berth 4	Point absorber with shared anchors	3	7	6,356
Maximum Total Anchor Footprint = **19,068 ft^2 (0.4 acres)**				
Full Build Out				
Berth 1	Point absorber	5	30	27,240
Berth 2	OWC	5	20	18,160
Berth 3	Point absorber	5	30	27,240
Berth 4	Attenuator	5	20	18,160
Maximum Total Anchor Footprint = **90,800 ft^2 (2 acres)**				

* Based on the total footprint of 34-ft-diameter gravity anchors (908 ft^2 per anchor), representing the largest possible footprint per anchor; other anchor types will have a considerably smaller footprint.

The OSU survey of WEC technology developers also asked developers about mooring systems, and analysis of the results shows that most WECs would use single- or three-point mooring systems (25 percent and 28 percent of responses, respectively). Mooring systems are generally classified by their configuration (e.g., single- or multi-leg) and components (i.e., anchors, buoys, and lines). As with anchor types, mooring lines would consist of types commonly used in the marine industry (e.g., chain, steel wire, or synthetic materials). Like the rest of the marine industry, WEC technologies use various combinations of these anchor types and mooring system components. Mooring infrastructure may also include buoys and/or subsurface floats. Although these components can be combined in various ways, there are only a few different component types (i.e., three common types of mooring line and four common types of anchor), as shown in Table 2-2.

Table 2-2. Standard mooring systems configurations and components.

CONFIGURATION	COMPONENTS		
A. Single Leg	**Anchors** (steel/concrete/both)	**Buoys**	**Lines**
B. Multi Leg	A. Gravity/deadweight	A. Steel	A. Chain
1. Three-point	B. Drag embedment	B. Composite	B. Wire rope
2. Four-point	C. Suction embedment	1. Surface	C. Synthetic
3. Five-point	D. Plate embedment	2. Subsurface	
4. Six-point			
i. Catenary			
ii. Taut			

Sample mooring and anchor specifications for different types of WECs are presented in Table 2-3.

Table 2-3. Illustrative WEC mooring and anchoring configurations.

	Point Absorber	**Point Absorber**	**Attenuator**	**Oscillating Water Column**
Mooring Configuration	Single leg	Multi-leg Catenary	Multi-leg Catenary	Multi-leg Taut
Approx. Water Depth (ft)	250	250	250	250
Line Length per Leg (ft)	~300	~600	~400	~350
Line Material	Chain & wire rope	Chain & synthetic rope	Chain & synthetic rope	Wire & synthetic rope
No. of Legs	1	3	4	4
No. of Anchors Per Leg	1	2	1	1
Anchor Type	Suction	Drag & gravity	Drag	Gravity
Anchor Sizes (ft)	DxH (Qty) 6x8 (1)	LxWxH (Qty) Drag: 12x13x8 (3) Gravity: 8x6x4 (3)	LxWxH (Qty) 16x18x11 (3) 22x24x15 (1)	DxH (Qty) 34x25 (4)
Anchor Material	Steel	Drag: Steel Gravity: Steel & concrete	Steel	Steel & concrete

*Note: D = Diameter; H = Height; L = Length; W = Width; (Qty) = number of anchors.

Anchor deployment and recovery would be infrequent. The OSU industry survey and OWET market analysis indicate that most developers plan to deploy WECs for multi-year test periods (e.g., 3-5 years), so anchors would likely also be deployed for multi-year periods. Furthermore, it is unlikely that anchor systems would be adjusted during a WEC test due to the high costs associated with installing and removing them. Therefore, disturbance due to anchor installation and removal operations within a berth should only occur occasionally (once a year, and perhaps only once every several years). Additionally, these activities rely on specific weather windows, so the timeframes within which anchor deployment and recovery operations could occur are limited. Finally, it is OSU's intent to reuse anchors wherever possible. If an incoming WEC developer could use an anchor and/or mooring configuration that was already in place from a previous test, then the anchors could be left in place to limit seafloor disturbance.

2.2.3 Power Transmission and Grid Interconnection

2.2.3.1 Subsea Connectors

Power generated by WECs would be transferred via umbilical cables (also known as dynamic risers) to a subsea connector attached to the end of a subsea cable and located on the seafloor at each test berth; from there, electricity would be transmitted from the subsea connector via the subsea cable to shore. As the WECs will be on or near the surface, the umbilical cables will run from the WEC to the seafloor and will therefore, be partially suspended in the water column. The common configuration for such umbilical cables is to attach subsurface floats to create a "lazy-S", which maintains tension but allows enough motion to prevent the umbilical from being damaged by WEC movements. There would be one umbilical cable per WEC. If a client were testing an array of WECs, or needed additional power conditioning or conversion support, the umbilicals would all connect to a client-supplied hub, which would then connect to the PacWave South subsea connector at that berth.

The final subsea connector choice will depend on a number of factors including the final cable specification. Subsea connectors are also an area of on-going research and development. However, one option is the GreenLink Inline Termination manufactured by MacArtney Underwater Technology (Figure 2-7). The connector has no external moving parts and can be dry, oil, gel or nitrogen filled as required. It is a "drymate" system, which requires the connector to be winched onto a vessel for a WEC to be connected or disconnected.

Figure 2-7. Example of subsea connector (MacArtney's GreenLink Inline Termination).

Using a system like this would allow test clients to easily connect their WECs to the subsea cables, monitor device performance, and export power to the grid via the onshore UCMF. Subsea connector systems such as this typically have built-in cathodic protection and are expected to operate for up to 25 years. The subsea connectors would be installed at the same time as the subsea cables to shore.

2.2.3.2 Subsea Cables

Four subsea transmission cables are planned, one for each of the four test berths. In addition, an auxiliary cable would also connect power to the site. The subsea transmission cables would transfer power back to shore and allow for the monitoring and control of WECs via fiber optic elements incorporated into the transmission cables themselves. The cable corridor dimensions and routing are described in further detail below.

The auxiliary cable would increase the monitoring capabilities at PacWave South. An auxiliary cable would allow for extended deployments of instruments or equipment with high data bandwidths or power requirements. Cabling instruments could also greatly reduce maintenance costs associated with some instrumentation (e.g., acoustic landers require battery replacements every few months) and increase the feasibility of real-time data. Field testing cutting edge technology and having real-time data for environmental and WEC monitoring would greatly enhance the PacWave South testing capabilities, and could potentially benefit other offshore projects and marine industries that require technological solutions.

OSU anticipates that the subsea transmission cables would be three-conductor, AC cables with a rated voltage of 35 kV, like the cable shown in Figure 2-8. At present, OSU is considering cables with either 70-mm^2 or 50-mm^2 copper conductors, which are slightly less than 4 inches in diameter and weigh between 7 and 8 pounds per foot.

The exact specifications for the subsea cables would be developed during final design. All the cables would have standard industrial shielding and armoring (e.g., galvanized steel wires), as illustrated in Figure 2-8. Electric fields from energized AC cable conductors are shielded effectively by metallic sheathing and armoring.

Figure 2-8. Example of medium-voltage subsea cable.

Within the Project site, the umbilical cables and a segment (approximately 300 m) of the subsea cables would remain unburied to allow for access during WEC deployment and removal, and maintenance activities (Figure 2-9); however, the majority of the subsea cable segment would, to the extent practicable, be buried to a target depth of 1-2 m from the offshore test site back to the HDD conduits. In areas where burial is not feasible (due to unsuitable seafloor conditions), the cables would be laid on the seafloor and protected by split pipe, concrete mattresses or other cable protection systems. The subsea cables will enter HDD-installed conduits at approximately the 10 m isobath and continue to shore passing under the beach and dune systems and into the parking lot at Driftwood Beach State Recreation Site (Figure 2-10). The industry best practice for minimum spacing between buried subsea cables is 1.5 times the water depth. The eastern edge of the Project site is in approximately 65 m of water, and the HDD conduits would be located in approximately 10 m of water. Accordingly, the minimum spacing between each cable at the edge of the Project site would be at least 100 m (i.e., 65 m x 1.5 = 97.5 m), and the minimum spacing between each cable at the HDD conduits would be approximately 15 m, resulting in a cable corridor that converges from at least 400 m at the offshore test site to a minimum of 60 m at the nearshore HDD conduits. As the seafloor does not shelve evenly, the cable corridor would not widen at a constant rate between the HDD conduits and the Project site (see Figure 2-9).

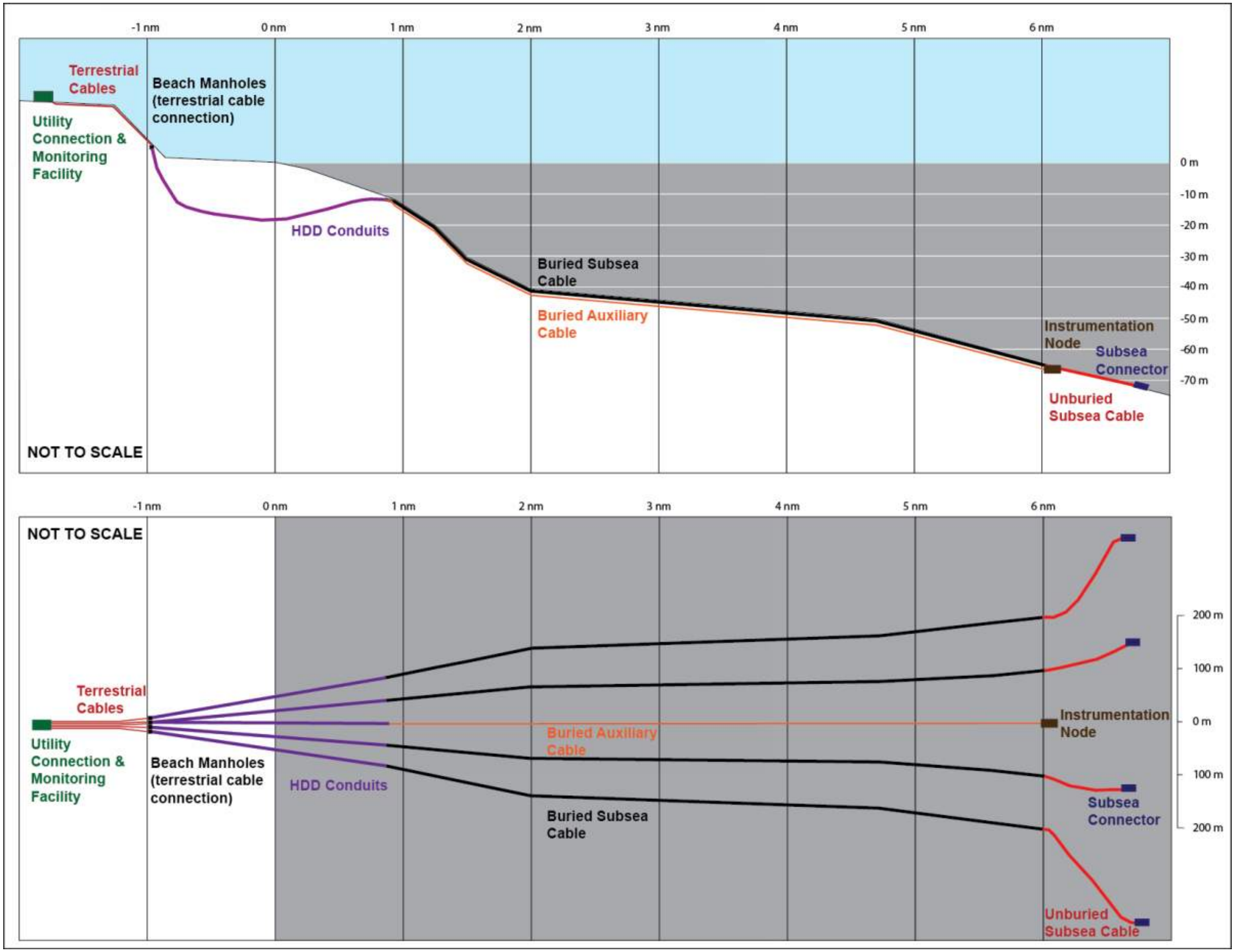

Figure 2-9. Subsea cables schematic. Note, these schematics are illustrative and are not to scale.

While a number of cable route corridor alternatives were evaluated, OSU has selected one cable corridor for the Project. The proposed corridor runs south of an area of rocky geology that extends along the coast to the north, and the cables would come ashore at Driftwood Beach State Recreation Site in Seal Rock (Figure 2-10). The subsea cables would be buried approximately 1 to 2 m below the seafloor to around the 10-m isobath using jet plow or a similar technique. At the 10-m isobath the cables would enter the HDD conduits.

Figure 2-10. PacWave South landfall, Driftwood Beach State Recreation Site. Beach manholes are shown in red, the buried HDD conduits to the test site are shown in green, and the underground HDD conduits to the Utility Connection and Monitoring Facility are shown in yellow.

HDD would be used to install five separate conduits (for four subsea transmission cables and one auxiliary cable) from the Driftwood Beach State Recreation Site, approximately 50-100 ft, beneath the beach and dune system and, out to about the 10-m isobath, a distance of about 0.6 nautical miles (Figure 2-9). The four transmission cables and auxiliary cable would each run through separate HDD conduits to individual, onshore cable splice vaults, known as a beach manholes, where the subsea cables would transition to terrestrial cables. It is anticipated that there would be five beach manholes, which would be made of precast concrete. The buried concrete vaults would measure approximately 10 x 10 x 10 feet. Access to each beach manhole would be via a standard manhole cover, similar to those used to access underground utilities (sewer, power, and telephone). The proposed Project subsea cable route would be about 8.3 nautical miles, consisting of about 3.7 nautical miles located on the Outer Continental Shelf, 4.0 miles in the Territorial Sea and 0.6 miles of HDD conduit near zone.

2.2.3.3 Terrestrial Cables

From the beach manholes at the Driftwood Beach State Recreation Site, the cables would be installed in up to five HDD bores to the UCMF property. From the beach manholes, the cables would run to the southeast, under the southern portion of the Driftwood Beach State Recreation Site. The HDD cable conduits would then run under small sections of six private properties located on either side of Highway 101, and then to the OSU-owned UCMF parcel east of the highway. From the UCMF, an additional conduit would also be buried by HDD west to, and under, Highway 101 to the grid connection point with the CLPUD overhead distribution lines along the road; for this part of the construction, the HDD rig would be set up on the UCMF property. The total distance of the terrestrial cables would be about 0.5 miles (Figure 1-2). The specifications of the terrestrial cables are dependent on the final subsea cable design and coordination with CLPUD to ensure compatibility with existing infrastructure. At this stage, OSU anticipates that the terrestrial transmission cables would either be three-conductor cables, such as the Okonite cable (Figure 2-11), or single-conductor terrestrial cables such as the Kerite cable (Figure 2-12). If three-conductor terrestrial cables are used, then one terrestrial cable would be needed for each subsea cable, plus the auxiliary (i.e., five terrestrial cables total). If single-conductor terrestrial cables are used, three terrestrial cables would be needed for each subsea cable (i.e., 15 terrestrial cables total).

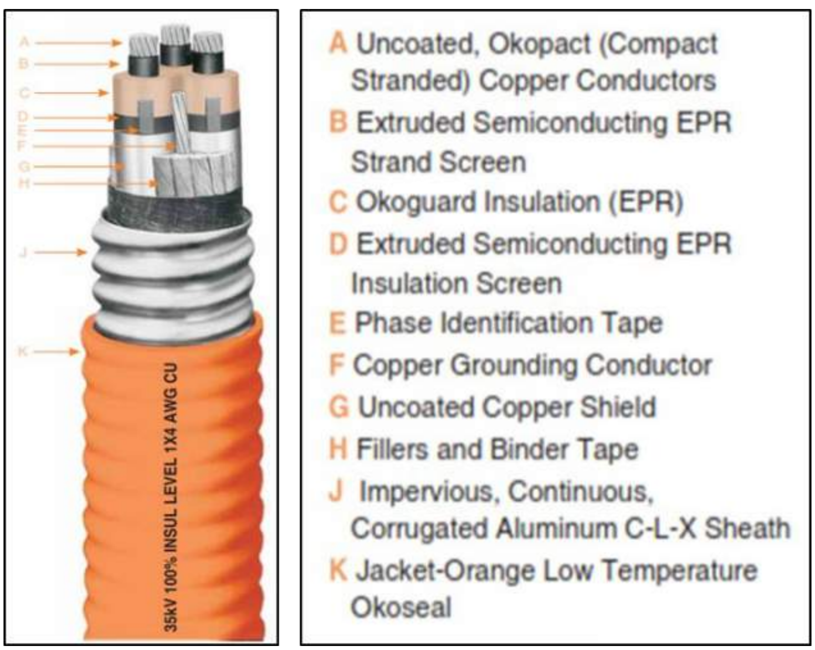

Figure 2-11. An example of an Okonite three-conductor terrestrial cable.

Depending on insulation type, the three-conductor cables are typically between 3.2 and 3.7 inches in diameter and weigh between 4.7 and 5.7 pounds per foot. The single conductor cables are between 1.4 and 1.6 inches in diameter and weigh between 0.9 and 1.5 pounds per foot. Due to the number, size, and weight of the cables, using the existing above-ground utility poles would not be feasible, and it would be necessary to bury the cables.

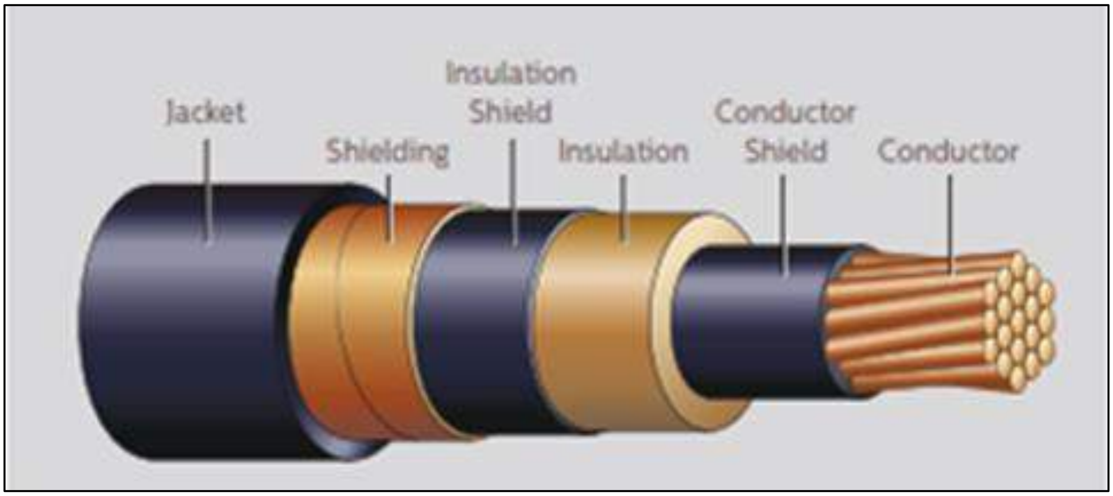

Figure 2-12. An example of a Kerite single-conductor terrestrial cable.

2.2.3.4 Utility Connection and Monitoring Facility

Power monitoring, conditioning, utility equipment and other electrical operations would be performed at the onshore UCMF, located on the OSU-owned property 0.3 miles south of Driftwood Beach State Recreation Site. The current plans for the UCMF include three, single-story buildings (Figure 1-2). One building would accommodate the conditioning and monitoring equipment for each of four potential test clients and would be approximately 11,250 ft^2. A second, 4,800 ft^2 building would include the PacWave South switch gear, utility equipment and general storage. The third building would be the Project's data, control, and communications center and would contain monitoring, communications, data storage, and supervisory control and data acquisition (SCADA) systems. The building would also contain operational support infrastructure such as restrooms and a maintenance/supply area. This building would be approximately 4,250 ft^2. The existing gravel lane (NW Wenger Lane) would be paved to accommodate semi-truck access to the UCMF. The improved road would be approximately 20 ft wide and 800 ft long and would run from Highway 101 to the UCMF compound. The UCMF compound would include the three buildings and a parking/laydown area large enough to allow truck access (approximately 80 feet by 200 ft). The entire area of the UCMF compound would be approximately 1.2 acres, and would be fenced and covered by security cameras and necessary lighting to meet building code standards.

The grid connection to CLPUD's distribution system would run from the UCMF to CLPUD's distribution lines on the west side of Highway 101. The proposed power line from the electrical meters at the UCMF to the grid connection on Highway 101 would be owned by OSU or owned and maintained by CLPUD, in which case OSU would negotiate the right to undertake any action required by FERC. All wire, conduit, transformers, meters, and other ancillary equipment needed to support the grid connection would be specified by CLPUD. OSU would be responsible for HDD installation of the conduits along the route, and CLPUD would then pull the wires through the conduits and complete the installation. It is expected that three 4-inch diameter conduits, and a bare copper ground wire would be required.

The CLPUD has existing telemetering capabilities at BPA's Toledo substation, which meets federal interconnection requirements. In addition, the CLPUD has experience installing and operating data and communications systems, including SCADA, ION metering, Distribution Automation, Smart Grid technologies, and other fiber-optic communications. This expertise, along with the CLPUD's proven track record of operating a highly reliable system, would facilitate a successful test facility operation at PacWave South. A single line diagram showing each component of power transmission and grid interconnection is provided in Figure 2-13.

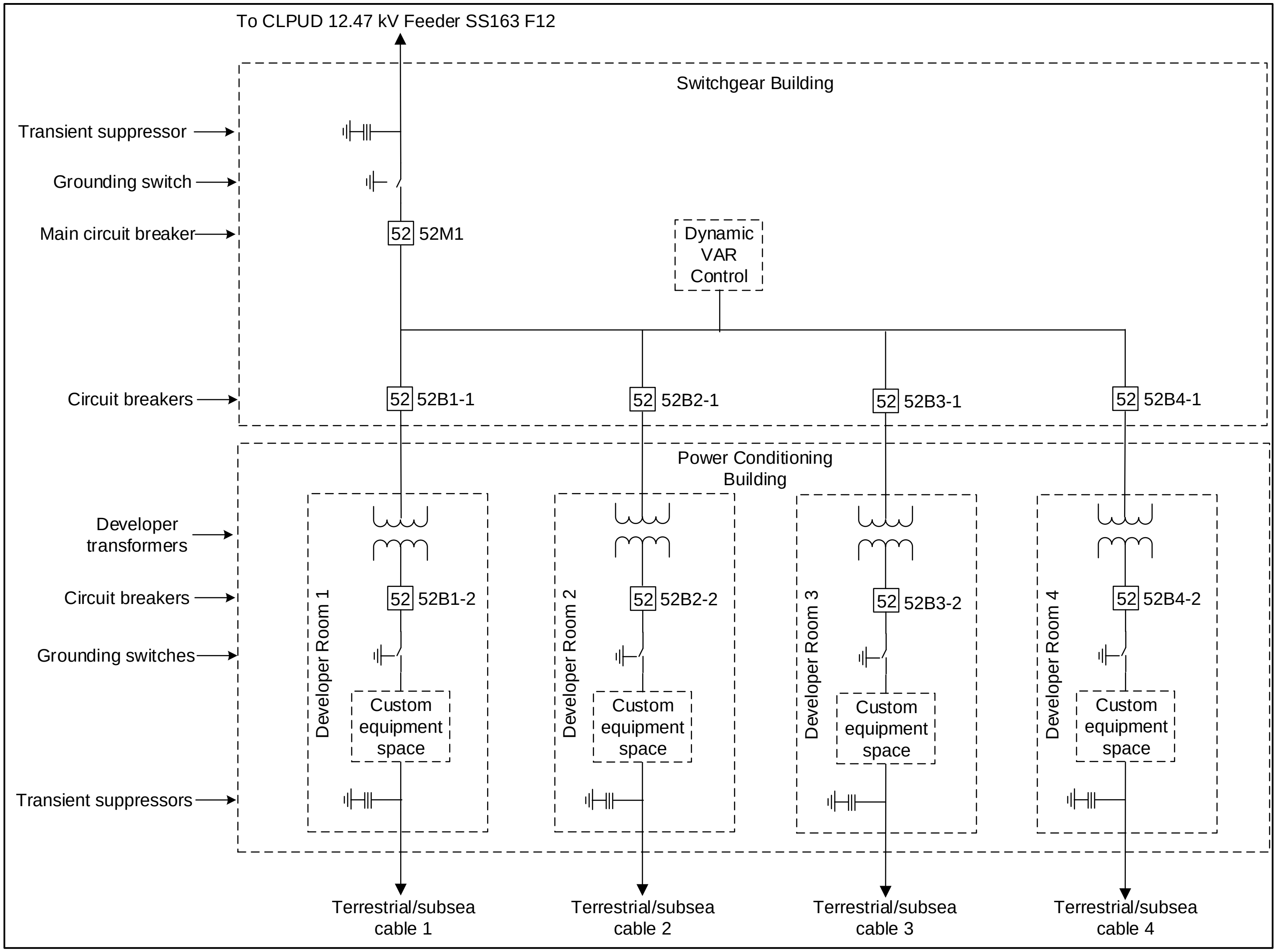

Figure 2-13. Single line diagram of PacWave South transmission.

OSU has worked with CLPUD to develop and submit an application for grid interconnection to BPA. The application submittal has placed the PacWave South into the BPA project queue and OSU and BPA have completed a series of grid interconnection studies to help ensure that the proper design requirements are developed during PacWave South design process. In addition to power transmission and grid-connection, OSU is also exploring power purchase options with the CLPUD and BPA. CLPUD has stated that there is sufficient grid capacity to accommodate the project, but OSU would continue to coordinate with both CLPUD and BPA to determine whether grid upgrades would be necessary to achieve the planned 20 MW of generating capacity as the facility approaches maximum capacity. If grid upgrades are determined to be necessary in the future to directly accommodate the generating capacity of the Project, such upgrades may be subject to FERC approval and any required federal and state environmental review. OSU is seeking issuance of a 25-year FERC license with an authorized installed capacity of 20 MW license for the proposed PacWave South Project.

2.2.4 Project Safety

To limit the potential for vessel collisions with Project structures, OSU proposes to properly illuminate the WECs and Project structures and OSU will require WECs to be equipped with Automatic Identification System (AIS) equipment. The site boundaries would be clearly marked on NOAA navigation charts. OSU has been coordinating with the USCG and will implement any navigational measures required by the USCG (e.g., special designations, restrictions, notices, etc.).

Pursuant to the Spill Prevention, Control and Countermeasure (SPCC) regulations, facilities subject to the Environmental Protection Agency's (EPA) Oil Pollution Prevention Rule must prepare and implement a plan to prevent discharge of oil into or upon navigable waters of the United States or adjoining shorelines. However, the Project would not be subject to the SPCC regulations because it would not meet the threshold of having an aggregate above-ground storage capacity great than 1,320 gallons (in containers of 55 gallons or greater) [(40 CFR §112)]. Similarly, the Project would not meet the criteria for substantial harm requiring a Facility Response Plan. Although the Project would be below the SPCC or substantial harm criteria, OSU has developed and will implement an Emergency Response and Recovery Plan that would include spill prevention and control measures. This plan would also include provisions for recording the types and amounts of hazardous fluids contained in Project structures and WECs to ensure that the necessary measures and procedures were in place to prevent and respond to accidental spills or leaks in the marine environment.

Additionally, OSU would require all vessels used for Project activities to be licensed, and have insured operators with the necessary spill prevention and response plans and would require WEC clients to adhere to waste management, hazardous material, and spill prevention protocols (as provided for in the Emergency Response and Recovery Plan). As part of the post-licensing compliance process, FERC would evaluate the adequacy of the Project facilities and safety measures. Commission staff would inspect the licensed Project both during and after construction. Inspections during construction would concentrate on adherence to Commission-approved plans and specifications, any special license articles relating to construction, and accepted engineering practices and procedures. Operational inspections would focus on the continued safety of the structures, efficiency and safety of operations, proper maintenance and compliance with the terms of the license.

2.3 CABLE INSTALLATION, TEST SITE OPERATION, AND MAINTENANCE

As a grid-connected test facility, PacWave South would provide domestic and international developers, clients, utilities, economists, and scientists with the opportunity to:

- Optimize WECs and arrays to increase their energy capture, improve their survivability and reliability, and decrease their levelized cost of energy;
- Refine deployment, recovery, operations, and maintenance procedures;
- Collect interconnection and grid synchronization data; and
- Gather information about potential environmental effects, and economic and social benefits.

OSU would oversee each stage of testing: deployment; testing plans, protocols, and procedures; WEC performance monitoring; environmental monitoring; demobilization; and removal.

As noted, up to six WECs would likely be deployed during the initial development scenario and a maximum of 20 WECs would be deployed for the full build out, with a maximum total capacity of 20 MW. OSU expects that fewer WECs would be deployed at PacWave South during initial operations and this number would increase gradually as the industry advances. However, the number of WECs will fluctuate based on clients' needs.

Project components would be fabricated at land-based facilities prior to being installed at the test site. The primary staging areas for PacWave South would likely center around the Port of Newport, Toledo or other private facilities. The WECs, mooring and anchor systems, navigational buoys, and monitoring equipment, would be staged at mobilization sites for vessel transport to the Project site for installation. In addition, OSU would develop a Removal and Decommissioning Plan for the facility. OSU anticipates that this plan would be developed in the future as a license term nears its end and implemented when the overall Project is decommissioned.

As a test center, deployment and recovery of WECs, supporting infrastructure and instrumentation, and associated anchor and mooring systems would occur throughout the license term of the Project.

2.3.1 Power Transmission and Grid Interconnection

The subsea cables would be buried approximately 1 to 2 m below the seafloor to around the 10-m isobath using jet plowing or a similar technique. Jet plowing is a standard technique used for burying subsea cables. This technique uses a plowshare and high pressure water jets to fluidize a trench in the seafloor. Using a barge or a dynamically positioned cable ship and towed plow device, installers simultaneously lay and embed the subsea cables. Cable installation would take approximately 30 days for active installation of all 5 cables assuming no weather delays, and 10 days for post-installation inspections. During cable installation a constant tension must be maintained to ensure the integrity of the cable. Each of the subsea cables will weigh between 175 to 275 tons (equivalent to 14 to 22 regular school buses) therefore any significant stoppage or loss of position during jet plow activities has the potential to result in significant damage to the cable. As with all cable laying operations, these activities at PacWave South will need to occur 24 hours a day until installation is completed.

The HDD from the shore out to approximately the 10-m isobath would likely be accomplished using a “drill and leave” technique where the drill pipe is left in place and becomes the cable conduit. This technique allows for installation of the conduits in a single pass and eliminates the need for successive reaming and conduit pullback. The HDD laydown area would be in the Driftwood Beach State Recreation Site and each bore would be spaced about 20 ft apart at the shoreside end. Drilling fluids, generally a mixture of bentonite clay and water, would be circulated through the drilling tools to lubricate the drill bit and conduits, and to remove drill cuttings. The HDD would be conducted per the requirements of an HDD Contingency Plan. Each HDD bore is expected to take up to one month to complete; the onshore cable landing installation will occur over a period of 6 to 8 months.

Each test berth at PacWave South would include a subsea connector that would rest on the seafloor. A surface buoy would likely mark the location of the subsea connector. The subsea connector would be hoisted onto the deck of an operations vessel (which could employ dynamic positioning [DP]), where it would be mated to the WEC umbilical cable or hub; based on experience at the European marine Energy Centre (EMEC), this may occur approximately once a year, but could occur as often as several times per year or as infrequently as once every 3 years or more (EMEC 2015). Once the connection is made, the mated umbilical cable and connector would be lowered to the seafloor. The final design process would provide a comprehensive set of engineering and operational requirements that minimize risks to equipment and personnel, as well as provide equipment and vessel requirements for installation and maintenance of the subsea connectors and cables.

As noted above, the terrestrial cables will be installed using up to five HDD bores from the Driftwood Beach State Recreation Site parking lot directly to the UCMF property on the east side of Highway 101. From the UCMF, conduits would also be buried west out to and under, Highway 101 to the grid connection point with the CLPUD overhead distribution line adjacent to the highway; HDD would also be used for this operation, with the HDD rig set up on the UCMF property.

The planned start date for construction at the Driftwood Beach State Recreation Site (Phase I - HDD operations and beach manhole and conduit installation) is spring 2020. A second phase (Phase II - cable pull/installation) would likely occur in spring 2021. Phase I would last approximately 6-8 months and Phase II would last approximately 45-60 days. It is anticipated the Driftwood Beach State Recreation Site would need to be closed to vehicular traffic during both phases. It may be possible to maintain limited pedestrian access during construction; however, OSU would need to work with OPRD to determine the feasibility of maintaining such access while ensuring public safety.

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2.3.2 Anchors and Mooring Systems

Installation of anchors and mooring systems would occur prior to WEC deployment. Anchors would be deployed and recovered by a vessel(s) with adequate assets and load-handling capabilities. For example, smaller anchors and mooring systems could be installed using a vessel such as OSU’s 82-ft, 510-horsepower (hp) *R/V Pacific Storm*. Larger anchors or more complex mooring systems would likely require tug boats and multi-purpose, offshore work vessels. OSU previously chartered the 159-ft, 486-ton, *NRC Quest* for operations at PacWave North. The *Quest* was equipped with a 122- by 28-ft stern deck, a 22-ton deck crane, and two Manitowoc 390 double drum winches with 10,000 ft of 1.25-inch wire rope. Similar type vessels are stationed in Oregon and Washington ports, and these are expected to be available for Project needs. While the number of vessels needed for anchor installation or removal would depend on the number and size of anchors being deployed, these activities typically require two to four vessels (specialized work vessels, tugs, barges, and smaller crafts).

Based on OSU’s experience at the nearby PacWave North, it is anticipated that it could take up to seven days to install the mooring system for a single WEC, and an additional one to two days to connect the WEC to the mooring. If an array was installed, which consisted of a number of WECs on individual mooring systems, this process would need to be repeated for each device. This time would not necessarily be continuous as weather could delay the start-to-finish completion, however, actual at-sea activities would not be expected to take more than nine days to install one mooring system and WEC. Although it is uncertain, it is possible that WEC and mooring system turnover could affect two berths per year.

Once the anchors arrived at the test site, the installation vessels would be positioned over preselected anchor locations. These locations would be selected based on the WEC mooring system design and engineering analysis of the sea floor characteristics. For drag embedment anchors, a second anchor handling vessel would likely be required to deploy and set the anchors.

A drag anchor resembles an "inverted kite". These are installed by positioning the anchor orientation at the seafloor and then tensioning the mooring line using a vessel. During the tensioning, the flukes penetrate the seafloor, and as tension increases, the anchor embeds itself to deeper depths (DOE 2011). Drag anchors are commonly used and are relatively easy to install. Large size and capacity anchors are available for both sandy seafloor conditions, as well as mud/soft clay (Sound & Sea Technology 2009).

"Suction piles are a relatively new type of pile system; however their use has been growing steadily in the offshore industry particularly for soft soil in deep water. They are also effective in normal sand seafloors but are not appropriate for hard bottom conditions." (Sound & Sea Technology 2009). For deployment of suction anchors, a floating crane is used to lift and lower the caissons to the sea floor, and suction equipment, a remotely operated vehicle, control cabin, and launch cradle are also frequently needed (DOE 2011). An important feature of suction piles is their ability to be extracted and recovered by reversing the pump to apply pressure inside the pile (Sound & Sea Technology 2009). An advantage of suction piles is that they are installed using a submerged pump, which produces low levels of sound (further described in Section 5.2.1) (Laurinollo et al. 2005).

Sound & Sea Technology (2009) further describes installation of suction piles:

> During installation, the suction caisson acts as an inverted bucket. Initial penetration of the suction caisson into the seabed occurs due to the self weight; subsequent penetration is by the "suction" created by pumping water out from the inside of the caisson. The installation method involves applying a pressure differential.
>
> The rim of the inverted bucket seals with the seafloor, and then water is pumped out of the upper end of the enclosed volume.... This produces a net downward pressure, or suction, forcing the bucket into the seabed. In clays, the pressure is sufficient to bring the suction caisson to a substantial depth. In sands, water inflow reduces the effective stresses in the sand near the bucket rim, allowing the bucket to penetrate the seafloor. Once installed to sufficient

> depth, the pumps are removed and the valves are sealed, with the sand quickly regaining its bearing capacity. Suction caissons can easily be removed by reattaching the pumps and pumping water back into the bucket cavity, forcing it out of the seabed.

Gravity anchors are heavy objects placed on the seafloor that resist vertical and lateral loading. They are typically made of concrete and/or steel, and are placed directly on the seafloor (Sound & Sea Technology 2009, DOE 2011).

Most anchors would likely be retrieved by winching the anchor up to the surface and onto a vessel (using the mooring system itself or a recovery line). Recovery lines may be installed at the time of deployment and activated by acoustic releases when retrieval is underway, or may be attached to the anchor at the time of recovery using an remotely operated underwater vehicle (ROV). Removal of embedment anchors is achieved by pulling the mooring line in a perpendicular direction to lift the anchor out of the sediment along the reverse of its initial traverse (DOE 2011). For removal of suction anchors, water would be pumped into the anchor chamber, creating positive pressure, and the mooring line pulled up raising the caisson from the sediment. Once the anchor is free of the seafloor, it would be raised to the deck of the vessel and brought to shore (DOE 2011). For removal of gravity anchors, the anchor would be raised from the seafloor and hoisted on board a vessel, or remain suspended from the vessel and be transported to a port or sheltered location on a route chosen to ensure it did not come in contact with the sea floor during transit. The anchor would then be recovered by shoreside crane or an inshore crane vessel (DOE 2011).

As noted previously, anchor deployment periods would align with WEC test durations, so they would likely be in place for 3-5 years at a time. Anchors could be in place up to 25 years if the anchors are to be used for multiple WEC tests throughout the Project life. Marker buoys may be installed between WEC deployments if anchors are not removed at the same time as the WECs. Although anchor deployment and recovery would occur periodically over the duration of the Project, OSU intends to limit the frequency of anchor deployment and recovery to the extent possible. These activities rely on specific weather windows, so the timeframes within which anchor installation or removal could occur are limited. Additionally, most clients will likely plan to deploy WECs for multi-year test periods, and it is unlikely that anchor systems would be adjusted or replaced during a WEC test due to the high costs associated with installing and removing them. Finally, OSU would aim to reuse anchors wherever possible.

2.3.3 WECs

Once the anchors and mooring systems are in place, the WECs would be deployed singly or in arrays. Results of the OSU industry survey and the OWET market analysis show that average deployment timeframes are likely to range from one to five years; the market analysis also indicates that five-year deployment periods are most likely during the initial stage of Project operations. OSU anticipates that most WECs would be transported by truck, barge, or marine tow transport to Newport for deployment. Acquisition of applicable permits required for shipment would be the responsibility of the test client. If a WEC is transported from a foreign location, it would require proper permits and licenses to enter the United States, which would also be the responsibility of the test client.

In general, WECs would be towed or barged to the site, configured, and attached to the mooring system. In most cases, two or three vessels would be needed to deploy a WEC, although some are designed to be deployed using a single vessel. Examples of vessels that might be used for such operations are OSU's *R/V Pacific Storm* and tug boats such as the 38-foot, 465-hp *Thea Knutson,* operated by Wiggins Tow & Barge. Larger, 3,000 to 8,000-hp, ocean-going tugs are located in Coos Bay and Astoria. Once the WEC is attached to its mooring system, it is anticipated that an umbilical cable would be attached to the WEC to connect it to the subsea connector, possibly through a developer-supplied hub. Connecting to the subsea connector would likely require that the connector be winched up onto the deck of a vessel with sufficient lift capacity. Therefore, if a test berth had five WECs, there would be five umbilical cables connecting to the developer-supplied hub, and the hub would be connected to the subsea connector. Test-specific deployment procedures would be developed to address each WEC deployment and subsea connection. OSU anticipates that it would take one to two days to deploy a single WEC and up to seven days to deploy a small array of WECs. Like anchor deployment, these operations would not necessarily be continuous because weather could delay the start-to-finish timeframe completion or postpone certain activities.

When a test is complete, the WEC would be de-energized and a suitable vessel would be used to disconnect the umbilical cable. With the umbilical cable detached, the WEC would be removed from the test site. If any materials are to be disposed of after the testing period, OSU would require test clients to dispose of these at permitted facilities in accordance with federal, state, and local environmental control regulations.

2.3.4 Estuarine Activities

As noted, Project components would be fabricated at land-based facilities prior to being installed at the test site. The primary staging area for PacWave South will likely be centered on the Port of Newport.

The natural harbor of Yaquina Bay provides a protected haven for commercial fishing vessels, and the Port provides a number of support facilities for the local fleet and the locally-based distant water fleet (commercial fishing boats that spend much of the year in waters off the coast of Alaska), including moorage, space for suppliers and services, fuel, and other essentials. The Port also leases space to seafood processors (FCS Group 2014). The North Shore Development Area of the Port is Newport's working waterfront, which includes a 214-slip marina that is used primarily by commercial fishermen and the Newport-based distant water fleet (Port of Newport 2013). In addition to these and other amenities, there is over 240 ft of floating moorage for boat maintenance, and a 220-ft fixed moorage that contains four hoists of varying capacities, enabling vessels to perform gear changes, off-load fish product, and do other maintenance or repair work (Port of Newport 2013). In 2000, the most recent year for which data were available, 393 commercially registered vessels (residents and non-residents) delivered landings to Newport (NOAA 2007).

The subsea cables, WECs, mooring and anchor systems, navigational buoys, and monitoring equipment, would likely be transferred from other locations to Newport, Toledo or other nearby ports for mobilization and transfer to PacWave South. Project components, other than WECs and subsea cables, are expected to be staged on land for the installation vessels to pick up and transport to the Project site.

The primary Yaquina Bay estuarine activities would be the following:

- Berthing one or more WECs dockside in Newport/Toledo prior to being towed to PacWave South.
- Vessel traffic in and out of Yaquina Bay to transport WECs, anchors, and other Project components, as well as operation and maintenance (O&M) and environmental monitoring crews.

Project-related vessels would stay within navigation channels and specifically designated areas for vessel use in Yaquina Bay. Test clients would use marine industrial facilities that have been and continue to be dredged to a sufficient depth. For example, the International Terminal is dredged to 33 ft.

2.4 PROPOSED ENVIRONMENTAL MEASURES

Proposed environmental measures that relate to ESA-listed fish, marine mammals, and sea turtles or are intended to avoid, minimize or mitigate potential effects to those resources are discussed below.

General

- Implement the Adaptive Management Framework (Appendix J of the APEA) in conjunction with specific PM&E measures to evaluate study results, identify any Project effects, and implement and/or modify response actions (Appendix I of the APEA) in consultation with key agency stakeholders.

- Beginning five years and six months after deployment of the first WEC at the Project, and recurring every five years thereafter, the licensee shall file with FERC a Five Year Report and provide copies to BOEM, NMFS, FWS, and ODFW. Contents of the report are further described in Appendix I of the APEA, Protection, Mitigation, and Enhancement Measures.
- Employ periodic, routine inspection and maintenance methods to ensure structural integrity of Project components (Appendix F, Operation and Maintenance Plan).
- Develop and implement the Emergency Response and Recovery Plan (Appendix G of the APEA).

Geologic and Soil Resources

- Use HDD to install the cables under the nearshore and intertidal habitat (to approximately the 10-m isobath) to minimize substrate disturbance.
- Use HDD to install the terrestrial cables in up to five bores, from the beach manholes at the Driftwood Beach State Recreation Site to the UCMF property, and from the UCMF to the Highway 101 grid connection point, to minimize habitat and substrate disturbance.
- Follow best practices during installation, operation, and removal activities to avoid or minimize potential effects to sediment, including:
    - Minimize the time that the seafloor is disturbed and sediment is dispersed and the associated effects by completing cable laying and other construction activities during appropriate construction windows and within one construction season to the extent practicable.
    - Develop and implement an Erosion and Sediment Control Plan, where appropriate, to minimize effects of ground disturbing activities associated with installation of the terrestrial cables and/or other terrestrial construction
- Implement the Benthic Sediments Monitoring Plan (Appendix H of the APEA) to evaluate effects on benthic habitat from anchors, WECs, and other equipment during operation, maintenance and monitoring activities. Based on monitoring results, implement the specified measures to mitigate for potential adverse effects (Appendix I of the APEA).
- Project components in the estuarine environment should not bottom out so as to prevent nearshore/estuarine habitat effects.
- To the extent possible, minimize frequency of anchor installation/removal cycles and reuse installed anchors.

Water Resources

- Follow industry best practices and guidelines[4] for antifouling applications (e.g., TBT-free) on Project structures such as marker buoys, subsurface floats and WECs.
- Develop and implement an Emergency Response and Recovery Plan (Appendix G of the APEA) with spill prevention, response actions, and control protocols, as well as and provisions for recording types and amounts of hazardous fluids contained in WECs and other Project components.
- Require all vessel operators to comply with an Emergency Response and Recovery Plan (Appendix G of the APEA) for installation and maintenance of Project facilities.
- Prepare waste management, hazardous material, and spill prevention plans, as appropriate, for onshore Project facilities.
- Minimize storage and staging of WECs outside of existing dock, port or other marine industrial facilities.
- Require that all Project chartered or contracted vessels comply with current federal and state laws and regulations regarding aquatic invasive species management.
- Develop and implement an HDD Contingency Plan to minimize the potential for inadvertent return of drilling fluids, provide timely detection, and address potential releases by describing monitoring, containment, response and notification procedures to be implemented by the contractor.

Aquatic Resources and Threatened and Endangered Species

General

- Bury subsea cables at a depth of 1-2 meters, to the maximum extent practicable, to minimize the amount of habitat conversion (soft bottom to hard structure) from laying exposed cable on the seafloor. In areas where a cable cannot be buried or persistently becomes unburied, that portion of the cable will be on the seafloor and will be protected by split pipe, concrete mattresses or other cable protection systems.
- To the maximum extent practicable, utilize shielding on subsea cables, umbilicals, and other electrical infrastructure to minimize electromagnetic field (EMF) emissions.
- Implement the EMF Monitoring Plan (Appendix H of the APEA) to measure and detect any adverse effects of Project-related EMF emissions. Based on monitoring results,

[4] Industry standards are sometimes published in written documents (e.g., the International Cable Protection Committee's cable recommendations available at https://www.iscpc.org/publications/recommendations/) or in manufacturer guidelines (e.g., for a vessel anchor, providing the recommended ratio of water depth to anchor line paid out). These standards are sometimes required as a condition of insurance or warranty. In other cases, industry standards represent unpublished best practices commonly implemented by a particular industry and that evolve over time.

implement the specified measures to mitigate for potential adverse effects (Appendix I of the APEA).
- In the event of an emergency in which fish or wildlife are being killed, harmed or endangered by Project facilities or operations in a manner that was not anticipated, OSU will notify agencies with regulatory authority as soon as possible and take action to promptly minimize the impacts of the emergency, including implementing any guidance pursuant to agency legal authorities, as outlined in Appendix I of the APEA.

Fish and Invertebrates

- Implement the Organism Interaction Monitoring Plan to track changes to pelagic and demersal fish and invertebrates (particularly Dungeness crab) that might be attracted to the installed components or affected due to the potential for reduced fishing pressure, as well as biofouling on the anchors/WECs (Appendix H of the APEA).
- Develop cable routes that avoid crossing areas with rocky reef and hard substrate to the maximum extent practicable to protect sensitive habitat features.
- Develop and implement an anchoring plan or protocol for any Project vessels that may anchor at the Project site, that:
    - Avoids anchoring in known rocky reef or hard substrate habitats to the maximum extent practicable; and
    - Minimizes the use of anchors within the Project area wherever practicable by combining onsite activities.

Marine Mammals

- Entangled fishing gear
    - Conduct opportunistic visual observations from the water surface in the portions of the test site which are being visited to conduct operations, maintenance, or environmental monitoring work and review any underwater visual monitoring conducted for other purposes to detect entangled fishing gear that has the potential to increase the risk of marine species entanglement. The licensee will ensure that surface observations will occur during all visits to the Project test site, and at least once per quarter each year for the duration of the license.
    - Annually following the peak storm season and period of maximum activity for the Dungeness crab fishery, the licensee shall conduct surface surveys of active WEC berths during the spring season (mid-March through mid-June), or the earliest possible time after that period that avoids jeopardizing human safety, property or the environment.
    - Conduct annual subsurface surveys of moorings and anchor systems using ROV or other appropriate techniques with approval by NMFS concurrent with spring

    (mid-March through mid-June) monitoring under the Organism Interactions Monitoring Plan (Appendix H of the APEA).
  - If entangled fishing gear or marine mammal (or sea turtle) stranding, entanglements, impingements, injuries or mortalities are detected, implement the specified measures to minimize risk of marine mammal entanglement and to make every effort to return the fishing gear to the owners (Appendix I of the APEA).
- Require vessels in transit to/from the Project site to avoid close contact with marine mammals and sea turtles and adhere to NMFS "Be Whale Wise" guidelines to minimize potential vessel impacts to marine mammals.
- Comply with current regulations that require marine mammal observers for certain vessel based activity (e.g., sub-bottom profiling).
- Require WEC testing clients to keep their equipment in good working order to minimize sound due to faulty or poorly maintained equipment.
- Implement the Acoustics Monitoring Plan (Appendix H of the APEA) to quantify sound levels using field measurements and validated sound propagation models. Based on monitoring results, implement specified measures to mitigate for potential adverse effects (Appendix I of the APEA).
- Minimize construction activities during key gray whale migration periods, to the extent possible.
- For use of Dynamic Positioning Vessels (DPVs) or other equipment that may exceed NMFS's published thresholds for injury:
  - Avoid use of these vessels to the maximum extent practicable during Phase B gray whale migration (April 1-June 15). If these construction activities are proposed during this migration period, the licensee will consult with ODFW regarding the timing of such activities including cable-laying in state waters.
  - With technical assistance from NMFS, establish and carry out the following actions and protocols necessary to maintain an appropriate acoustic zone of influence in accordance with NMFS's published harassment threshold (120 dB re: 1 μPa) during DPV operations to minimize behavioral disturbance and protect marine resources:
    - Post qualified marine mammal observers during daylight hours.
    - The licensee will conduct DP activities during daylight hours when feasible to ensure observations may be carried out.
    - DP for cable laying may occur during all hours; however, DP start up for cable laying will only occur during daylight hours.
    - The licensee will carry out the ramp-up procedures that are specified in Appendix I of the APEA, which may be modified by agreement of the licensee and NMFS.

    - Implement such additional measures as may be imposed pursuant to a Marine Mammal Protection Act authorization.
- Make opportunistic visual observations of pinnipeds in the portions of the test site which are being visited to conduct operations, maintenance, or environmental monitoring work. If pinnipeds are observed to be hauled out on Project structures, the licensee will follow the reporting and haulout protocols specified in Appendix I.
- To the extent practicable, direct the WEC testing clients to design and maintain cables and moorings in configurations that minimize the potential for marine mammal or sea turtle entrapment or entanglement and follow the reporting and haulout protocols specified in Appendix I of the APEA.

Seabirds

- Implement the Environmental Measures section as described in the Bird and Bat Conservation Strategy (Appendix B) to assess, minimize, and avoid impacts to birds, these are annotated below:
    - Conduct opportunistic visual observations from the water surface in the portions of the test site, that are being visited to conduct operations, maintenance, or environmental monitoring work, and review any underwater visual monitoring conducted for other purposes, to detect derelict gear that has the potential to increase the risk of marine species entanglement. If monitoring shows that derelict gear has become entangled or collected on any Project structure, the risk that it poses will be assessed based on type of gear, and the derelict gear will be removed as soon as is practicable while avoiding jeopardizing human safety, property or the environment, as described in Appendix I of the APEA.
    - Conduct opportunistic visual observations in the portions of the WEC test site during vessel-based visits for operations, maintenance or environmental monitoring work, to detect and document any instances of seabird perching.
    - Use low-intensity flashing lights and bird-friendly wavelengths on the Project structures to minimize seabird attraction and follow the specifications for Project lighting developed in consultation with the FWS and USCG.
    - Minimize lighting (e.g., use low intensity, bird-friendly wavelengths, shielded lighting not providing upward-pointing light or light directed at the sea surface) used at night by service and support vessels to reduce the potential for seabird attraction.
    - Require vessel operators to follow FWS instructions regarding appropriate handling and release of seabirds in the event of seabird fallout.
    - Require vessel operators to remain 500 feet away from seabird colonies during the nesting season to minimize disturbance to nesting seabirds.

  - Develop and implement an Emergency Response and Recovery Plan (Appendix G of the APEA).

Terrestrial Resources

- Minimize or avoid terrestrial activities in sensitive ecological areas (e.g., jurisdictional wetlands and nesting areas for listed avian species).
- Use HDD to install the cables conduits under the beach and sand dune habitat.
- Use HDD to run the terrestrial cable conduit directly from the Driftwood site to the UCMF, and from the UCMF to the Highway 101 grid connection point, minimizing effects to wetlands, streams, and terrestrial habitat.
- Employ environmental measures during installation, operation, and removal to avoid or minimize potential effects to sediment and soils. For example:
  - Minimize disruption of terrestrial geology and soils by maintaining buffers around wetlands to the degree practicable.
  - Develop and implement an Erosion and Sediment Control Plan, and maintaining natural surface drainage patterns.
  - Develop and implement stormwater runoff containment at land-based facilities to maintain existing drainage patterns, protect Project-adjacent habitat, and prevent contamination of streams. Develop a stormwater plan that meets all federal and state legal requirements during site design of the UCMF and associated facilities prior to any construction activities at the site.
- Avoid to the extent practicable, disturbance of snags and of wildlife or legacy trees including live or dead trees that provide benefit to wildlife. If unavoidable, additional pre-construction species specific surveys may be necessary to minimize effects.
- Avoid to the extent practicable, disturbance of forested wetlands.
- Avoid to the extent practicable, disturbance of wetlands and adjacent areas that may provide habitat for turtles, amphibians, and other semi-aquatic wildlife.
- Avoid to the extent practicable, disturbance of riparian wetlands where restoration of natural hydrology may be unsuccessful within a short timeframe. Natural hydrology should be restored after construction is complete, and may require a restoration plan with monitoring until successful restoration can be determined.
- Minimize disturbance of streams that support fish, or are connected to fish-bearing streams. Unavoidable work within or adjacent to fish-bearing streams may be subject to in-water work windows. If terrestrial activities directly or indirectly affect any stream used by anadromous fish or fish listed as threatened or endangered under the federal ESA, consult with NMFS staff to avoid and minimize any potential effects to listed species.
- Avoid to the extent practicable, disturbance of seaside hoary elfin butterfly habitat within and in the vicinity of Driftwood Beach State Recreation Site. Where unavoidable,

species-specific surveys may be necessary on properties outside of Driftwood Beach State Recreation Site but within the construction footprint to determine the extent of occupied habitat and associated mitigation[5].

- Develop a revegetation plan, in consultation with NMFS, ODFW, and appropriate agencies, using native species to the extent practicable for areas disturbed during construction. This plan will include the minimization measures identified in letters commenting on the DLA filed with FERC by NMFS (dated July 18, 2018) and ODFW (dated July 20, 2018) as appropriate.
- Develop measures that will limit the introduction or spread of invasive species, to be included in a construction plan.
- Implement the Environmental Measures section as described in the Bird and Bat Conservation Strategy (Appendix B) to assess, minimize, and avoid impacts to birds and bats; these related to ESA-listed species, are annotated below.
    - No HDD construction equipment or construction activities will occur on Driftwood Beach within suitable snowy plover nesting, roosting, or foraging habitat and is expected to be limited to the Driftwood Beach parking lot, at least 164 feet (50 meters) from any potentially suitable habitat.
    - HDD operations in the parking lot will occur during daylight hours, but if lighting is required at night it will be appropriately shielded and directed to minimize artificial light reaching western snowy plover nesting habitat at night. Animal-proof litter receptacles and related signage and coordination will be provided to minimize potential attraction of predators.
    - Develop and implement an HDD Contingency Plan to minimize the potential for inadvertent return of drilling fluids, provide timely detection, and address potential releases by describing monitoring, containment, response and notification procedures to be implemented by the contractor.
    - If HDD is initiated during the western snowy plover nesting season (March 15 to September 15), prior to operation of the HDD, surveys of suitable nesting habitat will be conducted. If nests are detected, measures specified in the BBCS will be implemented, including noise monitoring and implementation of engineering controls, if appropriate (e.g., install temporary noise barriers such as berms, stockpiles, dumpsters, bins, and/or engineered acoustical barriers).
    - Conduct preconstruction surveys for roosting bats, and minimize construction impacts from high frequency sound disturbance, night lighting, and air quality degradation near roosts by implementing bat roost buffers. If lighting is required at the UCMF, it will be appropriately shielded and directed to minimize artificial light attraction and prevent potential injury or mortality to seabirds. To the maximum extent practicable, while allowing for the public safety, low intensity

[5] Survey protocol to be consistent with the U.S. Forest Service Interagency Special Status/Sensitive Species Program protocol for Seaside Hoary Elfin (ISSSSP 2005).

energy saving lighting (e.g., low pressure sodium lamps) will be used, and bright white light will be minimized to the maximum extent practicable.

2.5 INTERDEPENDENT AND INTERRELATED ACTIONS

Interrelated actions are actions that are part of a larger action and depend on the larger action for their justification (50 CFR §402.02). Interdependent actions are actions having no independent utility apart from the proposed action (50 CFR §402.02). OSU has not identified any activities that are interrelated to the Project. OSU has identified transport of WECs and other components to and from the Port of Newport as an activity that is interdependent to the Project. Potential effects from WEC transport are analyzed in section 5.2.2.

3.0 STATUS OF SPECIES AND CRITICAL HABITAT

This draft BA examines the status of each species that would be affected by the proposed action. This evaluation takes into account the level of risk that the listed species face, using parameters considered in documents such as recovery plans, status reviews, and listing decisions. The species status section helps to inform the description of the species' current "reproduction, numbers, or distribution" as described in 50 CFR 402.02. The draft BA also examines the Primary Constituent Elements of critical habitat where designated critical habitat occurs in the Project or action area.

OSU determined with input from NMFS and FWS that 39 fish, reptile, and marine mammal, and bird species listed under the ESA may occur in the action area (Table 3-1). Of these species, critical habitat has been designated within the Project area for two species: Southern DPS North American green sturgeon and leatherback sea turtle.

Table 3-1. ESA-listed species under NMFS and FWS jurisdiction that may occur within the PacWave South action area.

Common Name	Scientific Name	Federal Status	State Status	Critical Habitat Designated	Critical Habitat in Action Area
Fish					
Chinook salmon[1]	*Oncorhynchus tshawytscha*				
Lower Columbia River Evolutionarily Significant Unit (ESU)		T	NL	Y	N
Upper Columbia River spring-run ESU		E	NL	Y	N
Snake River spring/summer -run ESU		T	T	Y	N
Snake River fall-run ESU		T	T	Y	N
Upper Willamette River spring-run ESU		T	NL	Y	N
California Coastal spring-run ESU		T	NL	Y	N
Sacramento River winter-run ESU		E	NL	Y	N
Central Valley spring-run ESU		T	NL	Y	N
Coho salmon[2]	*O. kisutch*				
Lower Columbia River ESU		T	E	Y	N
Oregon Coast ESU		T	NL	Y	N
Southern Oregon/ Northern California Coast ESU		T	NL	Y	N
Central California Coast ESU		E	NL	Y	N

Common Name	Scientific Name	Federal Status	State Status	Critical Habitat Designated	Critical Habitat in Action Area
Steelhead	*O. mykiss*				
Lower Columbia River Distinct Population Segment (DPS)		T	NL	Y	N
Middle Columbia River DPS		T	NL	Y	N
Upper Columbia River DPS		T	NL	Y	N
Snake River Basin DPS		T	NL	Y	N
Upper Willamette River DPS		T	NL	Y	N
Northern California DPS		T	NL	Y	N
Central California Coastal DPS		T	NL	Y	N
California Central Valley DPS		T	NL	Y	N
South-Central California Coast DPS		T	NL	Y	N
Sockeye salmon Snake River ESU	*O. nerka*	E	NL	Y	N
Chum salmon Columbia River ESU	*O. keta*	T	NL	Y	N
Green sturgeon Southern DPS	*Acipenser medirostris*	T	NL	Y	Y
Eulachon Southern DPS	*Thaleichthys pacificus*	T	NL	Y	N
Reptiles					
Leatherback sea turtle	*Dermochelys coriacea*	E	E	Y	Y
Green sea turtle	*Chelonia mydas*	T	E	Y	N
Loggerhead sea turtle	*Caretta caretta*	T	T	Y	N
Olive (Pacific) Ridley sea turtle Pacific DPS	*Lepidochelys olivacea*	E	T	N	N
Mammals					
Killer whale Southern Resident DPS	*Orcinus orca*	E	NL	Y	N
Humpback whale, Central America DPS/Mexico DPS	*Megaptera novaeangliae*	E/T	E	N	N
Blue whale	*Balaenoptera musculus*	E	E	N	N
Fin whale	*Balaenoptera physalus*	E	E	N	N
Sei whale	*Balaenoptera borealis*	E	E	N	N
Sperm whale	*Physeter macrocephalus*	E	E	N	N
North Pacific Right Whale	*Eubalaena japonica*	E	E	Y	N
Birds					
Marbled murrelet	*Brachyramphus marmoratus*	T	T	Y	N
Short-tailed albatross	*Phoebastria albatrus*	E	E	N	N
Western snowy plover	*Charadrius alexandrinus nivosus*	T	T	Y	N
Northern spotted owl	*Strix occidentalis caurina*	T	T	Y	N

Notes: [1]Based on recoveries of coded wire tagged Chinook salmon (Weitkamp 2010)
[2]Based on recoveries of coded wire tagged coho salmon (Weitkamp and Neely 2002)
E = Endangered, T = Threatened, NL = not listed.

3.1 SALMON AND STEELHEAD

ESA-listed Pacific salmon and steelhead species that may occur off the coast of Oregon include Chinook salmon, coho salmon, sockeye salmon, chum salmon, and steelhead. Additionally, coho salmon are known to occur in surface streams in the vicinity of the terrestrial Project area, and have the potential to be present in streams within the action area. Ocean dispersal and distribution varies widely among life stages, species and populations, and not all are likely to occur in the action area. Salmon and steelhead that may occur in the action area originate from the Columbia River Basin, the Oregon coast, and the California coast. Most salmon and steelhead enter the ocean as juveniles in spring; however, transition time from estuary habitats (e.g., Columbia River) to the ocean environment may be highly variable (McMichael et al. 2013).

3.1.1 Chinook Salmon

Chinook salmon are the largest of Pacific salmon and historically ranged from southern California (Ventura River) to northern Alaska (Point Hope). Given this widespread geographic distribution, Chinook salmon have developed diverse and complex life history strategies. Chinook salmon can be grouped into two generalized freshwater life history types: “stream-type” and “ocean-type.” Stream-type Chinook salmon reside in freshwater for a year or more following emergence, whereas “ocean-type” Chinook salmon migrate to the ocean predominantly within their first year. Stream-type Chinook salmon generally spawn in headwater streams and have a longer freshwater residency, in which the juveniles rear in freshwater streams and perform extensive offshore migrations before returning to their natal streams in the spring or summer (Myers et al. 1998). In addition to differences in freshwater life histories, there appears to be differing ocean use patterns between these stream-type and ocean-type Chinook salmon. Stream-type populations appear to undertake extensive offshore ocean migrations while ocean-type Chinook salmon undertake distinct, coastally oriented, ocean migrations (Good et al. 2005).

Juvenile Chinook salmon exhibit a patchy distribution in U.S. West Coast waters; in pelagic trawl surveys conducted in summer and fall along Oregon and Washington, half of all juvenile salmonids were collected in about 5 percent of the surveys and none were collected in about 40 percent of the surveys (Peterson et al. 2010). In general, salmonids are low in abundance in U.S. West Coast waters when compared to other fishes, as evidenced by: 1) the low numbers of juvenile salmonids captured in directed pelagic surface/ subsurface research trawls relative to other nekton (Brodeur et al. 2004, Brodeur et al. 2005, Fisher et al. 2014, Peterson et al. 2010, Trudel et al. 2009); and by 2) low numbers of adult and subadult salmonids captured as bycatch in midwater trawls (e.g., commercial trawls for whiting, see Lomeli and Wakefield 2014).

Juvenile Chinook salmon disperse from their natal streams to coastal waters; their ocean distribution changes with time, with juveniles typically moving northward or farther offshore (Brodeur et al. 2004). Juveniles during their first year at sea tend to remain within 200-400 km of their ocean entry point; northward migration appears to be initiated primarily in the second year at sea (Trudel et al. 2009). The combined freshwater plus ocean migration rates of juvenile Chinook salmon from coastal stocks averaged 0.4-1.2 km/d for subyearlings and 1.0-2.4 km/d for yearlings (Trudel et al. 2009).

Juvenile Chinook salmon tend to occur closer inshore than other juvenile salmonid species, generally within the 100 m isobath (Brodeur et al. 2004, Peterson et al. 2010). In fact, subyearling Chinook salmon have been found in the surf zone (Marin Jarrin et al. 2009). Juvenile Chinook salmon tend to be more abundant off Washington in comparison to coastal waters of central and northern Oregon, likely reflecting more favorable habitat in Washington waters with a northwards migration after ocean entry (Bi et al. 2008, Peterson et al. 2010, Trudel et al. 2009).

Growth of Chinook salmon is positively associated with upwelling, lower coastal sea surface temperature, and wind stresses during summer and spring, which are conditions that promote increased productivity in the California Current (Wells et al. 2008). Similarly, high adult return rates (signifying high survival) of Chinook salmon have coincided with periods of cool and productive ocean conditions (La Niña events), and declines have coincided with warm El Niño ocean conditions in the northern California Current (Peterson et al. 2006).

Juvenile salmonids are pelagic and typically surface-oriented, most often found in the upper 20 m of the water column (Emmett et al. 2004, Walker et al. 2007 Beamish et al. 2000). Their preferred prey types are also pelagic (e.g., copepods, euphausiids [*Euphausia pacifica* and *Thysanoessa spinifera*], and juveniles of northern anchovy [*Engraulis mordax*], Pacific herring [*Clupea pallasii*], sardines [*Sardinops sagax*], rockfishes [*Sebastes* spp.], and smelt [Osmeridae]; Brodeur et al. 2005, Brodeur et al. 2007, Daly et al. 2009, Santora et al. 2012). Juvenile and subadult Chinook salmon off Oregon and Washington feed opportunistically on pelagic fish and invertebrates; smaller juveniles tend to eat primarily juvenile fish of species that spawn in the winter (i.e., rockfishes, Pacific sandlance [*Ammodytes hexapterus*], osmerids, crab larvae, and euphausiids, with the diet shifting to juvenile pelagic fishes (e.g., northern anchovy, Pacific herring, and osmerids) as they grow (Daly et al., 2009, Brodeur et al., 2007). Adult salmonids, especially Chinook salmon, occur at greater depths than juveniles, as evidenced by their capture as bycatch in midwater trawl fisheries (Lomeli and Wakefield 2014). Their prey is predominately pelagic; based on stomach samples collected from adult Chinook salmon (≥56 cm in length) caught in coastal waters off Northern California coastal waters, frequently encountered prey items included euphausiids, northern anchovy, squid (*Loligo opalescens*), Pacific herring, Pacific sandlance, surf smelt (*Hypomesus pretiosus*), night smelt (*Spirinchus starksi*), and Dungeness crab megalopae (Hunt et al. 1999). Infrequently encountered prey items included Pacific saury

(*Cololabis saira*), juvenile rockfishes, amphipods, jacksmelt (*Atherinopsis californiensis*), octopi (*Octopus rubescens*), shrimp (mysid), juvenile pleuronectids, and juvenile cottids (Hunt et al., 1999, PFMC 2000). Prey items vary by year and by season (late spring versus late summer), likely reflecting variability in ocean conditions that influences local availability of prey.

There are eight ESUs of federally listed Chinook salmon that could occur in the action area: Lower Columbia River, Upper Columbia River, Snake River spring/summer, Snake River fall-run, Upper Willamette River, California Coastal, Sacramento River winter-run, and Central Valley spring-run (Table 3-1). Chinook salmon from these ESUs differ in their freshwater spawning and rearing locations, and differ somewhat in their marine distributions (Weitkamp 2010). Oregon Coast Chinook salmon are not listed under the ESA.

Lower Columbia River ESU – NMFS listed Lower Columbia River Chinook salmon as threatened under the ESA in 1999 (70 FR 37160). This ESU includes naturally spawned Chinook salmon originating from the Columbia River and its tributaries downstream of the Hood and White Salmon Rivers, and fish originating from the Willamette River and its tributaries below Willamette Falls.

The predominant life history type for this ESU is the fall run, which consists of an early component that returns to the Columbia River beginning in early to mid-August and spawns within a few weeks (Kostow 1995), entering the ocean from August through November (NMFS 2013a); and a later returning component, which returns to the Lewis and Sandy rivers (Myers et al. 2003, Kostow 1995). These later fish enter the Columbia River over an extended period of time and spawn from late October through November. Some runs of spring-run Chinook salmon also occur in this ESU on the lower Columbia River and enter freshwater in March and April, well in advance of spawning in August and September (Myers et al. 1998), entering the ocean from May through July (NMFS 2013a). Upon ocean entry, most Lower Columbia River fall Chinook salmon disperse slowly, remaining south of Vancouver Island through autumn (Fisher et al. 2014). The spring-run Chinook salmon become widespread along the coast from summer through autumn, indicating a diversity of dispersal rates (Fisher et al. 2014). Most of the spring-run and fall-run Chinook salmon appear to migrate northward after ocean entry, although a fraction of them migrate south of the Columbia River (Trudel et al. 2009). Designated critical habitat includes the mainstem Columbia River and its tributaries below Hood River (70 FR 52630). Critical habitat does not extend into the open ocean and does not include the Project area.

The Recovery Plan for this ESU (NMFS 2013a) indicates threats to Lower Columbia River ESU Chinook salmon are primarily degradation and/or loss of freshwater and estuarine habitat associated with hydropower and dam development, and past and/or current land uses that affect channel structure and form, habitat quantity and quality, riparian condition, instream flows, and water quality. Additional threats include harvest, hatcheries, and direct mortality by predation (NMFS 2013b). The Recovery Plan provides strategies to address each of these threats. In addition, NMFS (2011a) identified management actions for the Columbia River Estuary and plume, recognizing importance of these habitats for the recovery of Columbia River Basin salmon and steelhead stocks.

Upper Columbia River ESU – NMFS listed upper Columbia River spring-run Chinook salmon as endangered under the ESA in 1999 (64 FR 14308). The ESU includes stream-type Chinook salmon spawning above Rock Island Dam and downstream of Chief Joseph Dam, including the Wenatchee, Entiat, and Methow Rivers in Washington. This ESU also includes six artificial propagation programs in Washington. Upon ocean entry in spring, most Upper Columbia River Chinook salmon migrate rapidly northward and by late summer are not found south of Vancouver Island (Fisher et al. 2014). Designated critical habitat includes the Columbia River mainstem and tributaries in Washington (70 FR 52630). Critical habitat does not extend into the open ocean and does not include the Project area.

The three extant populations of this ESU are at a high overall risk of extinction, and they continue to rely on hatchery reared Chinook salmon to maintain the natural populations (NMFS 2016a). The Recovery Plan for this ESU (Upper Columbia Salmon Recovery Board 2007) indicates main threats to this ESU include degradation and/or loss of freshwater habitat associated with dams, residential development, agriculture, historic timber harvest, roads, and diversions, and hatcheries that affect genetic integrity. The Recovery Plan provides strategies to address each of these threats. In addition, NMFS (2011a) identified management actions for the Columbia River Estuary and plume, recognizing importance of these habitats for the recovery of Columbia River Basin salmon and steelhead stocks.

Snake River Spring/Summer ESU – NMFS listed Snake River spring/summer-run Chinook salmon as threatened in 1992 (57 FR 34639) and this status was reaffirmed in 2005 (70 FR 37160– 37204). This ESU includes all naturally spawned populations of spring/summer-run Chinook salmon from the mainstem Snake River, Tucannon River, Grande Ronde River, Imnaha River, Salmon River sub-basins, and 15 artificial propagation programs. Upon ocean entry in spring, most Snake River spring/summer Chinook salmon migrate rapidly northward and by late summer are not found south of Vancouver Island (Fisher et al. 2014), and they do not appear to migrate south of the Columbia River (Trudel et al. 2009). Designated critical habitat includes the Columbia River mainstem and Snake River tributaries (64 FR 57399). Critical habitat does not extend into the open ocean and does not include the Project area.

According to NMFS Recovery Plan, most population groups from this ESU remain at high risk with a low probability of persistence in 100 years (NMFS 2016b). The Recovery Plan indicates threats to Lower Columbia River ESU Chinook salmon are primarily degradation and/or loss of freshwater and estuarine habitat associated with hydropower and dam development, and past and/or current land uses that affect channel structure and form, habitat quantity and quality, riparian condition, instream flows, and water quality. Additional threats include harvest, hatcheries, and direct mortality by predation (NMFS 2016b). In addition, NMFS (2011a) identified management actions for the Columbia River Estuary and plume, recognizing importance of these habitats for the recovery of Columbia River Basin salmon and steelhead stocks.

Snake River Fall-run ESU – NMFS listed Snake River fall-run Chinook salmon as threatened in 1992 (57 FR 14653) and this status was reaffirmed in 2003 (70 FR 37160). This ESU includes all naturally spawned populations of fall-run Chinook salmon from the mainstem Snake River and below Hells Canyon Dam and in the Tucannon, Grande Ronde, Imnaha, Salmon, and Clearwater Rivers, as well as four artificial propagation programs. Upon ocean entry from the Columbia River, they migrate both north and south along the coast (Trudel et al. 2009). Designated critical habitat includes the Columbia River mainstem and Snake River tributaries (58 FR 68543). Critical habitat does not extend into the open ocean and does not include the Project area.

Population declines were attributed to a loss of primary spawning and rearing areas as a result of hydropower projects, decreases in naturally produced spawners, and harvest impacts by ocean and in-river fisheries. The current population of Snake River fall-run Chinook only occupies a fraction of its former range due to inundation of historically productive habitat by Snake River dams, plus the Hells Canyon Dam completely blocks access to a large portion of their historical range (Waples et at. 1991). The population has increased substantially since they were listed; current estimate (1999-2008 10-year geographic mean) of natural-origin spawners was just over 2,200 adults (NMFS 2011c). However, a large proportion of these adults (average of 78 percent) are of hatchery origin (NMFS 2011c). In addition, NMFS (2011a) identified management actions for the Columbia River Estuary and plume, recognizing importance of these habitats for the recovery of Columbia River Basin salmon and steelhead stocks.

Upper Willamette River ESU – NMFS listed the Upper Willamette River Chinook salmon as threatened in 1999 (64 FR 14308), and the threatened status was reaffirmed in June 2005 (70 FR 37160). This ESU includes all naturally spawned populations of spring-run Chinook salmon in the Clackamas River and in the Willamette River, and its tributaries, above Willamette Falls. This ESU also includes seven artificial propagation programs (79 FR 20802). Upper Willamette River Chinook salmon typically exhibit an ocean-type life history and enter the Columbia River estuary at a younger age; they are smaller in size than other salmon that rear longer in streams (Bottom et al. 2005). Upon ocean entry, most Upper Willamette River Chinook salmon become widespread along the coast from summer through autumn, indicating a diversity of dispersal rates (Trudel et al. 2009, Fisher et al. 2014). Designated critical habitat includes the Columbia

River mainstem, the Willamette River and its eastside tributaries above Willamette Falls (70 FR 52630). Critical habitat does not extend into the open ocean and does not include the Project area.

Upper Willamette River ESU Chinook salmon populations declined due to adverse interactions with hatchery fish and loss of habitat due to dam construction. Historical abundance was estimated at 300,000 fish, and current numbers likely number less than 10,000 (ODFW and NMFS 2011). According to the recovery plan, most populations are at very high risk of extinction, and significant natural production only occurs in the Clackamas and McKenzie populations while adult returns in the other basins within the ESU are typically 80-90 percent hatchery origin fish (ODFW and NMFS 2011). The recovery plan for this ESU identifies recovery actions in watersheds and the estuary (NMFS 2011d). In addition, NMFS (2011a) identified management actions for the Columbia River Estuary and plume, recognizing importance of these habitats for the recovery of Columbia River Basin salmon and steelhead stocks.

California Coastal ESU – The California Coastal ESU, which includes all Chinook salmon naturally reproduced in streams between Redwood Creek in Humboldt County, California, south to the Russian River, Sonoma County, was federally listed as threatened in 1999 (64 FR 50394). Critical habitat was designated in 2005 and consists of river reaches from Redwood Creek to the Russian River (70 FR 52488). Critical habitat does not extend into the open ocean and does not include the Project area. The California Coastal ESU includes 15 independent populations of fall-run and 6 independent populations of spring-run Chinook salmon (NMFS 2011e).

The historical abundance of California Coastal Chinook salmon was estimated at 72,550 in the 1965 and 20,750 in 1987, indicating a significant population decline (Good et al. 2005). More recent estimates were uncertain due to a general lack of population monitoring, with some populations showing slight decreases and others showing increases, although precipitous declines in distribution and abundance in spring-run Chinook salmon have been reported (NMFS 2011e). Risks to the ESU include degradation of freshwater habitats from agricultural and forestry practices, water diversions, urbanization, mining, and severe recent flood events (exacerbated by land use practices). Many of these factors are particularly acute in the southern portion of the ESU (Good et al. 2005). The Final Coastal Multispecies Recovery Plan (NMFS 2016c) does not recommend recovery actions in coastal habitats other than for fishing and collecting activities; most of the recovery actions address activities in watersheds and estuaries.

Sacramento River Winter-run ESU – The Sacramento River winter-run ESU was federally listed as threatened in 1989 (54 FR 32085), and reclassified as endangered in 1994 (59 FR 440). It was also listed as endangered by the State of California in 1989. This ESU includes all naturally spawned populations of winter-run Chinook salmon in the Sacramento River and its tributaries in California. Critical habitat was designated in 1993 and includes the Sacramento River from Keswick Dam, Shasta County, to Chipps Island at the westward margin of the Sacramento-San Joaquin Delta; all waters from Chipps Island west to the Carquinez Bridge; San Pablo Bay west of the Carquinez Bridge; and San Francisco Bay from San Pablo Bay to the Golden Gate Bridge (58 FR 33212). Critical habitat does not extend into the open ocean and does not include the Project area. Chinook salmon in this ESU enter the Sacramento River in the winter and spawn in the summer (Quinn, 2005). No other Chinook salmon populations have a similar life history pattern, and DNA analysis indicates substantial genetic differences between winter-run and other Chinook salmon in the Sacramento River. Chinook salmon from this ESU are the ocean-type race, and they migrate to the ocean in winter or spring after 5 to 9 months of freshwater residence. Juvenile Chinook salmon from the Sacramento and San Joaquin rivers in the Central Valley were more abundant along the Oregon coast north of Cape Blanco than in northern California during surveys conducted in the summer, which indicates that they likely migrate north during their ocean phase (Brodeur et al. 2004). Thus, Sacramento River winter-run Chinook salmon could occur in the Project area.

Historical abundance from the 1870s was estimated at 200,000 fish (Good et al. 2005). The population was estimated at near 100,000 fish in the late 1960s and declined to below 200 fish in the 1990s (Good et al. 2005). Abundance improved somewhat in the 2000s, with an estimate of 1,500 fish in 2010; although the 10-year trend is still negative (NMFS 2011f). The ESU is represented by a single naturally spawning population that was completely displaced from its historical spawning habitat by the construction of Shasta and Keswick Dams. The majority of their remaining spawning habitat is limited to a 44-mile stretch of the Sacramento River between Keswick Dam and Red Bluff, which is artificially maintained by cold-water releases from Shasta Dam. Other threats include unscreened water diversions, other passage impediments, heavy metal pollution from mine runoff, disposal of contaminated dredge sediments in San Francisco Bay, ocean harvest, predation, drought effects, juvenile losses at the CVP and SWP Delta pumping facilities, and elevated water temperatures in spawning grounds, although some of these threats have been alleviated (NMFS 2011f). The recovery plan identifies Pacific Ocean recovery actions that focus on fisheries, water quality, and marine sanctuaries (NMFS 2014a). Sacramento River winter-run Chinook salmon is also considered by NMFS to be a “Species in the Spotlight” because it is composed of just one small population that is currently under severe stress caused by one of California’s worst droughts on record (NMFS 2016h); key actions were identified for 2016-2020 and include actions within the Sacramento River watershed and delta to improve survival and increase access to habitat.

Central Valley Spring-run ESU – The Central Valley spring-run ESU was federally listed as threatened in 1999 and includes all naturally spawned populations of spring-run Chinook salmon in the Sacramento River and its tributaries in California, including the Feather River and the Feather River Hatchery spring-run Chinook program (64 FR 53094). Critical habitat was designated in 2005 and consists of the Sacramento River and its tributaries in California (70 FR 52488). Critical habitat does not extend into the open ocean and does not include the Project area.

Chinook salmon from this ESU are the ocean-type race, returning to freshwater in spring or summer and spawn in the fall, and the juveniles migrate to the ocean in spring. Juvenile Chinook salmon from the Sacramento and San Joaquin rivers in the Central Valley were more abundant along the Oregon coast north of Cape Blanco than in northern California during surveys conducted in the summer, which indicates that they likely migrate north during their ocean phase (Brodeur et al. 2004). However, these salmon are likely stream-type Chinook salmon that undertake extensive offshore migrations and return to freshwater in the fall, and would not include salmon from this ESU. Therefore, Chinook salmon from this ESU may be unlikely to occur in the Project area.

Historical abundance was estimated at over 600,000 fish in the 1880s. Current risks to the remaining populations include continued habitat degradation related to water development and use, and the operation of the Feather River Hatchery. Hatchery-reared Chinook salmon hybridize with the native stock, and thus are a major threat to the genetic integrity of the remaining wild spring-run Chinook salmon populations (Good et al. 2005). Current abundance is unclear but remains a fraction of their former numbers, and abundance has decreased since 2005 (NMFS 2011g). The recovery plan identifies Pacific Ocean recovery actions that focus on fisheries, water quality, and marine sanctuaries (NMFS 2014a).

3.1.2 Coho Salmon

Coho salmon are a widespread Pacific salmon species that inhabit most major river basins in western Oregon. Coho salmon typically exhibit a 3-year life history, divided between 18 months in freshwater and 18 months in saltwater phases. In freshwater, coho salmon spawn and rear in small streams with stable gravels and complex habitat features, such as backwater pools, beaver dams, and side channels. While rearing in freshwater, juvenile coho salmon feed on aquatic insects, zooplankton, and small fish (73 FR 7833). As young juveniles, coho salmon pass through estuaries to nearshore areas, where they grow rapidly feeding on small fish and marine invertebrates before moving into the open ocean (Schabetsberger et al. 2003). In ocean waters, juvenile and adult coho salmon feed on pelagic fish and invertebrates, such as Pacific herring, Pacific sardine, northern anchovy, Pacific sand lance, squid, smelt, groundfish, and crab megalopae (PFMC 2000). Marine survival and growth of coho salmon are linked to food availability, environmental conditions, and stressors present in the nearshore environment.

Juvenile coho salmon disperse from their natal streams to coastal waters; their ocean distribution changes with time, with juveniles typically moving northward or farther offshore (Brodeur et al. 2004). Ocean dispersal rates for yearling Columbia River coho salmon averaged between 3.2 and 6.6 km/d (Fisher et al. 2014). Juvenile salmonids are pelagic and typically surface-oriented, most often found in the upper 20 m of the water column (Emmett et al. 2004, Walker et al. 2007, Beamish et al. 2000). Adult coho salmon tend to occur at shallower depths (< 40 m) than adult Chinook salmon (Walker et al. 2007).

In general, juvenile salmonids are low in abundance in U.S. West Coast waters when compared to other fishes, as evidenced by the low numbers of juvenile salmonids captured in directed pelagic surface/subsurface research trawls relative to other nekton (Brodeur et al. 2004, Brodeur et al. 2005, Fisher et al. 2014, Peterson et al. 2010). Juvenile coho salmon exhibit a patchy distribution in U.S. West Coast waters; in pelagic trawl surveys conducted in summer and fall along Oregon and Washington, half of all juvenile salmonids were collected in about 5 percent of the surveys and none were collected in about 40 percent of the surveys (Peterson et al. 2010). Juvenile coho salmon occur in coastal waters, usually further offshore than juvenile Chinook salmon (Brodeur et al. 2004, Peterson et al. 2010). Juvenile coho salmon tend to be more abundant off Washington in comparison to coastal waters of central and northern Oregon, likely reflecting more favorable habitat in Washington waters (Bi et al. 2008, Peterson et al. 2010). Data from coded-wire tag recaptures suggest that juvenile coho salmon generally migrate northward from point of ocean entry (Morris et al. 2007).

There are four coho salmon ESUs that could occur in the action area: the Lower Columbia River, the Oregon Coast, the Southern Oregon/Northern California Coast, and the Central California Coast ESU.

Lower Columbia River ESU – NMFS listed the lower Columbia River coho salmon as threatened under the ESA in 1999 (64 FR 14308). This ESU includes all naturally spawned populations of coho salmon from Columbia River tributaries below the Klickitat River on the Washington side and below the Deschutes River on the Oregon side (including the Willamette River as far upriver as Willamette Falls), as well as coastal drainages in southwest Washington between the Columbia River and Point Grenville. Critical habitat was proposed for lower Columbia River coho salmon in 2013 and includes Columbia River tributaries between the Cowlitz and Hood rivers (78 FR 2726). Upon ocean entry, most Lower Columbia River coho salmon become widespread along the coast from summer through autumn, indicating a diversity of dispersal rates (Fisher et al. 2014).

Coho salmon declines in the lower Columbia River are related to widespread habitat degradation due to construction of dams in Columbia River tributaries, urbanization of floodplains, logging, and agriculture. These activities remain as limiting factors for recovery of this ESU. Coho salmon population levels declined drastically in the 1980s and reached near-zero spawner counts in the 1990s (Suring et al. 2006). Based on the most recent NMFS status review (NMFS 2011h and 2016d), Lower Columbia River coho salmon have very little natural reproduction throughout their ranged with the possible exceptions of Clackamas and Sandy rivers, and the majority of the populations are at high risk of extinction.

The Recovery Plan for this ESU (NMFS 2013a) indicates threats to Lower Columbia River ESU coho salmon are primarily degradation and/or loss of freshwater and estuarine habitat associated with hydropower and dam development, and past and/or current land uses that affect channel structure and form, habitat quantity and quality, riparian condition, instream flows, and water quality. Additional threats include harvest, hatcheries, and direct mortality by predation (NMFS 2013a). The Recovery Plan provides strategies to address each of these threats.

Oregon Coast ESU – NMFS listed the Oregon Coast coho salmon ESU as threatened in 2008 (73 FR 7816). NMFS initially listed this ESU as threatened in 1998 (63 FR 42587) but that decision was remanded following a legal challenge. The ESU includes all naturally spawned populations of coho salmon in Oregon coastal streams south of the Columbia River and north of Cape Blanco, including the Cow Creek coho hatchery program. Critical habitat is designated for most coastal streams in Oregon that currently or historically support coho salmon (73 FR 7816). Near the Project area, the Yaquina and Alsea rivers, and Thiel, Beaver, and Hill creeks are designated as critical habitat.

Although specific areas in the Pacific Ocean were not designated as critical habitat, primary constituent elements of estuarine, nearshore, and offshore marine areas were identified and include the following (73 FR 7816):

- Estuarine areas free of obstruction with water quality, water quantity, and salinity condition supporting juvenile and adult physiological transitions between fresh- and saltwater; natural cover such as submerged and overhanging large wood, aquatic vegetation, large rocks and boulders, and side channels; and juvenile and adult forage, including aquatic invertebrates and fishes, supporting growth and maturation.
- Nearshore marine areas free of obstruction with water quality and quantity conditions and forage, including aquatic invertebrates and fishes, supporting growth and maturation; and natural cover such as submerged and overhanging large wood, aquatic vegetation, large rocks and boulders, and side channels.
- Offshore marine areas with water quality conditions and forage, including aquatic invertebrates and fishes, supporting growth and maturation.

Coho salmon from the Oregon Coast ESU inhabit 11 major river systems and three coastal lakes located both north and south of the action area. These populations have been the focus of a considerable conservation effort by the State of Oregon, local and private entities, and federal management partners (Stout et al. 2011). The primary historic threats or impacts on Oregon coast coho salmon were habitat loss and degradation, water diversions, harvest, hatchery production, and poor ocean conditions (73 FR 7816).

Overall, spawning escapements declined substantially during the 20th century. The total number of returning coho dropped to below 14,600 fish in 1983, then improved for a few years before declining again to near 21,000 fish in 1990 and below 24,000 fish in 1997 (NMFS 2016e). Abundance varies greatly by year but has improved in recent years, reaching a modern-era high of over 350,000 spawners in 2011 and 2014, but slumped to lows of 99,000 in 2012 and, most recently, to 57,000 in 2015 (NMFS 2016e).

The primary life history of Oregon coast coho salmon is the fall run, entering freshwater in September through November, and 18-month old juveniles typically enter the ocean in spring (April to June) (NMFS 2016e). Oregon Coast coho salmon can occur in ocean waters from northern California to southern British Columbia, but the bulk of the population centers off the Oregon coast (Weitkamp and Neely 2002). Oregon Coast coho salmon that originate from the Yaquina basin are more likely than other salmonid ESUs to occur in the action area; adults would likely appear in the action area shortly before their migration into Yaquina Bay or Alsea River in fall, and juveniles during their ocean-bound emigration from the Yaquina basin in spring. The final recovery plan identifies recovery actions in tributaries and estuaries, but not in the ocean (NMFS 2016e).

Southern Oregon/Northern California Coast ESU – Coho salmon from the Southern Oregon/Northern California Coast ESU were listed as threated by NMFS in 1997 (62 FR 24588). This ESU includes naturally spawned coho salmon originating from coastal streams and rivers between Cape Blanco, Oregon, and Punta Gorda, California, plus coho salmon from three artificial propagation programs. Southern Oregon/Northern California coast coho salmon can occur in ocean waters from California to British Columbia, but they primarily occur off the California coast (Weitkamp and Neely 2002). Critical habitat was designated in 1999 (64 FR 24049) and revised in 2008 (73 FR 7816), and the closest designated rivers to the Project are the Chetco, Illinois, and Rogue rivers in Curry County, Oregon.

The historical abundance of Southern Oregon/Northern California coast coho salmon ESU may have ranged up to 500,000 adults (62 FR 24588, Good et al. 2005). Coho salmon populations within this ESU have declined significantly over the past decades with estimates of approximately 10,000 naturally produced adults. The overall ESU population status trend remains low since the initial status review (64 FR 24049). Factors for coho population declines along the Southern Oregon/Northern California coast include overfishing, loss of freshwater and estuarine habitat, hydropower development, poor ocean conditions, and hatchery practices

(NMFS 2011i). The recovery plan identifies recovery actions for the ESU in watersheds and estuaries but not in the Pacific Ocean (NMFS 2014b).

Central California Coast ESU – Coho salmon from the Central California Coast ESU were listed as threatened by NMFS in 1996 (61 FR 56138) and upgraded to endangered in 2005 (70 FR 37160). It was also listed as endangered by California in 2002. This ESU includes all coho salmon naturally spawned coho salmon from rivers south of Punta Gorda in Humboldt County, California (70 FR 37160, 77 FR 19552). Coho salmon from this ESU can occur in ocean waters from California to British Columbia, but they primarily occur off the California coast (Weitkamp and Neely 2002). Critical habitat was designated in 1999 and consists of accessible reaches of all rivers (including estuarine areas and tributaries) between Punta Gorda and the San Lorenzo River (64 FR 24049). Critical habitat does not extend into the open ocean and does not include the Project area.

The statewide abundance of coho salmon in California was estimated at 200,000 to 500,000 in the 1940s, and populations have declined significantly over the past decades, with only 2,000-3,000 naturally spawned adults from this ESU estimated in 2011, and the population is close to extinction (NMFS 2012a). Factors for Central California Coast ESU population declines include overfishing, loss of freshwater and estuarine habitat, hydropower development, poor ocean conditions, and hatchery practices (NMFS 2012a). The recovery plan for this ESU identifies recovery actions in watersheds and estuaries but not for the Pacific Ocean (NMFS 2012a). Central California Coast coho salmon is also considered by NMFS to be a “Species in the Spotlight” because it is a unique run of coho salmon, at the southern extent of the species’ range, that is in danger of extinction (NMFS 2016i); key actions were identified for 2016-2020 and include actions within freshwater and estuary habitats to improve survival and actions to utilize conservation hatcheries.

3.1.3 Steelhead

Steelhead are rainbow trout that exhibit an anadromous life history pattern. By migrating to the ocean, steelhead can grow much larger than their resident rainbow trout cohorts. Anadromous steelhead and resident rainbow trout can be considered to be from the same population, as “anadromous parents can produce resident offspring and resident parents can produce anadromous offspring” (LCFRB 2010). This adaptive life history makes steelhead flexible to changing habitat conditions. Also, unlike other Pacific salmonids, they can spawn more than one time.

Steelhead exhibit two distinct timings for runs: summer and winter (Myers et al. 2006). The two life history types differ in degree of sexual maturity at freshwater entry, spawning time, and frequency of repeat spawning. Winter steelhead enter the Columbia River between

December and May and spawn soon after between February and June, with peak spawning from late April to early May. Whereas, summer steelhead enter freshwater between May and October as sexually immature and reside in freshwater streams for months before spawning sometime between January and June. The longer freshwater residence time allows adult summer steelhead to reach higher elevation streams than winter steelhead. NMFS (2013) define productive steelhead habitat as areas with suitable gravel size, depth, and water velocity, and channel complexity primarily formed by large wood. As steelhead enter streams and arrive at spawning grounds in weeks (winter run) or months (summer run) before spawning they need cover in the form of overhanging vegetation, undercut banks, submerged vegetation, submerged objects to avoid disturbance and predation.

After emergence, young steelhead rear in freshwater streams for 1 to 4 years before out migrating to the ocean. After reaching the ocean in the spring, juvenile steelhead tend to move offshore quickly rather than use nearshore waters like other salmon. For example, Daly et al. (2014) captured tagged juvenile steelhead that migrated greater than 55km offshore of the Columbia River within 3 days. While as sea, steelhead are found in pelagic waters of the Gulf of Alaska principally within 10 m of the surface, though they sometimes travel to greater depths (Light et al. 1989).

There are nine listed DPSs of steelhead that may occur in the action area.

Lower Columbia River DPS – Listed as threatened in 1998, the lower Columbia River DPS includes naturally spawned steelhead originating in Columbia River tributaries between the Cowlitz and Wind Rivers in Washington and the Willamette and Hood Rivers in Oregon (63 FR 13347). Excluded are steelhead in the upper Willamette River basin above Willamette Falls (which are included in the upper Willamette River DPS) and steelhead from the Little White Salmon and Big White Salmon Rivers, Washington (which are part of the Middle Columbia River DPS). Critical habitat is designated for lower Columbia River DPS steelhead and includes the Columbia River and tributaries between Cowlitz and Hood Rivers (70 FR 52630).

The Lower Columbia River DPS was historically made up of 23 independent populations. Due to legacy of habitat degradation, harvest, hatchery production, and hydropower development, 16 of these populations are considered to have low or very low probability of persisting over the next 100 years, and six have a moderate probability of persistence (NMFS 2013a).

The Recovery Plan for this DPS (NMFS 2013a) indicates threats to Lower Columbia River DPS steelhead are primarily degradation and/or loss of freshwater and estuarine habitat associated with hydropower and dam development, and past and/or current land uses that affect channel structure and form, habitat quantity and quality, riparian condition, instream flows, and water quality. Additional threats include harvest, hatcheries, and direct mortality by predation (NMFS 2013a). The Recovery Plan provides strategies to address each of these threats. In addition, NMFS (2011a) identified management actions for the Columbia River Estuary and plume, recognizing importance of these habitats for the recovery of Columbia River Basin salmon and steelhead stocks.

Middle Columbia River DPS – Steelhead from the middle Columbia River ESU were first listed as threatened 1999 (64 FR 14517). This inland steelhead DPS occupies the Columbia River basin and tributaries from above (and excluding) the Wind River in Washington and the Hood River in Oregon upstream to, and including, the Yakima River in Washington. Steelhead of the Snake River basin are excluded from this DPS. Critical habitat is designated in Columbia River tributaries (70 FR 52630).

The Middle Columbia DPS is made up of 17 extant populations and four groups: the Yakima River basin, the Umatilla/Walla-Walla drainages, the John Day River drainages, and Eastern Cascade group. Limiting factors and threats identified in the recovery plan for this DPS included degraded tributary and mainstream habitat conditions, impaired fish passage, suboptimal water temperatures, interactions with hatchery fish, predation, competition, disease, degraded estuarine and nearshore marine habitat, harvest, and climate change (NMFS 2009a). The recovery plan for this DPS (NMFS 2009a) identifies recovery actions in the watersheds and tributaries but management actions for the Columbia River Estuary and plume were identified in NMFS (2011a), recognizing importance of these habitats for the recovery of Columbia River Basin salmon and steelhead stocks.

Upper Columbia River DPS – NMFS listed upper Columbia River steelhead as endangered in 1997 (62 FR 43937). This inland steelhead DPS occupies the Columbia River basin upstream from the Yakima River, Washington, to the U.S./Canadian border. The principal tributary rivers include the Wenatchee, Entiat, Okanogan, and Methow Rivers. Critical habitat is designated in Columbia River tributaries in Washington (70 FR 52630).

There are four remaining populations of steelhead within the Upper Columbia River DPS. Grand Coulee and Chief Joseph dams permanently blocked access to suitable habitat that historically supported additional populations. All four populations are considered to be at moderate to high risk of extinction. In response, most steelhead spawning the tributaries within this DPS are hatchery origin fish (UCSRB 2007). Recent estimates (Ford et al. 2010) of total and natural origin spawner abundance are greater than previous estimates, although the number of natural origin spawners remain well below recovery goals and the productivity remained low (Northwest Fisheries Science Center 2015). The recovery plan for this DPS provides recovery actions for watersheds and tributaries (UCSRB 2007), but management actions for the Columbia

River Estuary and plume were identified in NMFS (2011a), recognizing importance of these habitats for the recovery of Columbia River Basin salmon and steelhead stocks.

Snake River Basin DPS – The NMFS listed steelhead trout from the Snake River Basin as threatened in 1997 (62 FR 43937). This inland steelhead DPS includes fish originating from the Snake River basin of southeast Washington, northeast Oregon, and northwest Idaho, plus six artificial propagation programs. Critical habitat is designated in Snake River tributaries in northeast Oregon and central Idaho (70 FR 52630).

According to the latest status review, the persistence of Snake River DPS steelhead has not significantly changed since the final listing determination in 2006 (NMFS 2011c). Hydroelectric projects on the Columbia and Snake River has been, and continues to be, a limiting factor for recovery of Snake River DPS steelhead. The final recovery plan for this DPS provides recovery actions for watersheds and tributaries (NMFS 2016b), but management actions for the Columbia River Estuary and plume were identified in NMFS (2011a), recognizing importance of these habitats for the recovery of Columbia River Basin salmon and steelhead stocks.

Upper Willamette River DPS – Listed as threatened by NMFS in 2006 (71 FR 834), this DPS includes naturally spawned anadromous winter-run steelhead originating below natural and manmade impassable barriers from the Willamette River and its tributaries upstream of Willamette Falls to and including the Calapooia River. Critical habitat includes Willamette River tributaries upstream of Willamette Falls (70 FR 52630).

There are introduced steelhead runs in the upper Willamette River, and only the late run winter steelhead is considered to be native. Adult steelhead from this DPS enter freshwater in March and April, months earlier than other winter run steelhead. This run timing appears to be an adaptation for ascending Willamette Falls, which separates this population from lower Columbia River populations (NMFS 1999a). Those that pass Willamette Falls between February 15 and May 15 each year are considered to be native. The most recent population estimate was 4,900 fish in 2008 (NMFS 2011j). Declines in steelhead abundance in the upper Willamette DPS can be attributed to habitat degradation due to agricultural and urbanization, and changes in hydrology due dams on Willamette River tributaries. The recovery plan for this DPS identifies recovery actions in watersheds and the estuary (NMFS 2011d). In addition, NMFS (2011a) identified management actions for the Columbia River Estuary and plume, recognizing importance of these habitats for the recovery of Columbia River Basin salmon and steelhead stocks.

Northern California Steelhead DPS – This DPS was federally listed as threatened in 2000 and includes all naturally spawned steelhead populations below natural and manmade impassable barriers in coastal rivers, from Redwood Creek in Humboldt County, California, south to, but not including, the Russian River (65 FR 36074). Critical habitat was designated in 2005 and consists of river reaches between Redwood Creek south to Point Arena on the Mendocino coast (70 FR 52488). Critical habitat does not extend out into the open ocean and does not include the Project area. This DPS contains both winter and summer steelhead populations.

The current status of the populations within this DPS are uncertain. Threats include habitat degradation and loss from urban development, logging, roads, agriculture, mining and recreation, water withdrawals and diversions, and barriers to fish passage (NMFS 2011k). The Final Coastal Multispecies Recovery Plan (NMFS 2016c) provides recovery actions that address activities in watersheds and estuaries only.

Central California Coastal Steelhead DPS – This DPS was federally listed as threatened in 1997 and includes all naturally spawned steelhead populations below natural and manmade impassable barriers in California streams from the Russian River south to Aptos Creek and in the drainages of San Francisco, San Pablo, and Suisun bays, excluding the Sacramento-San Joaquin River Basin (62 FR 43937). Critical habitat was designated in 2005 and consists of accessible river reaches of the Russian River south to Aptos Creek, and the drainages of San Francisco, San Pablo, and Suisun bays and their tributaries (70 FR 52488). Critical habitat does not extend out into the open ocean and does not include the Project area.

The current status of the populations within this DPS are uncertain. Threats include habitat degradation and loss from urban development, logging, roads, agriculture, mining and recreation, water withdrawals and diversions, and barriers to fish passage (major ones in the Russian River basin in northern California) (NMFS 2011k). The Final Coastal Multispecies Recovery Plan (NMFS 2016c) provides recovery actions that address activities in watersheds and estuaries only.

California Central Valley Steelhead DPS – This DPS was federally listed as threatened in 1998 and reaffirmed in 2006, and includes all naturally spawned steelhead populations below natural and manmade impassable barriers in the Sacramento and San Joaquin rivers of California and their tributaries, excluding steelhead from San Francisco and San Pablo Bays and their tributaries (71 FR 834). Critical habitat was designated in 2005 and consists of accessible river reaches of the Sacramento River and San Joaquin Rivers and their tributaries (70 FR 52488). Critical habitat does not extend out into the open ocean and does not include the Project area. This DPS contains winter and summer steelhead populations.

The current status of the populations within this DPS are uncertain because population trend data are extremely limited, but the available information suggests that steelhead from this DPS are present in low numbers throughout most Central Valley watersheds (NMFS 2011l).

Threats include habitat degradation and loss from the presence of impassable dams, water diversions, and hydroelectric operations on almost every major river in the Central Valley, as well as other land use practices such as logging, agriculture, and urbanization (NMFS 2011l). The recovery plan identifies Pacific Ocean recovery actions that focus on fisheries, water quality, and marine sanctuaries (NMFS 2014a).

South-Central California Coast Steelhead DPS – This DPS was listed as threatened by NMFS in 1998 (63 FR 13347). This DPS includes all naturally spawned steelhead originating below natural and manmade impassable barriers from the Pajaro River to (but not including) the Santa Maria River in California. Critical habitat for the South-Central California steelhead was designated in 2005 and includes accessible river reaches from the Pajaro River to (but not including) the Santa Maria River (70 FR 52488). Threats include habitat degradation and loss from urban development, roads, mining, agriculture, water withdrawals and diversions, and barriers to fish passage (NMFS 2011m). The recovery plan for this DPS identifies recovery actions in watersheds and estuaries (NMFS 2013b).

3.1.4 Sockeye Salmon

Sockeye salmon are a widely distributed and abundant Pacific salmon species; however, the number of sockeye originating from the Snake River has dramatically declined and NMFS listed Snake River sockeye salmon as endangered in 1991 (56 FR 58619), confirming the listing in 2005 (70 FR 37160). The ESU includes all anadromous and residual sockeye salmon from the Snake River basin, Idaho, as well as artificially propagated sockeye salmon from the Redfish Lake captive propagation program. NMFS designated critical habitat for Snake River sockeye in 1993. Critical habitat includes the mainstem of the Columbia River and Snake River tributaries (58 FR 68543).

In its latest 5-Year Review, NMFS (2016f) indicated that substantial progress has been made with the Snake River Sockeye Salmon captive broodstock hatchery based program, but natural reproduction levels of anadromous returns remain extremely low for this ESU. In its latest 5-Year Review, NMFS (2016f) stated that "Snake River Sockeye Salmon extirpation and further loss of genetic diversity have been averted, largely due to the hatchery broodstock program, and the program is now adjusting to promote increased population structure, spatial structure, and recovery of the ESU." Barriers to historic lake habitat continues remains a limiting factor for sockeye, as only a fraction of historic habitat remains accessible to sockeye. According to NMFS (2015b), "sockeye salmon enter the ocean and immediately begin migrating north, as no sockeye from the Columbia River have been caught south of the river's mouth in 16 years of sampling in the Northern California Current." Therefore, it is unlikely that sockeye salmon would occur in the action area.

3.1.5 Chum Salmon

Historically, over a million chum salmon returned to the Columbia River each year. Today, Columbia River chum salmon returns are limited to a few thousand fish in a few lower Columbia River tributaries (e.g., Grays River, Washington; NMFS 2011h and 2016d). NMFS listed the Columbia River chum salmon ESU as threatened in 1999 (64 FR 14508). Chum salmon are rare in Columbia River tributaries in Oregon, but there are ongoing efforts by ODFW to reintroduce chum into the lower tributaries. NMFS designated critical habitat for chum salmon in 2005. Critical habitat includes the Columbia River (in Clatsop, Columbia, Multnomah, and Hood River counties) and a few other lower Columbia River tributaries (70 FR 52630).

Declines in chum salmon populations are related to overharvesting in the 1950s along with habitat degradation in the Columbia River estuary. Current limiting factors include small population size and low productivity rates, and predation from pinniped and Caspian terns (NMFS 1999b). Chum salmon have a short freshwater residence time and rear in estuaries prior to entering the ocean. Chum salmon are present in the Columbia River estuary following emergence as early as mid-January through mid-July, with the peak in abundance between mid-April and mid-May as they migrate seaward. Chum salmon juveniles may remain in the coastal area longer than other salmon before moving offshore to feed in pelagic ocean environments (Beamish et al. 2005). However, adult chum salmon are unlikely to occur in the action area, because it is at the southern end of their range. Juveniles could occur in the action area based on surveys along the Oregon coast (Brodeur et al. 2007, Fisher et al. 2007), but they generally migrate northward after ocean entry from the Columbia River (Beamish et al. 2005).

3.2 OTHER MARINE FISH

3.2.1 Green Sturgeon

NMFS listed the southern DPS of North American green sturgeon as threatened in 2006 (71 FR 17757). This DPS is defined as green sturgeon originating from the Sacramento River basin and from coastal rivers south of the Eel River in California.

Green sturgeon is a long-lived (up to 70 years), anadromous fish species that occurs along the Eastern Pacific Coast from the Bering Sea south to Ensenada, Mexico, although their consistently inhabited range is much smaller, primarily concentrating in the coastal waters of Washington, Oregon, and Vancouver Island (Huff et al. 2012). They spend most of their lives in coastal marine waters, coastal bays, and estuaries along the Pacific coast. Juveniles inhabit bays and estuaries for 1 to 4 years before traveling to the ocean. They spend about 15 years at sea before returning to spawn in their natal freshwater habitat, and spawn every 2 to 4 years thereafter (Moyle 2002). They spend summers in coastal waters typically <100 m deep along

California, Oregon, and Washington, migrate north in the fall to as far as southeast Alaska, and then return in the spring (Erickson and Hightower 2007, Lindley et al. 2008). They occur on the bottom, although they can forage throughout the water column, feeding on benthic invertebrates and small fishes (Radtke 1966, Israel and Klimley 2006).

Green sturgeon are known to occur in the vicinity of the action area based on trawl bycatch (Erickson and Hightower 2007, Al-Humaidhi et al. 2012) and coastal tracking of tagged fish (Erickson and Hightower 2007, Lindley et al. 2008, Huff et al. 2011, Lindley et al. 2011, Huff et al. 2012). They migrate and forage in coastal waters and in estuaries along the coast as well as in the Project area (Lindley et al. 2011, Huff et al. 2011, Payne et al. 2015, Henkel 2017). Models predict green sturgeon to have a high probability of presence in the action area during all seasons (Huff et al. 2012) and occur at the same depths as the Project (Erickson and Hightower 2007, Huff et al. 2011). Close to the action area, tagged green sturgeon spent longer durations in highly complex seafloor habitats (e.g., boulders) and tended to occur at depths of 20-60 m (Huff et al. 2011). Based on a tagging study near Reedsport, Oregon, green sturgeon most commonly occurred at depths of 50-70 m and were associated with flat, soft bottom habitat lacking high-relief habitat (Payne et al. 2015), which is similar to the depth and habitat type of the Project site. In addition, some sturgeon used the coastal waters near the mouth of the Umpqua River for extended periods of time (e.g., months), while others moved through the area quickly. It was thought that the coastal waters may represent an important feeding area for green sturgeon, likely because the river plume contributes to food resource availability in the adjacent coastal waters (Payne et al. 2015).

The depth distribution of green sturgeon captured as bycatch in groundfish trawls in Washington, Oregon and California indicated 60 percent of fish were encountered in the depth range of 9 to 16.5 m, and 75 percent were from 9 to 33 m (Al-Humaidhi et al. 2012). The spatial distribution of green sturgeon indicated the highest likelihood of encounter is in shallow depths surrounding the Columbia River plume at the Washington and Oregon border and off of San Francisco Bay, California; most of these fish were southern DPS green sturgeon (Al-Humaidhi et al. 2012). However, the majority of bottom trawl fishing grounds do not encounter green sturgeon bycatch (Al-Humaidhi et al. 2012).

Payne et al. (2015) used up to 43 automated acoustic receivers within and outside of an area about 2.5 miles offshore of Reedsport, Oregon to monitor the occurrence of green sturgeon tagged with coded ultrasonic transmitters. Two hundred forty eight green sturgeon were detected within the receiver array from January 2013 through June 2014 at depths of 12-110 m. The study showed a range of detecting fish only once in a 30 day period (implying migrating right through the area) to being detected for approximately 6 weeks straight in a single season, to fish that were detected more than once but were absent for long periods of time. The authors write, “Clearly, several different behavior patterns may be present.” In the second part of the study, the timing of peak 'residence' occurred 2 weeks earlier, indicating variability in 'normal' conditions. Researchers reported a preference of 45-80 m depths (based on box and whisker plots of 6 locations) with a median for Oregon of 66.6 m deep (Payne et al. 2015). The study, which was funded by the Oregon Wave Energy Trust, did not address residence time. Estimated durations of "residence" based on first and last detections would not necessarily mean that fish stayed in the area unless they were detected constantly by the receivers; for example, without data from other locations it cannot be determined if the fish moved out of the area and came back, etc.

Tagged green sturgeon also occur at PacWave South and PacWave North, based on lines of 8 acoustic receivers placed at PacWave North (1 line) and PacWave South (2 lines) between October 2015-January 2016, and April-October 2016 (Henkel 2017). Similar to Payne et al. (2015), most sturgeon moved through quickly (days) whereas others remained for longer periods (weeks or months) (Henkel 2017). When comparing the first set (Year 1) and the second set (Year 2), there were fewer unique green sturgeon in Year 2 (n=85 versus n=115 in Year 1) with fewer detections (pings) per sturgeon (n=245.8 versus n=1535.9 in Year 1), and shorter durations (half the time, average 19 days versus 38 days in Year 1) of each sturgeon's presence in the array, despite the longer duration of receiver deployment in Year 2 (Henkel 2017). However, despite differences in the number of sturgeon detected between the years, within each deployment period similar numbers of green sturgeon were seen at both NETS and SETS (Henkel 2017). Although this study evaluated use of the area by tagged green sturgeon, but as described above for the Payne et al. (2015) study, it is not sufficient to evaluate changes in residence times.

In October 2009, NMFS designated all nearshore waters to a depth of 60 fathoms (360 ft or 110 m) offshore Oregon as critical habitat for the southern DPS of the green sturgeon (74 FR 52300; Figure 3-1). This critical habitat includes the action area.

Figure 3-1. Southern DPS Green Sturgeon critical habitat (74 FR 52300).

The applicable[6] primary constituent elements essential for the conservation of the Southern DPS of green sturgeon are (74 FR 52300):

- **For estuarine habitats**
  - Food resources - Abundant prey items within estuarine habitats and substrates for juvenile, subadult, and adult life stages.
  - Water flow - Within bays and estuaries adjacent to the Sacramento River (i.e., the Sacramento-San Joaquin Delta and the Suisun, San Pablo, and San Francisco bays), sufficient flow into the bay and estuary to allow adults to successfully orient to the incoming flow and migrate upstream to spawning grounds.
  - Water quality - Water quality, including temperature, salinity, oxygen content, and other chemical characteristics, necessary for normal behavior, growth, and viability of all life stages.
  - Migratory corridor - A migratory pathway necessary for the safe and timely passage of Southern DPS fish within estuarine habitats and between estuarine and riverine or marine habitats.
  - Depth - A diversity of depths necessary for shelter, foraging, and migration of juvenile, subadult, and adult life stages.
  - Sediment quality - Sediment quality (i.e., chemical characteristics) necessary for normal behavior, growth, and viability of all life stages.

- **For nearshore coastal marine areas**
  - Migratory corridor - A migratory pathway necessary for the safe and timely passage of Southern DPS fish within marine and between estuarine and marine habitats.
  - Water quality - Nearshore marine waters with adequate dissolved oxygen levels and acceptably low levels of contaminants (e.g., pesticides, organochlorines, elevated levels of heavy metals) that may disrupt the normal behavior, growth, and viability of subadult and adult green sturgeon.
  - Food resources - Abundant prey items for subadults and adults, which may include benthic invertebrates and fishes.

A draft recovery plan was developed for green sturgeon (NMFS 2018) indicating that ocean energy projects are a “potential” risk factor for which future research was recommended. Specific concerns include potential exposure to EMF which could cause direct mortality, habitat loss, or migration, feeding, or habitat impacts.

[6] Not including PCEs for freshwater riverine systems.

3.2.2 Eulachon

Eulachon (commonly called smelt, candlefish, or hooligan) are a small, anadromous fish endemic to the eastern Pacific Ocean, ranging from northern California to southwest Alaska and into the southeastern Bering Sea. Eulachon leave saltwater to spawn in their natal streams late winter through early summer. During spawning, they release eggs over sandy river bottoms. Shortly after hatching, the larvae are carried downstream and dispersed by estuarine and ocean currents (WDFW and ODFW 2001). Winchuck, Chetco, Pistol, Rogue, Elk, Sixes, Coquille, Coos, Siuslaw, Umpqua, and Yaquina rivers; and Hunter, Euchre, Tenmile (draining Tenmile Lake), and Tenmile (near Yachats, Oregon) creeks are Oregon drainages that are reported to support eulachon spawning (Gustafson et al. 2010), as well as several tributaries to the Columbia River (ODFW and WDFW 2014).

Juveniles are reported to rear in nearshore marine waters. Eulachon spend most of their life in the ocean and grow up to 12 inches in length and return to spawn at age 3 to 5 years (WDFW and ODFW 2001).

Eulachon are typically found near the ocean bottom in waters of 20-150 m depth and are regularly captured as bycatch in the ocean shrimp trawl fishery (Hay and McCarter 2000, Hannah et al. 2011, Al-Humaidhi et al. 2012, Wargo et al. 2014). Off Washington, Oregon and California, 86 percent of the tows that encountered eulachon, and 86 percent of the eulachon captured in bycatch were in the depth range of 110-165 m; the shallowest observed tow that encountered eulachon was at 35 m and the deepest observed tow was at 217 m (Al-Humaidhi et al. 2012). Eulachon bycatch in British Columbia shrimp trawl fisheries has been estimated as high as 27 percent of biomass caught (Hay et al. 1999). Efforts to reduce bycatch of eulachon use bycatch reduction devices as well as an experimental footrope (Hannah et al. 2011); however, dramatic reductions in eulachon bycatch have been observed by placing LED lights at the opening of the trawl (Hannah and Jones 2014), suggesting that eulachon avoid light. In the 2010 NMFS status assessment, estimates of eulachon vary considerably over time (Gustafson et al. 2010) (Table 3-2). In Oregon and Washington, eulachon are often captured as bycatch in the pink shrimp trawl fishery; in 2002-2010, the highest densities of eulachon were reported offshore of Astoria, Port Orford and Coos Bay, Oregon, with relatively lower densities off Newport in the Project area (Al-Humaidhi et al. 2012), suggesting that they could occur in the Project area but they are more likely to concentrate in other coastal Oregon waters.

Table 3-2. Estimated number of eulachon reported in Alaska Fisheries Science Center (AFSC) triennial groundfish bottom trawl surveys on the continental slope in depths of 55 to 500 m in the U.S. and Canada.

Year	U.S. (millions of eulachon)	U.S. and Canada (millions of eulachon)
1995	4.0	44.1
1998	1.8	9.7
2001	45.4	386.2

Source: Gustafson et al. 2010.

NMFS listed eulachon as federally threatened in 2010 (75 FR 13012). NMFS designated freshwater rivers and associated estuaries in California, Oregon, and Washington as critical habitat for eulachon in 2011. In Oregon, designated critical habitat includes the Columbia River, Tenmile Creek, and Umpqua River (76 FR 65324) and does not include the action area. Eulachon are also an Oregon Conservation Strategy species and a candidate for listing in the State of Washington.

There are few direct estimates of eulachon abundance. In most areas of the southern DPS, escapement counts or estimates of spawning stock biomass are unavailable (NMFS 2011).

3.3 MARINE MAMMALS

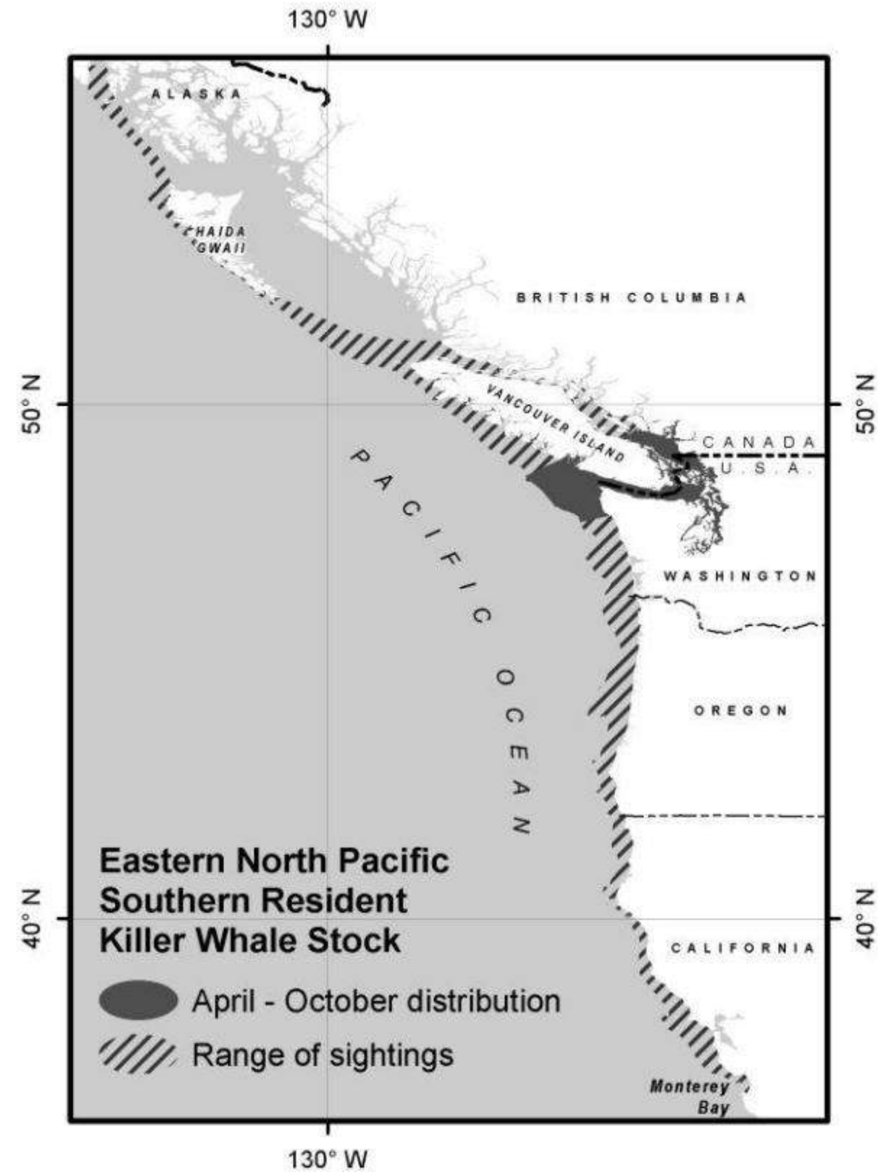
Southern Resident killer whales and humpback whales are known or likely to occur within the action area (Carretta et al. 2015). Blue and fin whales are rarely sighted off the coast in Oregon's coastal waters, but there were four sightings of blue whales near the Oregon coast during shipboard surveys between 1991 and 2008 (Carretta et al. 2015) and OSU detected one fin whale during surveys conducted from October 2013 to September 2015 (a total of 35 cruises) in the Project area (Henkel et al. 2016). Therefore, blue and fin whales could infrequently occur in the action area. Based on the 1991-2008 shipboard surveys off Oregon, sei and sperm whales would not be expected to occur within the action area due to their offshore distribution (Carretta et al. 2015); occurrence would still not be expected for these species even considering the 25-year license term but they are addressed below.

3.3.1 Southern Resident Killer Whale

NMFS listed the Southern Resident killer whale DPS as endangered in 2005 (70 FR 69903). The current population for Southern Resident killer whales is 75 animals (census count occurs every year), divided between three pods (J, K, and L pods) that mainly reside in waters around the Puget Sound (Center for Whale Research 2019). As such, NMFS designated intercoastal waters of Puget Sound as critical habitat in 2006 (71 FR 69054) but a 12 month finding in 2015 determined it was necessary to revise designated critical habitat and expand this designation to include inhabited marine waters along the U.S. West Coast that constitute essential foraging and winter areas (80 FR 9632). They mainly occur in the coastal waters of southern Vancouver Island and Washington, but two pods (K and L pods) have been sighted as far south as Monterey Bay, California (Carretta et al. 2009, 2015) (Figure 3-2).

Threats to Southern Resident killer whales include depletion of prey due to overfishing and habitat degradation, environmental contaminants, vessel collisions, noise disturbance from industrial and military activities, oil spills, interactions with fishing gear, and whale-watching can be a threat if not conducted responsibly (NMFS 2015c). Because NMFS believes they are at risk of extinction, they are considered a “Species in the Spotlight” by the NMFS (see NMFS 2016j), with identified actions needed between 2016 and 2020 including protecting important coastal habitat areas from anthropogenic threats by revising designated critical habitat and targeting recovery of critical prey (e.g., Chinook salmon). Based on recent findings, Southern Resident killer whale fecundity is highly correlated with the abundance of Chinook salmon, in particular the stocks from Fraser River, Puget Sound, and the Columbia River (Ward et al. 2009, Ford et al. 2016, Hansen et al. 2010, NOAA and WDFW 2018). Climate change is projected to cause a decline in Chinook abundance (Munoz et al. 2014, Lacy et al. 2017). Viability models suggest that prey limitation is the most important factor affecting population growth for Southern Resident killer whale, and that in order to meet recovery targets through prey management, Chinook salmon abundance would have to be sustained near the highest levels since the 1970s (Lacy et al. 2017).

From late spring to early autumn, Southern Resident killer whales spend considerable time in the Salish Sea; with concentrated activity around the San Juan Islands, and then move south into Puget Sound in early autumn (73 FR 4176). Pods make frequent trips to the outer coast during this time. Although they have the potential to occur along the outer coast (outside of Puget Sound) at any time during the year, they are more likely to occur along the outer coast from late autumn to early spring (73 FR 4176).



Source: Carretta et al. 2015.

Figure 3-2. Approximate April to October distribution of the southern resident killer whale stock (shaded area) and range of sightings (diagonal lines).

In describing the likelihood of Southern Resident killer whale to occur at PacWave North, NMFS (2012c) states “we have limited fine-scale information about Southern Resident foraging habits and space use along the Oregon coast, and do not have information specific to the action area [but] Southern Residents are likely to occur…given their general tendency to occupy nearshore coastal waters when foraging, which is consistent with nearshore sightings off the Oregon coast (i.e., near Depoe Bay, Yaquina Bay, and the mouth of the Columbia River).” Surveys from aircraft conducted offshore of northern California, Oregon, and southern Washington in 2011 and 2012 detected few killer whales (total of 12 individuals), and these were reported at greater depths (e.g., further offshore, 100-2,000 m depth) than the Project area

(Adams et al. 2014). However, killer whale vocalizations were detected on seven days in April, May, and June 2014 by an acoustic lander deployed inshore of the WEC deployment area and on three days in July and August 2015 by the acoustic mooring at PacWave South (Haxel 2019), which indicates their presence in the action area. During vessel-based, standard-line transect surveys conducted from October 2013 to September 2015 (a total of 37 cruises) in the Project area, a total of 4 killer whales was observed (Henkel et al. 2019). These surveys indicate that small numbers of killer whales could occur in the WEC deployment area. Autonomous monitoring with passive acoustic recorders from Cape Flattery, Washington to Pt. Reyes, California (including off Newport, Oregon) indicated the greatest frequency of detections off the Columbia River and Westport, which was likely related to the presence of their most commonly consumed prey, Chinook salmon (Hanson et al. 2013). Southern Resident killer whales may occur in the action area, but likely in small numbers and at low frequency.

3.3.2 Humpback Whale

NMFS listed humpback whales as endangered in 1970 (35 FR 18319). In 2016, NMFS divided the humpback whales into 14 distinct population segments (DPSs), removed the current species-level listing and in its place listed four DPSs as endangered and one DPSs as threatened (81 FR 62260). The remaining 9 DPSs are not proposed for listing based on their current status. Two of DPSs that are in U.S. waters that would remain listed under NMFS' status review are the Mexico (threatened) and Central America (endangered) DPSs. The humpback whale is a highly migratory marine mammal that ranges along the West Coast and worldwide. In the North Pacific, humpback whales migrate between feeding areas in the Bering Sea and wintering designations off Mexico, Central America, Hawaii, southern Japan, and the Philippines (Carretta et al. 2009). Humpback whales are commonly observed off the California, Oregon, and Washington coasts in spring, summer, and fall (NMFS 2012c). Past (Green et al. 1992) and recent (Tynan et al. 2005) studies noted summer concentrations of humpback whales in upwelled waters over Heceta Bank (about 15-30 miles offshore of Lincoln and Lane counties, Oregon), where they presumably gather for feeding opportunities and preferred sea surface salinity. NOAA also identified Stonewall and Heceta Banks as a "Biologically Important Area" for humpback whale feeding according to its Cetacean Density and Distribution Mapping Working Group (Calambokidis et al. 2015).

Surveys from aircraft conducted offshore of northern California, Oregon, and southern Washington in 2011 and 2012 frequently detected humpback whales (114 sightings of 264 total individuals), although most were reported at deeper depths (100-2,000 m depth) than the Project area, with the exception of higher densities reported inshore at focal areas located both south and north of the Project area (Adams et al. 2014). During surveys conducted offshore of Oregon from 1991 to 2008, humpback whales were observed near the Oregon coast (Carretta et al. 2015), and would be expected to occur at PacWave South. OSU detected humpback whales vocalizations during underwater noise monitoring at the "nearshore" sampling site east of the Project site and at the Project site (Haxel 2019), and a total of 20 humpback whales were observed during vessel-based, standard-line transect surveys conducted from October 2013 to September 2015 (a total of 37 cruises) in the Project area (Henkel et al. 2019). The minimum population estimate for the California/Oregon/Washington humpback whale stock is 1,876 (Carretta et al 2015). Current threats to humpback whale includes entanglement in fishing gear, vessel strikes, harassment from whale watching vessels, habitat degradation, and harvest, as well as elevated levels of sound from anthropogenic sources (e.g., shipping, military sonars) (NMFS 2015d).

Feeding Biologically Important Areas (BIAs) have been delineated for humpback whales in the general Project area (Figure 3-3). The Stonewall and Heceta Bank feeding BIA for humpback whales is approximately 2,573 square km in area (Calambokidis et al. 2015) and includes the Project site (1,695 acres or 6.8 square km). Calambokidis (et al. 2015) indicated humpback whales would primarily occur in the associated feeding BIAs from May to November, which is consistent with the timing of OSU's detections (Henkel et al. 2019).

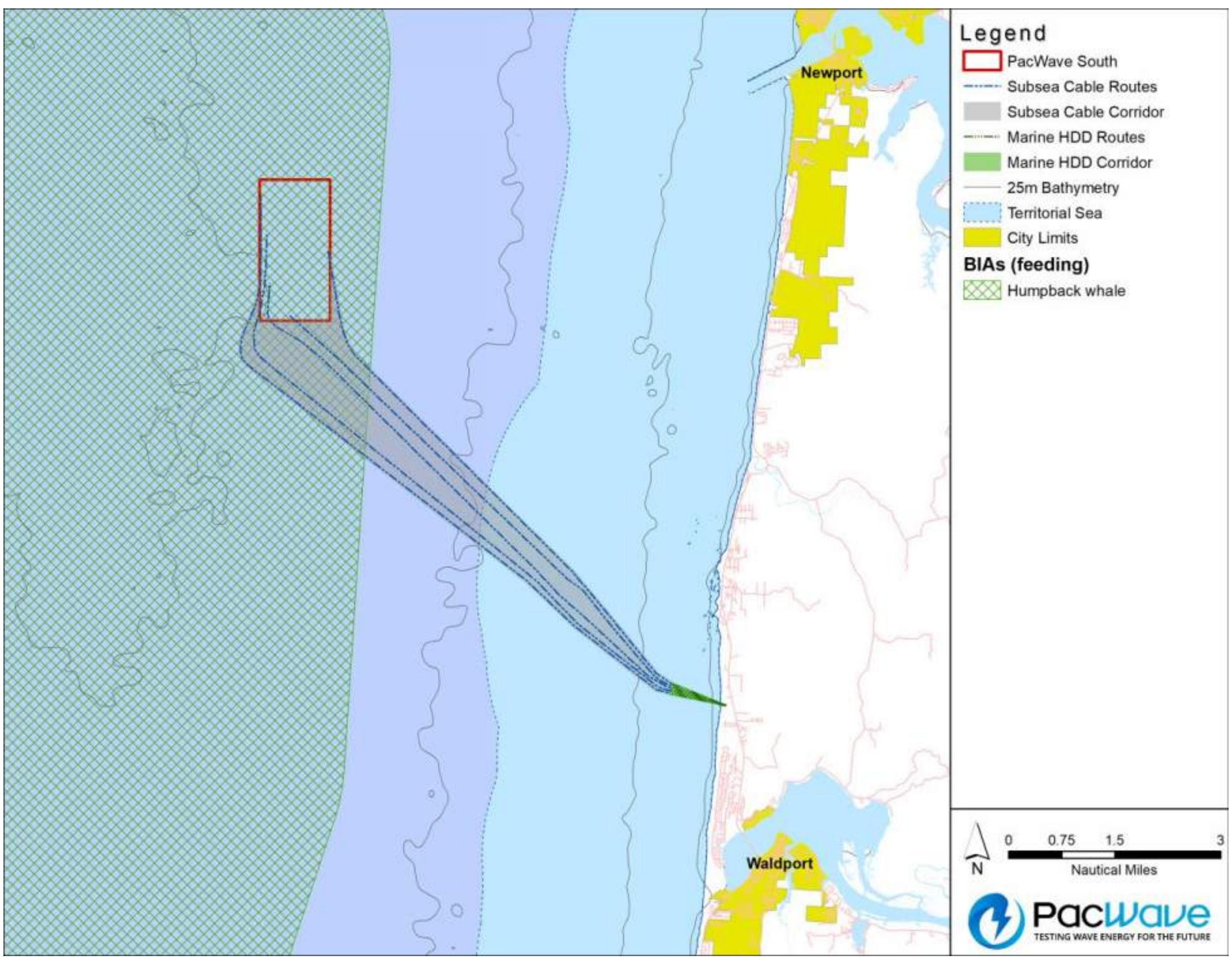


Figure 3-3 Feeding BIAs for Humpback Whales in the Project area (NOAA 2018a).

3.3.3 Blue Whale

Blue whales were designated as endangered in 1970 (35 FR 62919), but critical habitat is not designated. Blue whales are the largest whale with worldwide distribution, but they are rarely sighted off the coast in Oregon's coastal waters. Blue whales are often concentrated near continental shelf breaks downstream of upwelling centers where krill are concentrated, but overall their distribution is more offshore than coastal (NMFS 2014c). The offshore waters of Washington, Oregon, and California are thought to be important feeding areas for blue whales in the summer and fall (Carretta et al. 2009). Surveys from aircraft conducted offshore of northern California, Oregon, and southern Washington in 2011 and 2012 detected a few blue whales (10 sightings of 16 total individuals), most of which were in inner shelf waters (0-100 m depths) offshore of Oregon (Adams et al. 2014). OSU did not detect blue whales during vessel-based, standard-line transect surveys conducted from October 2013 to September 2015 (a total of 35 cruises) in the Project area (Henkel et al. 2016). NMFS (2012c) concluded that the occurrence of blue whales in the PacWave North areas action area would be rare. NOAA did not identify the action area as a "biologically important area" for blue whale feeding (Calambokidis et al. 2015). It should be noted that PacWave South is located 4 nautical miles further offshore than PacWave North. However, given that whale surveys from 1991-2008 were conducted out to 300 nm offshore (Carretta et al. 2015), PacWave South is only 1 percent further offshore than PacWave North within that survey corridor (Figure 1-3), and it is expected that whale observations and conclusions at PacWave North would be relevant to PacWave South. It is expected that blue whales could occur in the Project action area, though rarely (Carretta et al. 2015).

There are approximately 1,647 blue whales in the eastern North Pacific Stock (Carretta et al. 2015). The primary threats to blue whale are vessel strikes and fisheries interactions; additional threats that could potentially affect blue whale populations include anthropogenic noise, habitat degradation, pollution, vessel disturbance, and long-term changes in climate (NMFS 2015e).

3.3.4 Fin Whale

Fin whales are listed as endangered (35 FR 8491), but critical habitat has not been designated for the species. Fin whales occur in the major oceans of the world and tend to be more abundant in temperate and polar waters. NMFS recognizes three populations in the U.S., including one that occurs in waters off California, Oregon, and Washington. In its Biological Assessment of dredged materials disposal near Yaquina Bay, the EPA (2011) cites historical whaling records that note fin whales were harvested off the Oregon coast. However, fin whales are thought to prefer deeper waters than the action area. For example, Tynan et al. (2005) sighted fin whales in >2,000 m of water off the coast of Coos Bay during their linear transect surveys out to 150 km offshore from Newport, Oregon, to Crescent City, California. Surveys from aircraft conducted offshore of northern California, Oregon, and southern Washington in 2011 and 2012 only detected fin whales (6 sightings of 13 total individuals) at depths of >200 m (Adams et al. 2014). In shipboard surveys conducted off Oregon from 1991-2008, all but one fin whale were found much further offshore than PacWave South (Carretta et al. 2015). OSU only detected one fin whale during vessel-based, standard-line transect surveys conducted from October 2013 to September 2015 (a total of 37 cruises) in the Project area (Henkel et al. 2019). It is expected that fin whales could occur in the Project action area, though rarely (Henkel et al. 2019, Carretta et al. 2015).

Based on the surveys conducted from 1991 to 2008, it is estimated that there are 3,051 fin whales in California, Oregon, and Washington waters out to 300 nautical miles (Moore and Barlow 2011) (PacWave South is located 6 nautical miles offshore). Current threats to fin whale include collision with vessels, entanglement in fishing gear, reduced prey abundance due to overfishing, habitat degradation, and disturbance from low-frequency noise (NMFS 2013c). Of all the species of large whales, fin whales are the most often reported as hit by vessels (Jensen and Silber 2004).

3.3.5 Sei Whale

Sei whales are large baleen whales that occur in subtropical and tropical waters to subpolar waters around the world and into the higher latitudes. NMFS listed sei whales as endangered in 1970 (35 FR 18319). Sei whales in the eastern North Pacific (east of 180°W longitude) are considered a separate stock. They are predominately distributed over continental slopes, shelf breaks, and deep ocean basins situated between banks (NMFS 2011o). They are rarely seen off the Washington, Oregon, and California coasts; when observed, individuals are in oceanic waters, much further offshore than where PacWave South is located (Carretta et al. 2015). Surveys out to a distance of 300 nautical miles in 2005 and 2008 resulted in an abundance estimate of 126 sei whales off of Washington, Oregon, and California (Carretta et al. 2015). Surveys from aircraft conducted offshore of northern California, Oregon, and southern Washington in 2011 and 2012 did not detected any sei whales (Adams et al. 2014). OSU did not detect any sei whales during vessel-based, standard-line transect surveys conducted from October 2013 to September 2015 (a total of 37 cruises) in the Project area (Henkel et al. 2019). Therefore, sei whales are not expected to be encountered in the action area because the species occurs in much deeper waters farther offshore. NMFS has not designated critical habitat for the sei whale.

There are few records of vessel strikes involving sei whales but some strikes may go unreported (NMFS 2011p). Current threats to sei whales include ship strikes and interactions with fishing gear, such as traps/pots (NMFS 2015f).

3.3.6 Sperm Whale

Sperm whales are the largest of the toothed whales and are found in deep waters throughout the world's oceans. NMFS listed sperm whales as endangered in 1970 (35 FR 18319). Sperm whales primarily prey on other deep water species, like squid, and are rarely found in waters less than 300 m deep (NMFS 2010a). Sperm whales are present the Pacific Ocean off of Oregon and Washington most of the year, except mid-winter, when they migrate farther south (NMFS 2010a). Based on surveys out to a distance of 300 nautical miles from 1991 to 2008, sperm whales are found in oceanic waters offshore of Oregon, much further offshore than where PacWave South is located, and their abundance ranged between 2,000 and 3,000 animals (Carretta et al. 2015). Surveys from aircraft conducted offshore of northern California, Oregon, and southern Washington in 2011 and 2012 only detected sperm whales (2 sightings of 3 total individuals) at depths of >200 m (Adams et al. 2014). OSU did not detect any sperm whales during vessel-based, standard-line transect surveys conducted from October 2013 to September 2015 (a total of 37 cruises) in the Project area (Henkel et al. 2019). Sperm whales are therefore not expected to occur in the action area (NMFS 2012c). NMFS has not designated critical habitat for this species.

Threats to sperms whales include ship strikes, entanglements in fishing gear (not as great of a threat to sperm whales as they are to more coastal cetaceans), disturbance by anthropogenic noise primarily in areas of oil and gas activities and areas of high shipping activity, and pollution (NMFS 2015g). Although observations of serious injury or mortality of sperm whales has been rarely observed due to direct interaction (i.e. bycatch or entanglement) with California gillnet fisheries (10 animals during about 8,500 observed sets between 1990 and 2014), there has been limited evidence from whale strandings that showed ingestion of marine debris, including fishing gear (Carretta et al. 2015). Using the information from observer programs and stranding data, Carretta et al. (2015) estimated that fisheries interactions cause 1.7 sperm whales deaths per year for the period the between 2001 and 2012.

There have been few recorded incidents of vessel strike on sperm whale. Citing unpublished data, Carretta et al. (2015) described one recorded vessel strike off shore Oregon in 2007 but no information about location was provided. Fishery observers in Washington (at northern limit of U.S. Exclusive Economic Zone [EEZ]) also recorded a vessel strike with a sperm whale while at idle speed, there were no apparent injuries to the whale (Jannot et al. 2011). Yet vessel strikes are rare, and Carretta et al. (2015) estimate that annual average mortality or serious injury is zero whales, based on available data between 2008 and 2012.

3.3.7 North Pacific Right Whale

Eastern North Pacific Right whales have historically occurred along the West Coast and have been reported as far south as central Baja California in the eastern North Pacific, as far south as Hawaii in the central North Pacific, and as far north as the sub-Arctic waters of the Bering Sea and sea of Okhotsk (NMFS 2017). Migration patterns of the North Pacific right whale are unknown, although it is assumed the whales spend the summer in far northern feeding grounds and migrate south to warmer waters, such as southern California, during the winter. However, Shelden (2006, as cited in NMFS 2017)) suggests that records of right whales in southern California and Hawaii likely represent vagrant individuals. Since 1950, there have been at least 3 sightings from Washington coast, fourteen from California coast, two from Baja California, Mexico, and three from Hawaii (Brownell et al. 2001); sightings are extremely rare (NMFS 2017). The western Gulf of Alaska and the southeastern Bering Sea are both frequently used areas primarily in the 50-100m isobaths (NMFS 2017). There are no reliable estimates of current abundance however, the Eastern Pacific population is likely to be very small, and has been estimated to consist of approximately 30 individuals (Wade et al. 2011).

3.4 MARINE TURTLES

Based on the Biological Opinion for PacWave North (NMFS 2012c) and NMFS scoping comments on the PacWave South Project, four sea turtle species may occur in the action area. OSU commenced initial site characterization studies in 2013, which include recording opportunistic sightings of sea turtles in the action area during sampling cruises, and no sea turtles have been observed to date.

3.4.1 Leatherback Sea Turtle

The leatherback sea turtle was listed as endangered in 1979 (35 FR 8491). It has the widest distribution of all sea turtles, nesting on beaches in the tropics and sub-tropics and foraging in sub-polar waters. Following nesting, leatherbacks migrate along the west coast of North America from Mexico to Alaska. Although the leatherback is the most frequently observed sea turtle along the U.S. West Coast, sightings are relatively infrequent and based on telemetry leatherback are typically farther offshore than the action area (Benson et al. 2011).

Leatherback turtles occur along the Pacific coast of North America during summer and fall months, to prey on jellyfish aggregations. Leatherbacks primarily feed on cnidarians (jellyfish and siphonophores) but also on tunicates (pyrosomas and salps). They forage widely in both temperate and tropical waters and utilize a diversity of habitats in the open-ocean and coastal area where oceanic processes (e.g., convergence zones, coastal retention areas, and mesoscale eddies) results in prey congregations (NMFS 2012d).

Leatherbacks have been seen near Oregon from commercial seiners in pelagic areas, miles offshore, and along the continental slope (NMFS and FWS 1998). During the Oregon and Washington Marine Mammal and Seabird Survey, observers documented 16 leatherback turtles:

five were located offshore of northern Oregon along the continental slope and 11 were off the coast of Washington (Bruggeman et al. 1992). Tagged leatherback turtles have been observed offshore of the Oregon coast (TOPP 2010). Benson et al (2011) used satellite tagging data to track leatherback turtle movements in the California Current, and noted forage areas off of Oregon and Washington in the continental shelf and slope habitat between the 200-2,000 m isobaths and particularly in waters adjacent to the Columbia River plume. This indicates that leatherback turtles are unlikely to forage or spend extended amounts of time in the Project area.

NMFS inquired, if given the 25 year duration of the Project and the likely occurrence of El Niño or warm water currents off the coast of Oregon, leatherback occurrence would be more likely in the Project area. NMFS and FWS (2013) state in their Five-Year Review, “climate change is likely to increase abundance and change the distribution of jellyfish, a major food source for leatherbacks.” More specifically, during El Niño events the redistribution of primary prey (the jellyfish *Chrysaora fuscescens*) show a “poleward and offshore re-distribution” (NMFS 2010b). In discussing *C. fuscescens* distribution off of central California, Lenarz et al. (1995) states, “the distribution of the medusae towards the north is consistent with northward advection, but it should be noted that concentrations did not increase off Point Reyes during El Niño years.” Compared to other leatherback turtle populations, leatherbacks found along the west coast embark on trans-ocean migrations to forage on jellyfish at fixed or recurrent productive areas. Presumably, leatherbacks are still able to exploit prey-concentrating hydrographic features during El Niño periods, as otherwise, leatherbacks would not have developed a migratory life history strategy. Hypothetically, climate change may shift leatherback distribution or migration timing as leatherbacks follow redistribution of their prey (NMFS 2012d). Relative to the Project area, there are no field data that leatherback turtle occurrence at PacWave South would be significantly altered during unusual climate events.

The number of leatherback sea turtles in the Pacific Ocean is sizeable but declining, according to the latest status review (NMFS and FWS 2013). In the eastern Pacific, major nesting beaches are found in Costa Rica, Mexico, and Nicaragua. Based on nest counts in these areas, there are about 1,000 breeding females (NMFS and FWS 2013). Although, populations estimates from index surveys, such as nest counts, are somewhat unreliable because females may breed at different beaches each year.

Along the West Coast, the primary threat to leatherback sea turtles is incidental take in commercial fisheries, as fisheries overlap turtle feeding grounds and migratory corridors between the U.S. and Mexico (NMFS and FWS 1998). There have been reports of incidental catch in the eastern north Pacific include entanglement in gillnets and longline sets off the coast of Washington, Oregon, and California (NMFS and FWS 1998).

On January 26, 2012, NMFS designated critical habitat in the Pacific Ocean off areas of Washington, Oregon, and California (77 FR 4170; Figure 3-4). The area designated includes the offshore waters between Cape Flattery, Washington, and the Umpqua River (Winchester Bay), Oregon, out to the 2,000-m depth contour, and a similar area offshore California. NMFS identified one primary constituent element (PCE) that is essential for the conversation of leatherback sea turtle: "the occurrence of prey species, primarily scyphomedusae of the order Semaeostomeae (*Chrysaora*, *Aurelia*, *Phacellophora* and *Cyanea*), of sufficient condition, distribution, diversity, abundance and density necessary for growth and success of leatherback sea turtles." This PCE is to ensure that ample prey species are available for leatherback sea turtles during their long migrations. The action area occurs within designated critical habitat (Figure 3-3).

Leatherback sea turtles are considered a "Species in the Spotlight" by the NMFS (see NMFS 2016k), with identified actions needed between 2016 and 2020 including reducing interactions with fisheries, and improving understanding of migratory habitats and pelagic threats to better implement mitigation measures.

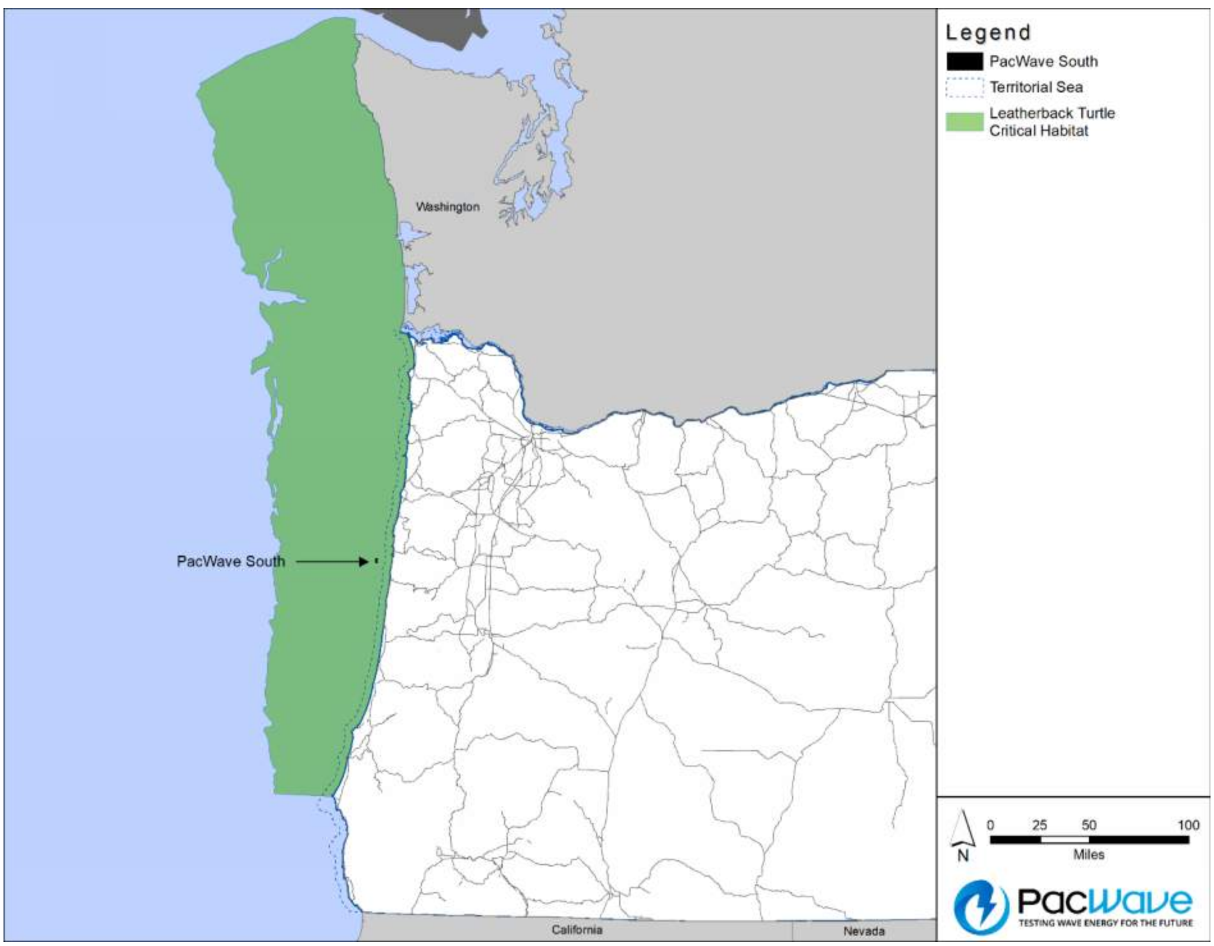


Figure 3-4. Leatherback Sea Turtle Critical Habitat (77 FR 4170).

3.4.2 Loggerhead Sea Turtle

The loggerhead sea turtle is listed as threatened both federally (43 FR 32800) and by the State of Oregon. Loggerhead nesting primarily occurs in the western Atlantic and Indian Oceans, and this species is not known to nest on the U.S. West Coast. Loggerheads have been documented off the U.S. West Coast and southeastern Alaska. In the Eastern Pacific, this species is primarily found south of Point Conception, which is the northern boundary of the Southern California Bight. In Oregon and Washington, loggerhead records have been kept since 1958, with nine strandings recorded over approximately 54 years or less than one stranding every 6-years (NMFS 2013d). NMFS has designated critical habitat for this species, but only in the Atlantic Ocean (79 FR 39855).

Threats to loggerhead sea turtles in the north Pacific include impacts on nesting habitat from coastal development, fisheries bycatch, channel dredging, sand extraction, marine pollution, and climate change. Illegal harvest of loggerhead sea turtles in Mexico continues to be a significant threat to this species.

3.4.3 Green Sea Turtle

The green sea turtle was listed as endangered in 1978 (43 FR 32800). This species inhabits warm coastal waters and is rarely observed off the coastline of Washington, Oregon, or California (NMFS 2012c). It is not known to nest on the U.S. West Coast, and the primary area of observations is in ocean waters south of San Diego, California (FERC 2010). Critical habitat for the green sea turtle has been designated only in the Atlantic Ocean (63 FR 46693).

Green sea turtles show fidelity to their natal beaches and ongoing monitoring of nest sites in Mexico estimate that about 6,050 nests are deposited each year (NMFS and FWS 2007). Thus protecting nesting sites is an important factor in species recovery (NMFS and FWS 2007). In addition to effects on nesting areas, human interactions have been implemented in the take of green sea turtles, including: fisheries bycatch, global warming, contamination, vessel strikes, and intakes of coastal power plants (NMFS and FWS 2007).

3.4.4 Olive Ridley Sea Turtle

The olive ridley sea turtle is thought to once have been the most abundant sea turtle, worldwide, but the breeding colony populations on Pacific coast of Mexico was listed endangered, and other populations were listed threatened in in 1979 (43 FR 328200). This species nests in Central America, and typically live in tropical and subtropical waters by individuals have been documented as far north as Alaska (NMFS and FWS, 2014). However, olive ridley sea turtles highly migratory and appear to spend most of their time in the oceanic zone, and they are rarely observed in the West Coast EEZ (NMFS 2012c). This species is primarily pelagic, feeding on mid-water organisms, though it has been found in coastal areas. There are no apparent migration corridors for olive ridley sea turtles (FERC 2010). NMFS has not designated critical habitat for this species.

Threats to olive Ridley sea turtles include harvest of eggs and adults, and accidental bycatch by long-line fishing gear, trawls, purse seines, and hook and line (NMFS and FWS 2014). Conservation measures have included efforts to protect nesting beaches from illegal harvest, and modifications to fishing gear to reduce or prevent accidental capture. In its latest status update, NMFS and FWS (2014) reported the "weighted average of the yearly estimates of olive ridley abundance was 1.39 million (confidence interval: 1.15 to 1.62 million)," which suggests a general trend in increasing population likely due programs to protect beach nest areas that began in the 1990s.

3.5 BIRDS

3.5.1 Marbled Murrelet

The FWS listed marbled murrelet as threatened in 1992 (57 FR 45328). Marbled murrelets occur in Alaska, British Columbia, Washington, Oregon, and California. Although only a small percentage of the population (2 percent) occurs in Washington, Oregon, and California, this area represents 18 percent of the species' linear coastal range and likely supported far greater murrelet numbers historically (McShane et al. 2004). Population declines have been attributed to forest fragmentation and loss of nesting habitat from the harvest of old-growth coniferous forests, and from mortality associated with gillnet fisheries and oil pollution. Critical habitat has been revised several times since the first designation in 1996, with the most recent designation in 2011 (76 FR 61599). There is no critical habitat in the action area, because critical habitat only includes inland nesting habitat (Figure 3-5). The species is also listed as threatened by the State of Oregon.

Marbled murrelets nest on naturally occurring branch platforms high in old-growth coniferous trees (Nelson 1997). They fly between coastal/ocean habitat where they feed and inland nesting habitat (Miller et al. 2002). Both nesting and non-nesting adult murrelets fly between the forests and the ocean; non-nesting murrelets fly inland presumably to locate and claim nest sites, and establish pair bonds for future nesting, while nesting murrelets fly inland to attend to nests (e.g., switch incubation duties with the partner), and feed chicks (Naslund 1993, Hébert and Golightly 2006). Inland flights can occur during both the breeding (April-September) and non-breeding season, but the number of inland flight detections is greatest between late April and late July (during egg and chick rearing) (Naslund 1993, O'Donnell et al. 1995). Inland flights occur predominately around sunrise and sunset to avoid detection by predators (Peery et al. 2004, Hébert and Golightly 2006). Nesting murrelets fly below the forest canopy, in singles or pairs, and approach nests silently, whereas murrelets thought to be non-nesting fly inland above the canopy in groups (>2 murrelets) and vocalize while flying (Jodice and Collopy 2000). In general, inland flight routes follow drainages rather than higher elevations or major ridges (Miller and Ralph 1995).

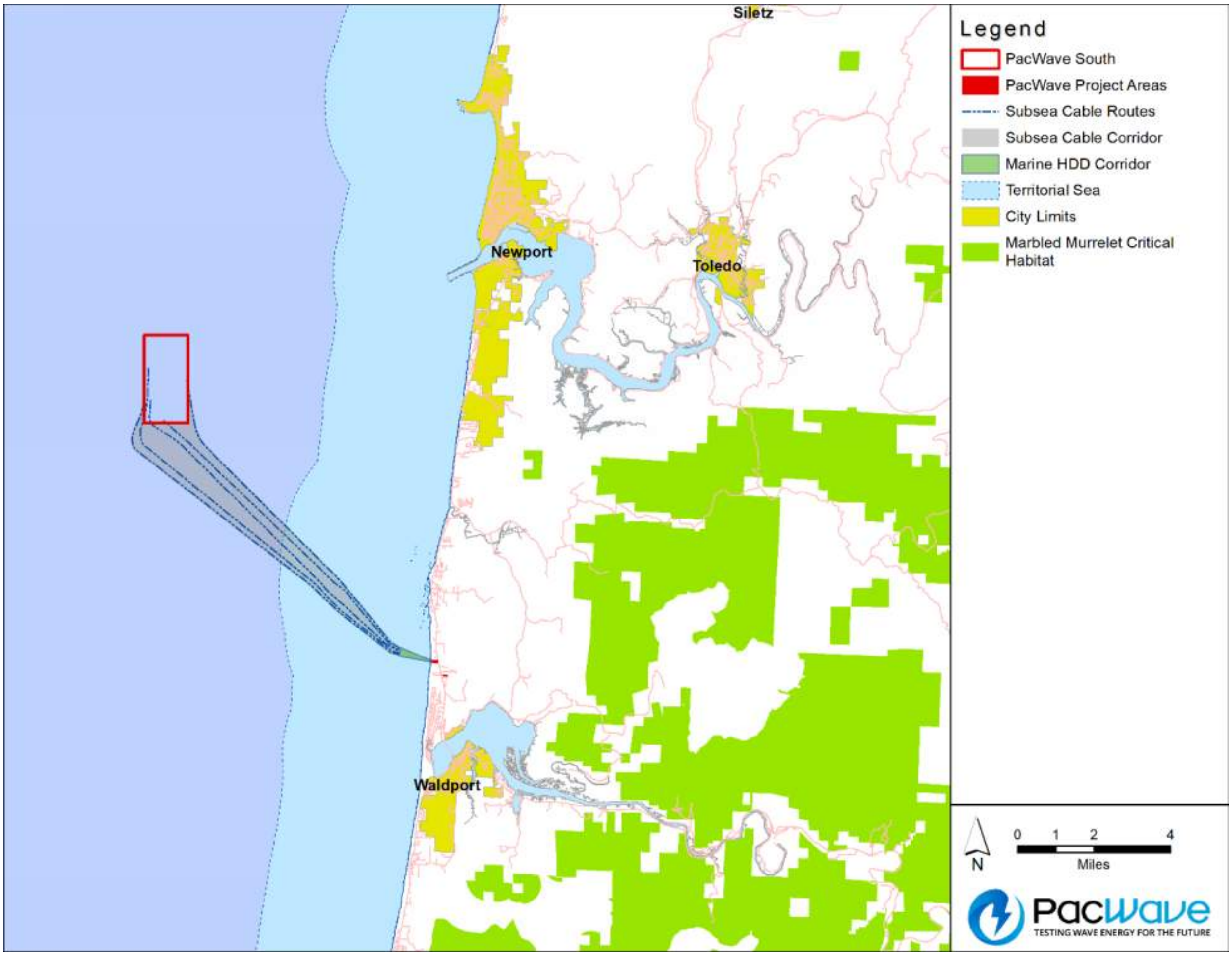


Figure 3-5. Marbled Murrelet Critical Habitat in Oregon (76 FR 61599).

At-sea abundance has been strongly correlated with inland areas containing contiguous old-growth forest (Miller et al. 2002). In Oregon, the at-sea density of marbled murrelets during the breeding season is highest in the nearshore waters of central Oregon between Reedsport and Newport (e.g., 9-50 murrelets/km^2; Strong 2009, Suryan et al. 2012), which is directly offshore from large tracts of inland nesting habitat. At sea, they forage on small schooling fishes and large pelagic crustaceans (euphausiids, mysids, amphipods), and occur primarily in very nearshore waters (<1.5 km from shore; Sealy 1974, Strachan et al. 1995, Strong 2009, Adams et al. 2016). Peak densities of murrelets in Oregon occur between 300 and 1,000 m from shore, and they are rare but consistently present beyond 4 km from shore (Strong 2009, Adams et al. 2016). They most often feed as singles or in pairs, although they do occur in loose aggregations (tens to hundreds of birds) where prey is concentrated (Sealy 1975, Carter and Sealy 1990, Strachan et al. 1995). There is some evidence that they occur farther offshore over the continental shelf during the non-breeding season (Suryan et al. 2012), thus it is possible that they are more likely to occur in the action area from fall through spring. Adult murrelets molt two times per year, and they are flightless for one to two months during the fall (October-November), during which time they remain on the water and do not fly to inland nesting areas (Carter and Stein 1995).

During vessel-based, strip transect surveys conducted from May 2013 to October 2015 (a total of 44 cruises) in the Project area, a total of 35 marbled murrelets were observed, primarily concentrated shoreward of the WEC deployment area and adjacent nearshore waters near the mouth of the Yaquina Bay, with the exception of a couple of murrelet observations just north and west of the deployment area (Porquez 2016; Suryan and Porquez 2016, Appendix D4) (Figure 3-6). These surveys indicate that occurrences would likely be limited to occasional occurrences of 1-2 murrelets in the WEC deployment area, but that they would be expected to occur along the subsea cable route and vessel route between Yaquina Bay and the WEC deployment area.

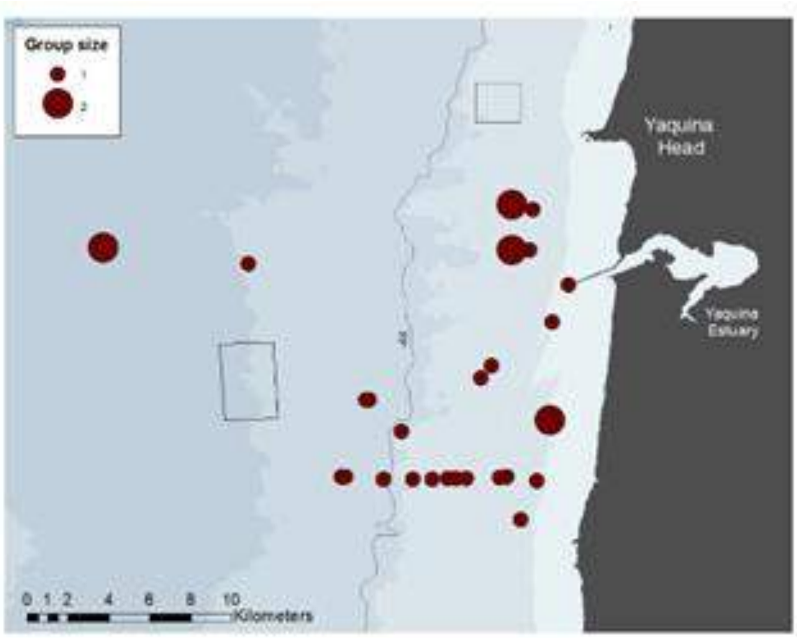


Figure 3-6. Marbled murrelet observations from vessel-based, strip transect surveys conducted from May 2013 to October 2015 (point size varies with observed group number [1-2]. A total of 35 marbled murrelets was observed) (Suryan and Porquez 2016, see Appendix D4).

The mixed conifer/deciduous forest in the terrestrial Project area does not contain suitable nesting habitat for marbled murrelets. However, murrelets could fly over or through the mixed conifer/deciduous forest in the terrestrial Project area as they fly between at-sea and inland nesting habitats.

3.5.2 Short-Tailed Albatross

The short-tailed albatross was federally listed as endangered in 2000 (65 FR 46643). Critical habitat has not been designated for the species. The species is also listed as endangered by the State of Oregon. The short-tailed albatross was once an abundant species, numbering more than a million birds. The species was decimated by feather hunting and egg exploitation at the turn of the 20th century and by the late 1940s was thought to be extinct. Through intense management efforts, the population has now reached an estimated4,354 individuals and is currently undergoing very high population growth (5-9 percent per year), mainly due to high survivorship, translocation of chicks and use of social attraction to establish a new colony, and reduction of bycatch in commercial fishing (FWS 2014a). This species is now showing up in the northwest Hawaiian Islands in double-digit numbers during the breeding season, and has bred on Midway Atoll (American Bird Conservancy 2012, FWS 2014a). Current potential threats to the short-tailed albatross include breeding colony habitat degradation due to volcanic activity, typhoons, flash floods, erosion, and invasive species; contaminants; plastics ingestion; by-catch in commercial fisheries; and offshore wind energy development (FWS 2014a).

With the exception of Hawaii, the short-tailed albatross nests exclusively on small volcanic islands in Japan. The breeding season lasts about eight months and occurs in October-June (FWS 2008). During the non-breeding season (summer), they range along the Pacific Rim from southern Japan to northern California, primarily along the continental shelf margins. Based on satellite tracking of 99 individuals between 2002 and 2012, juveniles generally range in shallower, nearer-to-shore waters than adults (e.g., <200 m depth), and are more likely than adults to occur off the west coast of U.S. and Canada (Suryan et al. 2006, 2007, and 2008; Suryan and Fischer 2010; Deguchi et al. 2012; Yamashina Institute for Ornithology and Oregon State University; unpublished data, as cited in FWS 2014a).

The short-tailed albatross is still quite rare off the U.S. West Coast, with 14 records in Oregon waters (most of them <10 years old) accepted by the Oregon Bird Records Committee (OBRC; Marshall et al. 2006, OBRC 2016). During vessel-based, strip transect surveys conducted from May 2013 to October 2015 (a total of 44 cruises) in the Project area, a total of 41 black-footed albatrosses (*Phoebastria nigripes*; used as a proxy for short-tailed albatross due to similar habitat use) was observed, primarily concentrated beyond 20 km from shore, with the exception of one sighting near the WEC deployment area about 16 km from shore (Porquez 2016, Suryan and Porquez 2016). In addition to the extreme rarity of this species off the Oregon coast, these surveys indicate that occurrence of the short-tailed albatross in the WEC deployment area is highly unlikely and would likely be limited to rare occasional occurrences, if at all, even as the population continues to grow.

3.5.3 Western Snowy Plover

The western snowy plover was federally listed as threatened in 1993 due to loss of nesting habitat and declines in breeding populations (58 FR 12864). Critical habitat was revised in 2012 and there are critical habitat units in California, Oregon, and Washington (77 FR 36728); however, there is no critical habitat designated in the action area. The main threats to the species include habitat loss and degradation from human disturbance, urban development, introduced beachgrass (*Ammophilia* spp.), and expanding predator populations (FWS 2007). The species is also listed as threatened by the State of Oregon.

The western snowy plover nests on sand spits, dune-backed beaches, beaches at creek and river mouths, and salt pans at lagoons and estuaries from southern Washington to Baja California (FWS 2007). They feed on invertebrates in wet sand within the intertidal zone, and dry sand above high tide, on salt pans, spoil sites, and along the edges of salt marshes, salt ponds, and lagoons. The breeding season occurs from March through September: FWS (2007) *Recovery Plan for the Pacific Coast Population of the Western Snowy Plover*, indicates "on the Oregon coast nesting may begin as early as mid-March, but most nests are initiated from mid-April through mid-July (Wilson-Jacobs and Meslow 1984); peak nest initiation occurs from mid-May to early July (Stern et al. 1990). In Oregon, hatching occurs from mid-April through mid-August, with chicks reaching fledging age as early as mid- to late-May. Peak hatching occurs from May through July, and most fledging occurs from June through August." Nests were observed at various points along the beach between the mouth of the Alsea Bay to Seal Rock, which includes the cable landing site at Driftwood Beach State Recreation Site; five nests were observed near Driftwood Beach State Recreation Site in 2017 (Lauten et al. 2017), and four nests were observed in 2018 (Taylor 2018). Some plovers remain in their coastal breeding areas year-round while others migrate south or north for winter, and most inland-nesting snowy plovers migrate to the coast for the winter (FWS 2007). They could be found wintering at any beach with suitable habitat along the Oregon coast, including the shore cable landing area. Winter surveys were conducted at South Beach State Park in Newport (approximately 9.5 miles north of Driftwood) in 1991-1994, 2001-2003, and in 2007, and no plovers were reported (FWS 2010); however, winter surveys observed plovers there in 2015, 2016, 2017, and 2018 (FWS 2018). A Habitat Conservation Plan prepared by the Oregon Parks and Recreation Department covering incidental take of western snowy plover included Lincoln County in its "covered lands", allowing recreation and beach management activities with minimal protection (50-m radius fenced area) of nests (ICF International 2010). Therefore, small numbers of this species could winter or nest in the vicinity of the shore cable landing area.

3.5.4 Northern Spotted Owl

The northern spotted owl was federally listed as threatened in 1990 due to habitat loss from timber harvest (55 FR 26114). The main threats to this species are past and current habitat loss, and competition from the barred owl (*Strix varia*). Critical habitat was designated in 1992 and revised in 2008 and 2012 and there are critical habitat units in California, Oregon, and Washington (77 FR 71875); however, there is no critical habitat designated in the action area. The species is also listed as threatened by the State of Oregon. Northern spotted owl nesting, roosting, and foraging habitat occurs in structurally complex, older coniferous forests (FWS 2011). Important habitat features include a moderate to high canopy closure (60 to 90 percent); multilayered, multi-species canopy with large overstory trees; a prevalence of large trees with various deformities (large cavities, broken tops, mistletoe infections, and other evidence of decadence); presence of large snags; accumulations of fallen trees and other woody debris on the ground; and sufficient open space below the canopy for spotted owls to fly (Thomas et al. 1990). Spotted owls spend most of the day roosting in trees; they forage at night between sunset and sunrise, although they may also forage opportunistically during the day (Forsman et al. 1984, Sovern et al. 1994). Spotted owls exhibit high site fidelity, generally retaining the same breeding territories from year to year (Forsman et al. 2002). Courtship behavior begins in February or March, and eggs are typically laid in late March or April (Forsman et al. 1984, FWS 2011). Nests are usually found in old-growth coniferous trees (i.e., exceeding 200 years), and Douglas fir is the most common nest tree species (Forsman et al. 1984, LaHaye and Gutierrez 1999). Northern spotted owls could occur in the mixed conifer/deciduous forest along the inland cable route, although it would be unlikely given that the surrounding forest is fairly fragmented due to housing developments and timber harvesting.

4.0 ENVIRONMENTAL BASELINE

The "environmental baseline" includes the past and present impacts of all federal, state, or private actions and other human activities in the action area, the anticipated impacts of all proposed federal projects in the action area that have already undergone formal or early Section 7 consultation, and the impact of state or private actions which are contemporaneous with the consultation in process (50 CFR 402.02).

The Project's deployed WECs, when fully built out, would occupy approximately 2 square nautical miles in federal waters about 6 nautical miles off the coast of Newport, Oregon, as well as the buried subsea cables from the test site to a terrestrial cable connection point at Driftwood Beach State Recreation Site in Seal Rock, Lincoln County, Oregon. The ocean surrounding the action area supports diverse assemblages of marine species and offers important economic and recreational opportunities for the surrounding communities. The Oregon coast near Newport is a high wave-energy, dynamic ocean environment. General marine habitat features around the action area include soft bottom subtidal, some hard bottom, open water pelagic, and surf zone habitats. The terrestrial area surrounding the action area consists of coastal beaches and dunes, and low mountains of the Coast Ranges, covered in Douglas fir and Sitka spruce, along with residential housing.

Oregon's beaches and coastal areas typically have mild temperatures, with mean summer temperatures in the low 60s (degrees Fahrenheit [°F]) and mean winter temperatures in the low 40s (°F). Average annual precipitation is 75 to 90 inches. Strong winds typically strike in advance of winter storms and can exceed hurricane force. Winter weather, which is typically wet, is generally influenced by counterclockwise-rotating low-pressure systems that cross the North Pacific, resulting in frontal cyclonic storms characterized by heavy rains and high south to southwesterly winds. Summers are relatively dry and fair, with mild north-northwesterly winds, driven by a persistent, seasonal, offshore high, and frequent strong afternoon breezes and coastal fog.

4.1 BENTHIC HABITAT

Oregon's continental shelf is relatively narrow and extends about 10 to 46 miles off the coast (Electricity Innovation Institute 2004). A rocky submarine bank, Stonewall Bank, begins about 15 miles offshore of Newport and extends southwest offshore about 40 miles south to the Siuslaw River, where the shelf is about 30 miles across (Electricity Innovation Institute 2004, USACE and EPA 2001). The Project's deployed WECs would be located shoreward of the Stonewall Bank, where sediments are mostly sand to depths of 91 m (300 ft), with a small percentage of silt and clay. The sediments present at this site are typical of much of the Oregon coast, with natural variations in the concentration of fine-sized particles in the seafloor sediments due to local currents (USACE and EPA 2001).

Benthic habitat stations at PacWave South and PacWave North were surveyed from 30 to 60 m from August 2013 to June 2015 (8 total surveys), and in 2015 a 70 m station was added at the Project's WEC deployment area, which was surveyed in April and June (Figure 4-1) (Henkel 2016). Thirty-nine macrofaunal taxa were collected during box core sampling in 2013 (Henkel 2016) adjacent to PacWave South (approximately 60 m depth) as well in the larger benthic study area beyond the Project site. Polychaetes were the most abundant taxa at stations closest to the Project site. The macrofaunal species assemblages identified at PacWave South were consistent with those collected at PacWave North over the same time period (2013-2015), and they varied in response to depth and median grain size (Henkel 2016). Two major "assemblages" of macro-invertebrates were described for the vicinity of PacWave South: a deeper, larger grain size-associated assemblage, and a smaller grain size-associated assemblage. At 50 m, two different assemblages were detected; however the stations with larger median grain size (PUD and SBC; Figure 4-1) had similar invertebrates to the 60 m stations. This suggests that, at these depths, differences in species assemblage are more strongly related to the sediment characteristics than the specific depth. An increase in species diversity was detected in 2014 and 2015 compared to 2013 (possibly attributed to warm ocean conditions in 2014-2015), and this increase was greater for the shallower stations (30-40 m) compared to the deeper stations (50-60 m) (Henkel 2016).

Principal findings from benthic monitoring (box cores, trawls, and videography) at PacWave North from May 2010 to December 2011 (10 total surveys; Henkel 2011) included:

- Two distinct sediment types: silty sand at approximately 30 m, and potentially shallower; and nearly pure sand at 40 m and deeper;
- Distinct macrofaunal invertebrate assemblages occur in the two sediment types;
- Distinct macrofaunal invertebrate assemblages occur at the deeper stations; and
- Mysid and crangonid shrimp are highly abundant and likely form the basis of the food web in this nearshore zone, as opposed to the euphausiid (krill)-supported food web farther offshore.

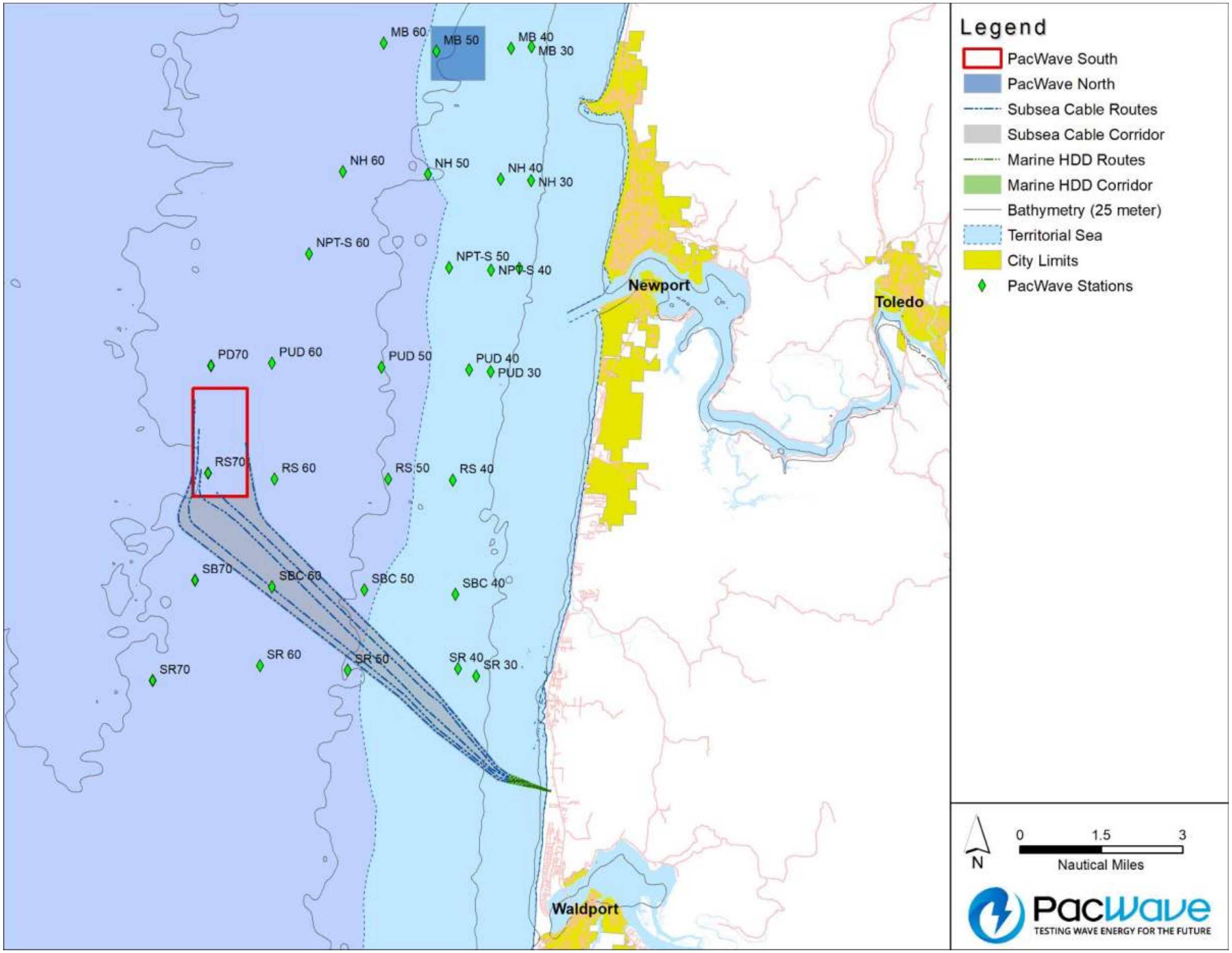


Figure 4-1. OSU sampling stations at PacWave South and vicinity (2013-2015).

4.2 ACOUSTIC ENVIRONMENT

Ambient sound in the marine environment originates from both natural and anthropogenic sources. Sound at PacWave South is likely to be influenced by three acoustics sources: 1) environmental processes such as surf, wind, rain; 2) anthropogenic activity such as vessel traffic; and 3) marine mammal vocalizations. The study area for underwater sound and vibration is defined as the vicinity within a distance of 125 m (410 ft) of the Project site, and the area used by vessels to transit between shoreside facilities and the Project site. The Project site off the coast near Newport already experiences considerable commercial vessel traffic from the Port of Newport, which is home to one of Oregon's largest commercial fishing fleets (see Section 2.3.4). The Project site is close enough to shore to possibly be affected by surf sound. Therefore, existing underwater sound levels are expected to be moderate to high (Austin et al. 2009).

A year-long acoustic monitoring study to describe long-term baseline ambient noise levels near Newport, Oregon was conducted adjacent to the PacWave North offshore site from March 2010 through April 2011 (Haxel et al. 2013). The strongest and most persistent ambient sounds (generally < 50 Hz) were generated by surf breaking inshore of the acoustic recording device, with noise energy levels scaling with wave heights, and therefore seasonally stronger in the fall, winter and spring than in summer (Haxel et al. 2013). Locally generated ship noise (e.g., originating from the Port of Newport) was the most dominant and persistent acoustic feature (generally >50 Hz); ambient sound levels increased with increasing vessel activity, particularly in summer associated with sportfishing and in winter with commercial crabbing (Haxel et al. 2013). However, distant commercial shipping noise was nearly continuous (Haxel et al. 2013). Biological sounds emanating from baleen whales (i.e., blue, fin, and humpback) tend to be the loudest (188 dB_{rms} *re* 1 μPa@ 1 m) but the lowest frequency (12-100 hHz) from September to early January, peaking in mid-October through November (Haxel et al. 2013). In 2015, Haxel (2019) collected baseline ambient noise levels over an approximately 6 week period in the southern region of the PacWave South area for site characterization. Sound pressure levels (SPL) root mean square (RMS) from 7 Hz-13 kHz were used to generate a cumulative distribution function (CDF) of noise levels where the 50th percentile (101 dB RMS re:1 μPa) was representative of a "typical" background sound level at PacWave South. Baseline monitoring recorded minimum SPL RMS levels for this time period of 83 dB RMS re:1 μPa, while local vessels generated the maximum RMS sound pressure level (138 dB RMS re:1 μPa) from a total of 61,380 SPL RMS values. Despite the measured maximum value of 138 dB, less than 1 percent of the measurements surpassed the 116 dB level at PacWave South (Haxel 2019).

It is notable that the summer baseline measurements at PacWave South were virtually identical to the year-long acoustic monitoring conducted at PacWave North, likely because of the relative close proximity of PacWave North and the PacWave South (approximately 8 nm), coupled with the fact that the two areas are used almost identically by commercial and recreational users and that there are no differences between them on which to conclude noise levels would differ. Specifically, ambient sound levels in the PacWave North and PacWave South Project areas appear to be influenced by the three types of dominant acoustic sources: environmental processes, anthropogenic activity, and marine mammal vocalizations. The low frequency recordings (<1 kHz) from the PacWave North monitoring site show a strong seasonal migratory presence of acoustically active baleen whales throughout the region during the months of September-January; at PacWave South acoustic activity increased in the fall (Haxel 2019). Accompanying these low frequency cetaceans, several high frequency odontocetes have also been detected with both regularity (e.g., harbor porpoise) and more seasonally (e.g., Orcas) within the Project site (Haxel 2019).

4.3 CHEMICAL CONTAMINANTS

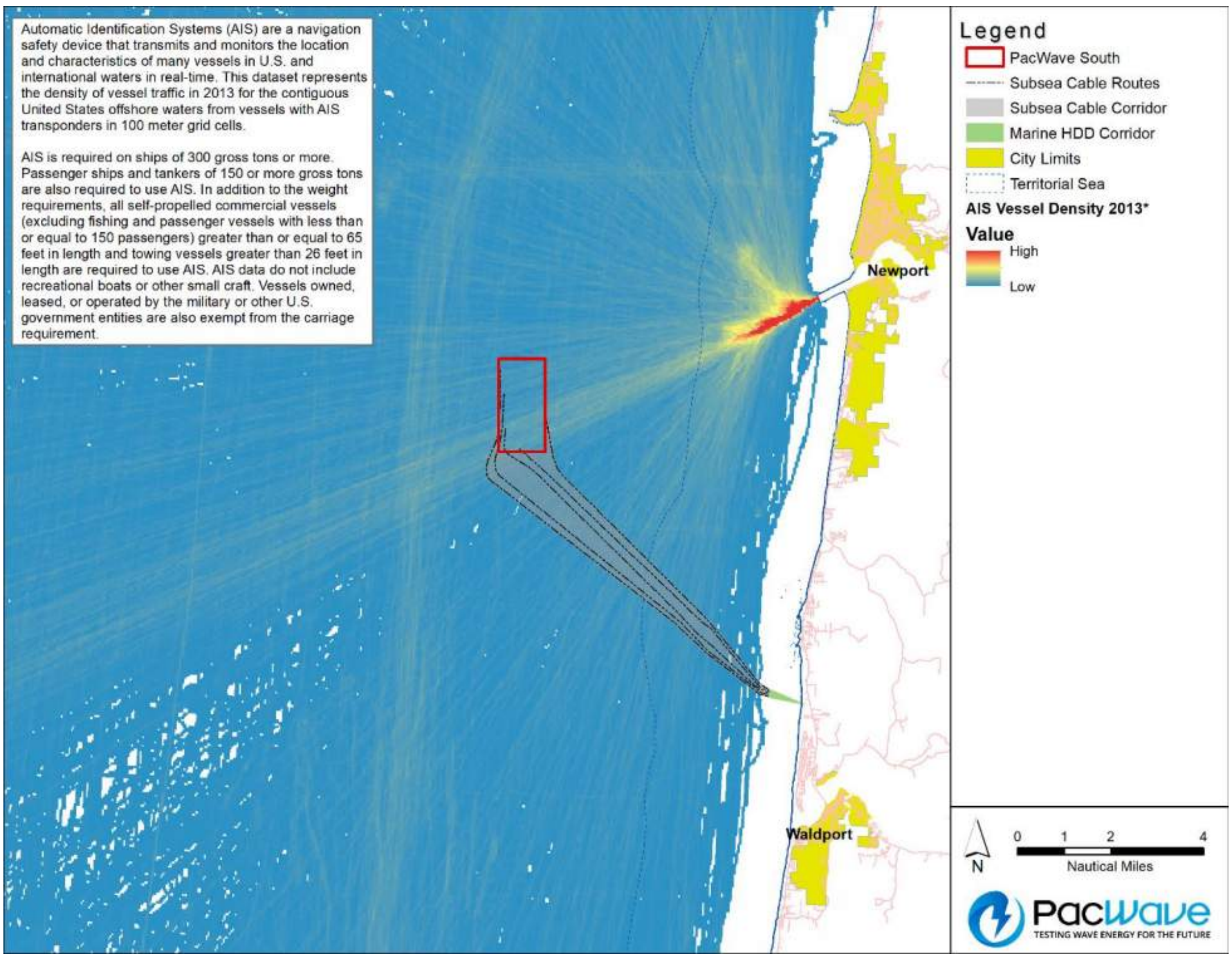
Water quality data taken in proximity to the Project site are available in the Oregon Department of Environmental Quality (ODEQ) Laboratory Analytical Storage and Retrieval (LASAR) Database, and sediment quality data were reported during studies performed prior and subsequent to designation of the dredged material disposal areas offshore of Newport. Also, on June 10, 2003, ODEQ collected water quality data throughout the water column just west of the Project site (Site ID 30223) in water having a depth of approximately 60 m.

Sediment samples were also taken from sites outside Yaquina Bay in various years from 1984 to 2000, mostly in summer and fall (USACE and EPA 2011). The 18 sample locations are in the open waters offshore of Yaquina Bay, an area that, like the test site and most of the cable route, has a uniform sand bottom. Metals concentrations detected in all samples were far below the screening levels outlined in the USACE's Sediment Evaluation Framework for the Pacific Northwest (USACE et al. 2009). All detected concentrations of organic compounds were either below the USACE's Sediment Evaluation Framework screening levels or below laboratory reporting limits.

4.4 VESSEL TRAFFIC AND NAVIGATION

Waters in the vicinity of the Project are used by a variety of recreational, charter, and commercial boats. Vessel traffic is often concentrated near the mouth of the Yaquina River and near the Port of Newport (Figure 4-2). The Yaquina River supports commercial traffic, primarily fishing vessels, research vessels from NOAA and OSU, and occasional lumber cargo vessels. To avoid conflicts between commercial crab fishermen and ocean going tugs that are towing barges, the Washington Sea Grant program helped broker an agreement that provided navigable towboat and barge lanes through the crabbing grounds between Cape Flattery and San Francisco. Based on the 2012 edition of the Washington Sea Grant Tow Lane Charts, the Project's WEC deployment area would be located in the southern corner of the existing tow lane off the coast of Newport, however, OSU has been working with the crabbers and tow boat operators and has secured an agreement to adjust the tow lanes to avoid PacWave South.

The USACE maintains the Yaquina Bay federal navigation channel to federally authorized depths by periodically dredging naturally occurring sedimentary material. Dredge material from this area has been placed at one of the two USACE designated Ocean-Dredged Material Disposal Sites (ODMDS North and South) located off the coast of Newport in the Yaquina Bay area (USACE 2012). The ODMDS sites are located about 6 nautical miles northeast of PacWave South and about 10 nautical miles north of the subsea cable route. The test site would be marked to aid navigation for vessel traffic and fishing activities, but OSU is not seeking a closure of the area.



Source: NOAA Office of Coastal Management, available via the Marine Cadastre (www.MarineCadastre.gov).

Figure 4-2. Vessel traffic in PacWave South and vicinity.

4.5 TERRESTRIAL HABITAT

The terrestrial environment in the vicinity of the Project site's land-based components includes the sandy beach area under which the cables would cross by HDD, the developed recreational area (i.e. Driftwood Beach State Recreation Site) where the HDD conduits would exit via beach manholes, the terrestrial habitat under which the cables would extend via HDD from the Driftwood Beach State Recreation Site to the UCMF and from the UCMF to the grid connection point, and the UCMF site. Upland vegetation communities surrounding the proposed terrestrial Project areas components include are maritime forest, grass-shrub-sapling/regenerating young forest, coastal dunes, and mixed conifer/deciduous forest (Kagan et al. 1999). HDR, on behalf of OSU, conducted field surveys in May 2016, June 2017, and February 2019 of the Project area to characterize terrestrial habitat (Appendix C). Forest stands are typically dominated by Sitka spruce with a mixture of other conifers such as western hemlock, Pacific red cedar, or yellow cedar. Understories are typically dense with shade-tolerant plants, including evergreen shrubs (e.g., salal, evergreen huckleberry), forbs (e.g., two-leaved Solomon's seal, redwood sorrel), and ferns (e.g., western sword fern, wood fern, deer fern). The surrounding forest is fairly fragmented due to housing developments and timber harvesting. In general, large tracts of land in Lincoln County are second and third generation woodland, having been logged and replanted over the years (3U Technologies 2013).

A total of four freshwater wetlands (Wetland C, D, H, and I) were delineated within the terrestrial Project area (i.e., Driftwood Beach State Recreation Site and UCMF) during wetland and waterway surveys conducted in May 2016 and June 2017 (Figure 4-3; HDR 2017). Wetland C is a 0.11 acre forested wetland, Wetland D is a 0.31 acre scrub-shrub/emergent wetland, Wetland H is a 0.27 acre scrub-shrub/emergent wetland, and Wetland I is a 0.15 acre emergent wetland (HDR 2017, 2019). In 2019, another wetland and waterway survey was conducted along the terrestrial HDD corridor, which included an extension of Wetland D. Wetland D, along with the 0.31 acres identified in the previous survey, collectively consisted of 2.93 acres of a forested/scrub-shrub wetland.

One named stream, Friday Creek, was identified in the Driftwood Beach State Recreation Site during surveys conducted in May 2016 and June 2017 (Figure 4-3). Friday Creek flows along Highway 101 at the entrance to Driftwood Beach State Recreation Site. It flows into Buckley Creek, which flows into the Pacific Ocean and is reported by Oregon Department of Fish and Wildlife (ODFW) to support anadromous coastal cutthroat trout (*Oncorhynchus clarkia clarkii* [Kelly 2016]). No streams were identified at the UCMF property (HDR 2017). During the 2019 survey along the terrestrial HDD corridor, Buckely Creek and "Stream 4" were identified, in addition to Friday Creek (Figure 4-3). A detailed description of each wetland and stream is provided in the Wetland Delineation Report (HDR 2017, 2019) in Appendix C of the APEA.

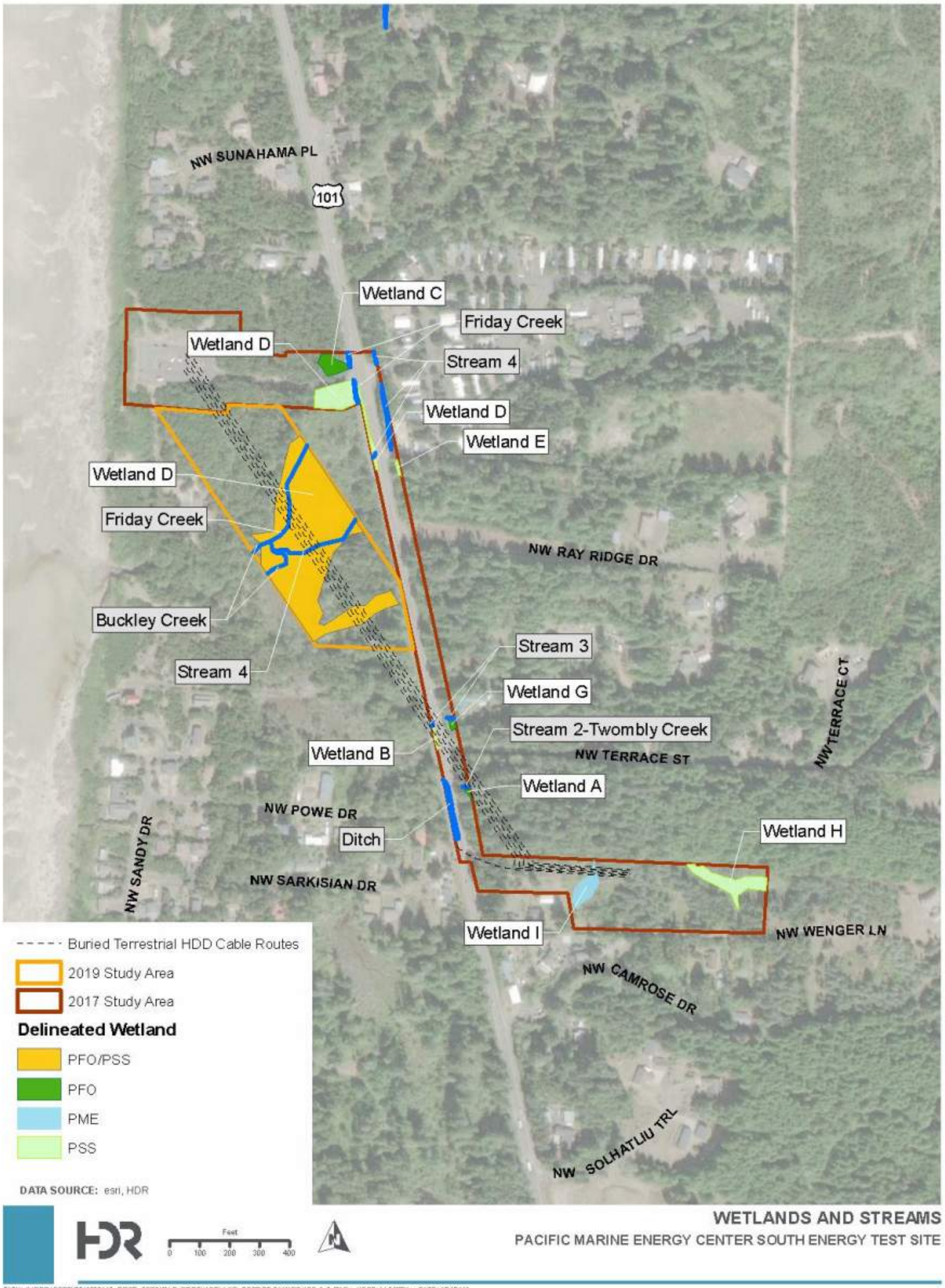


Figure 4-3. **Surface waters and wetlands in the terrestrial Project area.**

5.0 EFFECTS OF THE PROPOSED ACTION ON SPECIES AND DESIGNATED CRITICAL HABITAT

"Effects of the action" means the direct and indirect effects of an action on the species or critical habitat, together with the effects of other activities that are interrelated or interdependent with that action, that will be added to the environmental baseline (50 CFR 402.02). Indirect effects are those that are caused by the proposed action and are later in time, but still are reasonably certain to occur.

To facilitate the effects analysis, for each of these groups, the OSU has identified potential effects (stressors) of the Project that may affect an ESA-listed species. For each potential effect, the following sections provide a description of the stressor, a description of the expected exposure to the stressor, the likelihood of exposure to the stressor, and the risk to individuals and populations of ESA-listed species.

5.1 FISH

Based on input from the Collaborative Work Group, including discussion with NMFS, OSU has identified the following potential effects of Project construction and operation on ESA-listed fish:

- habitat alteration;
- underwater sound; and
- electromagnetic fields.

5.1.1 Habitat Alteration

The installation of subsea cables, subsea connectors, and anchors would result in both temporary and long-term alteration of habitat in the action area, which could have direct or indirect effects on ESA-listed fish. Potential stressors related to habitat alteration are:

- suspended sediment during installation and redeployments;
- disturbance of the benthic community from Project structures;
- changes to marine community composition and behavior (e.g., use patterns, attraction, and avoidance); and
- potential water quality contamination due to inadvertent release of toxic substances.

Suspended Sediment during Installation and Redeployments

Description of Stressor

It is anticipated that during each deployment, connection, disconnection, and retrieval events, sediment from the seafloor would be disturbed. Sediment will be temporarily disturbed as a result of placement of Project components on the seafloor. Subsequently, sediment will be disturbed during recovery as it is likely that the Project components (anchors, cables) will have become buried to varying degrees. As noted above, it is anticipated that it would take up to 7 days to install each mooring system and 1 to 2 days to attach a single WEC to the mooring. If an array was installed, which consisted of a number of WECs on individual mooring systems, this process would need to be repeated for each device. Deployment activities would not necessarily be continuous, because weather could delay the start-to-finish timeframe or postpone completion of certain activities. However, actual at-sea activities are not expected to take more than nine days to install one mooring system and WEC. It is anticipated that each WEC would be deployed for a year or more. The number of WECs deployed throughout the license term would vary throughout the license term (e.g., approximately 6 to a maximum of 20 WECs) and that fewer WECs would likely be deployed in the initial years of operation (i.e., the first five years or so).

The suspension of sediment during these events would be temporary and localized, including during initial Project construction (e.g. jet plowing of the subsea cables), and periodic as sediment would be temporarily suspended during deployment, connection, disconnection, and retrieval events that would occur throughout the 25-year license term. Sediment transport modeling completed for the subsea cable installation for the Deepwater Wind Project off Block Island, Rhode Island (Tetra Tech 2012), estimated that, in areas characterized by mostly coarse sand (particle diameter > 130 µm), sediment suspended during jet plow operations dropped quickly to the seafloor, and major plumes would not form in the water column. Suspended sediment concentrations within a few meters of the jet plow would be elevated, though outside of this nearfield zone, and no concentrations would exceed 100 mg/L. Concentrations above 10 mg/L would be confined to an area primarily within 50 m (160 ft) of the jet plow route and would last for approximately 10 minutes. This modeling also estimated that sediment deposition would exceed 10 mm (0.4 in) immediately adjacent to the trench, and sediment re-deposition would not exceed 1 mm beyond 40 m (130 ft) from the plow path (Tetra Tech 2012).

Sediment transport modeling conducted for the Virginia Offshore Wind Technology Advancement Project estimated that suspended sediment (particle diameter <200 µm) during subsea cable burying would extend vertically about 2 m above the trench and horizontally up to 100 to 160 m; sediment would deposit on the seafloor within 6 to 7 minutes; and sediment re-deposition would not exceed 1 mm within 100 m of the activity (BOEM 2014).

Grain sizes at and inshore of PacWave South are larger (mean median grain size = 364 μm) than the grain sizes evaluated by the studies in Virginia and Rhode Island; accordingly, less suspension and faster settling are expected with cable laying, subsea connector installation, and anchor deployment and recovery at PacWave South.

It is expected that the local conditions at the PacWave South site will differ from those at the Rhode Island and Virginia sites. Different water depths, salinities, currents and other hydrodynamic forcing and water quality parameters all combine to affect the magnitude and extent of sediment advection and transport. In a simplified sense, though, coarse, non-cohesive sediments exist at all locations. Therefore, it is scientifically reasonable to assume that the sediments will settle out of suspension rapidly after re-suspension. Coarse sediments that are advected away from the site will also likely settle out rapidly. Fine sediments, if re-suspended, will be advected the furthest away before depositing.

Rough estimates of the settling velocity of grain sizes in the 200-600 micron diameter size range, the grain sizes at the PacWave South site, are 2.5 cm/s for 200 micron diameters and 8.5 cm/s for 600 micron diameters (Hallermeier 1981, Van Rijn 1984 both from Soulsby 1997). These are slightly conservative as they are based on ideal conditions where there is no water current or additional turbulence from construction activity or hindered settling. However, for a practical example, if these sediment grains were suspended 10 m into the water column as a result of the construction activities, it would take the 200 micron and 600 micron sediments approximately 6.5 minutes and 2 minutes to settle out of suspension, respectively, given the settling velocities above. The settling velocities would be affected by ambient current speeds, the range of particle sizes that will be resuspended, and any impacts of hindered settling, these settling estimates may vary, but are anticipated to remain on the order of a factor of 1-3 times the zero-flow settling velocities (i.e., less than 20 minutes).

Seafloor sediment would be disturbed slightly upon initial installation of the subsea connector. The connector will be lowered by winch to the seafloor, the result likely being a small amount of sediment re-suspension, benthic disruption, and possibly settling of the connector into the sediment slightly. The subsea connector will be hoisted to the water surface to be connected to the WEC umbilical or hub. During this process, the sediments and macrofauna that exist on the connector and cable will be shed as the connector is brought to the surface. The result will likely be a low sediment concentration plume that drifts off the connector and cable as it is being brought to the surface. The sediments and macrofauna will settle out of suspension rapidly, according to the ambient hydrodynamic turbulence, elevation above the seafloor, water depth, and fall velocity. After being connected to an umbilical or hub, the connector, connector cable and umbilical will be lowered back to the seafloor. The sediment (which may or may not be in the same location on the seafloor) will be disturbed again. Sediment will be re-suspended due to the impact of the components on the bed, benthos may be disrupted, and there may be some settlement into the seafloor again. The disturbance process will repeat itself on a periodic basis over the 25-year Project license term, as new WEC umbilicals or hubs are connected, old ones are disconnected, and subsea connectors are retrieved and deployed. As noted above, settling estimates are anticipated to be on the order of minutes or tens of minutes.

HDD has the potential for inadvertent returns if drilling fluids leak through an unidentified weakness or fissure in the soil. HDD uses a slurry, composed of a fine clay material such as bentonite, as a drilling fluid. The drilling fluids are non-toxic but could result in increased suspended sediment and turbidity and possibly affect aquatic organisms. As the suspended material settles out of the water column, sedimentation would partially or entirely cover the waterbody substrate and any sessile benthic organisms, although effects would be minor, localized, and temporary. Inadvertent return during HDD or boring operations is considered highly unlikely. An HDD Contingency Plan will be developed to minimize the potential for inadvertent return of drilling fluids, provide timely detection, and address potential releases by describing monitoring, containment, response and notification procedures to be implemented by the contractor.

Exposure to Stressor

A complete list of ESA-listed fish that could occur within the action area is in Section 3.1 (Table 3-1). The ESA-listed fish and life stages could be in the action area and may be affected by suspended sediment during installation and redeployments from the Project are:

- juvenile and adult Chinook salmon (Lower Columbia River, Upper Willamette River, Upper Columbia River, Snake River spring/summer, Snake River fall-run, California Coastal, Sacramento River winter-run, and Central Valley spring-run ESUs);
- juvenile and adult coho salmon (Lower Columbia River, Oregon Coast, Southern Oregon/Northern California Coast, and Central California Coast ESUs);
- juvenile and adult steelhead (Lower Columbia River, Middle Columbia River, Upper Columbia River, Upper Willamette River, Snake River, South-Central California Coast, Central California Coastal, Northern California, and California Central Valley DPSs);
- adult and juvenile chum salmon (Columbia River ESU)
- adult southern DPS green sturgeon; and
- juvenile and adult eulachon.

Juvenile and adult sockeye salmon (Snake River ESU) are not likely to occur in the action area (NMFS 2015h) and therefore they are unlikely to be affected by suspended sediment during installation and redeployments.

Likelihood of Exposure

The probability of occurrence of the ESA-listed fishes in the action area is likely low at any given time, based on research and regional bycatch data, and because these fish are also migratory, they are unlikely to remain in the Project area but rather move through on a transitory basis.

Salmonids – In general, salmonids are low in abundance in U.S. West Coast waters when compared to other fishes, as evidenced by the relatively low numbers of juvenile salmonids captured in directed pelagic surface/subsurface research trawls (Brodeur et al. 2005, Fisher et al. 2014); and, for Chinook salmon, by the low numbers of adults and subadults captured as bycatch in midwater trawls (e.g., commercial trawls for whiting, see Lomeli and Wakefield 2014). Coho salmon of the Oregon Coast ESU that spawn and rear in the Yaquina and Alsea rivers could have more exposure to Project-related suspended sediment than coho salmon from other areas or than the other ESA-listed salmonid species; the juvenile coho salmon could be exposed during their ocean-bound emigration out of the rivers in spring, and adults during their return to these rivers to spawn in summer and fall.

Juvenile salmonids are unlikely to be exposed to elevated suspended sediment near the bottom, given that they are pelagic and typically surface-oriented, most often found in the upper 20 m of the water column (Emmett et al. 2004, Walker et al. 2007). They are also highly migratory; ocean dispersal rates averaged between 3.2 and 6.6 km/d for yearling Columbia River coho salmon (Fisher et al. 2014), and 0.4-1.2 km/d for subyearling and 1.0-2.4 km/d for yearling juvenile Chinook salmon (Trudel et al. 2009). Adult salmonids, especially Chinook salmon, occur at greater depths than juveniles, as evidenced by their capture as bycatch in midwater trawl fisheries (Lomeli and Wakefield 2014); however, their prey types are predominately pelagic and they are unlikely to remain at or near the bottom. Thus, potential exposure of salmonids to suspended sediment would likely be short-term and limited.

Eulachon – Adult eulachon are captured as bycatch in commercial bottom trawls for pink shrimp in low densities off Newport, but have been captured in much higher densities offshore of southern and northern Oregon (Al-Hummaidhi et al. 2012). They are typically caught in trawls during the day, near the ocean bottom in waters of 20-150 m depth, on the continental shelf and slope (Hay and McCarter 2000, Hannah et al. 2011, Al-Humaidhi et al. 2012, Wargo et al. 2014, Gustafson et al. 2017), therefore they could be exposed to elevated suspended sediment near the bottom.

Green Sturgeon – Green sturgeon are infrequently captured as bycatch in commercial groundfish fisheries along the Oregon coast (Al-Hummaidhi et al. 2012). However, adult green sturgeon typically concentrate and feed in coastal waters immediately offshore and upcoast and downcoast of estuaries, including Yaquina Bay (Erickson and Hightower 2007, Payne et al. 2015, Henkel 2017), thus they can concentrate in the general vicinity of the Project site and be exposed to suspended sediment. Green sturgeon also feed on the bottom and may encounter suspended sediments before it begins to disperse.

Risk to Individuals and Populations

Given the nature of a test site, and that WECs would periodically be deployed and retrieved throughout the license term, there would be intermittent, though localized, temporary disturbances throughout the license term.

Suspended sediment resulting from cable laying, subsea connector installation, and anchor installation/removal at PacWave South, is expected last for minutes or tens of minutes. Suspended sediment during cable laying is expected to dissipate quickly and not reach levels that would harm ESA-listed salmonids (Newcombe and Jensen 1996), and salmonids, eulachon, and green sturgeon would likely move away from the area of disturbance. Food sources of green sturgeon would also be largely unaffected by suspended sediment. Benthic fauna (e.g., polychaetes, clams, and amphipods) that inhabit the subsea cable route are likely to be adapted to dynamic ecosystems and likely would be unaffected by sediment burial. For example, Maurer et al. (1982) suggest that certain species of bivalves, amphipod crustaceans, and polychaetes can withstand burial under 3 inches of sediment from ocean dredged material disposal. It was concluded that dredged material disposal associated with the Yaquina Bay ODMDS would not affect green sturgeon prey species because many invertebrate prey species are capable of vertical migration through a deposition layer of 0.8 to 2.8 inches, therefore rehabilitation of prey species at the site would occur within days (EPA 2011). The width of the jet plow trench would be only about 3 ft wide, and would be surrounded by ample undisturbed habitat from which new recruits could be drawn. It is likely that affected areas would be quickly recolonized from nearby undisturbed areas (DOE 2012).

In conclusion, localized, temporary increases in suspended sediment are not expected to adversely affect any individual juvenile or adult salmon, juvenile or adult eulachon, or adult green sturgeon that could be in the action area; as such, increases in suspended sediment would not adversely affect any of these ESA-listed fishes at the population level.

Disturbance of the Benthic Community from Project Structures

Description of Stressor

The presence of Project structures on the seafloor will result in both direct and indirect disturbance to the benthic community. The subsea cables, extending from the subsea connectors to the HDD conduits near shore, would be installed in individual trenches 1 to 2 m below the seafloor using jet plowing or other trenching methods. This would cause temporary displacement of unconsolidated sediments as the cable is buried. Benthic and infaunal organisms (e.g., amphipods, bivalves, and polychaetes) within the pathway of the plow would be removed, displaced, or killed during the trenching process. Additionally, as the plow moves along the seafloor, slow-moving infaunal or surface dwelling organisms located in the path of the plow's skids or wheels that span the trench likely would be killed. Mobile invertebrates (e.g., crabs), fish species that feed on or near the bottom (e.g., green sturgeon), and species that shelter on the bottom at times would likely move away from the immediate vicinity of the anchors and cable and move to nearby areas during deployment and removal activities (Roegner and Fields 2015). While these activities would result in short-term benthic habitat disturbance, benthic fauna (e.g., polychaetes, clams, and amphipods) that inhabit the area are likely to be adapted to dynamic ecosystems and likely would be unaffected by sediment burial.

There would be long-term loss of unconsolidated sand habitat within the footprint of the WEC anchors. Suction caisson and plate anchors would be placed into and under the seafloor, and therefore would have a minimal footprint on the seafloor other than the mooring hardware and line extending from the anchor under the seafloor up to the WEC. The maximum footprint of the anchors would be 19,068 ft^2 (0.4 acres) for the initial development and 90,800 ft^2 (2 acres) for the full build out (Table 2-1), which is 0.1 percent of the total Project site surface area (1,695 acres). The estimates are based on exclusive use of large 34-ft-diameter gravity anchors; however, other types of smaller anchors will likely be used for some of the WECs, and shared anchors may be used for some WECs when feasible, so the actual seafloor footprint is expected to be considerably smaller than these estimates.

Installation of drag embedment anchors requires dragging the anchor a lateral distance across the seafloor to set them at a sufficient penetration (sediment depth). It is anticipated that most of this disturbance would be below the seafloor surface. The spatial extent of habitat modification would vary depending on anchor type and number of anchors, considering some anchor types would be buried and not rest on the seafloor. As anchors are removed, the disturbed areas are expected to recover over time by natural sediment transport processes.

Additional direct disturbance would result from the footprint of the four subsea connectors (each with a footprint of perhaps 30 ft^2), umbilical cables, and the segment of the cables that would be laid on the seafloor in a U-form (looped) spanning a distance of approximately 300 m, that would not be buried to allow access during maintenance activities (the remainder of the cable routes would be buried).

The placement of anchors on the seafloor could result in localized areas of scour or deposition; however, the particle size range found at PacWave South is likely less susceptible to movement than areas having finer grained sediment. Based on reviews of bottom changes resulting from deployment of artificial reefs and offshore oil platforms (Henkel et al. 2014), sedimentary changes could be expected to occur at least 20 m away from an anchor installation (the actual distance that scour and sediment change occurs will be monitored in the Organism Interactions and Benthic Sediments monitoring plans). Based on surveys at PacWave North, changes to benthic conditions (particularly higher proportions of very coarse sand and shell hash accumulation) may also be expected to occur; however, this accumulation did not have a measureable effect on the composition of the macrofaunal community (Henkel and Hellin 2016). Anchors may also reduce available benthic foraging habitat, although the total area lost by anchors would be small, as quantified above.

Whitehouse (1998) mentions that there is only a limited amount of experimental data and numerical studies of the flow field and scouring around gravity installations. However, physical model results at HR Wallingford for the scour around a large cylinder indicated maximum scour depths of 0.064xD for collinear waves and currents, plus accretions of 0.028xD in some areas adjacent to the installation (Rance 1980, from Whitehouse 1998). As a representative calculation, for a 10 m diameter gravity base anchor at the PacWave South, this would amount to 0.64 m equilibrium scour depth at the upstream side of the anchor and up to 0.28 m of accretion in lee of the structure. Field observations of scour in sandy sediment have been reported at 0.5 to 1.0 m for a 10.5 m diameter obstruction (Bishop 1980, from Whitehouse 1998). A second calculation was made using the methods of Sumer and Fredsoe (2002); assuming a water depth of 60 m, a wave height of 10 m, a wave period of 15 second and a 10 m diameter anchor, the maximum scour depth was estimated at 1 m[7].

Some additional minor and short-term bottom disturbance would be expected from the anchoring of vessels used for installation, maintenance, and environmental monitoring. As noted above, it is anticipated that it would take up to 7 days to install each mooring system and 1 to 2 days to attach a single WEC to the mooring. If an array was installed, which consisted of a number of WECs on individual mooring systems, this process would need to be repeated for each device. Deployment activity would not necessarily be continuous, because weather could delay the start-to-finish timeframe or postpone completion of certain activities. However, actual at-sea activities are not expected to take more than nine days to install one mooring system and WEC. Based on the experience at PacWave North, the anchoring of support vessels (e.g., for maintenance and monitoring) is typically not required. Because vessel anchoring would be short-term and represent a small disturbance, any effects on the seafloor would be negligible and similar to the anchoring of vessels that occurs regularly along the Oregon coast.

[7] Typical extreme wave conditions for this example were obtained from the NOAA NDBC website for Station 46050 – Stonewall Bank, located 20 nautical miles West of Newport, Oregon.

In summary, it is anticipated that scour depths may be up to 1 m, and scour widths may extend at least as far from the anchors as 20 m (the actual distance that scour and sediment change occurs will be monitored in the Organism Interactions and Benthic Sediments monitoring plans). Including an additional 20 m (65 ft) radius around each 34-ft diameter anchor to consider scour development and sediment re-deposition, the total direct and indirect disturbance surface area is anticipated to be approximately 21,124 ft^2 per anchor (which assumes a 164 ft diameter of direct and indirect disturbance). For the initial development scenario with 21 anchors, this could result in approximately 10 acres, or 0.6 percent of the total Project site being potentially affected. For the full build-out scenario with 100 anchors, this could result in approximately 48 acres, or 3 percent of the total Project site being potentially affected.

Exposure to Stressor

A complete list of ESA-listed fish that could occur within the action area is in Section 3.1 (Table 3-1), and a description of their potential exposure to the stressors is described in "Suspended Sediment during Installation and Redeployment" section above. In summary, the ESA-listed fishes that are likely to be in the action area and that may be affected by disturbance to benthic communities include juvenile and adult Chinook, coho and chum salmon, steelhead, and eulachon, and adult green sturgeon. These species are likely to be in the Project area and may experience short term exposure to this stressor. However, all of the listed fish are highly mobile and migratory, and therefore individuals are unlikely to remain in the Project area and be continually or repeatedly exposed to this stressor.

Likelihood of Exposure

As described above, the occurrence and relative abundance of ESA-listed fish in the action area may be relatively low at any given time, and because these fish are actively swimming to seek prey, and are also migratory, they are unlikely to remain in the Project area but rather move through on a transitory basis.

<u>Salmonids</u> – ESA-listed salmonids could be exposed to benthic habitat disturbance because they are known to forage and migrate along the Oregon coast. Oregon Coast coho salmon that originate from the Yaquina basin are more likely than other salmonids to occur in the action area and be exposed to benthic habitat disturbance because they would have a higher probability of encounter with the Project than other stocks; adults would likely appear in the action area shortly before their migration into Yaquina Bay or Alsea River in late summer to fall.

Juvenile salmonids are unlikely to be exposed to benthic habitat disturbance because they are pelagic and typically surface-oriented, most often found in the upper 20 m of the water column (Emmett et al. 2004, Walker et al. 2007), and their preferred prey types are also pelagic (e.g., copepods, euphausiids, and juveniles of northern anchovy, Pacific herring, sardines, rockfishes, and smelt; Brodeur et al. 2005, Brodeur et al. 2007, Daly et al. 2009, Santora et al. 2012). Adult salmonids, especially Chinook salmon, occur at greater depths than juveniles, as evidenced by their capture as bycatch in midwater trawl fisheries (Lomeli and Wakefield 2014), and thus they could be exposed to benthic habitat disturbance. However, adult salmonids are unlikely to have much exposure given that their prey is also predominately pelagic (e.g., euphausiids, northern anchovy, squid, Pacific herring, Pacific sandlance, and smelt; Hunt et al. 1999, PFMC 2000).

Green Sturgeon – Green sturgeon is a benthic species that may spend longer durations in habitats with highly complex seafloor (e.g., boulders) versus other benthic coastal habitats (Huff et al. 2011), and in association with estuaries (Payne et al. 2015, Lindley et al. 2011), and therefore may be exposed to benthic habitat disturbance during their coastal migration. They typically concentrate and feed in coastal waters immediately offshore and upcoast and downcoast of estuaries, potentially including Yaquina Bay (Erickson and Hightower 2007, Payne et al. 2015, Henkel 2017); thus they can concentrate in the general vicinity of the Project area. However, because sturgeon are also highly mobile and use a variety of coastal habitat types (Erikson and Hightower 2007), it is unlikely that individuals would remain at the structures long enough to be affected by benthic disturbances.

Eulachon – Juvenile eulachon are reported to rear in nearshore marine waters, and adults are regularly captured as bycatch in the ocean shrimp trawl fishery in nearshore marine waters of Oregon (Hannah et al. 2011, Al-Humaidhi et al. 2012, Wargo et al. 2014). They are typically caught in trawls during the day, near the ocean bottom in waters of 20-150 m depth, on the continental shelf and slope (Hay and McCarter 2000, Hannah et al. 2011, Al-Humaidhi et al. 2012, Wargo et al. 2014, Gustafson et al. 2017), therefore they could be exposed to benthic habitat disturbance.

Risk to Individuals and Populations

Changes in benthic habitat as a result of benthic habitat disturbance in the action area could result in changes to prey type or availability for salmonids, eulachon and green sturgeon, although any effects would likely be temporary and negligible. The NMFS' Biological Opinion for PacWave North stated that best available indicator for the level of incidental take associated with changes to benthic habitat was changes in substrate grain size and distribution over a substantial portion of the test site (NMFS 2012c). The threshold for ESA consultation reinitiation was a change in substrate type (grain size and distribution) from baseline conditions (188 μm to 462 μm) to another state (e.g. from a fine grained to a coarse sand) over 50 percent of the test site, and changes in substrate types from baseline conditions were well below the 50 percent threshold. The Project site is also unlikely to exceed this threshold.

In addition, total area of benthic habitat disturbed would be minor in comparison to surrounding available habitat: for the full build out scenario, 0.1 percent (2 acres) for direct effects to the seafloor at the test site, and 3 percent (48 acres) considering indirect effects to the seafloor at the test site (Figures 2-4 and 2-5).

Because it is assumed that the Project site is a high energy site (based on the existence of larger median grain sizes and low fine sediment percentages), it is estimated that the physical recovery will occur quickly. High energy site are typically inhabited by opportunistic organisms tolerant of disturbance (Pemberton and MacEachern 1997). At PacWave North, benthic community recovery was rapid (i.e., within 2 months) and species diversity and relative abundances of benthic macroinvertebrates was "indistinguishable" pre- (2010 and 2011) and post-installation (2012-2014) (NNMREC 2015a). Effects at PacWave South are expected to be minimized given that anchor installation/removal is not likely to occur more than once a year within a berth and anchors may be deployed for multi-year periods. More specifically, the number of species and species diversity of invertebrates collected in cores around the Ocean Sentinel (OS) anchors (about 45 m deep, at PacWave North) were not different from the number of species and species diversity of inverts collected from the reference stations at 40 m and 50 m depths (NNMREC 2015b). Assuming non-mobile macroinvertebrates are important groundfish prey as well as the organisms most susceptible to disturbance impacts from the Project, the best available science suggests that recovery/ recolonization times are minimal and there would be no impacts to predators (e.g., sturgeon and groundfish) of these macrofaunal invertebrates. The abundances of mobile, slightly larger prey, such as Crangon shrimp and small fishes did not seem to vary in a way attributable to deployment activities at PacWave North. For Crangon biomass collected at PacWave North across twenty months from 2010 to 2014, the only significantly different month was August 2011 when 2 exceptionally high catches occurred. Other than that, there has been no significant variability across 19 other months of sampling in Crangon biomass at the nine reference stations around the OS at PacWave North. Fish density at PacWave North was higher in summer 2013 and 2014 than previous years (2010-2012), although the June catches across all years were not actually statistically significantly different. This general increase began in spring 2013, four months before the OS installation. Overall, any effects on prey availability due to devices or anchors (if there are any) must be extremely localized; there certainly is no evidence that shrimp and fish species vacate the area. Therefore, any loss of prey species would not significantly reduce prey availability or abundance for fishes.

When anchors are removed at the Project's WEC deployment area, there may be scour holes or settlement pits remaining on the seafloor that will be initially void of macrofauna (due to the previous existence of the anchor). According to Collie et al. (2000) and Dernie et al. (2003), and depending upon the near-bottom hydrodynamics post-anchor removal, the seafloor is expected to revert back to native physical conditions relatively quickly because the substrate comprises sand as opposed to finer, muddy sediments. It is difficult to predict recovery times of the sediment and benthic habitat because their respective recoveries are dependent upon several variables; namely, the near-bottom current magnitudes and directions following disturbance. Occurrences of high energy (i.e., high current velocity) events may act to reshape the seafloor rapidly following disturbances; however, milder hydrodynamics may result in longer durations before the sediment is re-worked and benthos migrate back to the disturbed areas. Dernie et al. (2003) compared recovery rate of benthic assemblages and habitat parameters in different sediment types[8]. Dernie et al. (2003) stated that "sediment composition is largely controlled by hydrodynamic forces (Snelgrove and Butman 1994, from Dernie et al. 2003)…such that clean, coarse sandy bottoms predominate in high-energy environments….Presumably, the communities that inhabit such different sediment types have adapted to very different environmental disturbance regimes (Hall 1994, from Dernie et al. 2003). Many species that are typical of wave-exposed sandy environments exhibit behaviors that enable them to survive daily tidal scouring events (Gorzelany and Nelson 1987, from Dernie et al. 2003)." In general, they found that "clean sand had the most rapid recovery rate following disturbance. It is generally assumed that communities found in dynamic sandy habitats will recover more quickly following physical disturbance than those found in less energetic muddy environments based on the adaptive strategies of the differing assemblages (Kaiser 1998, Ferns et al. 2000, both from Dernie et al. 2003)." Dernie et al. (2003) determined a time on the order of 100 days to return to pre-disturbed conditions. Collie et al. (2000) came to similar conclusions.

Summary

The total area of benthic habitat disturbed would be very small relative to the range of and available marine habitat and prey for the ESA-listed fishes (particularly for the highly migratory salmonids and green sturgeon that range widely along the U.S. West Coast), and minor in comparison to surrounding available habitat (for full build out at the test site, maximum direct effects to the seafloor would occur for about 0.1 percent of the Project area [2 acres] and maximum indirect effects to the seafloor would occur for about 3 percent [48 acres] of the Project area) (Figures 2-4 and 2-5). Effects at PacWave South are expected to be minimized given that anchor installation/removal is not likely to occur more than once a year within a berth and anchors may be deployed for multi-year periods. Any effects on prey availability due to WECs or anchors (if there are any) is expected to be extremely minor, localized, short-term, and temporary, though intermittent throughout the 25-year license term, and exposure of this stressor on individual ESA-listed fishes is unlikely to be recurrent. Thus, benthic habitat disturbance is not expected to adversely affect any individual juvenile or adult salmonids, juvenile or adult eulachon, or adult green sturgeon that could be in the action area; as such, benthic habitat disturbance would not adversely affect any of these ESA-listed fishes at the population level.

[8] The Dernie et al (2003) experiment was restricted solely to the intertidal zone so they could facilitate site access for frequent physical measurements. But the scale of the disturbance was "chosen to be relevant to fishing impacts that occur intertidally and subtidally (e.g., digging, raking, dredging and trawling)."

Although no difference in macrofaunal assemblages was detected around the Ocean Sentinel anchors after one year of deployment at PacWave North, uncertainty remains regarding the potential long-term changes to benthic habitat, given that PacWave South will be a larger project and a longer deployment time than PacWave North. OSU will conduct the: 1) Organism Interactions Monitoring Plan to track changes to pelagic and demersal fish and invertebrates (particularly Dungeness crab) that might be attracted to the installed components or affected due to the potential for reduced fishing pressure, as well as biofouling on the anchors/WECs; and 2) the Benthic Sediments Monitoring Plan as part of the Adaptive Management Framework to track changes to benthic habitat in the vicinity of Project components (i.e., anchors) to determine what (if any) changes in sediment characteristics result in changes to the benthic invertebrate communities and implement mitigation measures, if warranted.

Changes to Marine Community Composition and Behavior

Description of Stressor

WECs, anchors, moorings, umbilicals, hubs, and subsea connectors would introduce structure on the seafloor, in the water column, and at the surface, which could result in changes to marine community composition and behavior, and affect ESA-listed salmonids, green sturgeon, and eulachon. The CWG was concerned that Project structure may possibly affect ESA-listed fish by providing habitat that attracts them or their prey, or by providing habitat that attracts predators which could increase the risk of mortality or result in avoidance of the Project area. At full build-out, seafloor structure could include up to 100 anchors that would occupy a total footprint of up to 90,800 ft^2 (2 acres), and water column and/or surface structure of up to 20 WECs (each separated by a distance of 50 to 200 m or more) and associated moorings and umbilicals (total area occupied within the water column is uncertain; see Figures 2-4 and 2-5, Table 2-1). These structures would be placed on sand substrate that is generally lacking vertical habitat features, which could result in localized seafloor habitat changes as the hard structures (e.g., anchors) are deployed.

Based on reviews of bottom changes resulting from deployment of artificial reefs and offshore oil platforms, sedimentary changes could be expected to occur at least 20 m away from an anchor installation (Henkel et al. 2014) (the actual distance that scour and sediment change occurs will be monitored in the Organism Interactions and Benthic Sediments monitoring plans). Structures would likely become colonized ("biofouled") by algae and invertebrates, such as barnacles, mussels, bryozoans, corals, tunicates, and tube-dwelling worms and crustaceans (Boehlert et al. 2008). Based on surveys at PacWave North, changes to the benthos (particularly shell hash accumulation) may be expected to occur up to 250 m away from an anchor installation; however, this accumulation does not appear to have a measureable effect on the composition of the macrofaunal community (Henkel and Hellin 2016). The CWG was concerned that some of these organisms might be eaten by or are part of the food webs for ESA-listed fishes, so the analysis considered the potential for added structure to increase forage opportunities and attract these species. The change in habitat complexity resulting from the exposure of anchors above the sea floor and any resulting localized scour or shell mounding might also increase habitat complexity and provide habitat for structure-associated fish. Some types of pelagic fishes are also known to associate with floating objects (Castro et al. 2002, Nelson 2003), so Project structures in the water column and at the surface (e.g., WECs, marker buoys and mooring lines) and associated biofouling might act as fish aggregating devices (FADs) and attract pelagic fishes through visual and/or olfactory cues (Dempster and Kingsford 2003). If Project-related structures do attract ESA-listed fish regularly, predictably, and in significant numbers, they might also attract larger fish predators, which could then prey on ESA-listed fishes. Cormorants (*Phalacrocorax* spp.), and brown pelicans (*Pelecanus occidentalis*) might roost on above-surface structures of WECs, and California sea lions might haul out on the structures, and these species may also occasionally prey on ESA-listed fish if they are present.

The CWG also expressed concern that ESA-listed fish could be entrained in WEC ballast water intakes.

Exposure to Stressor

A complete list of ESA-listed fish that could occur within the action area is in Section 3.1 (Table 3-1), and a description of their potential exposure to the stressors is described in “Suspended Sediment during Installation and Redeployment” section above. In summary, the ESA-listed fishes that are likely to be in the action area and that may be affected by this stressor include juvenile and adult Chinook, coho and chum salmon, steelhead, and eulachon, and adult green sturgeon. These species are likely to be in the Project area and may experience short term exposure to this stressor. However, all of the listed fish are highly mobile and migratory, and therefore unlikely to remain in the Project area and be continually or repeatedly exposed to this stressor.

Likelihood of Exposure

As noted in the sections above, the occurrence and abundance of ESA-listed fish in the action area may be relatively low at any given time, and because these fish are actively swimming to seek prey, and are also migratory, they are unlikely to remain in the Project area but rather move through on a transitory basis. In addition, the total footprint of the seafloor structures (about 2 acres) is very small relative to the available marine habitat for highly migratory salmonids and green sturgeon, and the WECs would be separated by 50 to 200 m or more (Figures 2-4 and 2-5).

Salmonids – Both juvenile and adult ESA-listed salmonids could be exposed to WEC structures because they are known to forage and migrate along the Oregon coast. Oregon Coast coho salmon that originate from the Yaquina basin are more likely than other salmonids to occur in the action area and be exposed to WEC structures because they would have a higher probability of encounter with the Project than other stocks; adults would likely appear in the action area shortly before their migration into Yaquina Bay or Alsea River in late summer to fall, and juveniles during their ocean-bound emigration from the Yaquina basin in spring.

Juvenile salmonids are unlikely to be exposed to seafloor structures but could interact with water column and surface structures, given that they are pelagic and typically surface-oriented, most often found in the upper 20 m of the water column (Emmett et al. 2004, Walker et al. 2007), and their preferred prey types are also pelagic (e.g., copepods, euphausiids, and juveniles of northern anchovy, Pacific herring, sardines, rockfishes, and smelt; Brodeur et al. 2005, Brodeur et al. 2007, Daly et al. 2009, Santora et al. 2012). Adult salmonids, especially Chinook salmon, occur at greater depths than juveniles, as evidenced by their capture as bycatch in midwater trawl fisheries (Lomeli and Wakefield 2014), and thus they could be exposed to both seafloor and water column structures. However, adult salmonids are unlikely to have much exposure to seafloor structures given that their prey is also predominately pelagic (e.g., euphausiids, northern anchovy, squid, Pacific herring, Pacific sandlance, and smelt; Hunt et al. 1999, PFMC 2000).

Green Sturgeon – Green sturgeon is a benthic species that may spend longer durations in habitats with highly complex seafloor (e.g., boulders) versus other benthic coastal habitats (Huff et al. 2011), and in association with estuaries (Payne et al. 2015, Lindley et al. 2011), and therefore may be exposed to seafloor structures during their coastal migration. They typically concentrate and feed in coastal waters immediately offshore and upcoast and downcoast of estuaries, including Yaquina Bay (Erickson and Hightower 2007, Payne et al. 2015, Henkel 2017), thus they can concentrate in the general vicinity of the Project area. They are also known to make rapid vertical ascents to near the surface (Erickson and Hightower 2007), and thus could have short-term exposure to midwater and surface structures.

Eulachon – Juvenile eulachon are reported to rear in nearshore marine waters, and adults are regularly captured as bycatch in the ocean shrimp trawl fishery in nearshore marine waters of Oregon (Hannah et al. 2011, Al-Humaidhi et al. 2012, Wargo et al. 2014). They are typically caught in trawls during the day, near the ocean bottom in waters of 20-150 m depth, on the continental shelf and slope (Hay and McCarter 2000, Hannah et al. 2011, Al-Humaidhi et al. 2012, Wargo et al. 2014, Gustafson et al. 2017), therefore they could be exposed to seafloor structures.

Risk to Individuals and Populations

Potential effects on these fishes as a result of WEC structures introduced to the marine environment could include changes in the marine community, forage opportunities, and predator/prey abundances. In general, although there is uncertainty about the degree to which marine animals may be attracted to WEC structures, there is no data that suggest that there would be any significant adverse effects to individuals or populations (Copping et al. 2016). However, structure is not novel or unusual in the marine environment along the U.S. West Coast, and includes natural and manmade objects in the water column and at the surface such as navigational buoys, kelp, floating debris, piers, and oil platforms, as well as seafloor structure such as large natural rocky reefs, artificial reefs, marine debris, and oil platforms; some types of fish (e.g., rockfishes) are known to associate with these structures (Kramer et al. 2015). Thus, it can be assumed that the ESA-listed fishes already encounter structure within marine waters. The following describes their potential use of seafloor, water column, and surface Project structures, and potential effects on individuals and populations as a result of changes to marine community composition, forage opportunities, and predator/prey abundances, in the following paragraphs.

<u>Seafloor Structure</u> – Salmonids and eulachon are not known to associate with structure or reefs (e.g., Love and Yoklavich 2006, Stephens et al. 2006), so they are not anticipated to associate with or be attracted to seafloor structures. No juvenile or adult salmonids or eulachon were reported at natural and artificial reefs in coastal waters from central California to Oregon, including at 4 natural reef locations in Oregon waters at 10-360 m depth, and one of dock pilings in Yaquina Bay and one of artificial reef structures placed in Yaquina Bay (Pearcy et al. 1989, Tissot et al. 2007, Tissot et al. 2008, Gallagher and Heppell 2010, Dauble 2010. Hannah and Rankin 2011, Easton 2012, as compiled in Kramer et al. 2015). At several wind and wave energy projects (that have both bottom and vertical structure) in Europe, no juvenile or adult Atlantic salmon (*Salmo salar*) were reported at these structures; this includes at wave power foundations and buoys on the Swedish west coast (Langhamer et al. 2009), and at wind farms offshore of Denmark (Leonhard et al. 2011), in the North Sea (Stenberg et al. 2012), and in the Baltic Sea (Bergstrom et al. 2013), which suggests that salmonids generally lack an attraction to bottom or vertical structures in the ocean. In one report, salmon were described as “common visitors” to reefs (ODFW 2006), although the source of that information was unclear and did not note if this was in reference to juvenile or adult salmon. It is possible that adult salmon could occasionally visit seafloor structure; however, it is unlikely that occasional foraging visits would result in increased predation or other adverse effects.

Green sturgeon adults and subadults could occur at the seafloor structures, given that they may spend longer durations in habitats with highly complex seafloor (Huff et al. 2011) and estuaries (Payne et al. 2015), and that coastal waters off Yaquina Bay may potentially be an important feeding and concentration area (Erickson and Hightower 2007, Payne et al. 2015, Henkel 2017). However, because sturgeon are also highly mobile and use a variety of coastal habitat types (Erikson and Hightower 2007), it is unlikely that they would remain at the structures long enough to be subject to increased predation or other adverse effects, and the structures may provide beneficial feeding and cover habitat.

The total footprint of the seafloor structures is very small (up to 2 acres) relative to the range and availability of marine habitat for ESA-listed fishes (particularly for the highly migratory salmonids and green sturgeon that range widely along the U.S. West Coast), and the WECs would be separated by 50 to 200 m or more (Figures 2-4 and 2-5), making the probability that any of the ESA-listed fishes would encounter the structures by chance fairly low (although as described above, Oregon Coast coho salmon from the Yaquina Basin would likely have a somewhat higher probability of encountering the seafloor structures than other salmonid species). There is a lack of expected association with or attraction to seafloor structure in the ocean, as well as a lack of expected adverse effects to individual ESA-listed fishes or their populations. Therefore, the presence of seafloor structures are not expected to adversely affect any individual juvenile or adult salmonids, juvenile or adult eulachon, subadult or adult green sturgeon that could be in the action area; as such, seafloor structures would not adversely affect any of these ESA-listed fishes at the population level.

Water Column/Surface Structure – Project structures in the water column and at the surface are unlikely to act as FADs that would attract pelagic salmonids, or make them more vulnerable to predation. In general, fish associations with FADs are not found in temperate waters like they are known to in tropical waters, based on evaluation of the fish assemblages found at various types of natural and manmade structures in marine waters along the U.S. West Coast and in Hawaii (Kramer et al. 2015). At existing wind and wave energy projects (that have both seafloor and vertical structure) in cold-temperate waters of Europe, none of them reported a measurable “FAD effect”, but all of them reported an artificial reef effect where demersal fish were attracted (e.g., Wilhelmsson et al. 2006, Langhamer et al. 2009, Leonhard et al. 2011, Bergstrom et al. 2013, Reubens et al. 2014, Krone et al. 2013). In temperate ocean waters of California, Oregon, and Washington, fish associations with midwater and surface structures were generally limited to pelagic juvenile rockfishes, which have been reported at various structures such as attached kelp (Matthews 1985, Bodkin 1986, Gallagher and Heppell 2010), floating kelp (Mitchell and Hunter 1970, Boehlert 1977), oil platforms (Love et al. 2010, 2012), vertical structures of docks and pilings (Gallagher and Heppell 2010), and “SMURFs”[9] (Ammann 2004, Caselle et al. 2010, Woodson et al. 2012, Jones and Mulligan 2014). None of the studies of fish assemblages at these structures reported juvenile or adult salmonids (nor eulachon or green sturgeon). Given that juvenile and adult salmonids are highly mobile and movements generally

[9] SMURF (Standard Monitoring Units for the Recruitment of temperate reef Fishes) = 1 x 0.25-m-diameter plastic wide-mesh tube loosely stuffed with strips of plastic sheeting, moored under the water’s surface; a type of FAD used to evaluate juvenile rockfish recruitment

follow available prey, which includes highly mobile pelagic or surface-oriented crustaceans and fish, they could occasionally occur at Project structures in the water column and at the surface but they are unlikely to remain there. In addition, because salmonids are relatively rare in U.S. West Coast waters compared to other pelagic fish species, as evidenced by the low numbers of juvenile salmonids captured in directed pelagic surface/subsurface research trawls (Brodeur et al. 2005, Fisher et al. 2014, Trudel et al. 2009), and the low numbers of adult and subadult salmonids captured as bycatch in midwater trawls (e.g., commercial trawls for whiting, see Lomeli and Wakefield 2014), potential predators of ESA-listed fish would be expected to rely on more locally abundant prey types such as northern anchovy, Pacific sardine, Pacific hake, Pacific herring, and squid (*Loligo* sp.) (Brodeur et al. 2005, Lomeli and Wakefield 2014). Therefore, water column structures would not be expected to cause increased predation of salmonids, even if they attracted potential predators of these species. In addition, because salmon are not constrained in the ocean like they are in a river, estuary or at a structure such as a dam, it is unlikely that predation risk to individuals on the open coast would be any higher at the Project site versus any other open coastal location.

The total area occupied by the WECs is very small relative to the range of and available marine habitat for all of the ESA-listed fishes (but particularly for the highly migratory salmonids and green sturgeon), and the individual WECs would be separated by 50 to 200 m or more (Figures 2-4 and 2-5), making the probability that any of the ESA-listed fishes would encounter the midwater/surface structures by chance fairly low (although Oregon Coast coho salmon from the Yaquina basin are more likely to encounter the structures than other salmonid species). There is a lack of expected association with or attraction to water column and surface structure in the ocean, as well as a lack of expected adverse effects to the ESA-listed fish species. Therefore, the presence of these structures are not expected to adversely affect any individual juvenile or adult salmonids, juvenile or adult eulachon, or adult green sturgeon that could be in the action area; as such, water column and surface structures would not adversely affect any of these ESA-listed fishes at the population level.

<u>Ballast Water Intake</u> – OSU anticipates some WECs will utilize ballasting systems to maintain proper position within the water column, however, there are very few specific examples from the industry given its current stage of development. One example is the Azura (formally WET-NZ) WEC that has deployed at PacWave North and is currently deployed at the Navy Wave Energy Test Site (WETS) in Hawaii. Although not full scale, nor commercial in size, it can offer context for this issue. The prototype Azura WEC maintains a ballast tank with an approximate 5,500-gallon capacity. To maintain proper position in the water column, about 2,000 gallons of water in the ballast tanks is required. The WEC maintains three, 3-inch ball valves near the bottom of the WEC to fill the ballast tanks when the WEC is on site, and ready to position vertically. When ballasting the Azura WEC, valves are opened near the bottom of the WEC, water moves into the ballast tanks, and when positioned upright and at the proper level,

valves are closed. The WEC arrives on site horizontal, and takes approximately one hour to fill the ballast tanks for the WEC to stand upright in the water column.

OSU anticipates that some WECs will need ballast "trimming" (to maintain the proper position in the water column) when on site and operational. When trimming for the Azura WEC, small amounts of water are transferred. If the trim (height of WEC) is changed by 0.5 m, that is equivalent to approximately 150 gal of water moving in or out of the ballast tank, resulting in a small amount of water being moved, relatively to the overall capacity. Some WECs may be equipped with automatic ballasting equipment, whereas with the Azura prototype WEC trimming and ballasting is done manually. An automatic ballasting system would likely move less water at any one time, but possibly more frequently. If the Azura prototype was equipped with an automatic ballasting system, and trimming is required, it is estimated that no more than 50 gallons a day of water transfer would be needed to keep the WEC in its proper position.

Because of the extremely low volume of seawater needed to ballast and trim WECs, and the expansive surrounding ocean, it is expected that entrainment of listed fish (listed salmonids, green sturgeon, eulachon) is highly unlikely as listed fish will be of a size that can readily swim and avoid entrainment. There is potential for smaller pelagic eggs and larvae of marine fish to be entrained but the volumes are extremely low with a low frequency of ballasting and trimming; none of the listed fish spawn at sea, so there would be no effect to listed fish.

Summary

Because of the small size of the Project, it is not anticipated that the addition of Project structures to the marine environment would represent a significant change to marine habitat above existing conditions, and the probability of the ESA-listed fishes encountering and being affected by Project structures is generally low. The ESA-listed fishes are not anticipated to be attracted to or associate regularly with the structures; therefore, they would not be expected to be at increased risk of predation by predatory fishes, seabirds, or pinnipeds, even if those predators associate with the structures. Because of the expected extremely low volume of seawater needed to ballast and trim WECs, no effects to ESA-listed fish species are anticipated. Based on all these factors, any changes to marine community composition as result of the presence of these structures are not expected to adversely affect any individual juvenile or adult salmon, juvenile or adult eulachon, or adult green sturgeon that could be in the action area; as such, changes to marine community composition would not adversely affect any of these ESA-listed fishes at the population level.

Effects of Toxic Substances Introduced by the Project on Water Quality

Description of Stressor

There are two pathways that the Project could contaminate the water quality in the action area: antifouling paints, and accidental spills of hazardous material. Antifouling paints or coatings are commonly used in marinas, offshore structures, and ships to prevent marine life from colonizing these underwater components (Schiff et al. 2007). Antifouling marine applications can leach copper, zinc, iron, and ethyl benzene over time, which could impact water quality (ODEQ 2011). It is anticipated that WECs, mooring buoys, and subsurface floats would be treated with antifouling applications. Antifouling paints could leach from the Project site, or from the WECs in the Port of Newport when the WECs are moored dockside, as well as during transport from the Port of Newport to the Project's WEC deployment area. The Port of Newport is full of vessels (See Section 2.3.4), many of which are coated with antifouling paint and are docked for months on end or that transit waters off the coast of Oregon. Test clients would likely use commercial dockage at OSU or the Port of Newport that has been designed for and is used for dockage. Antifouling paints are already present and in use on vessels and structures in the Port of Newport and nearshore marine waters.

Accidental spills of hazardous materials (e.g., fuel) from vessels used during construction and operation, or from the WECs themselves, are not expected but may occur. Accidental spills of hazardous material may possibly occur from Project-support vessels or WECs in the Port of Newport or during transit from the Port of Newport to the Project's WEC deployment area. Although WECs are designed for survivability at sea and to minimize the potential for leaks, they can contain fluids toxic to marine life, such as hydraulic fluid. The volume of fluids used in each WEC would be expected to be very small relative to other fuel uses in the action area. For example, the WEC deployed at PacWave North in 2012 contained less than 25 gallons of hydraulic fluid (DOE 2012). OPT's PB150, a point absorber WEC, would contain 198 to 264 gallons of hydraulic fluid; by comparison, an average commercial crabbing boat contains 10,000 to 30,000 gallons of diesel fuel (Reedsport OPT Wave Park, LLC 2010).

To minimize exposure of toxic substances on salmonids, eulachon, and green sturgeon, OSU would implement the following environmental measures:

- Follow industry best practices and guidelines for antifouling applications (e.g., TBT-free) on Project structures such as marker buoys, subsurface floats and WECs.
- Develop and implement an Emergency Response and Recovery Plan with spill prevention, response actions, and control protocols, as well as and provisions for recording types and amounts of hazardous fluids contained in WECs and other Project components.

- Require all vessel operators to comply with an Emergency Response and Recovery Plan for installation and maintenance of Project facilities.
- Prepare waste management, hazardous material, and spill prevention plans, as appropriate, for onshore Project facilities.
- Minimize storage and staging of WECs outside of existing dock, port or other marine industrial facilities.

A number of vessels, including tugs, installation vessels, and other workboats would be used for the construction, operation, and maintenance of the Project. These vessels contain fuel, hydraulic fluid, and other potentially hazardous materials, and as noted above, OSU would require vessel operators used for installation and maintenance to have vessel-specific spill response plans.

Exposure to Stressor

A complete list of ESA-listed fish that could occur within the action area is in Section 3.1 (Table 3-1), and a description of their potential exposure to the stressors is described in "Suspended Sediment during Installation and Redeployment" section above. In summary, the ESA-listed fishes that are likely to be in the action area and that may be affected by this stressor include juvenile and adult Chinook, coho and chum salmon, steelhead, and eulachon, and adult green sturgeon. These species are likely to be in the Project area and may experience short term exposure to this stressor. However, all of the listed fish are highly mobile and migratory, and therefore unlikely to remain in the Project area and be continually or repeatedly exposed to this stressor.

Likelihood of Exposure

As noted in the sections above, the occurrence and abundance of ESA-listed fish in the action area may be low, and because these fish are actively swimming to seek prey, and are also migratory, they are unlikely to remain in the Project area but rather move through on a transitory basis. In addition, toxic substances associated with coatings, or accidental spills (which are unlikely to occur), will quickly dissipate and be dispersed by ocean currents. Therefore, their likelihood of exposure to toxic substances, if released, would be very low.

Risk to Individuals and Populations

Petroleum-based contaminants, such as fuel, oil, and some hydraulic fluids, contain polycyclic aromatic hydrocarbons, which can kill salmon at high levels of exposure and cause sublethal effects such as compromised immune response, increased susceptibility to pathogens, reduced reproductive success and reduced growth rates at lower concentrations (Arkoosh and

Collier 2002, Spromberg and Meador 2006). Exposure to dissolved copper at relatively low concentrations has been shown to impair the olfactory sense in freshwater fish, resulting in an impaired avoidance of predators and may also reduce growth rates. In freshwater or sterile seawater, these effects were seen at concentrations between 1-3 μg/L over varying exposure durations, but in saltwater with a normal load of dissolved organic material, copper ions bind with dissolved organic material, decreasing the bioavailability of copper and partially protecting organisms against copper's neurotoxicity (Hecht et al. 2007, City of San Jose 2005). No toxicity data are available for eulachon or green sturgeon.

The Project test site is in the open ocean at 65 to 79 m deep; at this depth ocean advection along the continental shelf would quickly dissipate any toxic substances released from the WECs, preventing them from reaching high concentrations. Concentrations of antifouling substances in sediment and the adjacent water column depends on the water flow and on specific characteristics such as whether the body of water is enclosed (e.g., harbors and marinas), the number of vessels/area with antifouling coatings; typically, higher concentrations are found in enclosed waters such as bays and harbors, where there are a large number of commercial and recreational vessels docked, and lower in the open ocean (Konstantinou and Albanis 2004). In addition, the sandy bottom at the Project site reduces the likelihood that antifouling paint contaminants would adhere to the sediment or reenter the water column. For OPT's proposed wave energy project off Reedsport, Oregon, Oregon DEQ concluded that concentrations of constituents released from antifouling paint from 10 WECs and associated subsurface floats would be well below the water quality criteria (both chronic and acute criteria) to protect marine life (where applicable), as shown in Table 5-1. (ODEQ 2011, FERC 2010, Reedsport Ocean Power Technologies [OPT], LLC 2010). This conclusion is relevant to both the initial development scenario (six WECs) and the full build-out scenario (20 WECs) at PacWave South as the Project site would be at similar depth to the Reedsport Project and exposed to similar current patterns of the OCS. For example, considering there would be 20 WECs at PacWave South, doubling the calculated concentrations for the 10-WEC project shown in Table 5-1, yields values well below the standards.

Table 5-1. Constituent concentration comparison with criteria for the 10-WEC Reedsport OPT Wave Park.

Constituent Name	Calculated Concentration with Project Boundary (µg/l/day)	Calculated Concentration with Project Boundary (µg/l) over 4 days	Protection of Aquatic Life*	
			Marine Chronic Criteria (µg/l)	Marine Acute Criteria (µg/l)
Total Copper	0.02	0.08	2.9	2.9
Total Zinc	0.09	0.36	95	86
Total Iron	0.01	0.04	NA	NA
Ethyl benzene	0.0	0	NA	NA

* The acute criteria refer to the average concentration for one (1) hour and the chronic criteria refer to the average concentration for 96 hours (4 days), and that these criteria should not be exceeded more than once every three (3) years.
Source: ODEQ 2011

According to a 2013 BOEM study on the environmental risks, fate, and effects of chemicals associated with offshore wind turbines on the Atlantic OCS (Bejarano et al. 2013), the likelihood of catastrophic spills would be very low (one time in 1,000 years). Even in the highly unlikely event of an accidental release, the most likely type of release would be up to a few thousand gallons of oil. Bejarno et al. (2013) stated that these releases would cause minimal effects on water quality. WECs and infrastructure have been deployed since 2003 at the Wave Energy Test Site at Marine Corps Base Hawaii, and there has been no evidence of significant effects on marine water quality resulting from deployment and operation (Naval Facilities Engineering Command [NAVFAC] 2014). Accidental release of oil or toxic substances is unlikely to occur because OSU will develop and implement an Emergency Response and Recovery Plan that includes spill prevention and control protocols to minimize the potential for and, if needed, respond to accidental release of oils and toxic chemicals into the marine environment.

Effects of antifouling paints could leach from WECs in the Port of Newport when the WECs are moored dockside, as well as during transport from the Port of Newport to Project's WEC deployment area, and accidental spills of hazardous material that could occur from Project-support vessels or WECs in the Port of Newport or during transit from the Port of Newport to PacWave South are expected to be negligible. Newport is full of vessels, many of which are coated in antifouling paint and are docked for months on end or that transit waters off the coast of Oregon. Test clients are likely to be using commercial dockage at OSU or the Port of Newport that has been designed, permitted, and is used for dockage. Thus, antifouling paints are already present and in use in the Port of Newport and nearshore marine waters.

Summary

The concentrations of antifouling paints in the marine environment due to the Project are expected to be undetectable. Spill control and response measures proposed by OSU would greatly reduce the likelihood that a spill of hydraulic fluids or other petroleum-based contaminants would be large enough to adversely affect more than a few individual fish, or to affect habitat function. In addition, the location of PacWave South in the open ocean further minimizes the likelihood of impacts, because any minor effects on water or sediment quality would quickly dissipate, and there is good understanding of the potential effects certain chemicals may have if leached into the marine environment because each commercially available paint and coating has undergone rigorous approval testing and processes (Copping et al. 2016). Occurrence of the ESA-listed fish is likely to be low and/or short-term/transitory in the Project area, thus their potential exposure to toxic substances, if they are released, would likely be very low. For these reasons, toxic substances are not expected to adversely affect any individual juvenile or adult salmon, juvenile or adult eulachon, or adult green sturgeon that could be in the action area; as such, potential exposure to toxic substances would not adversely affect any of these ESA-listed fishes at the population level.

5.1.2 Underwater Sound

Description of Stressor

Underwater sound generated by the Project could affect ESA-listed fish. The primary sources of Project-related underwater sound would be from vessels at PacWave South and transiting between Newport and the site; cable laying; and from WECs and associated Project structures. Sound from these sources would vary in intensity and duration based on the activity and the sea state, and all would be continuous (i.e., non-impulsive) sounds. Underwater sounds generated by the Project may be similar to, or masked by, ambient underwater sounds in the action area, which are reported to be higher than the typical deep ocean sound found in the northeast Pacific Ocean (Haxel et al. 2011), likely due to wave activity and existing vessel traffic. Ambient sound levels at the PacWave South are similar to levels measured at PacWave North (as described above).

Vessel sound

Vessels used for initial Project construction and WEC installation, maintenance, environmental monitoring, and decommissioning (e.g., anchor handling and towing tugs, material transport barges, research vessels, and crew vessels) would regularly transit between Newport and PacWave South. Vessels transmit sound through water predominantly through propeller cavitation, although other ancillary sounds may be produced, and the intensity of sound from service vessels is roughly related to ship size and speed (Hildebrand 2009). Large ships tend to be noisier and have lower frequencies than small ones, and ships underway with a full load (or towing or pushing a load) produce more sound than unladen vessels (Hildebrand 2009). For vessels used at PacWave North, NMFS (2012c) assumed that "sound intensity generated by tugs, barges, and diesel-powered vessels (i.e., the types that would be used for Project installation and maintenance) when fully underway, traveling to and from the test site, or due to cavitation during starts and stops, would be no greater than 130 to 160 dB (re: 1 μPa) over a frequency range of 20 Hz to 10 kHz" (also see Richardson et al. 1995, DOE 2012). This assumption would also be applicable to the Project site because similar vessels would be used at both projects. These levels would occur when vessels are fully underway, coming to or leaving the site, which for most trips between the test site and Newport would last 1 to 1.5 hours. The sound intensity would be lower when the vessels are operating at very slow or idle speed, which is likely to occur at the Project's WEC deployment area when conducting monitoring or maintenance activities. A vessel with DP thrusters could likely be used during cable lay operations at the beginning of the Project and potentially during installation of individual WECs. In its Environmental Assessment for the Virginia Offshore Wind Technology Advancement Project on the Atlantic Outer Continental Shelf Offshore Virginia, BOEM (2014) estimated that the sound source-level for the DP cable laying vessel would be 177 dB re 1 μPa at 1 m, and Deepwater Wind LLC's Block Island Wind Farm estimated the sound source-level for the DP cable laying vessel would be 180 dB re 1 μPa at 1 m (NMFS 2015i). Yaquina Bay is a large commercial harbor with large numbers of recreational, charter, and commercial boats, and vessel traffic is often concentrated near the mouth of the bay (see Section 4.4 Vessel Traffic and Navigation, for description), so it is assumed that Project-related vessel sounds would not be significantly greater or different than existing conditions.

The estimated annual number of days during which vessels will be transiting between Newport and PacWave South for the initial development scenario and full build out scenario are shown in Table 5-2. During some days, only one vessel may be on site (e.g., environmental monitoring or O&M activities), while during deployment or removal activities, a number of vessels may be on site.

Table 5-2. Estimated number of days during which vessels will be transiting between Newport and PacWave South for the initial development and full build out scenarios.*

Build Out Scenario	Estimated Annual Vessel Round Trips Between Newport and PacWave South		
	Deployment, O&M, and Retrieval	Monitoring	Total
Initial Development (6 WECs)	36	45	81
Full Build Out (20 WECs)	69	36	105

* Note, during days when deployment activities are occurring, multiple vessels will be at PacWave South and transiting between the Port of Newport and PacWave South. During other days, only one vessel may be on site (e.g., environmental monitoring or O&M activities).

HDD sound

Subsea cable installation would generate sound during HDD. HDD involves drilling below the seafloor, and sound may be generated in the marine environment as the drill head approaches the breakout point underwater. The information that exists about sound that may be generated in the marine environment as the HDD drill head approaches the breakout point underwater is qualitative, and indicates that the sound from the bore hole drilling would be much less than typical work vessels that would be expected to be used for the Project (Gaboury et al. 2008, Navy 2008 *both cited in* NAVFAC 2014).

WEC operation sound

During operation, sound may be generated by water flowing past the mooring lines, waves splashing against the WECs and other structures, or by the moving components of the WECs and moorings. Due to the variety and complexity of differing sound sources within an array, it is difficult to model or predict the sound signature (Wilson et al. 2014). Based on underwater sound monitoring, the operational sounds of the test WET-NZ WEC at PacWave North were within the range of ambient conditions and did not exceed NMFS' 120 dB marine mammal harassment threshold (as discussed in section 5.2.1, below). The maximum sound pressure level (SPL) for Columbia Power Technologies' 1/7-scale WEC was measured from 116 to 126 dB re: 1 µPa in the integrated bands from 60 Hz to 20 kHz at distances from 10 to 1,500 m from the SeaRay (Bassett et al. 2011). From this, the SPL was estimated at 145 dB re: 1 µPa at 1 m, and 126 dB re: 1 µPa at 10 m (Thomson et al. 2012, as cited in NAVFAC 2014); in the EA prepared for the Hawaii Wave Energy Test Site, engineers conservatively assumed that a full-sized WEC would be 3-6 dB louder than the 1/7 scale version, and estimated that the maximum SPL for a WEC would be 148-151 dB re: 1 µPa at 1 m (NAVFAC 2014). The maximum SPL generated by WECs off the west coast of Sweden was reported at 133 dB re 1 µPa at 20 m with an average of 129 dB re 1µPa (Haikonen et al. 2013). Other analysis suggests that WECs would result in sound only in the range of 75 to 80 dB, with somewhat higher frequencies than light- to normal-density shipping sound (Sound & Sea Technology 2002 cited in Department of the Navy 2003). Per NMFS' request, to be conservative a source term of 151 dB re: 1 μPa at 1 m was used in this analysis.

Sounds emitted by the WECs, implementing NMFS practical spreading model with the highest WEC sound source term, sound levels would attenuate to 120 dB re: 1 μPa at 125 m. Because of the uncertainty of the WEC type and size that will be deployed at PacWave South, as well as the exact sound signatures, OSU will implement the Acoustic Monitoring Study under the Adaptive Management Framework to detect and, if needed, mitigate unanticipated adverse effects of WEC-related sound.

Exposure to Stressor

A complete list of ESA-listed fish that could occur within the action area is in Section 3.1 (Table 3-1), and a description of their potential exposure to the stressors is described in "Suspended Sediment during Installation and Redeployment" section above. In summary, the ESA-listed fishes that are likely to be in the action area and that may be affected by underwater sound include juvenile and adult Chinook, coho and chum salmon, steelhead, and eulachon, and adult green sturgeon. These species are likely to be in the Project area and may experience short term exposure to this stressor. However, all of the listed fish are highly mobile and migratory, and therefore unlikely to remain in the Project area and be continually or repeatedly exposed to this stressor.

Likelihood of Exposure

Salmonids

Both juvenile and adult ESA-listed salmonids could be exposed to underwater sound from the Project because they are known to forage and migrate along the Oregon coast. Coho salmon of the Oregon Coast ESU that spawn and rear in the Yaquina and Alsea rivers could have more exposure to underwater sound than coho salmon from other areas or than the other ESA-listed salmonid species; the juvenile coho salmon would be exposed during their ocean-bound emigration out of the rivers in spring, and adults during their return to these rivers to spawn in summer and fall. However, individuals are unlikely to be continually or repeatedly exposed to this stressor because they are highly mobile and migratory.

Juvenile salmonids are typically surface oriented and are most often found in the upper 20 m of the water column (Emmett et al. 2004, Walker et al. 2007) and more to likely be exposed to sounds from vessels and WECs produced nearer to the surface, with little to no acoustic transmission loss (De Robertis et al. 2012).

Green Sturgeon

Adult green sturgeon typically concentrate and feed in coastal waters immediately offshore and upcoast and downcoast of estuaries, including Yaquina Bay (Erickson and Hightower 2007, Payne et al. 2015, Henkel 2017), thus they can concentrate in the general vicinity of the Project area and be exposed to underwater sound. However, because sturgeon are also highly mobile and use a variety of coastal habitat types (Erikson and Hightower 2007), individuals are unlikely to be continually or repeatedly exposed to this stressor.

Eulachon

Juvenile eulachon are reported to rear in nearshore marine waters, and adults are regularly captured as bycatch in the ocean shrimp trawl fishery in nearshore marine waters of Oregon; thus, they could occur in the general vicinity of the Project area and be exposed to underwater sound. However, individuals are unlikely to be continually or repeatedly exposed to this stressor.

Risk to Individuals and Populations

Depending on the species, and the frequency and sound power level (loudness or amplitude) of the source, sound and vibration can cause stress, behavioral effects such as a startle response or movements away from the source, displacement from preferred feeding or reproduction sites, masking of acoustic communication and ability to find prey or detect predators, reduced growth, altered migration patterns, injury, or even mortality (Slotte et al. 2004, Popper and Hastings 2009, Popper et al. 2014). Underwater sound radiates outward from its origin until the sound pressure waves encounter land mass or attenuate to background levels. Rate of sound attenuation can vary based on sediment type, bottom topography, structures in the water, slope of bottom, temperature gradients, currents, and wave height (WSDOT 2014).

Most fish species can sense and may react to one or two components of sound waves: sound pressure, and/or particle motion. Species that are capable of detecting both sound pressure and particle motion can detect a wider range of frequencies and sounds of lower intensity, while those that can only detect particle motion (e.g., those lacking a swim bladder or those having a swim bladder and hearing structures that are far apart) are less sensitive. Salmonids are likely only sensitive to particle motion, and their hearing is restricted to lower frequencies (<380 Hz, with best hearing at 160 Hz), and they are considered to have a low overall sensitivity to sound (Gill and Bartlett 2010, Gill et al. 2012, Popper et al. 2014). Similarly, sturgeon are only sensitive to particle motion with lower frequency hearing thresholds of <500 Hz (Lovell et al. 2005). Eulachon, because they lack a swim bladder, are likely even less sensitive to sound than salmonids or sturgeon. Thus, these ESA-listed fishes are likely not very sensitive to sound, especially compared to more sound-sensitive fish species (e.g., Atlantic cod and herring). However, the frequencies and sound levels that would be emitted by the Project are within the ranges that could be detected by these ESA-listed species.

At very high intensities, the potential effects of sound on fish can include mortality, injury in the form of temporary and permanent hearing damage and tissue damage, and temporary reductions in hearing sensitivity (known as a "temporary threshold shift", or TTS) (Hastings and Popper 2005, Popper and Hastings 2009, Popper et al. 2014). These types of effects are generally related to impulsive sounds, such as the high-level, short-duration sounds of impact pile-driving, explosions, or seismic airguns (Popper et al. 2014). The thresholds for injury resulting from percussive pile driving have been defined as a peak sound pressure level of 206 dB re: 1 μPa and cumulative sound exposure level (SEL_{cum}) of 187 dB re 1 $\mu Pa^2 \cdot s$, by the U.S. Fisheries Hydroacoustic Working Group (FHWG 2009). The ESA-listed fishes would not be exposed to sound levels that would cause mortality, injury, or TTS, because Project activities would not generate impulsive sounds and the sound levels are expected to remain below these thresholds for injury. Therefore, the likelihood that any ESA-listed marine fishes would be injured or killed by the sound from the proposed action is negligible.

Sound associated with vessels, cable laying, and continuous sounds from the WECs and other Project infrastructure, could approach or occasionally exceed the threshold for behavioral effects. Potential effects of moderate (e.g., non-injury) anthropogenic noises on fish can include disturbance and deterrence, reduced growth and reproduction, interference with predator-prey interactions, and masking of communication (Slabbekoorn et al. 2010). A reduced ability to avoid predators was shown to occur in Ambon damselfish (*Pomacentrus amboinensis*) in response to motorboat noise (Simpson et al. 2015), and reduced forage efficiency was shown to occur by threespine sticklebacks (*Gasterosteus aculeatus*) in response to white noise similar to the noise environment in a shoreline area with recreational speedboat activity (Purser and Radford 2011). The threshold for causing temporary behavioral changes (startle and stress) on threatened and endangered fish species, as defined by NMFS and FWS, is 150 dB re 1 μPa RMS (FHWG 2009). There are a number of studies that suggest that Project-related sounds may elicit some behavioral responses by ESA-listed fishes but adverse effects are unlikely; these studies are described below.

Sound levels less than approximately 160 dB are reported to not adversely affect adult fishes, including rainbow trout (i.e., resident steelhead) (Hastings and Popper 2005, Popper et al. 2014). Based on the measured sound levels of drilling for cable laying in the U.K., avoidance of the sound source by fish was likely but auditory injury was unlikely (Nedwell and Edwards

2004). Rainbow trout exposed to continuous sound (up to 150 dB re: 1 µPa rms) in an aquaculture facility for nine months showed no hearing loss or adverse effects on fish health (Wysocki et al. 2007). A study that exposed juvenile Chinook salmon to simulated tidal turbine sounds at levels of 159 dB re 1 µPa RMS for 24 hours found low levels of temporary tissue damage that had low physiological costs to the fish, and no effects on hearing sensitivity (Halvorsen et al. 2011). This represented a worst-case scenario for temporal exposure; the more likely scenario would be that salmonids, due to their migratory nature, would pass by the turbine and very quickly back into waters with much lower and rapidly declining sound levels, and the risk of tissue damage would be much lower (Halvorsen et al. 2011). A study conducted by Wahlberg and Westerberg (2005) estimated that Atlantic salmon (*Salmo salar*) could detect sound emitted from a wind farm at a distance of 400-500 m, and speculated that they may change their swimming pattern to avoid the source. However, fish could habituate to the continuous sounds of the WECs; in one study comparing effects of intermittent versus continuous sounds, European seabass (*Dicentrarchus labrax*) returned to pre-exposure behaviors more quickly in response to continuous sounds as compared to intermittent sounds of the same intensity (Neo et al. 2014). Another study showed that giant kelpfish (*Heterostichus rostratus*) exhibited acute stress response to intermittent noise, but not to continuous noise (Nichols et al. 2015). The migratory nature of salmonids and green sturgeon would lower their potential temporal exposure to the continuous sounds of WECs and it is unlikely that the sounds would interrupt their migration path; in one study, the installation of wind farms within the migratory pathway of European silver eel (*Anguilla anguilla*) in coastal northern Europe elicited no apparent change in their migration patterns (Andersson et al. 2012). Haikonen et al. (2013) reported that noise generated by WECs off the west coast of Sweden (maximum 133 dB re 1 µPa at 20 m, average 129 dB re 1µPa) was detectable by fish, but not sufficient to alter fish behavior.

Based on the existing information, the short term and temporary sounds from vessels transiting to or from the Project site and within the Project site itself (i.e., hours or less as the vessels pass), and from DPVs (if used) for cable laying during installation and deployment of WECs, as well as from continuous sounds from the WECs, even though they would occur over the 25-year license term, are not likely to adversely affect ESA-listed fishes for several reasons: these species are not particularly sensitive to sound; the area affected (e.g., up to 125 m around the WECs) would be insignificant compared to the range of these species, particularly for the highly migratory green sturgeon and salmonids; and there is similar and abundant habitat available in the surrounding area that they could move to if they are exposed or disturbed by the sounds. In addition, sounds emitted from the WECs or from vessel traffic are unlikely to be significantly greater than existing conditions, given the high level of vessel traffic already present in the vicinity of the action area in association with the Port of Newport (see Section 2.3.4). ESA-listed salmon, green sturgeon, or eulachon may swim around a WEC or avoid a vessel transiting between the Port of Newport and PacWave South, but there is no basis to expect that noise associated with the Project, including deployment, O&M, retrieval, and environmental monitoring, would affect aggregating green sturgeon or the migratory path for salmonids leaving or returning to natal streams because of the offshore location of the Project, the spacing of the WECs, and relatively low levels of noise associated with the Project. All of the listed fish are highly mobile and migratory, and individual fishes are unlikely to remain in the Project area and be continually or repeatedly exposed to this stressor. Therefore, underwater sound from the Project would not be expected to adversely affect any ESA-listed salmon, green sturgeon, or eulachon individuals; as such, underwater sounds would not adversely affect ESA-listed salmon, green sturgeon, or eulachon at the population level.

Because of the uncertainty associated with the underwater sounds that will be associated with this relatively new industry, if acoustics monitoring results indicate that the operating WECs exceed an acoustic management or mitigation threshold, adaptive management and mitigation measures to address the unanticipated adverse effects would be implemented by OSU.

5.1.3 Electromagnetic Fields

Description of Stressor

Ambient Conditions

Ambient, natural EMF emissions in the ocean come from three sources: the geomagnetic field of the earth; electric fields induced by the movement of charged objects (e.g., currents/waves, organisms) through a magnetic field (i.e., induced electric field, iE); and bioelectric fields produced by organisms (Slater et al. 2010a, Normandeau et al. 2011, Gill et al. 2014, Bedore and Kajiura 2013). EMF includes both the electric field (E-field, measured as the voltage gradient in V/m) and the magnetic field (B-field, measured in tesla [T] or gauss [G]; 10,000G=1T; Slater et al. 2010a).

Wave, tidal, and current motion of seawater, an electrolyte, through the Earth's magnetic field induces electric and magnetic fields (Slater et al. 2010a). The earth's magnetic fields off Reedsport, Oregon is estimated at 52.2 microteslas (μT) [about 52,000 nanoteslas (nT)] and is largely vertical (Slater et al. 2010a). EMF in the ocean at the Reedsport site was modelled by incorporating the influence of ocean conditions (e.g., currents, waves) on the earth's magnetic field. Based on the wave climate at the Reedsport site, at surface (where effects are likely the strongest), electric fields are expected to range from 6 to 216 μV/m, and would be observed between 0.04 and 0.3 Hertz (Hz), with maximum induced magnetic fields due to wave motion ranging from 0.02 to 0.54 nT. The maximum electric fields generated by tidal motion are expected to be 33 μV/m, and the maximum magnetic fields because of tidal sources are expected to be 0.08 nT (Slater et al. 2010a). Coastal currents are expected to generate electric fields up to 22 μV/m, although higher values may be observed, with potential values in extreme current flows of up to 44 µV/m and corresponding estimated magnetic field values would be 0.06 nT (Slater et al. 2010a). Because of the similar levels of the earth's magnetic field, wave climate, tidal motion, and coastal currents at Reedsport and the Project area, it is expected that EMF modeled at Reedsport will be similar to that in the Project area; however, there is uncertainty about the underlying geology at PacWave South that may affect ambient conditions.

Project Generated EMF

EMF transmissions would be generated by the WECs, the umbilical cables (connecting the WECs to the subsea connectors), the hubs and subsea connectors, and the subsea cables to the shore. Each test berth could accommodate a WEC or array of WECs with a maximum capacity, based on cable specifications, of 8 MW (although not all 4 berths could be at capacity at any one time); the capacity of the umbilical cables would correspond with the WECs. The subsea cables would be three-conductor (3C), AC cables, with approximately 70 mm^2 copper conductors bundled together into a typical 3C submarine power cable configuration with a total diameter of approximately 10 cm. Each of these cables is estimated to have a rated capacity of up to 35 kV. Because the power cables would be shielded and armored, they would not emit any electric fields directly; however, electric fields could be induced by the movement of fish and currents through the magnetic fields produced by the cable.

Observations at energized transmission cables indicate rapid dissipation of EMF with distance from the cables. In studies of the Las Flores Canyon submarine power cables (6-7 inch diameter, 36 kV, unburied) that cross the Santa Barbara Channel to oil platforms, EMF [specifically, the magnetic field] is reported to dissipate to background levels at a distance of about 1 m from the cable (Love et al. 2015, 2016). Studies of a 33kV three-conductor buried power cable crossing the River Clwyd in Scotland indicate measureable [in nT – 1,000 times smaller than the µT measured by BOEM for the Las Flores Canyon cables] magnetic fields up to 10 m away from the cable (CMACS 2003). Field magnetic profiles of 10 subsea cables, many of which transmit considerably higher voltage than the cables at PacWave South, indicate very rapid decay of magnetic field strength moving away from the cable (Normandeau et al. 2011).

As a general rule, the higher the power output from a WEC, the higher the electrical current transmitted through AC cables and hence the stronger the emitted magnetic field and iE-field (Gill 2016). It is notable, however, that there is remarkable consistency among the measured attenuation of AC magnetic fields among 10 different cables (most of them associated with large offshore wind farms) (Normandeau et al. 2011, Gill 2016). These cables likely carried much larger currents than the proposed Project cables at full build out, all of them were unburied cables, and they all still showed an exponential decline that reached near ambient levels by around 2 m from the cable. Existing information (based on monitoring of EMF at 10 different cables) all showed similar and consistent exponential declines that reached ambient conditions by around 2 m from the cable, and it is expected this to be similar at the Project site (Normandeau et al. 2011, Kavet et al. 2016, Gill 2016). From the offshore test site, the majority of the cables would be buried 1-2 m (3-6 ft) below the seafloor, except within the footprint of the test site. Burial of the cable at a depth of 1 m will reduce the magnetic field at the seafloor by around 80 percent (Normandeau et al. 2011). Therefore, it is likely that EMF generated by the Project cables will be similar or less than other cables that have been measured, and that EMF generated by power cables above ambient levels would not extend much beyond 1-2 meters. Physical burial of most of the Project cables will additionally minimize any likelihood of exposure.

Models based on fundamental physics have been used to estimate the strength of localized EMF generated by a point source (i.e., an energized WEC; Slater et al. 2010b). Model results indicate that the EMF in the nearshore marine environment decrease rapidly with distance from the source, decreasing to minimum levels of instrumentation detection meters of the WEC (Slater et al. 2010b). Models have also developed to estimate the EMF generated by subsea transmission cables (Slater et al. 2010c, Normandeau et al. 2011, Kavet et al. 2016, Gill 2016). Three-conductor cables can either be individually shielded or have an outer shield encompassing all three conductors (Slater et al. 2010c); the three-conductor with a common shield has the lowest electric and magnetic field strengths compared to individually shielded three-conductor cables (Slater et al. 2010c); this is the type of cable planned for the Project. Modeling results indicate that EMF of the strength that could be detected by species is limited to a distance of much less than 10 m from the cable (Love et al. 2016, Normandeau et al. 2011); field measurements indicate robustness of model results (Slater et al. 2010b and c, Gill et al. 2014, 2016).

Because the majority of the subsea cables would be buried, there is little uncertainty related to EMF transmission given our understanding of existing cables and the capability to model EMF. However, there is some uncertainty in applying these results to WECs at PacWave South because specific EMF characteristics of WEC types and subsea connectors are not known. These uncertainties will be addressed in part by the EMF Monitoring Plan, by monitoring EMF production post-installation and comparing with modelled results, and through mitigation in consultation with appropriate agencies or pursuant to the Adaptive Management Framework.

Exposure to Stressor

A complete list of ESA-listed fish that could occur within the action area is in Section 3.1 (Table 3-1), and a description of their potential exposure to the stressors is described in “Suspended Sediment during Installation and Redeployment” section above. In summary, the ESA-listed fishes that are likely to be in the action area and that could be exposed to EMF emissions generated by the WECs, the umbilical cables (connecting the WECs to the hubs and/or subsea connectors), the hubs and/or subsea connectors, and the subsea cables to the shore, include juvenile and adult Chinook, coho and chum salmon, steelhead, and eulachon, and adult green sturgeon. These species are likely to be in the Project area and may experience short term exposure to this stressor. However, all of the listed fish are highly mobile and migratory, and therefore unlikely to remain in the Project area and be continually or repeatedly exposed to this stressor.

Likelihood of Exposure

As discussed in the sections above, the probability of occurrence of the ESA-listed fishes in the action area is likely low based on research and regional bycatch data, and because these fish are also migratory, they are unlikely to remain in the Project area but rather move through on a transitory basis. There is uncertainty about the ability for green sturgeon, ESA-listed salmonids, and eulachon to detect EMF at low levels, as well as the potential for EMF to affect their behavior and migration. It is important to consider not just ability of a species to detect EMF but that there is an effect to behavior.

Salmonids

Both juvenile and adult ESA-listed salmonids could be exposed to EMF generated by the Project because they are known to forage and migrate along the Oregon coast. Coho salmon of the Oregon Coast ESU that spawn and rear in the Yaquina and Alsea rivers could have more exposure to EMF than coho salmon from other areas or than the other ESA-listed salmonid species; the juvenile coho salmon would be exposed during their ocean-bound emigration out of the rivers in spring, and adults during their return to these rivers to spawn in summer and fall.

Salmonids may be capable of detecting geomagnetic fields and may use them to orient during migration; salmonids are known to respond to magnetic fields in the 10-12 µT range (Normandeau et al. 2011, Gill et al. 2014). In the laboratory, juvenile salmon, when subjected to the magnetic field intensity and inclination angles similar to those found at the latitudinal extremes of their ocean distribution (northern and southern intensity used in laboratory experiments of 555.5 µT and 444.6 µT), change their orientation (e.g., direction of swimming) and subjecting fish to unnatural pairings of field intensity and inclination resulted in more random orientation, indicating fish can detect and respond to both magnetic field intensity and inclination angles (Putman et al. 2014).

Juvenile salmonids are unlikely to be exposed to EMF associated with subsea cables or connectors but could interact with water column and surface EMF associated with umbilicals and WECs, given that they are pelagic and typically surface-oriented, most often found in the upper 20 m of the water column (Emmett et al. 2004, Walker et al. 2007), and their preferred prey types are also pelagic (e.g., copepods, euphausiids, and juveniles of northern anchovy, Pacific herring, sardines, rockfishes, and smelt; Brodeur et al. 2005, Brodeur et al. 2007, Daly et al. 2009, Santora et al. 2012). Adult salmonids, especially Chinook salmon, occur at greater depths than juveniles, as evidenced by their capture as bycatch in midwater trawl fisheries (Lomeli and Wakefield 2014), and thus they could be exposed to EMF from subsea cables and connectors. However, adult salmonids are unlikely to have much exposure to EMF given that their prey is also predominately pelagic (e.g., euphausiids, northern anchovy, squid, Pacific herring, Pacific sandlance, and smelt; Hunt et al. 1999, PFMC 2000).

Green Sturgeon

Adult green sturgeon typically concentrate and feed in coastal waters immediately offshore and upcoast and downcoast of estuaries, including Yaquina Bay (Erickson and Hightower 2007, Payne et al. 2015, Henkel 2017), thus they can concentrate in the general vicinity of the Project site and be exposed to EMF generated by the Project. Tagged green sturgeon also occur at PacWave South and PacWave North, based on lines of 8 acoustic receivers placed at PacWave North (1 line) and PacWave South (2 lines) between October 2015-January 2016, and April-October 2016 (Henkel 2017). Similar to Payne et al. (2015), most sturgeon moved through quickly (days) whereas others remained for longer periods (weeks or months) (Henkel 2017). Regardless, the likelihood of green sturgeon swimming past or near the cables and WECs during their migration and feeding is greater than for the other ESA-listed fishes because they could potentially occur in the action area for longer periods of time (i.e., days to months, Payne et al. 2015, Henkel 2017). Green sturgeon may be capable of detecting geomagnetic fields and may use them to orient during migration; they have specialized electroreceptors that are capable of electric field detection, which may be used to detect bioelectric fields emitted by prey, detection of mates, and detect predators, as well as for short and long term movements or migration (Normandeau et al. 2011, Gill et al. 2014). Green sturgeon feed on demersal prey such as clams, crabs, shrimp, amphipods, isopods, and fish including sand lance and ling cod (Dumbauld et al. 2008, Miller 2004), and tend to remain near the bottom; however, they can make rapid vertical ascents to the surface likely following vertical migrations of prey (Erickson and Hightower 2007). Therefore, they are more likely to be exposed to EMF associated with cables and subsea connectors, and less so with umbilicals and WECs.

BOEM and DOE-funded studies in San Francisco Bay evaluated effects of the Trans Bay Cable on the migration behavior of green sturgeon, Chinook salmon, and steelhead. The 85-km-long Trans Bay Cable, buried 0.9-1.2 m below San Francisco Bay, consists of a 25.4-centimeter-diameter bundled DC transmission cable, fiber-optic communication cable, and metallic return cable. The Trans Bay Cable transmits up to 400 MW, at a voltage of around 200 kV (Siemens 2011) (in comparison, the subsea cables at PacWave South will have a much lower rated voltage

[35 kV]). Green sturgeon, and juvenile and adult salmonids must all pass through the narrow straits where the cable is located on their migrations between freshwater habitats and the sea. Many of these fish were tagged with acoustic tags for other studies in the area and offshore, and lines of receivers have been in place both upstream and downstream of the cable, from before and after the cable was installed, providing an unintended experiment that provided the basis for an evaluation of effects of the cable's EMF on migratory behavior. Results of the Trans Bay cable study indicated that activation of the 200 kV Trans Bay cable 1) did not impede successful migration of juvenile salmonids through the San Francisco Bay, or 2) did not strongly impact the ability of green sturgeon to complete their outbound or inbound migrations (Kavet et al. 2016).

Eulachon

Juvenile eulachon are reported to rear in nearshore marine waters, and adults are regularly captured as bycatch in the ocean shrimp trawl fishery in nearshore marine waters of Oregon; thus, they could occur in the general vicinity of the Project area and be exposed to EMF generated by the Project. Eulachon tend to orient toward the bottom and may be exposed to EMF from Project subsea cables and connectors. Eulachon feed primarily on crustaceans, especially euphausiids, which tend to be distributed in large patches on the shelf, near the bottom but with diel vertical migrations (Ressler et al. 2005). Eulachon behavior (e.g., orientation or migration) could be affected by EMF; however, there are no specific studies conducted on their sensitivities (Normandeau et al. 2011).

Risk to Individuals and Populations

Multiple projects on the U.S. west coast have evaluated or are evaluating EMF at subsea cables and biotic interactions, indicating very minor, limited interactions. In particular, BOEM has evaluated effects of EMF from power cables by conducting in-situ studies of powered and unpowered cables using SCUBA and ROV surveys (Love et al. 2015, 2016). Results from three years of surveys included:

1. "Researchers did not observe any significant differences in the fish communities living around energized and unenergized cables and natural habitats;
2. They found no compelling evidence that the EMF produced by the energized power cables in this study were either attracting or repelling fish or macro invertebrates;
3. EMF strength dissipated relatively quickly with distance from the cable and approached background levels at about one meter from the cable[10]; and
4. Cable burial would not appear necessary strictly for biological reasons" (BOEM 2016).

[10] EMF readings from a 35 kV unburied AC power cable measured ~110-120 μT at cable surface (Love et al. 2016).

While evaluations of marine animal interactions with subsea cables have provided understanding that EMF produced by WECs and their subsea cables could be in the magnitude of the sensitivity ranges of many marine animals, the ability to detect EMF does not necessarily translate to an effect or an impact on individuals, populations, or ecosystems (Normandeau et al. 2011, Gill et al. 2014). Most effects are assumed to be minor and limited to a close distance (meters), with the exception of elasmobranchs that are considered to be the most vulnerable because of their high sensitivity and use of EMF for important behaviors (e.g., prey detection) (Normandeau et al. 2011, Gill et al. 2014). However, to date, there is no evidence that suggests that EMF at the levels expected from WECs and their subsea cables would have a negative or positive effect on any species (Gill 2016, Love et al. 2016, BOEM 2016).

Given the small spatial scale of the Project (relative to the surrounding area), the Project is not expected to affect salmon navigation and orientation. Results of modeling suggest that magnetic fields emitted by AC cables might be detectable by salmon; however, the fish would have to be very close to the cables (within meters) (Normandeau et al. 2011). Most juvenile salmonids and adult coho salmon are pelagic and less likely to swim close to the bottom, suggesting exposure to the subsea cables is unlikely (Normandeau et al. 2011); however, they could be exposed to the umbilicals and WECs. Juveniles outmigrating from Yaquina Bay to the ocean may have a slightly higher encounter rate, although based only on the physical location of the Project, a smolt migrating from Yaquina Bay would only have an approximately 9.4 percent chance of encountering the PacWave South deployment area[11], which is considerably larger than the area that EMF exposure could occur (e.g., in proximity to the WECs and umbilicals). Swimming through PacWave South from Yaquina Bay is less likely given that smolts migrating from Yaquina Bay to the ocean would likely have: 1) a very short residence time in the Project area (e.g., hours to a few days), based on recent work off the Columbia River with juvenile yearling and subyearling Chinook salmon and steelhead tagged with acoustic tags (McMichael et al. 2013); and 2) migrating smolts tend to swim in northward (Chinook and coho salmon) or westward (steelhead) direction (Fisher et al. 2014, Tucker et al. 2011, Weitkamp 2010, Weitkamp and Neely 2002, Daly et al. 2014). Adult salmonids foraging throughout the water column or migrating to natal spawning habitat in Yaquina Bay would have a slightly increased likelihood of swimming by or near the subsea cables during their migration, and to a lesser extent past the Project footprint, because they tend to be located closer to the bottom, and the Project footprint is relatively small in comparison to the area where subsea cables are buried; regardless adults would be using multiple senses including olfaction to return to natal streams, and can compensate for local changes in geomagnetic fields (Normandeau et al. 2011, Putman et al. 2013).

[11] Determined by drawing an arc using Yaquina Bay as the center point and with a radius of 8.3 nm, which encompasses the furthest point of the PacWave South test site from the center point. The angle of the arc that encompasses the PacWave South test site is 17 degrees/ degrees (assuming that the Oregon Coast is a straight line).

It is unlikely that magnetic fields associated with the subsea cables, hubs and connectors would affect green sturgeon navigation and orientation for the same reasons as described above for salmonids; green sturgeon would have to remain very close to the buried subsea cables or connectors (within meters) (Normandeau et al. 2011). Studies of unenergized and energized unburied subsea cables have found no differences in fish communities or in electrosensitive fish either being attracted or repelled by EMF from cables (BOEM 2016, Love et al. 2016). Because effects, if any, would be highly localized, and because green sturgeon make such extensive migrations and movements, this effect is likely to be very short term.

Eulachon are unlikely to be affected by EMF generated by the Project because: 1) their movements along the shelf are likely to follow aggregations of prey, such as euphausiids; and 2) magnetic fields associated with the Project subsea cables and connectors will be highly localized, and therefore unlikely to affect their navigation or orientation during spawning migrations.

Measures would be taken at PacWave South to minimize and avoid exposure of marine animals to EMF; for example, subsea cables would be shielded and armored, so that E-fields should not be produced from AC cables (Normandeau et al. 2011). Shielding against low-frequency magnetic fields would decrease, but not eliminate, field strength (Normandeau et al. 2011, Electric Power Research Institute [EPRI] 2013). The subsea cables would also be buried; this measure would be ineffective for shielding magnetic fields, but would decrease exposure by keeping animals physically away from the strongest fields which are closest to the cable (Normandeau et al. 2011). Because the cables would be buried 1-2 m (3-6 ft) below the seafloor, the physical separation will greatly reduce the amount of EMF exposure to marine animals (around 80 percent [Normandeau et al. 2011]). The magnetic field at the seafloor by would be expected to reach ambient conditions about 1-2 m above the seafloor (Normandeau et al. 2011, Gill 2016, Love et al. 2016).

To manage uncertainties and understand the magnitude and extent of Project-related perturbations of the natural EMF background, OSU would implement the EMF Monitoring Plan under the Adaptive Management Framework to detect and, if needed, mitigate any unanticipated adverse effects of Project-related EMF emissions. The objective of the EMF Monitoring Plan is to evaluate the EMF levels produced by the WECs, by using existing models to estimate the expected EMF output of the WECs and validating the model estimates using field measurements. If results of modeling and/or field surveys indicate that EMF attributable to the WECs has the potential to elicit a behavioral response from green sturgeon, salmonids or other species of concern (i.e., 3 milliteslas, based on Woodruff et al. 2012, Normandeau Associates et al. 2011, Gill 2016, and newer information), and exceeds the mitigation threshold, adaptive management and mitigation measures to address the unanticipated adverse effects would be implemented by OSU.

Summary

EMF emissions from the Project are expected to be minor and highly localized. EMF associated with the subsea cables should reach ambient levels within 1-2 m based on numerous models and studies described above. EMF emissions from WECs has a greater degree of uncertainty and has not been measured. As described above, previous studies on EMF from subsea cables observed little or no behavior change in fish, and similar responses are expected at PacWave South. Potential effects of EMF on green sturgeon, ESA-listed salmonids, and eulachon are unlikely. The proportion of a given population that might be exposed to EMF from the Project is expected to be low for ESA-listed salmonids and eulachon due to the very small spatial scale of the action area relative to the area within which these species migrate and feed. Even if individuals encounter and are exposed to magnetic fields, any potential effects are expected to be short term and minor, because of the very localized fields relative to the earth's geomagnetic field potentially being used for navigation; therefore these species are not expected to be affected by EMF. There is a slightly increased likelihood of exposure for listed salmonids from Yaquina River, during their initial migration out as juveniles to the ocean, and when adults migrate into Yaquina Bay to reach natal spawning areas; however, as discussed above, the likelihood of salmon migrating from the ocean to or from Yaquina Bay swimming through the PacWave South deployment is low and their presence in the Project area would be very short term (hours to a few days). In addition, it is unlikely that the EMF would have any more than a very temporary, if any, effect on spawning migration because adults would also use other environmental factors such as olfaction, and juveniles entering the ocean would not be exposed to EMF at the scale or level that would affect their orientation. Eulachon are more bottom-oriented and could be affected by EMF from the subsea cables; however, the cables will be shielded, armored and buried for the most part, limiting eulachon exposure to EMF. The likelihood of exposure for green sturgeon is greater than the other ESA-listed fishes because they could occur in the action area for longer periods of time (i.e., weeks to months) and because this species is known to have specialized electroreceptors for prey detection; however, their exposure is still relatively low because the species is also migratory and the action area represents a miniscule proportion of their total oceanic habitat, and individuals are unlikely to be repeatedly or continually exposed to EMF.

Based on the low levels of EMF expected, and spatially limited exposure to the ESA-listed fishes, it is anticipated that relatively minor, short-term potential effects, if any, could occur. All of the listed fish are highly mobile and migratory, and therefore unlikely to remain in the Project area and be continually or repeatedly exposed to this stressor. Conservation measures such as shielding to reduce potential EMF exposure and the EMF Monitoring Plan and adaptive management should address any potential effects. EMF emissions generated by the Project are not expected to adversely affect any individual juvenile or adult salmonid, juvenile or adult eulachon, or subadult or adult green sturgeon that could be in the action area; as such, EMF would not adversely affect any of these ESA-listed fishes at the population level.

5.1.4 Construction Effects on Surface Streams

Description of Stressor

Releases of diesel fuel, lubricants, hydraulic fluid, and other contaminants contained in construction equipment potentially could result in acute negative effects on fish, invertebrates, and instream habitat. In addition, long-term effects could result if a spill were not properly remediated. Potential sources of contaminants would be from the construction equipment itself (lubricating oils and fuel). There is only one fish-bearing stream in the Driftwood Beach State Recreation Site, Friday Creek, which is located at the entrance of the site, next to Highway 101. Construction activities would occur in the parking lot of the Driftwood Beach State Recreation Site, away from the stream. Implementation of and Erosion and Sedimentation Control Plan will prevent construction related impacts to the stream.

HDD could result in inadvertent returns of drilling fluids to a waterway. HDD uses a slurry, composed of a fine clay material such as bentonite, as a drilling fluid. The drilling fluids are non-toxic but aquatic habitats can be temporarily impacted and affect benthic invertebrates, aquatic plants, fish, and fish eggs can be smothered by the fine particles if drilling fluids are discharged to waterways. The depth of boring operations will be designed so that the engineers determine there is a low risk of inadvertent return of drilling fluids. Inadvertent return during HDD is considered highly unlikely. An HDD Contingency Plan will be developed to minimize the potential for inadvertent return of drilling fluids, provide timely detection, and address potential releases by describing monitoring, containment, response and notification procedures to be implemented by the contractor. Through implementation of construction best management practices (BMPs), no detrimental effects to freshwater fish are expected from hazardous materials releases.

Exposure to Stressor

Juvenile and adult coho salmon (Oregon Coast ESU) are the only ESA-listed fish and life stages that could be in the terrestrial action area and may experience short term exposure to stressors associated with construction in coho salmon habitat. Friday Creek (Figure 4-3) is the only fish-bearing streams in the action area where coho salmon could occur, but would not be affected by terrestrial cable installation because the stream would be avoided entirely.

Likelihood of Exposure

As noted in the sections above, the occurrence and abundance of coho salmon in the action area may be low, and the likelihood of exposure is low. Impacts to Friday Creek during cable installation will be avoided. Implementation of BMPs (e.g., implementing an Erosion and Sediment Control Plan) should also prevent the exposure of fish to this stressor.

Risk to Individuals and Populations

Effects on individual fish and populations associated with surface waterbodies in the action area are expected to be avoided due to the use of HDD and small footprint of the terrestrial component of the Project, located away from waterbodies. There is only one fish-bearing streams in the action area where coho salmon could occur, Friday Creek, which will be avoided entirely. Fish and their habitat would be protected during construction due to implementation of BMPs, and long-term effects would be minimal because the cable will be buried. For these reasons, construction activities are not expected to adversely affect any individual juvenile or adult coho salmon that could be in the action area; as such, potential impacts from construction activities on surface streams would not adversely affect any ESA-listed fishes at the population level.

5.1.5 Critical Habitat

The action area occurs within critical habitat for the southern DPS of green sturgeon. As noted in Section 3.2.1, the primary constituent elements that are essential for the conservation of the species in coastal marine areas are: migratory corridors that allow for the safe and timely passage between estuarine and marine habitats; water quality with adequate dissolved oxygen levels and acceptably low levels of contaminants; and adequate food resources including benthic invertebrates and fish. The primary constituent elements in estuarine habitats include migratory corridors, water quality, and adequate food resources, as well as a diversity of depths and adequate sediment quality (74 FR 52300). Potential stressors from the Project – habitat alteration (suspended sediment, disturbance of benthic communities, changes to marine community composition, and release of toxic substances), underwater sound, and EMF emissions – are not expected to adversely affect these primary constituent elements. As discussed above, the Project is not expected to affect green sturgeon movement. Water and sediment quality is not likely to be adversely affected because measures would be implemented to prevent the releases of hazardous materials and chemicals. Habitat alteration could affect prey resources of green sturgeon, mainly by providing habitat for reef-associated invertebrates and fish that could serve as prey resources for green sturgeon (see *Changes to Marine Community Composition*, above), but this would be a potentially beneficial, not adverse, effect. Any effect on the primary constituent elements in coastal marine areas would be minor or even negligible, even considering repeated disturbances over the life of the Project, given the small total footprint of the seafloor structures (about 2 acres) relative to the size of the marine portion of green sturgeon critical habitat (7.3 million acres). Even the total direct (Project components on the seafloor) and indirect disturbance (seafloor potentially affected by scour) surface area, which is anticipated to be approximately 21,214 ft^2 per anchor, results in only approximately 48 acres, or 3 percent of the total Project site being potentially affected during full build out (See Section 5.1.1, Disturbance of Benthic Community from Project Structures). The Project would not affect depths or food resources in estuarine habitat. Therefore, the Project would not adversely affect any of these primary constituent elements and would not adversely affect critical habitat for green sturgeon.

5.2 MARINE MAMMALS

Potential stressors that may affect ESA-listed marine mammals as a result of the Project include underwater sound and risk of collision with submerged structures or with vessels visiting or transiting to or from the site, and entanglement with debris if it accumulates on Project structures; these stressors are discussed below.

5.2.1 Underwater Sound

Description of Stressor

Underwater sound generated by the Project could affect ESA-listed marine mammals. As described in section 5.1.2, the primary sources of Project-related underwater sound would be from vessels at PacWave South and transiting between Newport and the site during Project construction and WEC and mooring installation, maintenance, and removal; cable laying; and operation of the WECs. Sound from these sources would vary in intensity and duration based on the activity and the sea state, but all would be continuous, non-impulsive, sounds. Underwater sounds generated by the Project may be similar to, or masked by, ambient underwater sounds in the action area, which are reported to be higher than the typical deep ocean sound found in the northeast Pacific Ocean (Haxel et al. 2011), likely due to wave activity and existing vessel traffic. Ambient sound levels at PacWave South are similar to levels measured at PacWave North (as described above).

In summary, the sound pressure levels produced by vessels are predicted to be no greater than 130 to 160 dB re: 1 μPa and below background levels a short distance from the vessel, and will be temporary and of short duration, though periodic. Sound pressure levels for DP cable laying vessel, if used during cable laying at the beginning of the Project and during installation of individual WECs, are predicted to be up to 180 dB re: 1 μPa (NMFS 2015i) at 1 m and of short duration.

Anchor installation is a short term activity (hours), with anchoring occurring in soft substrates that would likely produce less sound than the sounds from the vessels deploying the anchors. However, suction anchors require hydraulic pumps for installation. Suction anchors were proposed for installation for the Neptune LNG Deepwater Port, and noise modelling indicated that installation of the suction pile anchors at the Port would produce only low levels of underwater sound with no levels above the 120-dB criterion for continuous sound (Neptune LNG LLC 2007). Modeling for installation of the suction pile anchors was conducted by Jasco, indicating that the 120-dB threshold would not be exceeded and the 90-dB contour would occur only out to 300 to 1,000 feet from the source of the sound. The method for installation was using a submerged pump attached to an ROV (Engineering-Environmental Management Inc. 2006).

As for WEC operation sound, it is difficult to model or predict the sound signature due to the variety and complexity of differing sound sources within an array (Wilson et al. 2014). However, operational sounds of the test WET-NZ WEC at PacWave North were within the range of ambient conditions and did not exceed NMFS' 120 dB marine mammal harassment threshold. The sound pressure level (SPL) for Columbia Power Technologies' 1/7-scale WEC was 126 dB re: 1 µPa at 10 m (Thomson et al. 2012, as cited in NAVFAC 2014). As described in Section 5.1.2, and per NMFS request, a conservative source term of 151 dB re: 1 µPa at 1 m was used in this analysis. Implementing NMFS practical spreading model with the highest WEC sound source terms would attenuate to 120 dB re: 1 µPa at 125 m. Therefore, assuming a radius of 125 m this would represent an area of 49,087 m^2 (528,000 ft^2) or approximately 12 acres (4.9 ha) surrounding each WEC, in which the noise level would exceed 120 dB (Figure 5-1).

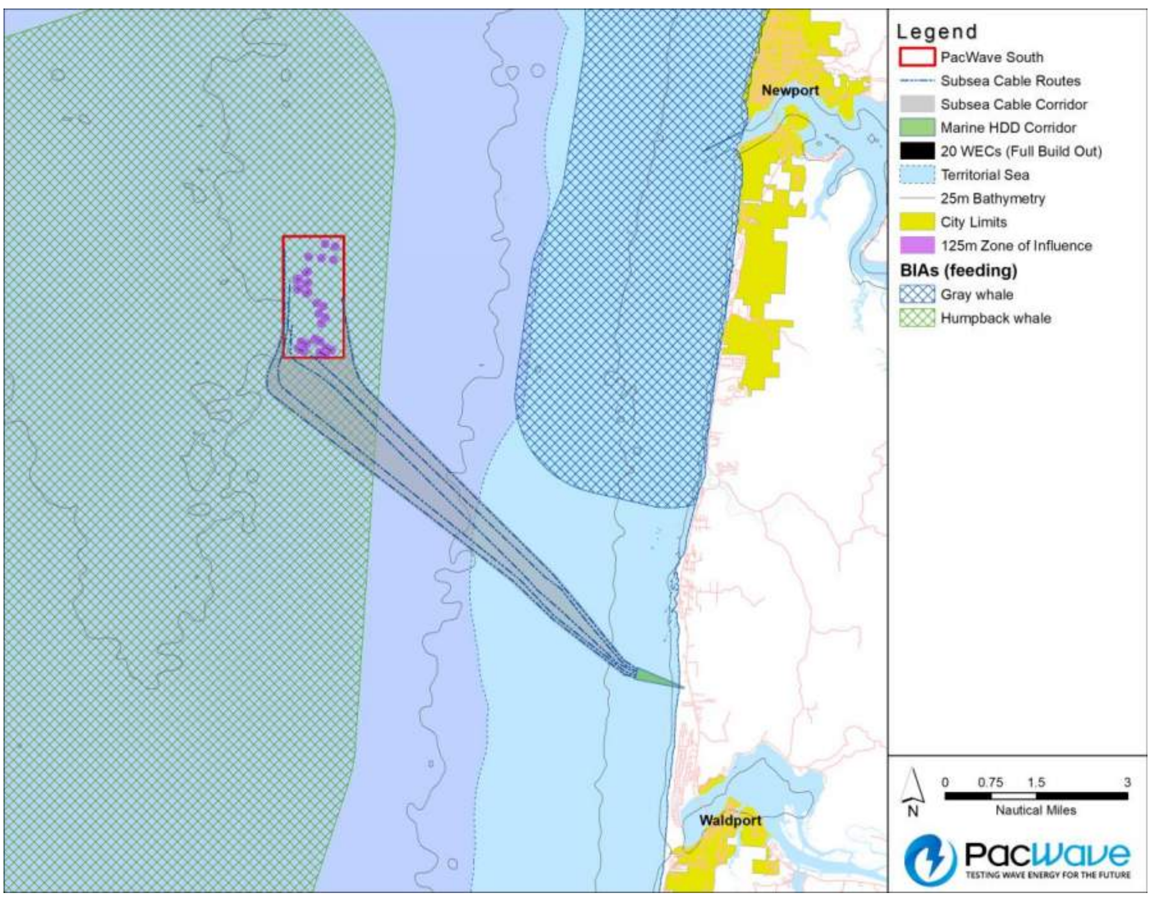


Figure 5-1. Area around each WEC in which the noise level would exceed 120 dB as modeled with highest expected WEC sound source.

Exposure to Stressor

Southern Resident killer whales and humpback whales are known or likely to occur within the action area. A total of 20 humpback whales and four killer whales were observed during vessel-based, standard-line transect surveys conducted from October 2013 to September 2015 (a total of 37 cruises) in the Project area (Henkel et al. 2019). Blue whales could infrequently occur in the action area; none were detected in the 37 surveys conducted from October 2013 to September 2015 in the Project area (Henkel et al. 2019), but there were four sightings near the Oregon coast during shipboard surveys between 1991 and 2008 (Carretta et al. 2015). Similarly, fin whales could infrequently occur in the action area; one was detected from the 37 surveys conducted from October 2013 to September 2015 in the Project area (Henkel et al. 2019). Based on shipboard surveys off Oregon in 1991-2008, sei and sperm whales occur in deeper waters further offshore than the Project, and would not be expected to occur within the action area due to their offshore distribution (Carretta et al. 2015), even considering the 25-year license term.

Likelihood of Exposure

Humpback and killer whales could be exposed to underwater sound from the Project because they are known to occur in the action area and may use the area for foraging or migration. However, individuals are unlikely to be continually or repeatedly exposed to this stressor because they are highly mobile and migratory. Moreover, proposed mitigation would minimize the potential for any such exposure to rise to levels that would modify behavior, making any potential risks discountable. Blue and fin whales are less likely to be exposed to underwater sound given their occurrences inshore are rare, they are generally farther offshore than the action area, and they are highly mobile and migratory. There is no information available to suggest that the action area is an important foraging area for humpback whales, blue whales, fin whales, or Southern Resident killer whales, or the other ESA-listed whales (i.e., the action area is not a “Biologically Important Area” for any of these whales, with the exception that the 6.8 square km project site is within the 2,573 square km feeding area BIA for humpback whales, see Calambokidis et al. 2015), and there is similar habitat in the surrounding area that would provide foraging areas for these species.

Risk to Individuals and Populations

Project-related underwater sound could interfere with communication, prey and predator detection, and migration of ESA-listed marine mammals. The intensity and duration of exposure to underwater noise would vary by Project activity (i.e., installation versus operation), and development stage (i.e., initial build out and full build out scenarios). Sensitivity to sound can vary between marine mammals and responses to sound can be highly variable, depending on the individual hearing sensitivity of the animal, the behavioral or motivational state at the time of exposure, past exposure to the sound which may have caused habituation or sensitization, habitat characteristics, environmental factors that affect sound transmission, and non-acoustic characteristics of the sound source, such as whether it is stationary or moving (NRC 2003). Whales migrating past the action area may be able detect Project-related sounds and may change course to avoid the action area. However, whales migrating over the OCS are occasionally exposed to elevated sound levels near Newport, and other larger ports along their migration route, as well as passing ships (Southall 2005); therefore, it is difficult to predict their response to Project-related sound or parse it out from responses to existing conditions.

NMFS has developed revised guidance on sound levels likely to cause injury for marine mammals (NMFS 2016g). The NMFS (2016g) guidance provide thresholds for injury levels using cumulative sound over a 24 hour period: TTS and permanent threshold shift (PTS) onset threshold levels for injury have been identified for low to mid-frequency cetaceans for non-impulse noise (178 & 179 dB re 1 μPa²s for TTS and 198 & 199 dB re 1 μPa²s for PTS) or Phocid and Otariid pinnipeds (181 dB & 199 dB re 1 μPa²s for TTS and 201 dB & 219 dB re 1 μPa²s for PTS). However, OSU is using guidelines with conservative exposure thresholds of sound pressure levels from broadband sounds that have been shown to cause behavioral disturbance (an adverse effect) (160 dB RMS re: 1μPa for impulsive sound and 120 dB RMS re: 1μPa for non-impulsive sound). As described above, underwater noise levels of up to 180 dB RMS are expected within 1 meter of the dynamically positioned vessel. ESA listed species of whales are not expected to occur within 1 meter of the dynamically positioned vessel and thus, no whales are expected to be exposed to injurious levels of underwater noise from the dynamically positioned vessel. None of the Project components or other activities are expected to generate sound at levels that could cause injury. The sound levels from vessels during installation and operation, from cable laying, DPVs, and from non-impulsive sounds produced by WECs over the 25-year operation of the test center is not expected to result in harassment of marine mammals.

Vessel sound could create temporary impacts on feeding patterns and socialization for whales, but these effects would be short term and temporary (i.e., hours or less as the vessels pass), though periodic over the 25-year license term, and are anticipated to be negligible and similar to what marine mammals already experience along the Oregon Coast. Also, ambient sound levels are also expected to approach 120 dB RMS re: 1μPa; as noted above, baseline underwater sound monitoring at PacWave South recorded sound pressures levels between 83 and 116[12] dB RMS re: 1 μPa (Haxel 2019). An estimate of the vessel traffic associated with Project installation, maintenance and monitoring is provided below in Section 5.2.2.

[12] A maximum value of 138 dB was measured, but less than 1% of the 61,380 SPL RMS values surpassed the 116 dB level (i.e., 99th percentile)(Haxel 2019)

Potential effects on ESA-listed marine mammals from underwater sound generated as the HDD drill head approaches the underwater breakout point is negligible given that it would be much less than typical work vessels that would be used for the Project (Gaboury et al. 2008, Navy 2008 both cited in NAVFAC 2014). Cetaceans are highly mobile and would be expected to avoid the effective range of cable laying operations, thus further reducing potential for exposure to sound generated by the DP thrusters. Considering the temporary nature of cable laying activities at PacWave South (occurring only during construction) and the low likelihood that Southern Resident killer whales, humpback whales, blue whales, or fin whales would be near the cable route, coupled with the proposed mitigation to further reduce the potential for marine mammals to experience sound exceeding 120 dB, any effects of sound generated during cable installation are expected to be discountable.

Sound generated by operating WECs is expected to be lower than the injury level for cetaceans (NAVFAC 2014) and is not expected to result in harassment of marine mammals. Ambient sounds at PacWave South were reported at 83-116 dB RMS re:1 μPa (Haxel 2019). During higher sea states, both WEC and ambient noise levels would be expected to increase concurrently, likely resulting in partial or total masking of the WEC generated sound. Although WEC generated sound is lower than the injury threshold for marine mammals, there is uncertainty about the potential behavioral effects of WEC-generated sound on marine animals (Copping et al. 2016). Because of uncertainty associated with this new industry and in order to determine the actual sound levels emitted by WECs at the Project, OSU would implement the Acoustic Monitoring Study under the Adaptive Management Framework to detect and, if needed, mitigate any potential effects of Project-related sound.

Southern Resident killer whale have mid-frequency hearing capabilities and behavioral responses to non-impulse sound could include changes in speed of travel, direction, or dive profile; cessation or modification of vocalizations; avoidance of the sound source, change in group distribution, and changes in foraging efficiency (Southall et al. 2007, Houghton et al. 2015). Holt et al. (2015) found that increased vocalization efforts by marine mammals in noisy habitats, such as areas exposed to regular vessel traffic, can increase their metabolic rate and consequently result in energetic costs to individuals.

Humpback, blue whales, and fin whales have low frequency hearing, and similar to killer whales, individuals could be displaced from foraging in the action area or from using it to move between foraging sites. Conversely, the noise levels created by the WECs may not affect whales at all, given that ambient sounds at higher sea states (when WEC-generated sounds will be higher) may partially or totally mask the WEC-generated sound. If displaced from the action area due to Project-related noise, alternative forging and migrating routes are available near the Project site. Humpbacks, the only baleen whale known to occur in the Project area relatively frequently, normally swim 4.8-14 km/hour, blue whales travel at 20 km/hour, and killer whales can reach speeds over 56 km/hour (Society for Marine Mammalogy 2015), so individuals of these species would be able to swim out of the area with disturbing levels of noise (e.g., up to 6 km for DP thrusters, 125 m for WECs) in less than an hour. The area where Project noise may occur is a miniscule portion of the available habitat used by whales. These factors suggest that avoidance of the action area due to sound, if it occurred, would not significantly impair essential life functions (i.e., foraging, migration, rearing), or impair the health, survivability, or reproduction of individual whales. In addition, behavioral avoidance due to WEC noise could reduce the risk of collision or entanglement (as described below).

Summary

Whales are not expected to be exposed to injurious levels of underwater noise resulting from Project components or activities (NMFS 2016g). In addition, the sound levels from vessels during installation and operation, from cable laying, DP thrusters, and from non-impulsive sounds produced by the various WECs over the 25-year operation of the test center is not expected to result in harassment of marine mammals (see Appendix N). Whales could be displaced from foraging in portions of the action area or from using it to move between foraging sites. However, the action area is not known to be an important foraging area for any of the ESA-listed whales, with the possible exception of humpback whales where the Project site is 0.2% of the feeding BIA, and there is similar habitat in the surrounding area that would serve as alternate foraging areas for these species if they are displaced. Any disruption or delay in foraging would be temporary and persist only as long as it took for the whale to swim away from the noisy area (under an hour). Because of uncertainty associated with this new industry and in order to determine the actual sound levels emitted by WECs at the Project, OSU would implement the Acoustic Monitoring Study in consultation with appropriate agencies or pursuant to the Adaptive Management Framework to detect and, if needed, mitigate any potential effects of Project-related sound.

5.2.2 Risk of Collision or Entanglement

Description of Stressor

The CWG was concerned that Project structures, including WECs, mooring lines, subsea floats, marker buoys, and umbilical cables, might possibly pose a risk to whales if they collide with these submerged components or become entangled with debris (e.g., lost fishing gear) if it accumulates at surface or on submerged structures. The estimated number of mooring lines and umbilical cables for each scenario is provided in Table 5-3.

Table 5-3. Estimated number of mooring lines and umbilical cables for Initial Development and Full Build-Out Scenarios.

Build -Out Scenario	No. WECs	No. Anchors/ Mooring Lines Total*	No. Umbilical Cables Total
Initial Development	6	21	6
Full Build Out	20	100	20

* One anchor per mooring line.

In addition, there was concern that whales may possibly collide with vessels visiting the site or transiting between the Port of Newport and PacWave South. The estimated annual number of days during which vessels will be transiting between Newport and PacWave South for the initial development scenario and full build out scenario are shown in Table 5-3. During days when deployment or retrieval activities are occurring, multiple vessels (e.g., up to 4 vessels) will be at PacWave South and transiting between Port of Newport and PacWave South, while for other activities (e.g., environmental monitoring or O&M activities), only one vessel may be on site. Therefore, on an annual basis, it is expected that vessels would be transiting between the Port of Newport and PacWave South, and working at PacWave South, during 81 days and 105 days for the initial and full build out scenarios, respectively (Table 5-3). Approximately 33-56 percent of vessel activity will be for required environmental monitoring purposes. OSU will minimize the risk of Project-related vessels colliding with these species by requiring vessels to avoid close contact with marine mammals and sea turtles and adhere to NMFS “Be Whale Wise” guidelines.

The CWG was concerned that marine mammals may become entangled in lost fishing gear if gear becomes entangled or fouled on surface or underwater Project structures and infrastructure (Henkel et al. 2013). Lost fishing gear with floats such as crab pots with float lines, or trawl or other nets with flotation are more susceptible to becoming fouled or entangled on Project structures as they are more likely to be dispersed by currents. OSU has proposed steps to monitor for and remove entangled fishing gear, which would minimize the potential for marine mammals to encounter lost fishing gear at the test site and become entangled. In addition, to the extent practicable, OSU will direct the WEC testing clients to design and maintain cables and moorings in configurations that minimize the potential for marine mammal or sea turtle entrapment or entanglement and follow the reporting protocols specified in the Protection, Mitigation, and Enhancement measures (Appendix I of the APEA).

Exposure to Stressor

As discussed in Section 3.3 and 5.2.1, juvenile and adult Southern Resident killer whales and humpback whales are likely to occur in the action area and blue and fin whales would be expected to rarely occur in the action area, and therefore could be exposed to risk of collision with Project components or entanglement with marine debris if it snags on Project components. The exposure to collision or entanglement with Project components for killer whale, humpback whale, blue, or fin whale is influenced by overlap in both the spatial and temporal distribution of these species with the WECs. In addition, the number of WECs deployed would vary over time between the initial and full development scenarios, thus their potential exposure to collision or entanglement risks would also vary. Additionally, variables that may influence the outcome of a direct interaction include the size and mass of the individual, its angle and speed of approach, and the individual's detection and avoidance abilities and curiosity.

Likelihood of Exposure

Humpback whales and Southern Resident killer whales are known to use the action area with higher frequency than other species and could be subject to collision or entanglement risks, but proposed mitigation would minimize potential risks to discountable levels. Blue and fin whales are known to infrequently occur in and around the action area, but generally occur farther offshore and are unlikely to be exposed to collision or entanglement.

Risk to Individuals and Populations

Marine mammals offshore of Oregon are exposed to a variety of anthropogenic structures that present collision risk, including moored navigation aids, and NOAA oceanographic buoys, other research buoys and autonomous vehicles, as well as moored and moving ships. Marine mammals have evolved to avoid colliding with natural features and to avoid predators, but whale collisions with moving, moored or drifting vessels have been recorded (Nielsen et al. 2012). It is also possible that sound generated by WECs could result in behavioral avoidance of the devices, which could reduce the risk of collision (NMFS 2012c, NMFS 2012e). There are no data documenting whale collisions with stationary structures (e.g., piers, oil platforms) along the west coast.

Many toothed whales, such as Southern Resident killer whale, have a well-developed ability to echolocate and avoid structures in the water (Akamatsu et al. 2005), and moorings for WECs would consist of large cables, which would likely be detected at distances of tens of meters by echolocation (Nielsen et al. 2012 *cited in* Benjamins et al. 2014). Akamatsu et al. (2005) found that finless porpoise inspected a distance of up to 76 m (250 ft) forward of the animal and swam less than 20 m (65 ft) without using sonar, and the inspection distance was sufficient to provide for a wide safety margin before meeting any risk. NMFS (2012e) noted that killer whales, which use sonar for hunting and communication, would likely be able to detect and avoid an array of WECs even when they were not making sound. It is expected that this would be true for other toothed whales. Therefore, the risk of collision with Project structures, for any

Southern Resident killer whales in the Project area, even assuming the 25-year Project term, would likely be very low.

While odontocetes use echolocation for active detection, most other species rely on hearing or pressure wave detection to detect their surroundings. There is uncertainty regarding the ability of baleen whales (e.g., humpback, blue, and fin whales), which do not use sonar, to detect or avoid objects in the water column or on the seafloor. Moorings will produce noise relative to current flow, and marine mammals, including baleen whales may be able to detect these cues (Bartol and Ketten, 2006, Kot et al. 2012, *both cited in* Benjamins et al. 2014). Therefore, the risk of collision with Project structures, for any humpback, blue, or fin whales that occur in the Project area, may be higher than for odontocetes but is still highly unlikely.

In 2016, there were reports of 71 entangled whales off the coasts of Washington, Oregon, and California (NOAA 2016). Sixty six of these were off California, though this does not necessarily reflect the location of entanglement, but could instead be the result of higher reporting rates (i.e., more people to report entanglements off the California coast). Sources of entanglement, identified for 29 of the entanglements were as follows: Dungeness crab fishery (22), set gillnet and tribal gillnet fishery (2), and spot prawn trap fishery (3), and sablefish trap fishery (2) (NOAA 2016).

Similarly, entanglement records from 1990 through 2007 maintained by NMFS Northeast Regional Office showed that, for the 46 confirmed right whale entanglements that occurred during that time period, the whales were entangled in weirs, gillnets, and trailing lines and buoys (NMFS 2009b). In an evaluation of the potential for entanglement of large marine life with marine renewable energy development, Benjamins et al. (2014) report that “the vast majority of reported instances of entanglement ... are associated with ropes forming part of fishing gear. To date, there are few reported cases of marine megafauna becoming entangled in moorings or cables of any kind.” Umbilical cables are thought to be less of a concern than mooring lines because power cables have a lower minimum breaking load than mooring lines, as they are not designed to maintain a WEC on station (Harnois et al. 2015).

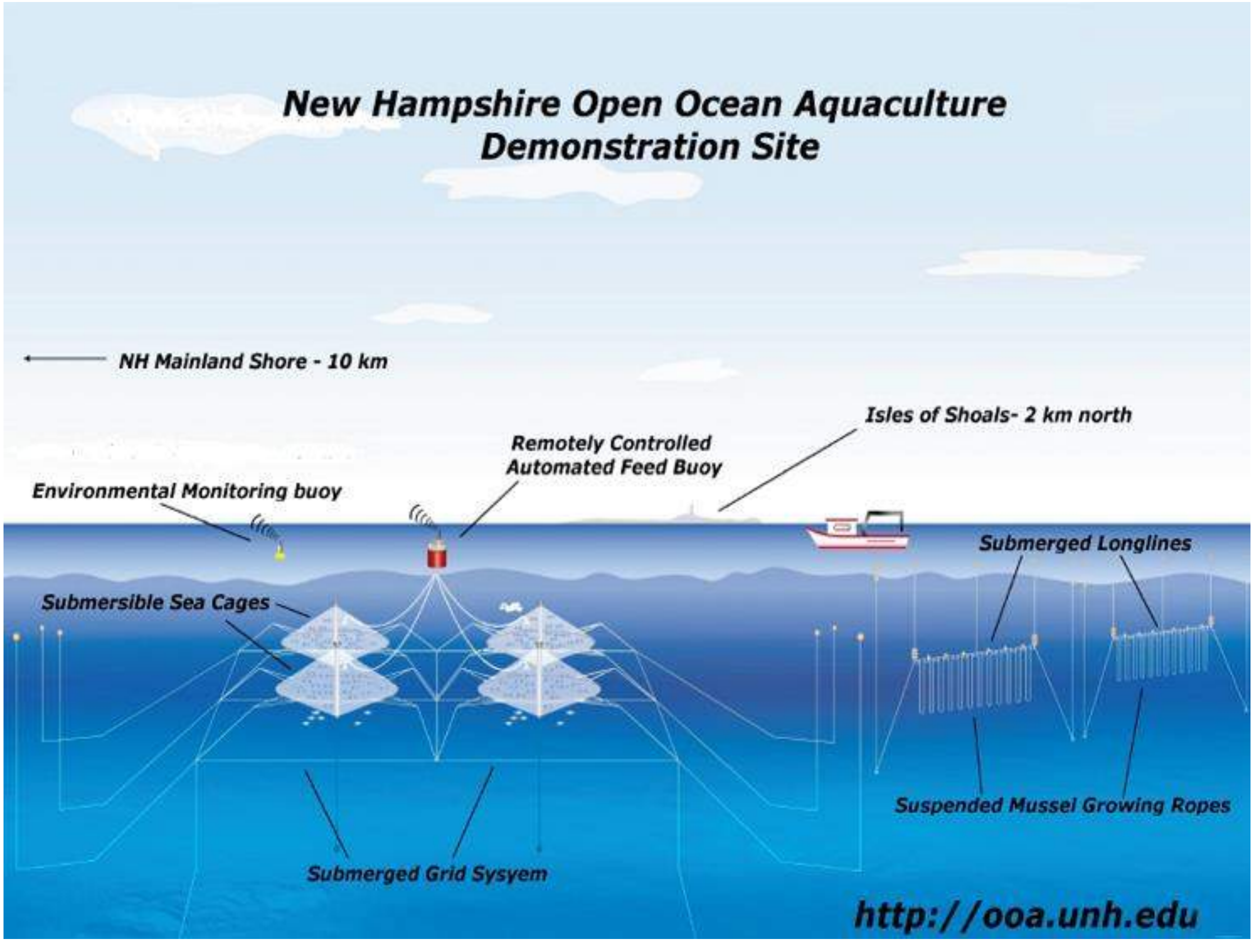
The Project mooring lines (up to 21 and 100 for the initial development and full build out, respectively; Table 5-3) and the umbilical cables (up to 6 and 20 for the initial development and full build out, respectively) are considerably more substantial in size and rigidity than those used for fishing or crab pot lines within which whales have become entangled. Also, the WECs are expected to create substantial tension on the mooring lines. Heavy mooring gear combined with relatively taut mooring lines has been shown to render the potential for entanglement negligible (Würsig and Gailey 2002). Entanglement is unlikely due to the moorings’ size and mass regardless of the mooring configuration, though taut mooring systems represented lower relative risk than catenary mooring systems, particularly those using nylon (Benjamins et al.

2014, Harnois et al. 2015). The umbilical cables descending from the WECs to the seafloor would also be substantially taut and relatively rigid. Therefore, it is likely the umbilical cables and mooring lines would act more as structures than as lines and entanglement would be unlikely to occur. In addition, the spacing of the WECs, approximately 50 to 200 m or more apart, would further minimize the potential for entanglement by providing ample space for marine mammals to pass between the devices and associated mooring lines and umbilical cables (Figures 2-4 and 2-5). Tighter WEC spacing would result in a smaller array footprint, yet still allow spacing for larger cetaceans to maneuver between mooring lines (Figure 2-5); greater WEC spacing would result in a larger array footprint with more room for cetaceans to maneuver between mooring, but the wider spacing could increase the risk of debris entanglement. The Organism Interactions Monitoring Plan will evaluate debris that entangles on Project components that is not observable from the surface and animals that may become entangled.

The expectation that it would be very unlikely for whales to become entangled in the mooring lines or cables is consistent with the "... apparent absence of entanglement records in similar moorings associated with other offshore industries (e.g., oil and gas)", which is the closest parallel to moorings used for marine renewable energy converters (Benjamins et al. 2014). This has also been confirmed at a NOAA-funded open ocean aquaculture facility located 6 miles off of New Hampshire (Atlantic Marine Aquaculture Center 2008). The facility, installed in 1997, covered about 30 acres at depths of 164 ft and had a mooring system comparable to those that would be used at PacWave South (Figure 5-2). Celikkol (1999) evaluated the risk of entanglement and concluded that "the chance of whale entanglement should be considered unlikely to very unlikely" because of the absence of structures that are known to cause entanglement such as slack lines and netting. Monitoring of whales and sea turtles occurred in the Project vicinity following deployment of the facility, and fin and humpback whales were observed in the vicinity but not in the immediate area. Researchers reported in 2006 that "…no incidents related to marine mammals or turtles have occurred at the open ocean aquaculture field site and no impacts have occurred since the beginning of aquaculture activities in 1997" (Atlantic Marine Aquaculture Center 2006) [13]. The findings from the Atlantic Marine Aquaculture Center are relevant to PacWave South because the New Hampshire site occurred at comparable depths (164 ft), comparable distance offshore (6 miles), had a mooring system comparable to those that would be used at PacWave South, and similar species of interest were present (e.g., baleen whales [fin and humpback] and sea turtles). However, the netting of the large net pens would likely be harder for a large whale to detect than the more substantial steel WECs; thus the fact

[13] Prior to 2002, sightings data were obtained from fisherman and personnel associated with the Atlantic Marine Aquaculture Center. In 2001, the database of mammal and sea turtle sightings recorded by onboard naturalists from a local sight-seeing and whale watching commercial operation was obtained and analyzed for species of interest in the project area (Atlantic Marine Aquaculture Center 2002). From 2002 to 2006, marine mammals and sea turtles in the vicinity of the site were monitored by the University of New Hampshire and the Blue Ocean Society for Marine Conservation. From May through late October or November, trained naturalists and interns on whale watch cruises identified and recorded locations and other data on the species sighted (Atlantic Marine Aquaculture Center 2008).

that no impacts were observed during 10 years of monitoring is extremely relevant to evaluating the potential risks of PacWave South.



Source: Atlantic Marine Aquaculture Center 2014.

Figure 5-2. NOAA-funded New Hampshire open ocean aquaculture demonstration site.

Observations of whale interactions with moored offshore net pens in Hawaii found a similar lack of effect to marine mammals (Sims 2013). This site is located a half-mile offshore in waters over 200 ft deep, with a sandy bottom and strong currents. Eight submersible net pens, each with a capacity of around 4,000 cubic yards, are centered in the 90-acre lease (e.g., approximately 0.33 nautical miles per side if square). The net pens are tied into a submerged grid anchored by 14 steel embedment anchors and chains, with 14 mooring lines at a 5:1 scope. A series of weights and buoys are attached to the chains to keep them taut, and bridles extend from the mooring grid corners to the net pen rims to hold the net pens in place. Regarding interactions of humpback whales with the farm, which are monitored as part of the Project's Marine Mammal Monitoring Plan, Sims (2013) noted: "There is no definitive pattern of whales avoiding, or being attracted to the cages. Whales are occasionally seen within the lease area. On one instance, the farm workers witnessed a humpback on the surface inside the mooring grid array; the animal appeared to negotiate its path between the net pens and mooring lines with ease." Sims (2013) also reported that bottlenose dolphins frequent the site, and adverse effects have not been observed.

At the Hawaii Wave Energy Test Site (Marine Corps Base Hawaii), researchers evaluated the effects on marine mammals from the shallow-water (water depth of about 30 m) WEC test berth from 2001 to 2003, and in 2011, before and after the first WEC was installed. No marine mammals were seen or heard within 1,640 ft of the anchor or power cable (NAVFAC 2014). It should be noted that Hawaii WETS occurs in shallow water, and is nearer to shore than PacWave South.

Summary

Southern Resident killer whales use sonar for hunting and communication, and thus would likely be able to detect and avoid an array of WECs, even over the 25-year Project term. The large size of the WECs is expected to be readily perceived by an approaching humpback, blue or fin whale. Even though humpback whales may be common in the action area, the risk of a humpback whale colliding with a WEC, anchor, or mooring structure is expected to be unlikely, as corroborated by similar projects (Atlantic Marine Aquaculture Center 2008, NAVFAC 2014, Sims 2013). The risk of a blue or fin whale colliding with a WEC, anchor, or mooring structure is also expected to be unlikely because both species typically occur further offshore (Caretta et al. 2015) and in deeper water (Adams et al. 2014) in Oregon than where PacWave South would be located. In addition, whales are not known to collide or entangle with taut moorings, which would be used at PacWave South; whale entanglement appears to be associated with fishing gear such as crab pots (especially buoy lines) and lost nets. OSU would conduct opportunistic surface observations at least quarterly to detect and remove marine debris from the Project, review results of Organism Interactions Monitoring Plan for lost fishing gear, and implement mitigation measures to remove detected lost fishing gear to minimize risk of marine mammal entanglement. Vessel strikes are so unlikely for any of the ESA-listed marine mammals as to be discountable. OSU will further minimize the risk of Project-related vessels colliding with these species by requiring vessels avoid close contact with marine mammals and sea turtles and adhere to NMFS "Be Whale Wise" guidelines. Potential non-strike encounters (e.g., a whale approaching a service vessel that is on site) are expected to be sporadic with transitory behavioral effects and therefore would be insignificant. The small footprint of the Project relative to the surrounding open ocean along the coastline also minimizes the likelihood of a collision occurring.

Based on the existing information, the potential for collision or entanglement with Project structures or with vessels associated with the Project, both at the site, and between PacWave South and Newport, over the 25-year license term, would not be expected to adversely affect any individual humpback whales, blue whales, fin whales, or Southern Resident killer whales; as such, collision or entanglement would not adversely affect any these species at the population level.

5.3 MARINE TURTLES

Potential stressors that may affect marine turtles include underwater sound, collision or entanglement with submerged structures, and entanglement with debris (e.g., lost fishing gear) if it accumulates on surface or submerged structures, and toxic effects from accidental release of oil/toxic substances.

The action area also occurs within designated critical habitat for the leatherback turtle. Loggerhead, green, and olive ridley sea turtles are unlikely to occur in the action area and therefore unlikely to be affected by these stressors.

Accidental release of oil or toxic substances is unlikely to occur because OSU will develop and implement an Emergency Response and Recovery Plan that includes spill prevention and control protocols to minimize the potential for and, if needed, respond to accidental release of oils and toxic chemicals into the marine environment. The remaining potential effects are discussed below.

5.3.1 Underwater Sound

Description of Stressor

As described in sections 5.1.2 and 5.2.1, vessels used during Project construction, O&M, and environmental monitoring, and WEC installation, maintenance, and removal, cable laying operations, and WEC operation could generate underwater sound.

Exposure to Stressor

The ESA-listed marine turtle that is likely to be in the action area and that may be affected by underwater sound is the leatherback sea turtle. Green, olive ridley and loggerhead sea turtles are rarely observed in the West Coast EEZ (NMFS and FWS 2007, 2013, 2014), and leatherback sea turtles are more likely to occur further offshore than the action area (NMFS and FWS 2007). OSU considers these species rarely or only occasionally sighted as close to shore as PacWave South, extremely unlikely to occur in the action area.

Likelihood of Exposure

Occurrences of the leatherback sea turtle are expected to be infrequent in the action area, therefore, the likelihood that they would be affected by underwater sound is low. For the PacWave North Project, NMFS noted that leatherback sea turtles were not anticipated to forage or spend extended amounts of time in the action area (NMFS 2012c), and OSU expects that the same is true for PacWave South. It should be noted that NMFS' conclusions for PacWave North were specific to a smaller project and a shorter deployment time. Nonetheless, OSU expects that the same is true for PacWave South, and this is corroborated by a satellite tracking study completed by Benson et al. (2011) that reported no use of the action area or vicinity by leatherback sea turtles, rather most occurrences in Oregon waters were farther offshore or concentrated offshore of the mouth of the Columbia River.

Risk to Individuals and Populations

Sound associated with vessels, cable laying, and continuous (non-impulsive) sounds from the WEC operations, could cause leatherback sea turtles to startle and move away from the action area to the surrounding similar habitat. Unlike marine mammals, sea turtles do not appear to vocalize or use sound for communication; sound may be used to navigate, locate prey, avoid predators, and be important for general environmental awareness (Dow Piniak et al. 2012). Sea turtles, in general, appear to have a relatively narrow, low-frequency range of hearing sensitivity, and respond to low frequencies between 250 and 1,000 Hz (Bartol and Ketten 2006). Juvenile loggerhead sea turtles respond behaviorally to sounds in the low frequency range of 200-700 Hz (Lavendar et al. 2012), and leatherback sea turtles hatchlings respond to stimuli between 50 and 1,200 Hz, with maximum sensitivity at 100-400 Hz (Dow Piniak et al. 2012). Data are lacking regarding sea turtle response to continuous sounds, but it is assumed that sea turtles may exhibit avoidance behavior when exposed to high amplitude, low frequency sound (e.g., Lenhardt 1994, Bartol 2008, Popper et al. 2014). McCauley et al. (2000) observed sea turtles in cages and reported that sound from airguns louder than 166 dB re: 1mPa RMS increased swimming activity, and louder than 175 dB re 1m Pa RMS caused erratic behavior. They also reported alert behavior at a distance of 2 km from the sound source and escape behavior at a distance of 1 km. Other than installation of the cables using a DPV (if used) over a period of about 30 days, Project activities are not expected to reach such sound levels, nor would they be impulsive sounds, but they could reach levels that result in minor behavioral responses (startle, avoidance), based on evidence from studies on the response to continuous sounds by fish (Popper et al. 2014). However, because leatherback sea turtles are rare in the action area, the likelihood of exposure to Project-related underwater sound is remote. Therefore, underwater sound anticipated for the Project is not expected to adversely affect individual sea turtles; as such, underwater sounds would not adversely affect leatherback sea turtles at the population level.

5.3.2 Risk of Collision or Entanglement

Description of Stressor

As described in Section 5.2.2, submerged Project structures, including WECs, mooring lines, subsea floats, and umbilical cables, could pose a risk of collision to passing sea turtles, and entanglement of lost fishing gear on Project components could pose a risk of entanglement. NMFS noted that sea turtle mobility may be compromised due to the effects of colder water temperatures in Oregon, and this may increase the likelihood of collision or entanglement. However, this could also lessen the chance of effect if sea turtles are swimming slower (i.e., lessen the effect of collision).

Exposure to Stressor

The ESA-listed marine turtle that is likely to be in the action area and that may be subject to collision or entanglement is the leatherback sea turtle. As described above, leatherback sea turtles are expected to be infrequent in the action area.

Likelihood of Exposure

As discussed in section 5.3.1, occurrences of the leatherback sea turtle are expected to be rare and infrequent in the action area, therefore, the likelihood that they would be subject to collision or entanglement is low.

Risk to Individuals and Populations

Leatherback sea turtles are expected to be rare in the action area. Leatherback sea turtles are unlikely to collide with WECs or mooring lines, because the WECs would be spaced at 50 to 200 m or more apart, which would provide ample space for sea turtles to pass between the WECs and associated mooring lines and umbilical cables (Figures 2-4 and 2-5), even if their maneuverability is reduced from being in colder water temperatures. Mooring lines and umbilical cables would have little slack and could not form or be capable of forming loops to entangle turtles. There is a slight risk that turtles could be entangled in lost fishing gear caught on Project structures or mooring lines, but OSU would implement measures to detect and remove lost fishing gear to minimize this risk. Therefore, leatherback sea turtles are not expected to exposed to collisions or entanglement; as such, collisions or entanglement would not adversely affect leatherback sea turtles at the population level.

5.3.3 Critical Habitat

NMFS identified one PCEs essential to the conservation of leatherback sea turtles in marine waters of the U.S. West Coast: occurrence of prey species of sufficient condition, distribution, diversity, and abundance to support individual as well as population growth, reproduction, and development (77 FR 4170). The proposed listing identified eight groups of activities that have the potential to affect this PCE: pollution from point sources, runoff from agricultural pesticide use, oil spills, power plants, desalination plants, tidal energy projects, wave energy projects, and liquid natural gas projects (NMFS 2009a).

NMFS noted that possible impacts to PCEs include disturbance to their primary prey species, jellyfish, during the benthic polyp stage (77 FR 4170). Like most attached organisms, jellyfish polyps prefer to grow on hard substrates. It is therefore unlikely the Project site is currently habitat for the benthic stage of jellyfish. At PacWave North, OSU found little fouling of concrete block anchors deployed for over two years at the site, and therefore, it can be expected that the introduction of hard structure (e.g., anchors) at PacWave South would not provide substrate for polyps. Little effect on their prey is expected, although, it should be noted that NMFS' conclusions for PacWave North were specific to a shorter deployment time. As noted above, disturbance to the seafloor by the Project would be short term and temporary, occurring during installation activities, and would not affect leatherback prey species condition, distribution, diversity, or abundance.

5.4 BIRDS

5.4.1 Marbled Murrelet

The mixed conifer/deciduous forest in the terrestrial action area does not contain suitable nesting habitat for marbled murrelets. However, murrelets could fly over or through the mixed conifer/deciduous forest in the terrestrial action area as they fly between at-sea and inland nesting habitats. They are unlikely to be affected by sound and human disturbance (e.g., movement of equipment and personnel) during construction activities given that these activities are located along Highway 101 where disturbance from vehicles and human activity are already present. In addition, inland flights occur around sunrise and sunset, which is outside of the typical construction schedule. No effects to marbled murrelets are expected to occur as a result of terrestrial construction activities.

Potential marine effects of the Project on marbled murrelets include attraction to operational lighting on service and supply vessels or navigational aid lighting on Project structures, collision with above-surface or submerged structures, entanglement with debris (e.g., lost fishing gear) if it accumulates at surface or submerged structures, sound and vibration emitted from the WECs during ordinary operation or during HDD and subsea cable laying, and fouling of feathers and toxic effects from accidental release of oil/toxic substances. There is no evidence suggesting that seabirds would be attracted to or harmed by association with WECs (Copping et al. 2016). A study on wave and tidal energy converters in Scottish waters, which has a similar suite of seabird species as Oregon waters (e.g., predominately alcids and cormorants) described the vulnerability of most seabird populations to adverse effects from WECs as low or very low, with the exception of "divers" (i.e., loons) which were considered a moderate risk; however, even a high score for collision risk with WECs "would probably represent a relatively low risk compared to risks such as entanglement in netting" (Furness et al. 2012). Notably, common murres, the species likely to be most abundant at the WEC deployment area, were ranked as having a low vulnerability to WEC impacts. There is no proposed or designated critical habitat for marbled murrelets in the action area, thus the Project would have no effect on critical habitat for this species. Accidental release of oil or toxic substances is unlikely to occur because OSU will develop and implement an Emergency Response and Recovery Plan that includes spill prevention and control protocols to minimize the potential for and, if needed, respond to accidental release of oils and toxic chemicals into the marine environment. The remaining potential effects are discussed below.

Artificial Lighting

Description of Stressor

Artificial lighting associated with the Project includes navigational lighting on the WECs and corner markers, and navigational lighting on servicing and support vessels associated with installation or maintenance of the Project. Marbled murrelets are a phototactic seabird and could be attracted to Project-associated lighting, and collide with or land on the WEC or vessels or become exhausted by continual circling around the lights (Montevecchi 2006). To minimize the potential for attraction to lights on Project structures by marbled murrelets and other seabirds, low-intensity flashing lights that meet the minimum USCG and FWS requirements would be used. The specifications for Project lighting would also be developed in compliance with FWS lighting requirements. For the Reedsport OPT Wave Park, OPT consulted with the FWS, and agreed that navigation lights would be shielded, to direct light only towards approaching watercraft (and not directly upwards) and that the flash timing interval would be equal to or greater than 4 seconds for each individual light to minimize the potential for seabird attraction (Reedsport OPT Wave Park, LLC 2010). OSU expects to implement similar measures to minimize effects of Project lighting, as determined in coordination with the USCG and FWS. To minimize the potential for attraction to lighting on service and support vessels by marbled murrelets and other seabirds, servicing and maintenance operations at the PacWave South would occur during daylight whenever practicable.

Exposure to Stressor

Marbled murrelets could be exposed to artificial lights from the Project because they are known to occur in nearshore waters along the Oregon coast.

Likelihood of Exposure

Marbled murrelets are rarely observed seaward beyond 5 km (Adams et al. 2016), and were not observed in the WEC deployment area during boat surveys conducted from May 2013 to October 2015 (a total of 44 cruises) in the Project area (Porquez 2016, Suryan and Porquez 2016). Therefore, presence of this species in the WEC deployment area and exposure to artificial lighting from the WECs and Project structures would likely be rare and limited to few individual birds. More birds could be exposed to lighting from service and support vessels in nearshore waters if they transit at night between Yaquina Bay and the WEC deployment area, as a small number of birds (<10 total) were observed in this area during boat surveys conducted from May 2013 to October 2015 (Porquez 2016).

Risk to Individuals and Populations

Phototactic seabirds have been shown to be highly attracted to artificial light in the marine environment; typical sources of light include boats, lighthouses, oil and gas platforms, coastal resorts, and commercial fishery operations. Continuous high-intensity white lighting is more likely to attract seabirds than lower-intensity, colored lights and those that flash at intervals (Montevecchi 2006, Poot et al. 2008). Nocturnal seabirds are most susceptible to light attraction in cloudy, foggy, or hazy conditions, in light rain, and when the moon is absent or obscured. Immature and nonbreeding nocturnal seabirds tend to be more attracted to light than breeding adults (Montevecchi 2006, Miles et al. 2010). However, the minimization measures including use of shielded, low-intensity flashing lights on the WECs, and minimizing nighttime vessel lighting during installation and maintenance activities would likely prevent attraction to artificial lighting and potential injury or mortality to murrelets. In addition, the Bird and Bat Conservation Strategy identifies that vessel operators will follow FWS instructions regarding appropriate handling and release of seabirds in the event of seabird fallout. The potential effects on marbled murrelets from vessel lighting are expected to be short-term and intermittent, limited to installation of the WECs and during periodic maintenance and repair activities. For these reasons, there is little risk to individuals or the population of marbled murrelets as a result of artificial lighting.

Risk of Collision/Entanglement

Description of Stressor

Marbled murrelets could collide with above-surface structures at PacWave South; these structures would consist of WECs that extend up to 12 m above the water's surface. They could also collide with submerged Project structures, including WECs, mooring lines, subsea floats, and umbilical cables; become in entangled in marine debris (e.g., lost fishing gear) if it accumulates at surface or on submerged structures; or become entrapped or crushed by moving parts. However, OSU would develop and implement protocols to detect and remove marine debris from WECs, which would minimize the potential for murrelets and other seabirds to become entangled in marine debris at the surface or submerged portions of WEC moorings.

Exposure to Stressor

Marbled murrelets could be at risk of collision/entanglement from Project structures because they are known to occur in nearshore waters along the Oregon coast.

Likelihood of Exposure

Marbled murrelets are rarely observed seaward beyond 5 km (Adams et al. 2016), and were not observed in the WEC deployment area during boat surveys conducted from May 2013 to October 2015 (a total of 44 cruises) in the Project area (Porquez 2016, Suryan and Porquez 2016). Therefore, presence of this species in the WEC deployment area and exposure to risk of collision/entanglement from the WECs and Project structures would likely be rare and limited to few individual birds.

Risk to Individuals and Populations

During periods of high visibility and low winds, murrelets are unlikely to collide with the above-surface Project structures because avoidance rates at wind farms (e.g., avoidance by seabirds of an entire wind farm and of individual wind turbines, used to predict potential collision risk) by many species of seabirds, including alcids, have been estimated at greater than 98 percent (Cook et al. 2012). However, avoidance rate estimates are generally based on surveys conducted when sea conditions and visibility are good (Camphuysen et al. 2004), and seabirds, including marbled murrelets, may be more susceptible to collisions during periods of high winds or poor visibility (e.g., storm conditions, fog, and darkness; Boehlert et al. 2008, Suryan et al. 2012, Henkel et al. 2014). Artificial lighting on WECs could increase the likelihood of collisions for marbled murrelets; however, this effect is not expected to occur due to the environmental measures that would be implemented at PacWave South, such as use of low-intensity flashing lighting instead of high-intensity static, white lights on the Project structures and WECs, and because lighting used at night by service and support vessels will be minimized.

Marbled murrelets are unlikely to collide with submerged structures, become in entangled in marine debris (e.g., lost fishing gear) if it accumulates at surface or on submerged structures, or become entrapped or crushed by moving parts, because pursuit-diving seabirds such as marbled murrelets are agile swimmers and have high underwater visual acuity (Henkel et al. 2014). Diving birds have to capture highly mobile prey in very low visibility temperate waters along the Pacific Coast with a turbidity range on a large scale of 5-30 m (Secchi depth; Ainley 1977) and on a much smaller scale (i.e., in Monterey Bay) of 3-9 m (Secchi depth, Laird 2006). For example, alcids (e.g., common murres, tufted puffins, and murrelets) are wing-propelled pursuit divers that swim rapidly (approximately 1 m per second) to pursue and capture mobile prey such as schooling fishes, and can veer, turn, and glide underwater (Johnsgard 1987); thus, it is expected that their vision and agility is adequate for navigating around submerged structures. Furthermore, OSU would develop and implement protocols to detect and remove marine debris from WECs, which would minimize the potential for murrelets and other seabirds to become entangled in marine debris at the surface or submerged portions of WEC moorings. Therefore, marbled murrelets are not expected to be injured or killed from collision, entrapment, crushing, or entanglement with debris or submerged portions of Project structures.

An analysis of the potential effects on marbled murrelets at a proposed wave park 4.6 km offshore of Reedsport, Oregon, found a low likelihood of collisions with above-surface and submerged structures at the park due to the low density of marbled murrelets at that distance from shore, the spacing between the WECs (approximately 100 m apart), and the relatively small area encompassed by the WECs (Kropp 2013). Similarly, due to the expected low density of murrelets in the WEC deployment area, and the relatively small area of the submerged and above-surface structures (maximum of 20 WECs, maximum height of 10-12 m above the water surface) compared to their available at-sea habitat, the likelihood of marbled murrelets encountering PacWave South and colliding with Project structures is very low. The spacing of WECs 50 to 200 m or more apart should provide ample space for marbled murrelets to maneuver between them, further reducing the potential for collisions.

In summary, collisions with above-surface structures, or collisions, entrapment, or crushing by submerged structures could result in injury or mortality of individual murrelets, and entanglement with marine debris at the submerged structures could result in mortality of individuals by drowning. However, the likelihood of marbled murrelets encountering or using the WEC deployment area is very low, the area of the submerged and above-surface structures is small compared to their available at-sea habitat, and the potential for collisions with above-surface or submerged structures is low. In addition, the Bird and Bat Conservation Strategy and Mitigation Measures will be implemented to address lost fishing gear. For these reasons, there is little risk to individuals or the population of marbled murrelets as a result of potential collision, entanglement, entrapment, or crushing by Project structures.

Underwater Sound

Description of Stressor

Underwater sound generated by the Project could affect marbled murrelets. As described in section 5.1.2, the primary sources of Project-related underwater sound would be from vessels at PacWave South and transiting between Newport and the site during Project construction and WEC and mooring installation, maintenance, and removal; from HDD and the DP thrusters during cable lay (if used); and during operation of the WECs. Sound from these sources would vary in intensity and duration based on the activity and the sea state, but all would be continuous, not impulsive, sounds. Underwater sounds generated by the Project may be similar to, or masked by, ambient underwater sounds in the action area, which are reported to be higher than the typical deep ocean sound found in the northeast Pacific Ocean (Haxel et al. 2011), likely due to wave activity and existing vessel traffic. Ambient sound levels at PacWave South are similar to levels measured at PacWave North (as described above).

Exposure to Stressor

Marbled murrelets could be exposed to underwater sound generated by the Project because they are known to occur in nearshore waters along the Oregon coast.

Likelihood of Exposure

Marbled murrelets are rarely observed seaward beyond 5 km (Adams et al. 2016), and were not observed in the WEC deployment area during boat surveys conducted from May 2013 to October 2015 (a total of 44 cruises) in the Project area (Porquez 2016, Suryan and Porquez 2016). Therefore, presence of this species in the WEC deployment area and exposure to underwater sound and vibration emitted by the WECs during ordinary operation would likely be rare and limited to few individual birds. Some birds could be exposed to underwater sound and vibration from service and support vessels in nearshore waters as they transit between Yaquina Bay and the WEC deployment area, as a small number of birds (<10 total) were observed in this area during boat surveys conducted from May 2013 to October 2015 (Porquez 2016). Some birds could also be exposed to underwater sound and vibration emitted from HDD and the DP thrusters during cable lay (if used), as a small number of birds (<10) were observed in this area during boat surveys (Porquez 2016).

Risk to Individuals and Populations

The threshold for underwater sounds to result in injury to marbled murrelets is 202 dB SEL (SAIC 2011), and 150 dB rms for behavioral effects such as flushing and avoidance of the area (FWS 2014b). None of the Project components or activities are expected to generate sound at levels that could cause injury to marbled murrelets. Underwater sound emitted by the WECs during ordinary operation is expected to be within the range of ambient sound levels, and thus is not expected to interfere with or disrupt normal behavior. Vessel sound throughout the life of the Project could cause short-term, temporary behavioral disturbances (i.e., minutes per trip) to marbled murrelets as the vessels transit through nearshore waters. During cable lay operations at the beginning of the Project, and during installation of individual WECs throughout the Project, sound from a vessel with DP thrusters could also cause short-term, temporary behavioral disturbances. The Acoustics Monitoring Plan will monitor sound produced by WECs, and measures to mitigate excessive sound are described in the Mitigation Measures (Appendix F of APEA). Because Project associated sounds would not result in injury or mortality and may only result in short-term temporary behavioral disturbances, there is little risk to individuals or the population of marbled murrelets as a result of exposure to sound and vibration from the Project.

5.4.2 Short-tailed Albatross

Potential effects of the Project on short-tailed albatross include injury or mortality from collision with above-surface structures of WECs, and fouling of feathers and toxic effects from accidental release of oil/toxic substances. This species is also attracted to boat activity (Hyrenbach 2001), so they could be attracted to Project-related service and support vessels, or possibly to WECs. However, attraction to boat activity or to WECs is not likely to result in any adverse effects such as increased energy expenditure, given their ability to fly short distances with little energy cost (Sachs et al. 2012), or collisions with vessels, given that vessel collision is not mentioned in the Recovery Plan as a threat to the species despite their frequent attraction to vessels (FWS 2008). Accidental release of oil or toxic substances and harm to short-tailed albatross is unlikely to occur because OSU will develop and implement an Emergency Response and Recovery Plan that includes spill prevention and control protocols to minimize the potential for and, if needed, respond to accidental release of oils and toxic chemicals into the marine environment. There is no proposed or designated critical habitat for short-tailed albatross; thus, the Project would have no effect on critical habitat for this species.

Currently, short-tailed albatross are extremely rare along the Oregon coast; thus the species is unlikely to occur in the action area. Therefore, effects of the Project on the species are considered unlikely in the short term. However, more short-tailed albatrosses may occur in Oregon waters in the future if the population of this species continues to increase, which could make individuals more likely to be affected by the Project.

If short-tailed albatross do become more common in Oregon waters in the future, the likelihood of albatrosses occurring in the WEC deployment area and being affected by WECs or vessels is still very low. During boat surveys conducted from May 2013 to October 2015 (a total of 44 cruises), black-footed albatrosses (used as a proxy for short-tailed albatross due to similar habitat use) were primarily concentrated beyond 20 km from shore, westward of the WEC deployment area (Porquez 2016, Suryan and Porquez 2016). If they did occur in the WEC deployment area, the likelihood of encountering Project structures would still be low due to the relatively small area of the above-surface structures (maximum of 20 WECs, maximum height of 10-12 m above the water surface) compared to their available at-sea habitat. Although albatrosses are known to fly altitudes of less than 30 m some of the time, they tend to fly at higher altitudes when wind speeds increase (Ainley et al. 2015), which would reduce their likelihood of collision with WECs at higher wind speeds. In lower wind speeds, when they are more likely to fly in the path of WECs, the lower wind speeds makes them more able to maneuver and avoid colliding with the structures. Additionally, the spacing of the WECs (50 to 200 m or more apart) should provide ample space for short-tailed albatrosses to maneuver between them. For these reasons, it is extremely unlikely that short-tailed albatrosses would be affected by the Project.

5.4.3 Western Snowy Plover

Western snowy plovers could use the beach near the proposed cable landing site for nesting, wintering, foraging, and roosting. Western snowy plovers are known to occur on the sandy beaches along the central Oregon coast, and nesting was documented along the beach between the mouth of Alsea Bay to Seal Rock, to the south and the north of Driftwood Beach State Recreation Site in 2017 (L. Hillman, Oregon Parks and Recreation Department, pers. comm. 2017). There is no proposed or designated critical habitat for western snowy plover in the action area, nor in Lincoln County; thus, the Project would have no effect on critical habitat for this species.

Snowy plovers that occur on the beach within the action area could potentially be affected by installation of the cables where they come ashore at Driftwood Beach State Recreation Site. Potential effects on plovers will largely or entirely be avoided by the use of HDD to install the cables from the onshore cable landing ("beach manholes") at Driftwood Beach State Recreation Site parking lot, 50-100 ft under the beach and dunes, and beneath the seafloor to about the 10-m isobath, a distance of about 0.6 nautical miles. The onshore cable landing installation will occur over a period of 6 to 8 months. All activities and equipment associated with the onshore cable landing will be limited to the parking lot at least 164 feet (50 meters) from any potentially suitable nesting or foraging habitat (for reference, Oregon Parks and Recreation Department establishes a 164-foot radius roped buffer around plover nests [ICF International 2010a], and Oceano Dunes State Vehicular Recreation Area in California prohibits parking and camping within 100 feet of posted nesting areas [California State Parks 2017]). No HDD, equipment, personnel, or activities will occur on the beach; however, resource agency staff have raised concerns that human activity at the Driftwood Beach State Recreation Site parking lot associated with the Project could attract predators (e.g., common ravens) to anthropogenic food sources, and with inadvertent return of drilling fluids at the beach.

Anthropogenic food sources are unlikely to increase because it is anticipated that vehicular access to Driftwood Beach State Recreation Site would be closed to the public during construction activities. The parking lot is a busy public access point to the beach; therefore, any snowy plovers that nest or forage on the nearby beach would likely already be habituated to human disturbance.

Human activity at the Driftwood Beach State Recreation Site parking lot associated with Project construction could result in additional disturbance to nesting western snowy plovers, in the form of increased light at night, and the potential to increase risk of predation due to anthropogenic food source associated with poorly contained refuse or debris (because Driftwood Beach State Recreation Site is already used by visitors, food sources are already likely present, but construction at the parking lot could potentially introduce food sources). Operations at the parking lot are proposed during daylight hours, but if lighting is required at night it will be appropriately shielded to minimize lighting reaching western snowy plover nesting habitat. To minimize and mitigate for human debris and food waste, animal-proof litter receptacles will be provided to the Park, along with signage, to notify construction crews and visitors after construction is completed about the importance of litter removal on wildlife. Construction crews will receive guidance that includes the need to keep the parking lot and surrounding area clean of litter and food waste. For these reasons, there is little risk to individuals or the population of western snowy plovers as a result of terrestrial operations at the Driftwood Beach State Recreation Site.

Inadvertent return of drilling fluids would not affect nesting and foraging habitat for western snowy plover because the depth of boring operations 50-100 ft below the dunes and beach should curtail the risk of inadvertent return of drilling fluids to the beach. Regardless, a contingency plan will be developed to minimize the potential for inadvertent return of drilling fluids, provide timely detection, and address potential releases by describing monitoring, containment, response and notification procedures to be implemented by the contractor. The contingency plan will rely on beach access for containment response and monitoring, if necessary, to occur from existing vehicle access points such as Quail Street, approximately 1.3 miles north of the Driftwood Beach State Recreation Site.

The HDD rig is likely to be the loudest equipment used during operations from the Driftwood Beach State Recreation Site parking lot (Tetra Tech 2013). Sound emitted from the

HDD rig is not likely to affect plovers on the beach because the HDD rig will be operated in the eastern half of the Driftwood Beach State Recreation Site parking lot away from any potential nesting or foraging habitat for snowy plovers. At a distance of 300 ft, and assuming no deflection or masking of the noise, the sound pressure levels of the HDD rig (the maximum sound pressure level of a HDD rig at 50 ft is estimated at 92 dBA [TetraTech 2012]) would be reduced by 40 percent to 76 dBA from the levels at the source. Blocking and deflection due to the elevational difference (Harmelink and Hajek 1973), estimated to be 40 ft, between plover habitat and the location of the HDD, and deflection and absorption due to dune vegetation (Huddart 1990, Fang and Ling 2003, van Renterghem et al. 2012, 2015) will further reduce HDD noise in plover habitat. Acoustic shadows created by temperature differences between the ground surface and near-ground atmosphere (West et al. 1989), late in the day, are expected to further ameliorate noise from the drill rig. However, the sound levels at 300 feet are likely overestimated, given that these calculations do not account for prevailing onshore winds and elevation difference between the parking lot and the beach habitat (approximately 40 ft), both factors likely physically block the noise and limit the impact of HDD noise levels on the beach (TetraTech 2013). Ambient noise in the surf zone is unknown at Driftwood Beach; however, based on an analysis of surf noise in the Baltic Sea at different wave heights, surf noise would be expected to exceed 70 dBA at wave heights above 1 m (average annual wave height at PacWave North was estimated at 2.0 m) (Bolin and Åbom 2010). Noise is considered significant if it increases background noise by more than 10 dBA above background (ICF International 2010b), and HDD noise levels within potential snowy plover habitat are not expected to exceed this value.

Masking of HDD noise is also expected to be substantial due to heavy surf and strong onshore winds. Auditory perception is dependent, in part, on filtering background noise: near-constant ambient noise is expected to largely or completely mask those associated with the HDD rig.

Surf contributes substantially to ambient noise (e.g., Cato 2012), and surf-generated noise scales roughly with the square of the wave height (Deane 2000). Bathymetry affects surf-generated noise, influencing source level densities as well as the sound spectra (Fabre and Wilson 1997, Wilson et al. 1997). While these studies refer to the noise underwater due to breaking waves, these sounds are also audible on the beach, in air. Bolin and Åbom (2010) recorded sound pressure levels in air ranging from 60 dB at 0.4 m wave height to 78 dB at 2.0 m wave height in the Baltic Sea, and Tollefsen and Byrne (2011) recorded comparable levels across a similar range of surf heights. Ocean waves (i.e., not surf or breaking waves, *sensu* Bascom 1980) are regularly recorded offshore of the Project site (NDBC, Station 46098)[14] that suggest local surf conditions – and thus surf-generated noise – regularly exceed these levels. The average wave height at sea exceeds 2 meters offshore of the Project area and rarely falls below 1 meter,

[14] National Data Buoy Center, Station 46098 – OOI Waldport Offshore, www.ndbc.noaa.gov, accessed March 24, 2018.

even in the summer; these wave heights translate to surf of comparable or greater size, depending largely on their period (Bascom 1980).

Wind-dependent noise is correlated with wind speed (Wenz 1962), and local wind conditions indicate that this is likely to be a substantial contributor to ambient noise. An average wind speed near 10 knots and the onshore direction of the prevailing winds[15] are expected to combine to further limit sound propagation from the HDD rig towards plover habitat (Tanaka and Shiraishi 2008, Oshima and Li 2013).

Thus, the sound pressure level of a HDD rig (Engineering Page 2017) diminishes rapidly with distance from the source, and these estimates are expected to be an overestimation due to strong onshore winds, elevational differences between the sound source and plover habitat, and the effects of intervening vegetation. Ambient noise from the surf zone and strong winds that are common along the coastline of Oregon is expected to be high, masking HDD rig noise in western snowy plover habitat. Ambient noise in the surf zone has not been measured at Driftwood Beach State Recreation Site; however, surf noise would be expected to exceed 60 dBA at wave heights above 1 m (Bolin and Åbom 2010, Tollefsen and Byrne 2011), and the surf at Driftwood Beach is expected to be considerably greater. Noise is considered significant if it increases background noise by more than 10 dBA above background (ICF International 2010b), and HDD noise levels within potential snowy plover habitat are unlikely to exceed this value. For these reasons, there is little risk to individuals or the population of western snowy plover as a result of onshore cable installation or due to sound from HDD.

If HDD occurs outside of the nesting season (September 16-March 14), but then extends into the nesting season, any western snowy plovers that initiate nesting near the parking lot while HDD is ongoing, are assumed to be undisturbed by the HDD, assuming there is no significant change in Project operations after nesting is initiated. However, if HDD is initiated within the nesting season (March 15-September 15), prior to operation of the HDD, surveys of suitable nesting habitat will be conducted within 600 ft of the HDD rig for signs of nesting western snowy plovers (eggs or chicks) following the *Western Snowy Plover Breeding Window Survey Protocol* (Elliott-Smith and Haig 2007). If no nests are detected, HDD can proceed. If nests are detected, then noise monitoring will be conducted to evaluate the sound levels within the nesting habitat. Noise monitoring includes evaluating existing ambient noise levels prior to start of HDD (7-14 days), during calm wind and ocean conditions (e.g., <10 mph winds, seas <1.5 m) and at windy, high wave conditions (e.g., >15 mph winds, seas >2 m). After HDD is initiated, additional sound monitoring should be conducted at calm conditions and windy, high wave conditions, 50 ft from the HDD rig (to determine if sound levels cited and analyzed in the BA, 92 dBA, are accurate), and at 300 ft from the HDD rig in snowy plover nesting habitat. If sound

[15] Winds measured at Station NWPO3 off Newport, Oregon, http://www.ndbc.noaa.gov/view_climplot.php?station=nwpo3&meas=ws, accessed March 24, 2018)

levels produced by the HDD rig are greater than 10 dBA above ambient conditions at 300 ft in either calm or windy conditions, then engineering controls will be implemented to minimize HDD-related operational noise (e.g., install temporary noise barriers such as berms, stockpiles, dumpsters, bins, and/or engineered acoustical barriers). Specialized panels that absorb and deflect sound when effectively positioned around noise generating areas are commercially available, and are advertised by some companies (e.g., http://www.drillingnoisecontrol.com/panels.html). The effectiveness of noise reducing measures will be tested upon deployment to verify that they reduce noise to less than 10 dBA above ambient conditions at 300 ft. For these reasons, there is little risk to individuals or the population of western snowy plovers as a result of onshore cable installation or due to sound from HDD.

5.4.4 Northern Spotted Owl

Northern spotted owls could occur in the mixed conifer/deciduous forest found in the terrestrial action area, although it would be unlikely given that the surrounding forest is fairly fragmented due to housing developments and timber harvesting. There is no critical habitat for northern spotted owls in the action area; thus, the Project would have no effect on critical habitat for this species. If northern spotted owls use the mixed conifer/deciduous forest in the terrestrial action area for foraging, they could be affected by sound and human disturbance (e.g., movement of equipment and personnel) during construction activities. These effects would likely be limited to short-term, temporary disturbance of individuals. However, the terrestrial action area is located along Highway 101 and the UCMF site, so it can be assumed that disturbance from vehicles is already present. The terrestrial action area does not contain suitable nesting habitat. For these reasons, there is little risk to individuals or the population of northern spotted owls as a result of exposure to sound and human disturbance from construction activities.

5.5 CUMULATIVE EFFECTS

“Cumulative effects” are those effects of future state or private activities, not involving federal activities, that are reasonably certain to occur within the action area of the federal action subject to consultation (50 CFR 402.02). Future federal actions that are unrelated to the proposed action are not considered in this section because they require separate consultation pursuant to Section 7 of the ESA.

There are three types of reasonably foreseeable activities that could occur or do occur in the vicinity of the PacWave South: testing of WECs at PacWave North and Camp Rilea, dredged material disposal, and deployment of sensor arrays for oceanographic monitoring. However, because these activities are considered to be federal actions, effects of these future activities will be analyzed via Section 7 consultation and therefore are not considered in this cumulative effects analysis.

Within the action area, there are some state, tribal, and local government actions that may contribute to negative cumulative effects. Those that are currently ongoing or occurred frequently in the recent past can also be considered reasonably certain to occur in the future, especially if authorizations or permits have not yet expired. Private activities are likely to include continuing fishing vessels, research vessels from NOAA and OSU, and shipping; floating navigational and fishing devices; lost fishing gear; and contaminant leaks, as described in the baseline. Although these factors are ongoing and likely to continue in the future, past occurrence is not a guarantee that these activities will continue at the same level. Whether ongoing adverse effects continue and contribute to cumulative effects will depend on whether there are economic, administrative, and legal impediments (or in the case of contaminants, safeguards). For purposes of this analysis, it is reasonable to assume that cumulative effects of these activities will be commensurate to those of similar past activities, as analyzed in the baseline. When considered together with other relevant past, present, and reasonably foreseeable actions, Project impacts are not expected to incrementally contribute to collectively significant cumulative adverse effects on the marine or terrestrial environment, including marine and terrestrial protected species and sensitive habitats.

6.0 DETERMINATION OF EFFECT

6.1 FISH

6.1.1 Salmon and Steelhead

The proposed action ***may affect, but is not likely to adversely affect*** Snake River ESU sockeye salmon, the steelhead DPSs (Lower Columbia River, Middle Columbia River, Upper Columbia River, Upper Willamette River, Snake River, South-Central California Coast, Central California Coast, Northern California, and California Central Valley), and the Columbia River ESU Chum salmon because they are not likely to occur in the action area.

The proposed action ***may affect, and is likely to adversely affect,*** ESA-listed:

- Chinook salmon ESUs
  - Lower Columbia River,
  - Upper Willamette River,
  - Upper Columbia River spring-run,
  - Snake River spring/summer-run,
  - Snake River fall-run,
  - California Coastal spring-run,
  - Sacramento River winter-run, and
  - Central Valley spring-run
- Coho salmon ESUs
  - Lower Columbia River,
  - Oregon Coast,
  - Southern Oregon/Northern California Coast, and
  - Central California

This conclusion is based on the following information, detailed in the effects analysis and here summarized:

- The occurrence and abundance of salmon in the action area may be relatively low, and because these fish are also migratory, they are unlikely to remain in the Project area but rather move through on a transitory basis, reducing their potential exposure to stressors.
- Salmonids are predominately surface oriented and are unlikely to be exposed to benthic habitat disturbance associated with installation of subsea cables and WEC anchors.
- Any changes to the marine community composition as a result of Project structures are not likely to result in adverse effects, such as increased predation, on salmonids.

- Accidental release of oil or toxic substances that could harm salmonids is unlikely to occur because of the implementation of spill prevention and control protocols.
- Project components are not likely to generate underwater sound at levels that have been implicated in either behavioral or physical effects on fishes. However, there is some uncertainty in this conclusion because of limited data on underwater sound generation by WECs. Monitoring as detailed in the Acoustics Monitoring Plan, Adaptive Management Plan, and Protection, Mitigation and Enhancement Measures provide high confidence that potentially substantial acoustic effects would soon be detected and appropriate responses implemented, ensuring protection of potentially affected species.
- Although salmon may be able to perceive EMF at distances within a few meters of WECs, available data do not indicate that EMF exposure at expected levels has a substantial potential to cause a change in their movements, foraging activities, or other behaviors. To manage uncertainties and understand the magnitude and extent of Project-related perturbations of the natural EMF background, OSU would implement the EMF Monitoring Plan under the Adaptive Management Framework to detect and, if needed, mitigate any unanticipated adverse effects of Project-related EMF emissions.

6.1.2 Green Sturgeon

The proposed action ***may affect, and is likely to adversely affect,*** green sturgeon. However, the Project would not jeopardize the continued existence of this species. This determination is based on the following information, detailed in the effects analysis and here summarized:

- Suspended sediment caused by installation of the subsea cables and periodic deployment of WECs and anchors would be temporary and localized, although the frequency of WEC deployments would vary.
- There would be no significant loss of prey resources due to localized benthic disturbance.
- The addition of Project structures on the seafloor would affect only a miniscule portion of the available habitat for green sturgeon and would not result in a significant loss of prey resources.
- Any changes to the marine community composition as a result of Project structures are not likely to result in adverse effects, such as increased predation, on green sturgeon.
- Accidental release of oil or toxic substances that could harm green sturgeon is unlikely to occur because of the implementation of spill prevention and control protocols.

- Project components are not likely to generate underwater sound at levels that have been implicated in either behavioral or physical effects on fishes. However, there is some uncertainty in this conclusion because of limited data on underwater sound generation by WECs. Monitoring as detailed in the Acoustics Monitoring Plan, Adaptive Management Plan, and Protection, Mitigation and Enhancement Measures provide high confidence that potentially substantial acoustic effects would soon be detected and appropriate responses implemented, ensuring protection of potentially affected green sturgeon.
- Although green sturgeon are likely to perceive EMF at distances within a few meters of power cables, subsea connectors, and WECs, available data do not indicate that EMF exposure at expected levels has a substantial potential to cause a change in their movements, foraging activities, or other behaviors. To understand the magnitude and extent of Project-related perturbations of the natural EMF background, OSU would implement the EMF Monitoring Plan under the Adaptive Management Framework to detect and, if needed, mitigate any unanticipated adverse effects of Project-related EMF emissions.

6.1.3 Eulachon

The proposed action ***may affect, and is likely to adversely affect,*** eulachon. This determination is based on the following information, detailed in the effects analysis and here summarized:

- Suspended sediment caused by installation of the subsea cables and periodic deployment of WECs and anchors would be temporary and localized, although the frequency of WEC deployments would vary.
- There would be no significant loss of prey resources due to benthic disturbance.
- Any changes to the marine community composition as a result of Project structures are not likely to result in adverse effects, such as increased predation, on eulachon.
- Accidental release of oil or toxic substances that could harm eulachon is unlikely to occur because of the implementation of spill prevention and control protocols.
- Project components are not likely to generate underwater sound at levels that have been implicated in either behavioral or physical effects on fishes. However, there is some uncertainty in this conclusion because of limited data on underwater sound generation by WECs. Monitoring as detailed in the Acoustics Monitoring Plan, Adaptive Management Plan, and Protection, Mitigation and Enhancement Measures provide high confidence that potentially substantial acoustic effects would soon be detected and appropriate responses implemented, ensuring protection of potentially affected eulachon.

- Although eulachon could perceive EMF at distances within a few meters of power cables, available data do not indicate that EMF exposure at expected levels has a substantial potential to cause a change in their movements, foraging activities, or other behaviors. To manage uncertainties and understand the magnitude and extent of Project-related perturbations of the natural EMF background, OSU would implement the EMF Monitoring Plan under the Adaptive Management Framework to detect and, if needed, mitigate any unanticipated adverse effects of Project-related EMF emissions.

6.2 MARINE MAMMALS

The proposed action ***may affect, but is not likely to adversely affect*** Oregon, sei and sperm whales because they are not likely to occur in the action area.

In addition, based on the analysis above and in consultation with NMFS marine mammal staff, the proposed action ***may affect, and is not likely to adversely affect,*** Southern Resident killer whales, humpback, blue, and fin whales. Specifically, this determination is based on the following information, detailed in the effects analysis and here summarized:

- Southern Resident killer whales and humpback whales are known or likely to occur within the action area. Blue and fin whales could infrequently occur in the action area.
- Underwater noise, even considering potential for repeat exposures of individual whales to sound from various periodic tests and vessel traffic associated with the Project over the 25-year license term, is not expected to reach levels that could result in injury to whales. Similarly, Project-related noise is not expected to rise to levels constituting harassment. Moreover, monitoring as detailed in the Acoustics Monitoring Plan, Adaptive Management Plan, and Protection, Mitigation and Enhancement Measures provide high confidence that potential acoustic effects would be detected and appropriate responses implemented, ensuring protection of potentially affected whales, making potential noise effects unlikely and discountable.
- The risk of injury or mortality to individual killer whales, humpback, blue, and fin whales from collisions or entanglement with Project components, lost fishing gear or marine debris snagged on Project components is very low. OSU would conduct opportunistic surface observations at least quarterly to detect and remove marine debris from the Project, review results of Organism Interactions Monitoring Plan for lost fishing gear, and remove lost fishing gear to minimize risk of marine mammal entanglement. Mitigation for lost fishing gear is described in Appendix I of the APEA that would minimize, to discountable levels, the potential for marine mammals to

encounter lost fishing gear at the Project's WEC deployment area and become entangled.

6.3 MARINE TURTLES

The proposed action ***may affect, but is not likely to adversely affect*** green sea turtles, olive ridley sea turtles, or loggerhead sea turtles because they are not likely to occur in the action area.

The proposed action ***may affect, and is not likely to adversely affect*** leatherback sea turtles. This determination is based on the following information, detailed in the effects analysis and here summarized:

- Occurrences of leatherback sea turtles would likely be infrequent in the action area.
- The risk of injury or mortality to individual sea turtles as a result of underwater sound or from collisions or entanglement with lost fishing gear or marine debris snagged on Project components is very low, especially given the scale of the project, and the low likelihood of exposure. Monitoring and mitigation for acoustic impacts and lost fishing gear should further minimize the risks of any potential adverse effects, so that effects are discountable.

6.4 BIRDS

6.4.1 Marbled Murrelet

The proposed action ***may affect, and is not likely to adversely affect,*** the marbled murrelet. This determination is based on the following information, detailed in the effects analysis and here summarized:

- Marbled murrelets are unlikely to nest in the terrestrial action area or be affected by terrestrial Project activities.
- Marbled murrelets are unlikely to occur in the WEC deployment area, but are more likely to occur between the deployment area and shore and could be affected during cable laying.
- Marbled murrelets are not expected to be attracted to lighting because low-intensity flashing lights instead of high-intensity static, white lights will be used on the Project structures and WECs, and lighting used at night by service and support vessels will be minimized. In addition, vessel operators will follow FWS instructions regarding appropriate handling and release of seabirds in the event of seabird fallout.

- Marbled murrelets are unlikely to collide with above-surface structures or be subject to collisions, entrapment, or crushing by submerged structures of WECs because they have a low likelihood of encountering or using the WEC deployment area, and the area of the submerged and above-surface structures is small compared to their available at-sea habitat.
- Marine debris at the submerged structures will not pose an entanglement risk to murrelets. Lost fishing gear will be monitored and removed as described in the Organism Interaction Plan and in the Mitigation Measures (Appendix I of the APEA).
- Accidental release of oil or toxic substances that could harm marbled murrelets is unlikely to occur because spill prevention and control protocols will be implemented.
- Underwater sound and vibration generated by the WECs is not expected to cause auditory harm to marbled murrelets.
- Vessel sound could create short-term, temporary disturbance (i.e., hours) to marbled murrelets, but would not result in injury or mortality.
- Sound and vibration from onshore HDD and cable laying could create short-term, temporary disturbance (i.e., hours) to marbled murrelets in nearshore waters, but would not result in injury or mortality.

6.4.2 Short-tailed Albatross

The proposed action ***may affect, and is not likely to adversely affect,*** the short-tailed albatross. This determination is based on the following information, detailed in the effects analysis and here summarized:

- Short-tailed albatross occurrences are sporadic and rare along the Oregon coast and they are unlikely to occur in the action area, but could be more likely as the population grows and recovers.
- Short-tailed albatrosses are unlikely to collide with above-surface structures of WECs because they have a low likelihood of encountering or using the action area, and the area of the structures is small compared to their available at-sea habitat.
- Accidental release of oil or toxic substances that could harm short-tailed albatrosses is unlikely to occur because of the implementation of spill prevention and control protocols.

6.4.3 Western Snowy Plover

The proposed action ***may affect, but is not likely to adversely affect,*** the western snowy plover because no Project construction activities or equipment will occur on the beach in potential plover habitat, and noise from HDD in the Driftwood Beach State Recreation Site parking lot is likely indistinguishable from ambient noise from the surf zone and strong winds on the beach.

6.4.4 Northern Spotted Owl

The proposed action ***may affect, but is not likely to adversely affect,*** the northern spotted owl because there is no suitable nesting habitat in the action area, and they are unlikely to occur in the vicinity of the terrestrial action area. If they do occur in the vicinity of the terrestrial action area, potential effects would be limited to short-term, temporary disturbance of individuals.

6.5 CRITICAL HABITAT

The proposed action ***may affect, but is not likely to adversely affect*** designated critical habitat of green sturgeon, which is present in the action area. Potential stressors from the Project are not expected to adversely affect any of the primary constituent elements (e.g., food, passage, water quality). Any effect on the primary constituent elements in coastal marine areas would be minor or even negligible, given the small total footprint of the seafloor structures (about 2 acres, at full build-out) relative to the size of the marine portion of green sturgeon critical habitat (7.3 million acres).

The proposed action ***may affect, but is not likely to adversely affect*** designated critical habitat of the leatherback sea turtle, which is present in the action area. Although critical habitat for leatherback sea turtle is present in the action area, the proposed action is not expected to affect the PCEs (prey species) for critical habitat.

7.0 ESSENTIAL FISH HABITAT

The Magnuson-Stevens Fishery Conservation and Management Act (MSA), as amended by the Sustainable Fisheries Act of 1996 (Public Law 104-267), established procedures designed to identify, conserve, and enhance Essential Fish Habitat (EFH) for those species regulated under a federal fisheries management plan. The consultation requirement of section 305(b) of the MSA directs federal agencies to consult with NMFS on all actions or proposed actions that may adversely affect EFH. EFH is defined as “those waters and substrate necessary to fish for spawning, breeding, feeding, or growth to maturity” (16 U.S.C. 1802(10)). NMFS has further added the following interpretations to clarify this definition:

- “waters” include aquatic areas and their associated physical, chemical, and biological properties that are used by fish, and may include areas historically used by fish where appropriate;
- “substrate” includes sediment, hard bottom, structures underlying the waters, and associated biological communities;
- “necessary” means the habitat required to support a sustainable fishery and the managed species’ contribution to a healthy ecosystem; and
- “spawning, breeding, feeding, or growth to maturity” covers the full lifecycle of a species (50 CFR 600.10).

The objective of this EFH assessment is to determine whether the proposed Project “may adversely affect” designated EFH for relevant commercial, federally managed fisheries species within the proposed Project area. It also describes conservation measures proposed to avoid, minimize, or otherwise offset potential adverse effects to designated EFH resulting from the proposed action. Adverse effects occur when EFH quality or quantity is reduced by a direct or indirect physical, chemical, or biological alteration of the waters or substrate, or by the loss of (or injury to) benthic organisms, prey species and their habitat, or other ecosystem components.

In a notice dated May 27, 2014, FERC designated OSU as its non-federal representative for carrying out informal consultation, pursuant to Section 305 of the MSA.

7.1 ESSENTIAL FISH HABITAT AFFECTED BY THE PROJECT

Section 302 of the MSA established regional fishery management councils that develop management plans for each fishery requiring conservation and management. Section 303(a) (7) of the MSA requires that these fishery management plans (FMPs) describe and identify EFH. Within the West Coast EEZ, the Pacific Fishery Management Council (PFMC) manages four groups of commercially fished species: 1) groundfish, 2) salmon, 3) highly migratory species, and 4) coastal pelagic species. The groundfish FMP includes more than 80 species of fish, and the salmon FMP includes all species of salmon occurring along the west coast of the United States that are commercially fished, including Chinook, coho, and pink salmon. The highly migratory species FMP includes tunas, some shark species, and billfish. The coastal pelagic FMP includes five taxa: northern anchovy, market squid, Pacific sardine, Pacific (chub) mackerel, and jack mackerel.

Pursuant to the MSA, EFH has been designated for each of these groups, and all waters within and adjoining the Project area constitute EFH for these groups. The proposed action would affect areas designated as EFH for certain life stages of groundfish, coastal pelagics, Pacific salmon, and highly migratory species (NMFS 2012c; Table 7-1).

Table 7-1. Species with designated EFH in the action area.

Common Name	Scientific Name	Lifestage	Activity
Groundfish			
Arrowtooth flounder	*Atheresthes stomias*	Eggs, Larvae, Adults	All
Big skate	*Raja binoculata*	Adults	All
Black rockfish	*Sebastes melanops*	Adults	All
		Juveniles	Feeding, Growth to Maturity
Blue rockfish	*S. mystinus*	Juveniles, Adults	All
		Larvae	Feeding
Bocaccio	*S. paucispinis*	Juveniles, Adults	Feeding, Growth to Maturity
Brown rockfish	*S. auriculatus*	Adults	All
		Juveniles	Feeding, Growth to Maturity
Butter sole	*Isopsetta isolepis*	Adults	
Cabezon	*Scorpaenichthys marmoratus*	Adults	
California skate	*R. inornata*	Eggs	Unknown
Chilipepper	*S. goodei*	Juveniles	Feeding, Growth to Maturity
Curlfin sole	*Pleuronichthys decurrens*	Adults	All
Darkblotched rockfish	*S. crameri*	Larvae, Juveniles, Adults	
English sole	*Parophrys vetulus*	Adults	All
		Juveniles	Feeding, Growth to Maturity
Flathead sole	*Hippoglossoides elassodon*	Adults	All
Greenstriped rockfish	*S. elongatus*	Adults	All

Common Name	Scientific Name	Lifestage	Activity
Kelp greenling	*Hexagrammos decagrammus*	Adults	All
		Larvae	
Lingcod	*Ophiodon elongatus*	Adults	All
		Larvae	Feeding
Longnose skate	*R. rhina*	Adults	All
		Juveniles	Growth to Maturity
		Eggs	
Pacific cod	*Gadus macrocephalus*	Adults	All
		Juveniles	
		Larvae	
Pacific hake	*Merluccius productus*	Adults	All
		Juveniles	
Pacific ocean perch	*S. alutus*	Adults	All
		Juveniles	
Pacific sanddab	*Citharichythys sordidus*	Adults	All
Petrale sole	*Eopsetta jordani*	Adults	All
Quillback rockfish	*S. maliger*	Adults	All
Redbanded rockfish	*S. babcocki*	Adults	All
Redstripe rockfish	*S. proriger*	Adults	All
Rex sole	*Glyptocephalus zachirus*	Adults	All
Rock sole	*Lepidopsetta bilineata*	Adults	All
Rosethorn rockfish	*S. helvomaculatus*	Adults	All
Rosy rockfish	*S. rosaceus*	Adults	All
Rougheye rockfish	*S. aleutiamus*	Adults	All
		Juveniles	Feeding, Growth to Maturity
Sablefish	*Anoplopoma fimbria*	Juveniles, Adults	Growth to Maturity
		Larvae	Feeding
Sand sole	*Psettichthys melanostictus*	Adults	All
		Juveniles	Feeding, Growth to Maturity
Sharpchin rockfish	*S. zacentrus*	Adults	All
		Juveniles	Feeding, Growth to Maturity
Shortbelly rockfish	*S. jordani*	Adults	All
Shortraker rockfish	*S. borealis*	Adults	All
Shortspine thornyhead	*Sebastolobus alascanus*	Adults	All
Silvergray rockfish	*S. brevispinis*	Adults	All
Soupfin shark	*Galeorhinus galeus*	Adults	All
		Juveniles	Growth to Maturity
Spiny dogfish	*Squalus acanthias*	Adults	All

Common Name	**Scientific Name**	**Lifestage**	**Activity**
Splitnose rockfish	*S. diploproa*	Juveniles	Feeding
		Larvae	
Spotted ratfish	*Hydrolagus colliei*	Adults	All
		Juveniles	Growth to Maturity
Starry flounder	*Platichthys stellatus*	Adults	Growth to Maturity
		Juveniles	Feeding
Stripetail rockfish	*S. saxicola*	Adults	All
		Juveniles	Feeding, Growth to Maturity
Tiger rockfish	*S. nigrocinctus*	Adults	All
Vermilion rockfish	*S. miniatus*	Adults	All
Widow rockfish	*S. entomelas*	Adults	All
		Juveniles	Feeding, Growth to Maturity
Yelloweye rockfish	*S. ruberrimus*	Adults	All
Yellowtail rockfish	*S. flavidus*	Adults	All
Coastal Pelagic Species			
Northern anchovy	*Engraulis mordax*		
Pacific sardine	*Sardinops sagax*		
Pacific (chub) mackerel	*Scomber japonicus*		
Market squid	*Loligo opalescens*		
Jack mackerel	*Trachurus symmetricus*		
Pacific Salmon			
Coho Salmon	*Oncorhynchus kisutch*		
Chinook Salmon	*O. tshawytscha*		
Highly Migratory Species			
Common thresher shark	*Alopias vulpinus*		

Source: NMFS 2012c

*All refers to spawning, breeding, and feeding

The PFMC has designated rocky reef habitats as Habitat Areas of Particular Concern (HAPCs). HAPCs, are distinct subsets of EFH and are considered high priority areas for conservation, management, or research because they are rare, sensitive, stressed by development, or important to ecological function. The HAPC designation does not necessarily mean additional protections or restrictions are applied to an area, but they help to prioritize and focus conservation efforts. An HAPC designation does not confer additional protection or restriction upon an area, but helps prioritize conservation efforts, and should be considered in an analysis of an area’s sensitivity. As noted previously, the proposed cable route would bypass the rocky geology associated with Seal Rock Reef near the Project area, as the reef is considered as HAPCs (Letter from PFMC dated July 9, 2014 to FERC providing comments on Scoping Document 1).

The proposed action may affect EFH by: 1) changes in the marine and freshwater fish and invertebrate communities, 2) changes to predator/-prey interactions, 3) impacts of underwater sound/vibration, and 4) EMF effects. However, as described in section 5.1, NNMREC-OSU anticipates that the Project would have only minor or inconsequential localized effects on the local marine and freshwater fish and invertebrate communities and their habitats, and thus would have no adverse effects on EFH.

As detailed in section 5.1.1, the installation, removal, and redeployment of the subsea cables, subsea connectors, and anchors would result in both temporary and long-term alteration of benthic habitat in the Project area, potentially affecting groundfish EFH. The anchoring system for the Project would consist of approximately 21 anchors for the initial development scenario and up to 100 anchors for the full build out. The maximum footprint of the anchors would be 19,068 ft^2 (0.4 acres) for the initial development and 90,800 ft^2 (2 acres) for the full build out (Table 2-1), which is approximately 0.1 percent of the total Project site surface area (2 acres out of 1,695 acres). The estimates are based on exclusive use of large 34-ft-diameter gravity anchors; however, other types of smaller anchors will likely be used for some of the WECs, and shared anchors may be used for some WECs when feasible, so the actual seafloor footprint is expected to be considerably smaller than these estimates. Once an anchor is removed, the local benthic habitat would likely return to normal within months.

The placement of anchors on the seafloor could result in localized areas of scour or deposition. As noted in Section 5.1.1, it is anticipated that scour depths may be up to 1 m, and sedimentary changes may extend as far from the anchors as 20 m (Henkel et al. 2014). If an additional 20-m radius was included around each anchor to consider scour development and sediment re-deposition, the total direct and indirect disturbance surface area is anticipated to be approximately 21,124 ft^2 per anchor (which assumes a 164 ft diameter of direct and indirect disturbance). For the initial development scenario with 21 anchors, this could result in approximately 10 acres, or 0.6 percent of the total Project site being potentially affected. For the full build-out scenario with 100 anchors, this could result in approximately 48 acres, or 3 percent of the total Project site being potentially affected. Installation of the buried portions of the four subsea cables and single auxiliary cable (from the offshore test site to the seaward end of the HDD conduits) by jet plow in separate trenches would result in a temporary disturbance of the sand bottom and could displace or cover benthic and infaunal organisms. The width of each jet plow trench would be only about 3 ft wide, and would be surrounded by ample undisturbed habitat from which new recruits could be drawn. Therefore, it is likely that affected areas would be quickly recolonized by benthic invertebrates from nearby undisturbed areas (DOE 2012). Effects of habitat alteration associated with the presence of these Project components would be insignificant, due to the relatively small Project footprint and prevalence of unconsolidated sand habitat offshore of Oregon.

Food resources would be lost within the footprint of the anchors and subsea connects (up to about 2 acres of direct disturbance) because these structures would cover the substrate and any substrate dwelling organisms would be buried. Anchors would be removed and deployed periodically over the duration of the license period. PacWave South is a high energy site (based on the existence of larger median grain sizes and low fine sediment percentages) that is typically inhabited by opportunistic organisms tolerant of disturbance (Pemberton and MacEachern 1997 *cited in* NMFS 2012c). The exposure, response, and risks to forage fish species (both as a food resource and managed coastal pelagic fishes) and groundfish are likely to be similar to those described in Section 5.1.1 for ESA-listed salmon, eulachon and green sturgeon. Because these impacts to the forage base are highly localized, the decrease in forage abundance is considered insignificant to the total food resources available to EFH management species in the action area.

Fish would likely avoid the immediate Project area during construction activities, moving to abundant similar habitat that surrounds the Project area. During informal consultation, PFMC raised concerns on impacts the Project may have on Seal Rock Reef, specifically along the habitat interfaces where fish species often congregate. PFMC suggested that the subsea cable route avoid rocky reef habitat, canopy kelp, and seagrass HAPCs; OSU has addressed this concern by selecting the cable route to avoid reefs altogether and other hard substrate to the greatest extent possible. Therefore, the Project would not affect HAPC, including Seal Rock Reef or the associated habitat interfaces where fish congregate.

As detailed in section 5.1.1 *Changes to Marine Community Composition and Behavior,* the introduction of Project-related structures could result in localized habitat changes as the hard structures are colonized by algae and invertebrates, such as barnacles, mussels, bryozoans, corals, tunicates, and tube-dwelling worms and crustaceans, termed “biofouling” (Boehlert et al. 2008). Project structures at or near the seafloor (e.g., anchors) may also act as artificial reefs and provide habitat for structure-oriented fishes, such as rockfish (Danner et al. 1994, Love and Yoklavich 2006, Kramer et al. 2015), potentially affecting groundfish EFH. Attraction to Project structures could alter the fish species composition in and around the Project area, and may also affect predator/prey interactions (Wilhelmsson and Langhamer 2014). Some fish are also known to associate with or aggregate at floating objects (Castro et al. 2002, Nelson 2003), so Project structures in the water column and at the surface (e.g., WECs, marker buoys and mooring lines) and any associated biofouling could act as FADs and attract pelagic fishes through visual and/or olfactory cues (Dempster and Kingsford 2003), potentially affecting coastal pelagic EFH.

Fish attracted to Project components on the seafloor (e.g., anchors) could include the deep rocky reef (>25 m depth) associated fish species and affect groundfish EFH. Project structures could provide additional habitat, enhanced forage opportunities, or expose some of these fish species to increased predation by predatory fishes, seabirds, or marine mammals. However, most of these reef fish species are also known to occur at the bottom and midwater structures of oil platforms offshore of southern and central California (Caselle et al. 2002, Love et al. 2010), and negative population-level effects on reef-associated species at these oil platforms have not been reported. In fact, the oil platforms contribute to rockfish productivity and have some of the highest secondary production per unit area of any marine habitat studied globally (Claisse et al. 2014). The Project would not be expected to have a population-level impact on rocky reef fishes due to the small overall footprint and low density of WECs, and studies conducted at offshore oil platform (Claisse et al. 2014) suggest that artificial structure does not adversely affect rocky reef fishes.

Typical FAD-associated pelagic fish species are tropical or subtropical, and do not occur in the Project area. In temperate ocean waters of California, Oregon, and Washington, fish associations with midwater and surface structures were generally limited to some species of pelagic juvenile rockfish, which have been reported at various structures such as attached kelp (Matthews 1985, Bodkin 1986, Gallagher and Heppell 2010), floating kelp (Mitchell and Hunter 1970, Boehlert 1977), oil platforms (Love et al. 2010, 2012), vertical structures of docks and pilings (Gallagher and Heppell 2010), and "SMURFs" (Ammann 2004, Caselle et al. 2010, Woodson et al. 2012, Jones and Mulligan 2014). None of the studies of fish assemblages at these structures reported juvenile or adult salmonids. Due to the small Project footprint, the proposed action is not expected to have an adverse effect on EFH for coastal pelagic, salmon, groundfish or highly migratory species.

As detailed in section 5.1.2 *Underwater Sound*, temporary sound associated with Project construction and operations (e.g., WEC installation, maintenance, and removal), as well as the WECs themselves during operation, would generate underwater sound that could potentially affect EFH for groundfish, salmon, coastal pelagics, and highly migratory species. Measurements taken at PacWave North indicate ambient underwater sound pressures levels between 83 to 116 dB RMS re:1 µPa, with 50th percentile of 101 dB RMS re:1 µPa (Haxel 2019). Sound from vessel types that would be used for Project installation, operations and maintenance would not exceed 130 to 160 dB (re: 1 µPa) over a frequency range of 20 Hz to 10 kHz, except for the occasional use of DPVs, which could create sound levels of 180 dB re 1 µPa at 1 m (NMFS 2015i).

It is expected that a low level of additional sound could be produced by the WECs based on measurements taken at existing WECs deployments. The maximum sound pressure level (SPL) for Columbia Power Technologies' 1/7-scale WEC was estimated at 146 dB re: 1 µPa at 1 m, and 126 dB re: 1 µPa at 10 m (Thomson et al. 2012, as cited in NAVFAC 2014). In the EA prepared for the Hawaii Wave Energy Test Site, engineers conservatively assumed that a full-sized WEC would be 3-6 dB louder than the 1/7 scale version, and estimated that the maximum SPL for a WEC would be 148-151 dB re: 1 µPa at 1 m (NAVFAC 2014). Other analysis suggests that WECs would result in sound only in the range of 75 to 80 dB, with somewhat higher frequencies than light- to normal-density shipping sound (Sound & Sea Technology 2002 cited in Department of the Navy 2003). Per NMFS request, to be conservative a source term of 151 dB re: 1 μPa at 1 m was used in this analysis. Implementing NMFS practical spreading model with the highest WEC sound source term, sound levels of WECs would attenuate to 120 dB re: 1 μPa at 125 m. OSU would implement the Acoustic Monitoring Study under the Adaptive Management Framework to detect and, if needed, mitigate any effects of Project-related sound. Therefore, acoustic emissions from Project vessels and WECs are unlikely to adversely affect EFH.

As detailed in section 5.1.3 *Electromagnetic Fields*, the subsea cables, umbilicals, subsea connectors, and WECs would produce EMF that could potentially affect EFH for high migratory species, coastal pelagics, groundfish, and salmon. However, as described above, studies on EMF from subsea cables observed no behavior change in invertebrates or fish (BOEM 2016, Kuhnz et al. 2011, Love et al. 2016, Kogan et al. 2006), and similar lack of responses are expected at PacWave South. In addition, the levels of EMF are expected to be low and would be minimized through armoring and subsea cable shielding and burial. Because the cables would be buried 1-2 m (3-6 ft) below the seafloor, the physical separation will greatly reduce the amount of EMF exposure to marine animals (around 80 percent [Normandeau et al. 2011]). The magnetic field at the seafloor by would be expected to reach ambient conditions about 2 m above the seafloor (Normandeau et al. 2011, Gill 2016). To manage uncertainties and understand the magnitude and extent of Project-related EMF emissions relative to the natural EMF background, OSU would implement the EMF Monitoring Plan under the Adaptive Management Framework to detect and, if needed, mitigate any unanticipated adverse effects of Project-related EMF emissions. Consequently, EMF emissions from the Project are not expected to adversely affect EFH.

As detailed in Section 5.1.4 *Construction Effects on Surface Streams*, the terrestrial portion of the Project would occur at Driftwood, and is subject to disturbance associated with construction and presence of roadways and proximal development. Potential effects to EFH in surface waterbodies in the Project area include effects from potential increases in turbidity and sediment loading in streams, and potential hazardous materials release. However, these effects are expected to be minor, short-term, and temporary, and very localized due to the small footprint of the terrestrial component of the Project (there are only two named and three unnamed stream crossings) and implementation of BMPs during construction. The fish-bearing streams in the Project area will be avoided entirely by installing the cables under them using HDD, and their habitat would be protected during construction due to implementation of BMPs. Consequently, terrestrial construction activities are not expected to adversely affect EFH.

7.2 ESSENTIAL FISH HABITAT CONSERVATION MEASURES

The Project is not expected to result in any significant effects on EFH, and therefore, no habitat conservation measures are proposed. However, the proposed environmental measures outlined in section 2.4 would also benefit EFH. Specifically, the following:

- Use HDD to install the cables under the nearshore and intertidal habitat (to approximately 10-m isobath) to minimize substrate disturbance.
- Bury subsea cables to the maximum extent practicable, at a depth of 1-2 meters, to the maximum extent practicable, to minimize the amount of habitat conversion (soft bottom to hard structure) from laying exposed cable on the seafloor.
- Implement the Benthic Sediments Monitoring Plan to evaluate effects on benthic habitat from anchors, WECs, and other equipment during operation, maintenance and monitoring activities. Based on monitoring results, implement the specified measures to mitigate for potential adverse effects.
- Utilize shielding on subsea cables and umbilicals, and other electrical infrastructure (including, to the extent feasible, hubs and subsea connectors) to minimize EMF emissions, to the maximum extent practicable.
- Implement the EMF Monitoring Plan to measure Project-related EMF emissions. Based on monitoring results, implement the specified measures to mitigate for potential adverse effects.
- Follow industry best practices and guidelines for antifouling applications (e.g., TBT-free) on Project structures such as marker buoys, subsurface floats and WECs.
- Develop and implement an Emergency Response and Recovery Plan with spill prevention, response actions, and control protocols, as well as and provisions for recording types and amounts of hazardous fluids contained in WECs and other Project components.
- Require all vessel operators to comply with an Emergency Response and Recovery Plan for installation and maintenance of Project facilities
- Prepare waste management, hazardous material, and spill prevention plans, as appropriate, for onshore Project facilities.
- Implement the Organism Interactions Monitoring Plan to track changes to pelagic and demersal fish and invertebrates (particularly Dungeness crab) that might be attracted to the installed components or affected due to the potential for reduced fishing pressure, as well as biofouling on the anchors/WECs (Appendix H of the APEA).
- Develop cable routes that avoid crossing areas with rocky reef and hard substrate to the maximum extent practicable to protect sensitive habitat features.
- Develop and implement an anchoring plan or protocol for any Project vessels that may anchor at the Project site, that:

  - Avoids anchoring in known rocky reef or hard substrate habitats to the maximum extent practicable; and
  - Minimizes the use of anchors within the Project area wherever practicable by combining onsite activities.
- Minimize disturbance of streams that support fish, or are connected to fish-bearing streams. Unavoidable work within or adjacent to fish-bearing streams may be subject to in-water work windows. If terrestrial activities directly or indirectly affect any stream used by anadromous fish or fish listed as threatened or endangered under the federal ESA, consult with NMFS staff to avoid and minimize any potential effects to listed species.

7.3 DETERMINATION OF EFFECTS ON ESSENTIAL FISH HABITAT

The proposed Project would cause come disturbances to benthic habitat throughout the license term, but impacts would intermittent and localized. Benthic species including mobile organisms and fish are anticipated to quickly recolonize the disturbed areas along the cable route and anchors following installation. The potential loss of food resources for EFH management species due to Project activities would be insignificant due to the relatively small affected area and the ability of the disturbance-adapted benthic species found in the Project area to recover quickly. WEC-associated mooring systems would add in-water structure that could be used as habitat by reef associated species, including many groundfish species. However, the physical change to EFH (i.e., placement of anchors on the seafloor) would be relatively small compared the vast amount of surrounding habitat. Plus, studies on the artificial structures of oil platforms did not observe adverse effects on rockfish. Coastal pelagic species, Pacific salmon, and highly migratory species may pass through the action area but the structures are unlikely to concentrate these species (i.e., FAD-effect). Due to the low density of WECs and relatively small size of the Project area, the Project is not anticipated to prohibit movement of fishes through the action area or affect their prey species, and hence not effect EFH. Likewise, Project-related sound from WEC operation or vessels and EMF emitted from subsea cables are unlikely to reach levels that would displace fish or interrupt migratory patterns. The anticipated direct or indirect physical, chemical, or biological alterations of the waters or substrate within the Project site would be insignificant, and any loss of benthic organisms, prey species or habitat would be temporary or insignificant due to the small spatial scale. Therefore, the construction and operation of the Project would not adversely affect EFH designated for groundfish, coastal pelagic species, Pacific salmon, and highly migratory species.

8.0 REFERENCES

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APPENDIX B
Bird and Bat Conservation Strategy

BIRD AND BAT CONSERVATION STRATEGY

STATEMENT OF PURPOSE

The purpose of this Bird and Bat Conservation Strategy is to address bird and bat conservation practices from wind energy guidelines that are being applied to other renewable energy development, in compliance with the Migratory Bird Treaty Act (MBTA), for the installation and operation of the PacWave South (Project; formerly known as Pacific Marine Energy Center South Energy Test Site [PMEC-SETS]), a grid-connected wave energy test facility (FERC Project No. P-14616). The Project would be located approximately 6 nautical miles off the coast of Newport, Oregon, and would transfer power to the grid through four buried subsea cables running from the test site to a terrestrial cable connection point. An Applicant Prepared Environmental Assessment (APEA) has been developed to support this Project and is referenced throughout this document.

REGULATORY FRAMEWORK

MIGRATORY BIRD TREATY ACT (MBTA)

The MBTA (Act, 16 U.S.C. 703 et. seq.) is the cornerstone of migratory bird conservation and protection in the United States. The MBTA implements four treaties that provide for international protection of migratory birds. The statute prohibits the "taking" or possession of protected migratory birds in the absence of a U.S. Fish & Wildlife Service (FWS) permit or regulatory authorization. The FWS is the Federal agency with regulatory oversight and enforcement responsibility of MBTA provisions, and for providing guidance on best management practices and the FWS maintains a list of all species protected by the MBTA at 50 CFR 10.13. This list currently includes 1,026 species of migratory birds. Bird species and populations described in the Birds of Conservation Concern 2008 (FWS 2008) receive the highest priority for conservation action, aside from threatened and endangered species.

ENDANGERED SPECIES ACT (ESA)

The ESA directs the FWS to identify endangered and threatened species, including migratory birds, and their critical habitat. Pursuant to section 7 of the ESA, federal agencies must consult with the FWS before undertaking an action that "may affect" an ESA-listed species or its critical habitat. If the action is expected to adversely affect the species or its critical habitat, the FWS prepares a "biological opinion" regarding the proposed action's potential effects. If the FWS concludes that the action will not jeopardize the continued existence of the species or destroy or adversely modify its critical habitat, it will issue a statement authorizing any "take" of ESA-listed species that is incidental to the proposed action and imposing conditions to minimize and monitor the effect of such incidental take.

MIGRATORY BIRD MOU

Under Executive Order 13186, "Responsibilities of Federal Agencies to Protect Migratory Birds," Federal agencies have been directed to take certain actions to further implement the MBTA. To this end, the FWS has entered into Memorandums of Understanding (MOUs) with over a dozen agencies, including the

Federal Energy Regulatory Commission (FERC) and the Minerals Management Service (MMS) (precursor to Bureau of Ocean Energy Management (BOEM)). The MOU, between BOEM and the FWS, signed in June 2009, obligated the two agencies to strengthen migratory bird conservation through enhanced collaboration and to work together to reduce negative impacts of resource development projects on migratory birds. Specifically, it obligates BOEM to integrate migratory bird conservation principles, as well as reasonable and feasible conservation measures and management practices into BOEM approvals, procedures and practices consistent with the Council on Environmental Quality's (CEQ) regulations, and FWS and BOEM guidelines and procedures. While this MOU expired in 2014, FWS and BOEM are in the process of updating this MOU and the 2009 MOU is indicative of the agencies' commitments to work collaboratively to conserve migratory birds.

PROJECT DESCRIPTION

Oregon State University (OSU) is planning to file an application with the FERC for an original license for the installation and operation of the PacWave South, a grid-connected wave energy test facility (FERC Project No. 14616). The wave energy converter (WEC) deployment area would be located in the Pacific Ocean, approximately 6 nautical miles (11 km) off the coast of Newport, Oregon on the Outer Continental Shelf (OCS) and would occupy an area of approximately 2 square nautical miles (1,695 acres). The Project would support up to 20 commercial-scale WECs and transfer power to a grid connection point with the Central Lincoln People's Utility District (CLPUD) in Lincoln County, Oregon. The Project could generate up to 20 megawatts of energy that would travel through four individually buried subsea cables running from the test site to a terrestrial cable connection point at Driftwood Beach State Recreation Site in Seal Rock, Lincoln County, Oregon and then about 0.5 miles (0.8 km) south to a grid connection point with CLPUD via a Utility Connection and Monitoring Facility (UCMF). The portion of the OCS where the test site would be located is federal land administered by the BOEM. The subsea cables would cross Oregon's territorial sea. The terrestrial components of the Project would be sited on state, county, and privately-owned lands. The Project would serve as an integrated test center. As a grid-connected test facility, PacWave South would provide the opportunity to optimize WECs and arrays; refine deployment, retrieval, operations, and maintenance procedures; increase system reliability and survivability; collect interconnection and grid synchronization data; and gather information about potential environmental effects. See Section 2.2 of the APEA for a more detailed description of the Project.

BIRD AND BAT PRESENCE AND RISK ASSESSMENT

EXISTING ENVIRONMENT AND BIRD AND BAT PRESENCE

The special-status bird species that could occur in the WEC deployment area, in nearshore waters along the subsea cable route, on the beach at the cable connection point, and/or along the inland cable route are listed in Table 1. The potential effects on the federally listed species, marbled murrelet, short-tailed albatross, western snowy plover, and northern spotted owl, are addressed in greater detail in the biological assessment for PacWave South.

Table 1. Special-status bird species that could occur in the PacWave South Project area

Species	Scientific name	Status[1]	Project areas where it could occur[2]	Status in Project Areas	Comments
Black brant	*Branta bernicula nigricans*	S, CS (CR, N)	Nearshore	Migrant and winter resident	Does not breed in Project region
Harlequin duck	*Histrionicus histrionicus*	S, CS (CR)	Inland, Nearshore	Common in winter	Common nearshore in winter. Does not breed in Project region
Western grebe	*Aechmophorus occidentalis*	BCC	Nearshore	Common in winter	Does not breed in Project region
Laysan albatross	*Phoebastria immutabilis*	BCC	WEC deployment	Rare to uncommon year-round	Does not breed in Project region
Black-footed albatross	*Phoebastria nigripes*	BCC	WEC deployment	Uncommon to Fairly common year-round	Does not breed in Project region
Short-tailed albatross	*Phoebastria albatrus*	FE, SE	WEC deployment	Highly unlikely in Project area	Rare in pelagic waters south of Alaska. Does not breed in Project region
Pink-footed shearwater	*Ardenna creatopus*	BCC	WEC deployment	Common in summer, fall	Does not breed in Project region
Fork-tailed storm-petrel	*Oceanodroma furcata*	S, CS (N)	WEC deployment, Nearshore	Uncommon year-round	Nests in very small numbers along the Oregon coast, occasionally observed in large groups (>20 birds)
Leach's storm-petrel	*Oceanodroma leucorhoa leucorhoa*	S, CS (N)	WEC deployment, Nearshore	Uncommon year-round	Nests on offshore islands including along the Oregon coast (mostly off Curry County)
Pelagic cormorant	*Phalacrocorax pelagicus*	BCC	WEC deployment, Nearshore	Common nearshore year-round	Nests at Yaquina Head
Brown pelican	*Pelecanus occidentalis*	FD, SE, CS (N)	WEC deployment, Nearshore, Beach	Common nearshore visitor in spring-fall, unlikely offshore	Does not breed in Project region
Bald eagle	*Haliaeetus leucocephalus*	FD, BCC,EP	Beach, Inland	Year-round resident	Could nest in forested areas of Project region
Northern goshawk	*Accipiter gentilis laingi*	BCC	Inland	Uncommon year-round	Not likely to nest in Project region

Species	Scientific name	Status[1]	Project areas where it could occur[2]	Status in Project Areas	Comments
Golden eagle	*Aquila chrysaetos canadensis*	EP	Inland	Irregularly observed in winter along the coast	Does not breed in Project region
Black oystercatcher	*Haematopus bachmani*	BCC, SOC, S, CS (N)	Beach	Resident on rocky shores and sand/gravel beaches	Likely breeds in Project region
Western snowy plover	*Charadrius nivosus nivosus*	FT, ST, CS (CR, N)	Beach	Uncommon year-round	Likely breeds in Project region. Recent nests confirmed at and in the vicinity of Driftwood Beach.
Lesser yellowlegs	*Tringa flavipes*	BCC	Beach	Migrant	Does not breed in Project region
Whimbrel	*Numenius phaeopus*	BCC	Beach	Common spring and fall migrant	Does not breed in Project region
Long-billed curlew	*Numenius americanus*	BCC	Beach	Uncommon spring and fall migrant	Does not breed in Project region
Marbled godwit	*Limosa fedoa*	BCC	Beach	Common spring and fall migrant	Does not breed in Project region
Red knot	*Calidris canutus roselaari*	BCC	Beach	Uncommon spring and fall migrant	Does not breed in Project region
Rock sandpiper	*Calidris ptilocnemis*	S, CS (N)	Beach	Uncommon to rare spring and fall migrant and winter visitor on rocky shores	Does not breed in Project region
Short-billed dowitcher	*Limnodromus griseus*	BCC	Beach	Common spring and fall migrant	Does not breed in Project region
Marbled murrelet	*Brachyramphus marmoratus*	BCC, FT, ST, CS (CR, N)	WEC deployment, Nearshore	Common in nearshore waters (<1.5 km from shore), occasionally farther offshore	Nests in old-growth coniferous forests in Oregon, no suitable nesting habitat at the Project site
Guadalupe/Scripps's murrelet	*Synthliboramphus hypoleucus/scrippsi*	SOC	WEC deployment	Uncommon late summer and fall	Does not breed in Project region
Tufted puffin	*Fratercula cirrhata*	SC, CS (CR, N)	WEC deployment, Nearshore	Uncommon year-round	Nests at Yaquina Head
Caspian tern	*Hydroprogne caspia*	BCC, S, CS (CR, N)	WEC deployment, Nearshore	Uncommon spring through fall	Does not breed in Project region
Arctic tern	*Sterna paradisaea*	BCC	WEC deployment	Uncommon spring and fall migrant	Does not breed in Project region

Species	Scientific name	Status[1]	Project areas where it could occur[2]	Status in Project Areas	Comments
Northern spotted owl	*Strix occidentalis caurina*	FT, ST, CS (CR)	Inland	Year-round resident, likely rare to uncommon, visitor in Project area	Nests in mature coniferous forests in coastal mountains in the region but not the immediate Project area
Black swift	*Cypseloides niger*	BCC	Inland	Rare to uncommon transient/visitor in spring through fall	Unlikely to nest in Project region
Rufous hummingbird	*Selasphorus rufus*	BCC	Inland	Common transient and breeder in western Oregon	Could nest in forested areas of Project region
Peregrine falcon	*Falco peregrinus*	FD, BCC, S, CS (CR)	Inland, Beach, Nearshore	Resident and migratory in a wide variety of habitats in Oregon	Could nest in Project region
Olive-sided flycatcher	*Contopus cooperi*	BCC, S, CS (CR)	Inland	Uncommon breeder and spring/fall migrant	Nests in coastal Oregon forests, could nest in Project region
Willow flycatcher	*Empidonax traillii adastus*	BCC	Inland	Transient during breeding season and spring/fall migrant	Does not breed in Project region
Purple martin	*Progne subis*	SC, CS (CR)	Inland	Uncommon breeder and spring/fall migrant	Nests in coastal open habitats, could nest in Project region
Purple finch	*Carpodacus purpureus*	BCC	Inland	Common year-round	Nests in a variety of coastal habitats, could nest in Project region

Notes: [1]BCC – Birds of Conservation Concern (FWS 2008); FE – Federally endangered; FT – Federally threatened; FD – Federally delisted; EP – Protected under the Bald and Golden Eagle Protection Act; SOC – FWS Species of Concern; ST – Oregon State threatened; SE – Oregon State endangered; S – Oregon sensitive species list, Sensitive in Coast Range (CR) and/or Nearshore (N) ecoregions; SC – Oregon sensitive species list, Sensitive-Critical in Coast Range (CR) and/or Nearshore (N) ecoregions (ODFW, 2016); CS – Oregon Conservation Strategy species, designated in Coast Range (CR) and/or Nearshore (N) ecoregions as needing management attention (Krutzikowsky et al. 2016)
[2] Locations in the Project Area where species could occur: WEC deployment, nearshore, beach, and/or inland

Marine Environment

See Section 3.3.3.1 of the APEA, "Seabirds" for more information about seabird use and abundance in the Project area, including special-status birds. The north-central Oregon coast, where the Project is located, has extensive sandy beaches and hosts relatively few nesting seabirds; it is home to about six percent of the Oregon seabird breeding population (Naughton et al. 2007). Ten species of breeding seabirds and one species of rocky-intertidal shorebird (Leach's storm-petrel, Brandt's and pelagic cormorants, black oystercatcher, common murres, pigeon guillemot, Cassin's auklet, rhinoceros auklet, tufted puffin, and western and glaucous-winged gulls) are known to nest in this region (Naughton et al. 2007); in the Project region, the majority nest at Yaquina Head located about 15 km to the northeast of the Project site, although a few cormorants, gulls, pigeon guillemots, and black oystercatchers nest along the shores south of Newport, potentially in the general vicinity of the shore cable landing. With the exception of black oystercatchers, which are restricted to shore and rocky reefs, any of the other seabird species that nest in the area could occur in and forage in waters around the PacWave South.

Oregon coastal waters provide important foraging habitat for seabirds throughout the year, but particularly in the fall, as millions of marine birds that breed elsewhere (e.g., auklets, albatrosses, shearwaters, loons, grebes, sea ducks, and gulls) migrate to Oregon's productive coastal waters to feed (Naughton et al. 2007, Suryan et al. 2012). Based on aerial surveys conducted in 2011-2012 from Fort Bragg, CA to Grays Harbor, WA and from shore to 2,000 m depth (e.g., inner-shelf waters to continental slope waters), the highest marine bird densities occurred along the entire nearshore (<100 m depth) Oregon coast during fall (49.4 ± 5.0 birds/km^2), with smaller but similar densities in winter and summer (37.4 ± 4.6 birds/km^2 and 37.5 ± 6.4 birds/km^2, respectively; Adams et al. 2014). Common murres and sooty shearwaters were the most abundant species in the Project area in spring and summer, based on boat and aerial surveys conducted in the inner shelf waters (<100 m depth) around Newport in March-August 2003-2009 (Suryan et al. 2012), in 2011–2012 (Adams et al. 2014), and in 2013-2014 (R. Suryan, unpubl. data); these two species are also the most abundant seabirds along the entire Oregon coast in spring and summer (Strong 2009, Suryan et al. 2012, Zamon et al. 2014).

Focused vessel-based strip transect surveys conducted in 2013-2015 around the PacWave South and PacWave North (formally known as Pacific Marine Energy Center - North Energy Test Site [PMEC-NETS]) WEC deployment areas (1.6-40 km from shore) reported common murres and sooty shearwaters as the most abundant species around PacWave South; common murres were most densely aggregated in spring (800-1,100 murres/km^2), while sooty shearwaters dominated in fall (100-220 shearwaters/km^2) (Porquez 2016). The PacWave South had low overall relative abundance compared to adjacent areas, although the whole area appears to be productive foraging habitat for many seabird species (Porquez 2016). Brown pelicans and marbled murrelets were observed inshore of PacWave South, and black-footed albatross were only detected west of the area (Porquez 2016).

Aerial surveys in 2011-2012 indicated that the inner shelf waters (<100 m depth) around Newport had an influx of seabirds such as shearwaters, northern fulmars, Cassin's auklets, rhinoceros auklets, and brown pelicans in the fall (Adams et al. 2014). Thus, seabirds would likely occur and forage in the PacWave South throughout the year; abundance would likely be highest in the fall, and species composition would change throughout the year. The seabird species included in Table 2 represent a list of species that have been reported in waters 0–20 km from shore in the vicinity of the PacWave South and could be expected to occur in the PacWave South throughout the year. Cormorants, however, have been shown to take advantage of perching opportunities on novel structures.

Table 2. Marine bird species that could occur in the PacWave South offshore WEC deployment area based on survey data (Strong 2009; Adams et al. 2014; R. Suryan, unpubl. data; Porquez 2016) and *Birds of Oregon* (Marshall et al. 2006)

Species	Scientific name	Status	Spring/ Summer	Fall	Winter
Surf scoter[1]	*Melanitta perspicillata*	--	U	U[5, 6]	U[5, 6]
White-winged scoter[1]	*Melanitta fusca*	--	U	U[5]	U[5]
Pacific loon	*Gavia pacifica*	--	U	U[5, 7]	U[5, 6, 7]
Common loon	*Gavia immer*	--	U[7]	U[5, 6, 7]	U[5, 6, 7]
Laysan albatross	*Phoebastria immutabilis*	BCC	U	U	U
Black-footed albatross	*Phoebastria nigripes*	BCC	U[6]	U	U
Northern fulmar	*Fulmarus glacialis*	--	U	C[5]	C[6]
Pink-footed shearwater	*Ardenna creatopus*	BCC	C[6]	C[5, 6]	U
Flesh-footed shearwater	*Ardenna carneipes*	--	U[6]	U[6]	U
Buller's shearwater	*Ardenna bulleri*	--	U	C[5]	U
Sooty shearwater	*Ardenna grisea*	--	C[5, 6, 7, 8]	C[5, 6, 7, 8]	C[6, 8]
Short-tailed shearwater	*Ardenna tenuirostris*	--		C[6, 7]	C[6]
Fork-tailed storm-petrel	*Oceanodroma furcata*	S, CS (N)	U[5]	U[6]	U[6]
Leach's storm-petrel	*Oceanodroma leucorhoa leucorhoa*	S, CS (N)	U[5]	U[6]	U[6]
Brandt's cormorant[2]	*Phalacrocorax penicillatus*	--	C[5, 6, 7, 8]	C[5, 6, 7, 8]	C[5, 6, 7, 8]
Double-crested cormorant	*Phalacrocorax auritus*	--	U[6]	U	U[6]
Pelagic cormorant[2]	*Phalacrocorax pelagicus*	BCC	U[5, 6, 7, 8]	U[5, 6, 7, 8]	U[5, 6, 7, 8]
Brown pelican	*Pelecanus occidentalis*	FD, SE, CS (N)	U[6]	U[5, 6]	U
Red-necked phalarope[3]	*Phalaropus lobatus*	--	C[6, 8]	C[5, 6, 8]	
Red phalarope[3]	*Phalaropus fulicarius*	--	U	C[5]	U
South polar skua	*Stercorarius maccormicki*			U	
Pomarine jaeger	*Stercorarius pomarinus*	--	U	U	U
Parasitic jaeger	*Stercorarius parasiticus*	--	U	U	U
Long-tailed jaeger	*Stercorarius longicaudus*		U	U	
Common murre	*Uria aalge*	--	C[5, 6, 7, 8]	C[5, 6, 7, 8]	C[5, 6, 7, 8]
Pigeon guillemot	*Cepphus columba*	--	U[6, 7]	U[6, 7]	U
Marbled murrelet	*Brachyramphus marmoratus*	BCC, FT, ST, CS (CR, N)	U[6, 7]	U[6, 7]	U
Ancient murrelet	*Synthliboramphus antiquus*	--	U	U	U
Guadalupe/Scripps's murrelet	*Synthliboramphus hypoleucus/scrippsi*	SOC	U	U	U
Cassin's auklet	*Ptychoramphus aleuticus*	--	U[6, 8]	C[5, 6, 7, 8]	C[5, 6, 7, 8]
Rhinoceros auklet	*Cerorhinca monocerata*	--	U[6]	C[5, 6, 7]	C[5, 6]
Tufted puffin	*Fratercula cirrhata*	SC, CS (CR, N)	U	U	U
Black-legged kittiwake	*Rissa tridactyla*	--	U	C	C[5]
Sabine's gull	*Xema sabini*	--	U	U	

Species	Scientific name	Status	Spring/ Summer	Fall	Winter
Bonaparte's gull	*Chroicocephalus philadelphia*	--	U	U	U
Heermann's gull	*Larus heermanni*	--	U	U[6, 7]	U[6]
Mew gull	*Larus canus*	--	U	U	U[6]
Ring-billed gull	*Larus delawarensis*	--	U	U[6]	U[6, 7]
Western gull	*Larus occidentalis*	--	C[5, 6, 7, 8]	C[5, 6, 7, 8]	C[5, 6, 7, 8]
California gull	*Larus californicus*	--	C[5, 6, 7]	C[5, 6, 7]	C[5, 6]
Herring gull[4]	*Larus argentatus*	--	U	C[5]	C[5]
Iceland (Thayer's) gull[4]	*Larus glaucoides thayeri*	--	U	U[5]	U[5]
Glaucous-winged gull	*Larus glaucescens*	--	U[5]	C[5, 6]	C[5, 6]
Caspian tern	*Hydroprogne caspia*	BCC, S, CS (CR, N)	U	U[7]	U
Common tern	*Sterna hirundo*	--	U	U	
Arctic tern	*Sterna paradisaea*	BCC	U	U	

Notes: BCC – Birds of Conservation Concern (FWS 2008); FE – Federally endangered; FT – Federally threatened; FD – Federally delisted; EP – Protected under the Bald and Golden Eagle Protection Act; SOC – FWS Species of Concern; ST – Oregon State threatened; SE – Oregon State endangered; S – Oregon sensitive species list, Sensitive in Coast Range (CR) and/or Nearshore (N) ecoregions; SC – Oregon sensitive species list, Sensitive-Critical in Coast Range (CR) and/or Nearshore (N) ecoregions (ODFW, 2016); CS – Oregon Conservation Strategy species, designated in Coast Range (CR) and/or Nearshore (N) ecoregions as needing management attention (Krutzikowsky et al. 2016)

C – Common; U – Uncommon
[1] Surf and white-winged scoters were indistinguishable and thus reported together in aerial surveys (Adams et al. 2014)
[2] Brandt's and pelagic cormorants were indistinguishable and thus reported together in aerial surveys (Adams et al. 2014)
[3] Red and red-necked phalaropes were indistinguishable and thus reported together in aerial surveys (Adams et al. 2014)
[4] Herring and Thayer's gulls were indistinguishable and thus reported together in aerial surveys (Adams et al. 2014)
[5] Species reported from aerial surveys conducted 0-100 m depth offshore of Newport in 2011-2012 (Adams et al. 2014)
[6] Species reported from boat surveys conducted within 20 km of shore around PacWave South in 2013-2014 (R. Suryan, unpubl. data)
[7] Species reported from boat surveys conducted 0-10 km from shore around PacWave North (<10 km north ofPacWave South) in 2013-2014 (R. Suryan, unpubl. data)
[8] Reported as a "dominant" species from boat surveys conducted 1.6-40 km from shore around PacWave South and PacWave North in 2013-2015 (Porquez 2016)

Bat species that could occur in the marine Project area include hoary bats (*Aeorestes cinereus*), which are known to migrate south in autumn offshore and along the coast of central California (Cryan and Brown 2007). Although eastern red bats (*Lasiurus borealis*) are known to migrate offshore along the mid-Atlantic (Hatch et al. 2013) and western red bats (*Lasiurus blossevillii*) are also known to migrate offshore of central California (Cryan and Brown 2007), western red bats do not occur north of the California – Oregon border. Therefore, western red bats are not expected to occur in the marine Project area. No other occurrences of bats in the marine Project area have been identified to species based on observations, museum records and reviewed literature.

Nearshore/Intertidal Environment

Typical bird species associated with nearshore waters similar to those of the cable landing site include harlequin duck, surf scoter, white-winged scoter, black scoter, long-tailed duck, red-throated loon, Pacific loon, common loon, red-necked grebe, eared grebe, western grebe, Brandt's cormorant, double-crested cormorant, pelagic cormorant, brown pelican, red-necked phalarope, red phalarope, common murre, pigeon guillemot, Cassin's auklet, rhinoceros auklet, tufted puffin, and gulls (e.g., western, herring, Thayer's, California, glaucous-winged, Bonaparte's, mew, and Heermann's gulls) (Marshall et al. 2006). Shorebird species likely to occur on wide sandy beaches at the cable landing site include black oystercatcher, semipalmated plover, killdeer, whimbrel, marbled godwit, ruddy turnstone, black turnstone, sanderling, dunlin, least sandpiper, and western sandpiper (Marshall et al. 2006). Other bird species that could occur on the sandy beaches at the cable landing site include brown pelican, great blue heron, snowy, and great egrets, turkey vulture, osprey, bald eagle, gulls, and western snowy plover. A list of the bird species that could occur in the PacWave South nearshore and intertidal waters, and in the beach cable landing area are listed in Table 3.

Table 3. Bird species that could occur in the PacWave South nearshore/intertidal waters and beach cable landing area (Kelly pers. comm. 2014, Marshall et al. 2006)

Species	Scientific name	Status
Black brant	*Branta bernicula nigricans*	S, CS (CR, N)
Aleutian cackling goose	*Branta canadensis leucopareia*	
Greater scaup	*Aythya marila*	
Lesser scaup	*Aythya affinis*	
Harlequin duck	*Histrionicus histrionicus*	S, CS (CR)
Surf scoter	*Melanitta fusca*	
White-winged scoter	*Melanitta fusca*	
Black scoter	*Melanitta nigra*	
Long-tailed duck	*Clangula hyemalis*	
Bufflehead	*Bucephala albeola*	
Common goldeneye	*Bucephala clangula*	
Barrow's goldeneye	*Bucephala islandica*	
Common merganser	*Mergus merganser*	
Red-breasted merganser	*Mergus serrator*	
Ruddy duck	*Oxyura jamaicensis*	
Red-throated loon	*Gavia stellata*	
Pacific loon	*Gavia pacifica*	
Common loon	*Gavia immer*	
Horned grebe	*Podiceps auritus*	
Red-necked grebe	*Podiceps grisegena*	
Eared grebe	*Podiceps nigricollis*	
Western grebe	*Aechmophorus occidentalis*	BCC
Clark's grebe	*Aechmophorus clarkii*	
Sooty shearwater	*Ardenna grisea*	
Fork-tailed storm petrel	*Oceanodroma furcata*	S, CS (N)
Leach's storm-petrel	*Oceanodroma leucorhoa leucorhoa*	S, CS (N)
Brandt's cormorant	*Phalacrocorax penicillatus*	
Double-crested cormorant	*Phalacrocorax auritus*	
Pelagic cormorant	*Phalacrocorax pelagicus*	BCC
Brown pelican	*Pelicanus occidentalis*	FD, SE, CS (N)
Great blue heron	*Ardea herodias*	
Great egret	*Ardea alba*	
Snowy egret	*Egretta thula*	
Turkey vulture	*Cathartes aura*	
Osprey	*Pandion haliaetus*	

Species	Scientific name	Status
Bald eagle	*Haliaeetus leucocephalus*	FD, BCC
Northern harrier	*Circus cyaneus*	
Red-tailed hawk	*Buteo jamaicensis*	
Black oystercatcher	*Haematopus bachmani*	BCC, SOC, S, CS (CR, N)
Western snowy plover	*Charadrius nivosus nivosus*	FT, ST, CS (N)
Black-bellied plover	*Pluvialis squatarola*	
Pacific golden-plover	*Pluvialis fulva*	
Semipalmated plover	*Charadrius semipalmatus*	
Killdeer	*Charadrius vociferus*	
Spotted sandpiper	*Actitis macularius*	
Wandering tattler	*Tringa incana*	
Greater yellowlegs	*Tringa melanoleuca*	
Lesser yellowlegs	*Tringa flavipes*	BCC
Whimbrel	*Numenius phaeopus*	BCC
Long-billed curlew	*Numenius americanus*	BCC
Marbled godwit	*Limosa fedoa*	BCC
Ruddy turnstone	*Arenaria interpres*	
Black turnstone	*Arenaria melanocephala*	
Red knot	*Calidris canutus roselaari*	BCC
Surfbird	*Calidris virgata*	
Sanderling	*Calidris alba*	
Dunlin	*Calidris alpina*	
Rock sandpiper	*Calidris ptilocnemis*	S, CS (N)
Baird's sandpiper	*Calidris bairdii*	
Least sandpiper	*Calidris minutilla*	
Pectoral sandpiper	*Calidris melanotos*	
Western sandpiper	*Calidris mauri*	
Short-billed dowitcher	*Limnodromus griseus*	BCC
Long-billed dowitcher	*Limnodromus scolopaceus*	
Wilson's snipe	*Gallinago delicata*	
Red-necked phalarope	*Phalaropus lobatus*	
Red phalarope	*Phalaropus fulicarius*	
Pomarine jaeger	*Stercorarius pomarinus*	
Parasitic jaeger	*Stercorarius parasiticus*	
Common murre	*Uria aalge*	
Pigeon guillemot	*Cepphus columba*	
Marbled murrelet	*Brachyramphus marmoratus*	BCC, ST, FT, CS (CR, N)
Ancient murrelet	*Synthliboramphus antiquus*	
Cassin's auklet	*Ptychoramphus aleuticus*	
Rhinoceros auklet	*Cerorhinca monocerata*	
Tufted puffin	*Fratercula cirrhata*	SC, CS (CR, N)
Black-legged kittiwake	*Rissa tridactyla*	
Bonaparte's gull	*Chroicocephalus philadelphia*	
Heermann's gull	*Larus heermanni*	
Mew gull	*Larus canus*	
Ring-billed gull	*Larus delawarensis*	
Western gull	*Larus occidentalis*	
California gull	*Larus californicus*	
Herring gull	*Larus smithsonianus*	

Species	Scientific name	Status
Thayer's gull	*Larus thayeri*	
Glaucous-winged gull	*Larus glaucescens*	
Caspian tern	*Sterna caspia*	BCC, S, CS (CR, N)
Common tern	*Sterna hirundo*	
Elegant tern	*Thalasseus elegans*	
Short-eared owl	*Asio flammeus*	
American kestrel	*Falco sparverius*	
Merlin	*Falco columbarius*	
Peregrine falcon	*Falco peregrinus*	BCC, FD, S, CS (CR)
Notes: BCC – Birds of Conservation Concern (FWS 2008); FE – Federally endangered; FT – Federally threatened; FD – Federally delisted; EP – Protected under the Bald and Golden Eagle Protection Act; SOC – FWS Species of Concern; ST – Oregon State threatened; SE – Oregon State endangered; S – Oregon sensitive species list, Sensitive in Coast Range (CR) and/or Nearshore (N) ecoregions; SC – Oregon sensitive species list, Sensitive-Critical in Coast Range (CR) and/or Nearshore (N) ecoregions (ODFW 2016); CS – Oregon Conservation Strategy species, designated in Coast Range (CR) and/or Nearshore (N) ecoregions as needing management attention (Krutzikowsky et al. 2016))		

Terrestrial Environment

See Section 3.3.4.1 of the APEA, "Upland Vegetation and Terrestrial Wildlife" for more information about terrestrial bird species use of the Project area, including special-status birds. A large number of bird species could occur along the inland cable route; these species include, for example, great blue heron, snowy and great egrets, turkey vulture, osprey, bald eagle, Cooper's hawk, sharp-shinned hawk, red-tailed hawk, gulls, band-tailed pigeon, rufous hummingbird, killdeer, red-breasted sapsucker, northern flicker, olive-sided flycatcher, western wood-pewee, willow flycatcher, Pacific-slope flycatcher, gray jay, American crow, common raven, purple martin, tree swallow, black-capped and chestnut-backed chickadees, bushtit, red-breasted nuthatch, brown creeper, Bewick's wren, Pacific wren, golden-crowned kinglet, Swainson's thrush, American robin, wrentit, hermit, black-throated gray, MacGillivray's and Wilson's warblers, common yellowthroat, yellow-breasted chat, spotted towhee, savannah, song, and white-crowned sparrows, black-headed grosbeak, red-winged blackbird, purple and house finches, and house sparrow (Marshall et al. 2006). A list of the special-status bird species that could occur along the inland cable route is included in Table 1.

The terrestrial Project area occurs through mixed conifer/deciduous forest habitat with Sitka spruce and a mixture of other conifers such as western hemlock, Pacific red cedar, or yellow cedar that provides many bat species with maternity roosting habitat as well as hibernacula. More open habitats such as estuaries, creeks, and open meadows provide many bat species with appropriate foraging habitat. Based on capture records for Lincoln County from Ormsbee et al. (2010), and unpublished acoustic data (ODFW 2015), bat species that could occur in the terrestrial Project area include big brown bat (*Eptesicus fuscus*), California myotis (*Myotis californicus*), fringed myotis (*M. thysanodes*), long-legged myotis (*M. volans*), Yuma myotis (*M. yumanensis*), little brown bat (*M. lucifugus*), long-eared myotis (*M. evotis*), hoary bat, Townsend's big-eared bat (*Corynorhinus townsendii*), and silver-haired bat (*Lasionycteris noctivagans*).

A survey for potential bat roost habitat was conducted on April 17, 2019, at and within 400 ft of the Driftwood Beach State Recreation Area and the UCMF property, and a SM4 bat detector (Wildlife

Acoustics Inc., Maynard, Massachusetts) was deployed at two different locations overnight on April 16, 2019 (at the metal shed on the UCMF property) and April 17, 2019 (south of the UCMF property but within 250 feet of potential construction on an adjacent homeowner's property) to record any potential bats that might emerge from these potential roost sites (Attachment A). At Driftwood, none of the trees or structures within 400 feet of the construction zone provided suitable habitat for the Townsend's big eared bat, a cavernous roosting bat. Additionally, the homes to the north of Driftwood are occupied by humans and their activities would not be tolerated by this sensitive species. Most of the shore pines (*Pinus contorta*) are low to the ground and have dense foliage; and thus, they provide no potential roosting habitat for bats. The shore pines and a very few Douglas fir trees (*Pseudotsuga menziesii*) become larger on the site when they occur away from the coast (closer to Highway 101). However, none of these larger trees at Driftwood or inside the forests occurring within 400 feet of the construction area appear to provide potential habitat for crevice-roosting bats. Although the private properties to the east and across the highway from Driftwood were not physically walked for surveys, these trees and structures do not appear to support potential roosting habitat for bats.

At the UCMF property, there is a relatively small unused barn covered with metal sheeting that does not provide potential maternity colony roosting habitat. As at Driftwood, none of the trees or structures within 400 feet of the construction area provided suitable habitat for the Townsend's big eared bat. A bat detector deployed at the small barn recorded three calls from likely a single California myotis (*Myotis californicus*) on the evening of April 17, 2019. The structure is too light inside and does not provide a consistently warm environment needed for a maternity colony. However, the residential area immediately south of the UCMF property has potential for several species of crevice-roosting bats. Many echolocation calls were recorded at about dusk from two commonly occurring species, the California myotis and the silver-haired bat (*Lasionycteris noctivagans*), within a short distance of the UCMF property suggesting these species have formed maternity colonies near the UCMF property. The private properties to the west of the UCMF property were viewed from the highway, and the trees within the 400 foot buffer of the western edge of the property line do not appear to support potential maternity colony bat roosting habitat.

Table 4. Bat species expected to occur in the PacWave South terrestrial Project area, and Bat species documented by acoustic detectors on April 16 and 17, 2019 near the UCMF property

Vernacular name	Scientific name	Potential to raise young in Project area	State status	Federal status
Big brown bat	*Eptesicus fuscus*	Yes		
California myotis[1]	*Myotis californicus*	Yes	S, CS (CR)	
Yuma myotis	*Myotis yumanensis*	Yes		BLM-S, SOC
Fringed myotis	*Myotis thysanodes*	Yes	S, CS (CR)	BLM-S, SOC
Long-legged myotis	*Myotis volans*	Yes	S, CS (CR)	SOC
Little brown bat	*Myotis lucifugus*	Yes		
Long-eared bat	*Myotis evotis*	Yes		BLM-S
Hoary bat	*Aeorestes cinereus*	No	S, CS (CR)	SOC
Townsend's big-eared bat	*Corynorhinus townsendii*	Yes	SC, CS (CR)	BLM-S, SOC

Vernacular name	Scientific name	Potential to raise young in Project area	State status	Federal status
Silver-haired bat[1]	*Lasionycteris noctivagans*	Yes	S, CS (CR)	SOC
BLM-S – Bureau of Land Management Sensitive; SOC – U.S. Fish and Wildlife Service Species of Concern; S – Sensitive in Coast Range (CR) ecoregion; SC – Oregon sensitive species list, Sensitive-Critical in Coast Range (CR) ecoregion (ODFW 2016); CS – Oregon Conservation Strategy species, designated in Coast Range (CR) ecoregion as needing management attention (Krutzikowsky et al. 2016). [1] Detected by SM4 bat detectors (Wildlife Acoustics Inc., Maynard, Massachusetts) near the UCMF property				

RISK ASSESSMENT

Effects on Seabirds

In a review of existing world-wide information on environmental effects of marine renewable energy development, the authors stated there was “no evidence that seabirds are likely to be unduly attracted to or harmed by association with static MRE devices”; although there were concerns that seabirds could collide with the moving parts of devices (Copping et al. 2016). However, a study on wave and tidal devices in Scottish waters, which has a similar suite of seabird species as Oregon waters (e.g., predominately alcids and cormorants) described the vulnerability of most seabird populations to adverse effects from wave energy devices as low or very low, with the exception of “divers” (i.e., loons) which were considered a moderate risk; however, even a high score for collision risk with wave energy devices “would probably represent a relatively low risk compared to risks such as entanglement in netting” (Furness et al. 2012). Notably, common murres, the species likely to be most abundant at the PacWave South, were ranked as having a low vulnerability to wave energy device impacts. The following have been identified as potential direct and indirect impacts of the Project on seabirds:

- Effects of habitat alteration - changes to marine community composition and behavior (e.g., use patterns, attraction, and avoidance)
    - Effects of seabird attraction and perching on Project structures
    - Effects of seabird avoidance/displacement of Project area
    - Effects of artificial lighting on seabirds
- Effects of underwater sound/vibration on seabirds
- Effects or risk of collision, entanglement, crushing, or entrapment with Project structures, entangled gear, or service vessels
- Effects of increased human activity on nesting seabirds

Effects of Habitat Alteration on Seabirds - Changes to Marine Community Composition and Behavior

Effects of Seabird Attraction and Perching on Project Structures – Seabirds, such as gulls and cormorants, could perch on or attempt to nest on above-water structures at PacWave South. Perching on buoys and other manmade structures is a common behavior for gulls and cormorants, and perching itself is not generally considered to adversely affect these birds. However, if they do perch on the structures, they could adversely affect the structures themselves, complicate maintenance activities, forage around underwater WEC components, and potentially be subject to collision with underwater WEC components or entanglement with marine debris that becomes entangled with the components, although this effect is also unlikely to occur (Henkel et al. 2013; see "potential effects of collision or entanglement" section below). Significant adverse effects on seabirds as a result of perching on Project structures or feeding on fish are not expected to occur. OSU would make opportunistic visual observations in the portions of the WEC test site during vessel-based visits to conduct operations, maintenance or environmental monitoring work to detect and document any instances of seabird perching at least once per quarter. If perching is such that it may prevent access to a WEC (e.g., nest(s) are observed, accumulated guano prevents safe access), or may result in damage to a WEC (guano is corroding treated surfaces), OSU and the WEC testing client will devise a plan in coordination with FWS to prevent or discourage future seabird perching or nesting utilizing any practicable non-lethal measures available. Active nests will not be disturbed after egg-laying or before fledging of young unless critical maintenance is required or in the event of an emergency.

Effects of Seabird Avoidance/Displacement of Project Area – Some species of marine birds could exhibit avoidance behavior around the WECs. In Europe, common eiders (*Somateria mollissima*) and pink-footed geese (*Anser brachyrhychus*) have been shown to avoid offshore wind farms during their migration between wintering and breeding grounds, by adjusting their flight trajectories and flying around the farms (Desholm and Kahlert 2005; Masden et al. 2009; Plonczkier and Simms 2012), and several species of loons, sea ducks, and seabirds have been estimated to have a moderate to high risk of displacement by offshore wind farms (Bradbury et al. 2014). Avoidance behavior could have the positive effect of reducing their risk of collision with turbines, but it could also result in increased energetic costs associated with migration (Masden et al. 2009).

Although avoidance behavior has been reported for some species of sea ducks at offshore wind farms, this behavior is unlikely to occur in response to WECs at PacWave South. Wind turbines are considerably taller and much more massive than the WECs at PacWave South (>100 m versus < approximately 10–12 m height) presenting a greater barrier to migratory flight. In the study on wave and tidal devices in Scottish waters, the vulnerability of seabird populations to adverse effects from wave energy devices was ranked as low or very low (with the exception of divers/loons, which were ranked as moderate), and one of the seven vulnerability factors used for this ranking was the potential for exclusion from foraging habitat (Furness et al. 2012). Therefore, there is a low likelihood of avoidance or displacement of seabirds as a result of the Project; as such, significant adverse effects are not expected to occur due to displacement.

Effects of Artificial Lighting on Seabirds – Phototactic seabirds such as shearwaters, petrels, storm-petrels, auklets, and murrelets could be attracted to U.S. Coast Guard (USCG) required navigational lighting on Project structures (WECs and navigation marker buoys), and servicing and support vessels associated with installation, maintenance or monitoring of the Project, and could collide with or land on Project structures or vessels, or become exhausted by continual circling around the lights (Montevecchi 2006). Phototactic seabirds have been shown to be highly attracted to artificial light in the marine environment; typical sources of light include boats, lighthouses, oil and gas platforms, coastal development, and commercial fishery operations. Continuous high-intensity white lighting has a higher likelihood of attracting seabirds than lower-intensity, colored lights and those that flash at intervals (Montevecchi 2006; Poot et al. 2008). Nocturnal seabirds are most susceptible to light attraction in cloudy, foggy, or hazy conditions, in light rain, and when the moon is absent or obscured. Immature and nonbreeding nocturnal seabirds tend to be more attracted to light than breeding adults (Montevecchi 2006; Miles et al. 2010).

To minimize the potential for seabird attraction to lights on Project structures, low-intensity flashing lights that meet the minimum USCG and FWS requirements would be used. The specifications for Project lighting would also be developed in compliance with FWS lighting requirements. For the Reedsport Ocean Power Technologies (OPT) Wave Park, OPT consulted with the FWS, and agreed that navigation lights would be shielded, to direct light only towards approaching watercraft (and not directly upwards) and that the flash timing interval would be equal to or greater than 4 seconds for each individual light to minimize the potential for seabird attraction (Reedsport OPT Wave Park, LLC 2010). OSU will implement similar measures to minimize effects of Project lighting as directed by the USCG and relevant agencies. Nocturnal seabirds are unlikely to be attracted to navigational lights on WECs or Project structures with implementation of the minimization measures.

The potential effects on seabirds from vessel lighting are expected to be short-term and intermittent, likely limited to installation of the WECs and during periodic maintenance and repair activities; environmental monitoring is unlikely to occur at night. To minimize the potential for seabird attraction to lighting on service and support vessels, servicing and maintenance operations at the PacWave South would occur during daylight whenever practicable. Managing Project lighting requirements properly would minimize the likelihood that seabirds would be adversely affected by navigational lighting on Project structures, or on servicing and support vessels. Therefore, significant adverse effects on seabirds as a result of artificial lighting associated with the Project are not expected to occur and will be minimized by the avoidance and minimization measures.

Effects of Underwater Sound/Vibration on Seabirds

Although intense underwater sound, such as impulses produced by underwater explosions, seismic pulses, sonar, and pile-driving, has the potential to cause injury or mortality to seabirds, sound emitted by the WECs during ordinary operation is expected to be within the range of ambient sound levels; furthermore, it is not expected to produce intense sound at amplitudes capable of causing temporary or permanent auditory harm to marine vertebrates (Wilson et al. 2013). Vessel sound could create temporary disturbance to seabirds, but these effects are anticipated to be negligible since they would not rise to the level of causing harm, and would be short term and temporary (i.e., hours). In addition, OSU would implement the Acoustics Monitoring Plan to detect and, if needed, mitigate any effects of Project-related underwater sound. For these reasons, Project-related underwater sound and vibration are not likely to have significant adverse effects on seabirds.

Effects or Risk of Collision/Entanglement to Seabirds

Seabirds are unlikely to collide with above-surface structures at PacWave South during periods of high visibility and low winds (Camphuysen et al. 2004; Boehlert et al. 2008; Suryan et al. 2012; Henkel et al.

2013). Avoidance rates at wind farms (e.g., avoidance by seabirds of an entire wind farm and of individual wind turbines, used to predict potential collision risk) by many species of seabirds, including terns, divers (loons), cormorants, alcids, gulls, fulmars, and shearwaters, have been estimated at greater than 98% (Cook et al. 2012). The avoidance rate estimates are based on surveys conducted when sea conditions and visibility are good (Camphuysen et al. 2004), although seabirds may be more susceptible to collisions with above-surface structures during periods of high winds or poor visibility (e.g., storm conditions, fog, and darkness; Boehlert et al. 2008; Suryan et al. 2012; Henkel et al. 2013). Artificial lighting on Project structures may increase the likelihood of collisions for some light-attracted nocturnal seabirds (e.g., shearwaters, petrels, storm-petrels, auklets, and murrelets) (Montevecchi 2006; Miles et al. 2010). However, light attraction is expected to be minimized due to the environmental measures that would be implemented at PacWave South, such as use of low-intensity flashing lights instead of high-intensity static, white lights on the Project structures and WECs (see discussion of artificial lighting, above).

The presence of seabirds in the Project area and opportunities to encounter Project structures and WECs would likely be highly variable and dependent on factors such as prey availability (Ainley et al. 2009), seasonal migrations, unique physiology of each species, and distance to breeding sites. The seabird species likely to occur in the Project area most susceptible to colliding with WECs include those known to fly at altitudes of less than 30 m at least some of the time, including alcids (common murres, auklets, puffins), cormorants, storm-petrels, shearwaters, gulls, brown pelicans, and phalaropes (Geo-Marine, Inc. 2011; Suryan et al. 2012; Henkel et al. 2013). Of these species, alcids, gulls, phalaropes, storm-petrels, and cormorants may be most likely to collide with above-surface structures during high winds because they tend to fly at lower altitudes (<10 m), especially during high winds, whereas fulmars and shearwaters would be less likely to collide with above-surface structures because they fly at higher altitudes when wind speeds increase (Ainley et al. 2015). Scoters and loons also fly at low altitudes but they are uncommon as far offshore as the Project site (Strong 2009, Adams et al. 2012).

Even during times of low visibility or high winds, seabirds are unlikely to collide with above-surface structures of the Project because the relative proportion of seabirds that may encounter WECs would be low, given the relatively small area of the above-surface structures (maximum of 20 WECs, and each WEC is expected to extend less than 10–12 m above water) compared to their available at-sea habitat and the density of seabirds in the Project area. Additionally, the WECs would be at least 50 to 200m or more apart, which would provide ample space for seabirds to maneuver between them.

Pursuit-diving seabirds such as alcids and cormorants, and plunge-diving seabirds such as brown pelicans, gulls, and shearwaters could occur in the vicinity of the WECs and collide with underwater WEC components or become in entangled in marine debris (e.g., derelict fishing gear) if it accumulates at underwater WEC components (Henkel et al. 2013), or be crushed or entrapped by moving parts. Some diving seabirds (e.g., cormorants) could attempt to roost or nest on above-water structures (Henkel et al. 2013). Additionally, the diving seabirds likely to occur in the Project area are unlikely to collide with underwater WEC components, or become entrapped or crushed by moving parts, because they are agile swimmers and have high underwater visual acuity (Henkel et al. 2013). Diving birds have to capture highly mobile prey in very low visibility temperate waters along the Pacific Coast with a turbidity range on a large scale of 5-30 m (Secchi depth; Ainley 1977) and on a much smaller scale (i.e., in Monterey Bay) of 3-9 m

(Secchi depth, Laird 2006). For example, alcids (e.g., common murres, tufted puffins, and murrelets) are wing-propelled pursuit divers that swim rapidly (approximately 1 m per second) to pursue and capture mobile prey such as schooling fishes, and can veer, turn, and glide underwater (Johnsgard 1987); thus, it is expected that their vision and agility is adequate for navigating around submerged structures. Furthermore, OSU would implement measures to minimize entanglement of derelict gear on underwater WEC components, which would minimize the potential for entanglement by diving birds. Therefore, seabirds are not expected to be injured or killed from collision or entanglement with debris or underwater WEC components.

Effects of Increased Human Activity on Nesting Seabirds

Increased human activity in the Project area has the potential to disturb nesting seabirds. No Project-associated activities would occur in the vicinity of the Yaquina Head nesting colony, given that it is more than 1.5 miles north of the entrance to Newport, and well outside the expected travel route for Project-associated vessels traveling from Yaquina Bay to the WEC deployment area. A small population of pigeon guillemots nest along the shoreline in the vicinity of the shore cable landing. The activities described are not expected to prevent or disturb their nests in cavities in sandy coastal bluffs, away from the Project activity. Furthermore, OSU would require that vessel operators remain a minimum of 500 feet away from any known seabird colonies during the nesting season. Therefore, nesting seabirds are not expected to be disturbed by Project activities.

Effects on Terrestrial Birds

Around the 10-m isobath (i.e., the 10-m [33-ft] depth contour), each subsea cable would enter a dedicated conduit, installed by horizontal directional drilling (HDD), running to an onshore cable landing point, or beach manhole. Each of the five beach manholes would consist of a 10 x 10 x 10 ft buried concrete vault. Within the beach manholes, the subsea cables would be connected to terrestrial cables, which would connect to the UCMF. The HDD rig would be set up in part of the parking lot of Driftwood Beach State Recreation Site, and each bore would take approximately a month to complete and would be 50-100 ft under the beach and dunes. The terrestrial portion of the cable would be installed in up to five underground HDD bores from the beach manholes in the Driftwood Beach State Recreation Site to the UCMF. The cable route would be about 0.5 miles. From the UCMF, a cable would also be buried by HDD west to, and under, Highway 101 to the grid connection point with the CLPUD overhead distribution line along the road; for this operation the HDD rig would be set up on the UCMF property. The HDD rig is likely to be the loudest equipment used during operations from the Driftwood Beach State Recreation Site parking lot (Tetra Tech 2013). Sound from HDD and other construction activities could disturb birds in the vicinity of the nearshore (sub-surface) and onshore cable interconnection points during the construction phase of the Project. Nesting and non-nesting birds that could be affected by Project activities include pigeon guillemots, which are known to nest sparsely in sandy coastal bluffs; western snowy plovers that may use the beach for nesting, wintering, or foraging; black oystercatchers that nest on exposed rocky shorelines and reefs; seabirds such as scoters, gulls, loons, and marbled murrelets that may be present in nearshore waters; shorebirds that may be present on the sandy beaches; and nesting or non-nesting songbirds in coastal shrub/pine forest habitats. Effects on non-nesting birds as a result of HDD would be limited to disturbance at the footprint of the drill rig and support equipment in the onshore staging area during the period during which construction is occurring. Because the HDD would be operating in the Driftwood Beach State Recreation Site parking lot and not in potential bird habitat, effects of sound and vibration from HDD would be minimal, temporary (lasting 6-8 months), and localized, occurring only during construction.

Sound emitted from the HDD rig is not likely to affect plovers on the beach because the HDD rig will be operated in the eastern half of the Driftwood Beach State Recreation Site parking lot at least 300 ft from any potential nesting or foraging habitat for snowy plovers. At a distance of 300 ft, and assuming no deflection or masking of the noise, the sound pressure levels of the HDD rig (the maximum sound pressure level of a HDD rig at 50 ft is estimated at 92 dBA [TetraTech 2012]) would be reduced by 40% to 76 dBA from the levels at the source. Blocking and deflection due to the elevational difference (Harmelink and Hajek 1973), estimated to be 40 ft, between plover habitat and the location of the HDD, and deflection and absorption due to dune vegetation (Huddart 1990, Fang and Ling 2003, van Renterghem et al. 2012, 2015) will further reduce HDD noise in plover habitat. Acoustic shadows created by temperature differences between the ground surface and near-ground atmosphere (West et al. 1989), late in the day, are expected to further ameliorate noise from the drill rig. Masking of HDD noise is also expected to be substantial due to heavy surf and strong onshore winds. Auditory perception is dependent, in part, on filtering background noise: near-constant ambient noise is expected to largely or completely mask those associated with the HDD rig.

Surf contributes substantially to ambient noise (e.g., Cato 2012), and surf-generated noise scales roughly with the square of the wave height (Deane 2000). Bathymetry affects surf-generated noise, influencing source level densities as well as the sound spectra (Fabre and Wilson 1997, Wilson et al. 1997). While these studies refer to the noise underwater due to breaking waves, these sounds are also audible on the beach, in air. Bolin and Åbom (2010) recorded sound pressure levels in air ranging from 60 dB at 0.4 m wave height to 78 dB at 2.0 m wave height in the Baltic Sea, and Tollefsen and Byrne (2011) recorded comparable levels across a similar range of surf heights. Ocean waves (i.e., not surf or breaking waves, *sensu* Bascom 1980) are regularly recorded offshore of the project site (NDBC, Station 46098)[1] that suggest local surf conditions – and thus surf-generated noise – regularly exceed these levels. The average wave height at sea exceeds 2 meters offshore of the project area and rarely falls below 1 meter, even in the summer; these wave heights translate to surf of comparable or greater size, depending largely on their period (Bascom 1980).

Wind-dependent noise is correlated with wind speed (Wenz 1962), and local wind conditions indicate that this is likely to be a substantial contributor to ambient noise. An average wind speed near 10 knots and the onshore direction of the prevailing winds[2] are expected to combine to further limit sound propagation from the HDD rig towards plover habitat (Tanaka and Shiraishi 2008, Oshima and Li 2013).

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[1] National Data Buoy Center, Station 46098 – OOI Waldport Offshore, www.ndbc.noaa.gov, accessed March 24, 2018.
[2] Winds measured at Station NWPO3 off Newport, Oregon, http://www.ndbc.noaa.gov/view_climplot.php?station=nwpo3&meas=ws, accessed March 24, 2018).

Thus, the sound pressure level of an HDD rig (Engineering Page 2017) diminishes rapidly with distance from the source, and these estimates are expected to be an overestimation due to strong onshore winds, elevational differences between the sound source and plover habitat, and the effects of intervening vegetation. Ambient noise from the surf zone and strong winds that are common along the coastline of Oregon is expected to be high, masking HDD rig noise in western snowy plover habitat. Ambient noise in the surf zone has not been measured at Driftwood Beach State Recreation Site; however, surf noise would be expected to exceed 60 dBA at wave heights above 1 m (Bolin and Åbom 2010, Tollefsen and Byrne 2011), and the surf at Driftwood Beach is expected to be considerably greater. Noise is considered significant if it increases background noise by more than 10 dBA above background (ICF International 2010), and HDD noise levels within potential snowy plover habitat are unlikely to exceed this value. For these reasons, there is little risk to individuals or the population of western snowy plovers, or other birds at the beach, as a result of onshore cable installation or due to sound from HDD.

Human activity at the Driftwood Beach State Recreation Site parking lot associated with the Project construction could result in additional disturbance to nesting western snowy plovers, in the form of increased light at night, and the potential risk of predation due to a anthropogenic food sources associated with poorly contained refuse or debris (because Driftwood Beach State Recreation Site is already used by visitors, food sources are already likely present, but construction at the parking lot could potentially introduce food sources). Inadvertent return of drilling fluids would not affect nesting and foraging habitat for western snowy plover because the depth of boring operations at 50-100 ft below the dunes and beach should curtail the risk of inadvertent return of drilling fluid to the beach.

Construction and maintenance activities at the UCMF parcel could remove or alter terrestrial bird habitat, habitat for special status bird species (e.g., state listed, special status species, and species of state management concern) and cause sound disturbance to terrestrial birds. However, effects of construction activities on terrestrial birds would be temporary, and use of the area would be expected to return to normal following completion of construction and site restoration activities. In addition, most of the terrestrial cable route is near a busy highway (Highway 101) so it is likely any birds in the area would be habituated to sound and disturbance. Furthermore, OSU would conduct pre-construction nesting bird surveys prior to any Project site disturbance, and avoid disturbing nesting birds. Therefore, construction and maintenance activities are not likely to have significant adverse effects on terrestrial birds.

Effects on Bats

No bats are expected to be affected by the offshore components of the Project at PacWave South. Although hoary bats are known to occur offshore during fall migration and could encounter WECs, they would not be expected to collide with the structures given their ability to echolocate and visually observe (Griffin 1958) and detect structures. However, hoary bats that are offshore may be attracted to the WECs for roosting: occasionally hoary bats will roost at small islands and rarely at novel plants such as cattails (*Typha* sp.) or anthropogenic structures such as wood towers during migratory periods (D. Johnston, unpublished data). Because the Project provides structure in a marine environment that has little to no other options for temporary roost sites, hoary bats could roost on the WECs or marker buoys rarely, possibly putting them at risk of predation during daylight hours, although they would already be susceptible to predation if flying during the day while at sea.

Burial of the terrestrial cable will avoid potential impacts to bat habitats for the most part, though terrestrial bats could be affected during construction activities at the UCMF property, including installation of the cables by HDD at Driftwood Beach State Recreation Site parking lot and the UCMF property, if roosting habitat for bats (snags or live trees with cavities, sloughing bark, or basal hollows) is removed. Construction activities (e.g., bright lights used for nighttime construction or construction activities that generate high frequency sound) could potentially disturb a roost to the point that adult female bats at a maternity roost (i.e., females that are pregnant or are raising young) could abandon the roost and possibly their young. If bats abandon a roost during daylight hours they are subject to predation by raptors, corvids, and other birds. The following is a discussion of the potential direct and indirect impacts of the Project on bats.

Effects of High Frequency Sound on Roosting Bats

Ultrasonic sounds can disturb roosting bats to the point that bats will abandon a roost (California Department of Transportation 2016, DTSC 2017, Johnston et al. 2017). The operating of small gasoline generators and the use of backhoes for trenching produce high frequency sounds that could potentially disturb a colony. Additionally, operating cranes, graders, trucks and other construction equipment are expected to make high frequency sounds that could disturb bats that are not normally acclimated to such sounds. OSU has conducted surveys for bat roosting habitat (Attachment A) and has determined suitable roosting habitat only adjacent to the UCMF property, therefore, will employ measures for construction activities around roosts during the maternity season at that location. Therefore, high frequency sound is not expected to disturb roosting bats.

Increase in Artificial Light Levels at Night on Roosting and Foraging Bats

Whereas a few species of bats benefit from foraging around lights that attract nocturnal insects, many bat species show an aversion to areas with anthropogenic lights (Mathews et al. 2015, DTSC 2017). An increase in light values for permanent or temporary situations near roosts can potentially increase predation on bats and possibly cause bats to abandon a roost. A review of lighting and impacts to bats is provided by Fure (2006) and Rowse et al. (2016). OSU would minimize lighting at night or limit construction to daytime activities, and employ a buffer zone between lights and bat roost sites based on species (see Table 5). Therefore, artificial lights are not expected to disturb roosting bats.

Air Quality Degradation

Idling motor vehicles and generators produce exhaust that can greatly impact roosting bats to the extent that bats will abandon their roost. This is especially true during the maternity season when bats tend to be more sensitive and are more easily disturbed. However, most of the terrestrial Project area is located near Highway 101, which is already subject to exhaust-producing vehicular traffic from motor vehicles and trucks. OSU would conduct preconstruction surveys for roosting bats near the areas to be disturbed and employ buffer zones (Table 5) for exhaust-generating construction equipment around roosts (DTSC 2017, H.T. Harvey & Associates 2015). Therefore, locally degraded air quality is not expected to disturb roosting bats.

ENVIRONMENTAL MEASURES

OSU would implement the following measures to mitigate for the potential effects of the Project on seabirds:

- To minimize risk of entanglement for diving seabirds, once the Project is operational (i.e., as soon as WECs or other equipment are deployed), during all visits to the Project test site, and at least once per quarter, conduct opportunistic visual observations from the water surface in the portions of the test site, that are being visited to conduct operations, maintenance, or environmental monitoring work, and review any underwater visual monitoring conducted for other purposes to detect derelict gear that has the potential to increase the risk of marine species entanglement. If monitoring shows that derelict gear has become entangled or collected on any Project structure, the risk that it poses will be assessed based on type of gear. If it poses a threat to navigational safety or marine species, the Licensee will notify the USCG, NMFS, FWS and ODFW within seven (7) days of detection, and shall remove the derelict gear as soon as is practicable while avoiding jeopardizing human safety, property or the environment, as described Appendix I of the APEA.
- Once the Project is operational (i.e., as soon as WECs or other equipment are deployed), at least once per quarter, conduct opportunistic visual observations in the portions of the WEC test site during vessel-based visits for operations, maintenance or environmental monitoring work, to detect and document any instances of seabird perching. If perching is such that it may prevent access to a WEC (e.g., nest(s) are observed, accumulated guano prevent safe access), or may result in damage to a WEC (guano is corroding treated surfaces), OSU and the WEC testing client will devise a plan in coordination with FWS to prevent or discourage future seabird perching or nesting utilizing any practicable non-lethal measures available. Active nests will not be disturbed after egg-laying or before fledging of young unless critical maintenance is required or in the event of an emergency.

OSU would implement the following Best Management Practices (BMPs) to minimize any potential effects of the Project on seabirds:

- Use low-intensity flashing lights and bird-friendly wavelengths on the Project structures to minimize seabird attraction and follow the specifications for Project lighting developed in consultation with the FWS and USCG.
- Minimize lighting (e.g., use low intensity, bird-friendly wavelengths, shielded lighting not providing upward-pointing light or light directed at the sea surface) used at night by service and support vessels to reduce the potential for seabird attraction.
- Require vessel operators to follow FWS instructions regarding appropriate handling and release of seabirds in the event of seabird fallout.

- Require vessel operators to remain 500 feet away from seabird colonies during the nesting season to minimize disturbance to nesting seabirds.
- Develop and implement an Emergency Response and Recovery Plan with spill prevention, response actions and control protocols, as well as provisions for recording types and amounts of hazardous fluids contained in WECs and other Project components, to minimize the potential for and, if needed, respond to accidental release of oils and toxic chemicals into the marine environment.
- If lighting is required at the UCMF, it will be appropriately shielded and directed to minimize artificial light attraction and prevent potential injury or mortality to seabirds. While allowing for the public safety, lighting will be minimized to the maximum extent practicable.

OSU would implement the following measures to minimize, detect, and respond to potential effects of the Project on western snowy plovers:

- No HDD construction equipment or construction activities will occur on Driftwood Beach within suitable snowy plover nesting, roosting, or foraging habitat and is expected to be limited to the Driftwood Beach State Recreation Site parking lot, at least 164 feet (50 meters) from any potentially suitable habitat.
- Human activity at the Driftwood Beach State Recreation Site parking lot associated with the Project construction could result in additional disturbance to nesting western snowy plovers, in the form of increased light at night, and the potential risk of predation (e.g., common raven) due to potential anthropogenic food sources associated with poorly contained refuse or debris during construction (because Driftwood Beach State Recreation Site is already used by visitors, food sources are already likely present, but construction at the parking lot could potentially increase food sources). Operations at the parking lot are proposed during daylight hours, but if lighting is required at night it will be appropriately shielded and directed to minimize artificial light reaching western snowy plover nesting habitat at night. To minimize and mitigate for human debris and food waste, animal-proof litter receptacles will be provided to the Park, along with signage, to notify construction crews and visitors after construction is completed about the importance of litter removal to wildlife. Construction crews will receive guidance that includes the need to keep the parking lot and surrounding area clean of litter and food waste. For these reasons, there is little risk to individuals or the population of western snowy plovers as a result of terrestrial operations at the Driftwood Beach State Recreation Site.
- Inadvertent return of drilling fluid could would not affect nesting and foraging habitat for western snowy plover because the depth of boring operations at 50-100 ft below the dunes and beach should curtail the risk of inadvertent return of drilling fluid to the beach. Regardless, a contingency plan will be developed to minimize the potential for inadvertent return of drilling fluids, provide timely detection, and address potential contamination by describing monitoring, containment, response and notification procedures to be implemented by the contractor. The contingency plan will rely on beach access for containment response and monitoring, if necessary, to occur from existing vehicle access points such as Quail Street, approximately 1.3 miles north of the Driftwood Beach State Recreation Site.

- If HDD occurs outside of the nesting season (September 16-March 14), but then extends into the nesting season, any western snowy plovers that initiate nesting near the parking lot while HDD is ongoing, are assumed to be undisturbed by the HDD, assuming there is no significant change in project operations after nesting is initiated. However, if HDD is initiated within the nesting season (March 15-September 15), prior to operation of the HDD, surveys of suitable nesting habitat will be conducted within 600 ft of the HDD rig for signs of nesting western snowy plovers (eggs or chicks) following the *Western Snowy Plover Breeding Window Survey Protocol* (Elliott-Smith and Haig 2007). If no nests are detected, HDD can proceed. If nests are detected, then noise monitoring will be conducted to evaluate the sound levels within the nesting habitat. Noise monitoring includes evaluating existing ambient noise levels prior to start of HDD (7-14 days), during calm wind and ocean conditions (e.g., <10 mph winds, seas <1.5 m) and at windy, high wave conditions (e.g., >15 mph winds, seas >2 m). After HDD is initiated, additional sound monitoring should be conducted at calm conditions and windy, high wave conditions, 50 ft from the HDD rig (to determine if sound levels cited and analyzed in the BA, 92 dBA, are accurate), and at 300 ft from the HDD rig in snowy plover nesting habitat. If sound levels produced by the HDD rig are greater than 10 dBA above ambient conditions at 300 ft in either calm or windy conditions, then engineering controls will be implemented to minimize HDD-related operational noise (e.g., install temporary noise barriers such as berms, stockpiles, dumpsters, bins, and/or engineered acoustical barriers). Specialized panels that absorb and deflect sound when effectively positioned around noise generating areas are commercially available, and are advertised by some companies (e.g., http://www.drillingnoisecontrol.com/panels.html). The effectiveness of noise reducing measures will be tested upon deployment to verify that they reduce noise to less than 10 dBA above ambient conditions at 300 ft. For these reasons, there is little risk to individuals or the population of western snowy plovers as a result of onshore cable installation or due to sound from HDD.

OSU would implement the following measures to minimize, detect, and respond to potential effects of the Project on terrestrial birds:

- Prior to any vegetation clearing that occurs within the nesting season; February 1 through April 15 for early nesters such as raptors, herons, geese, and hummingbirds, and April 15 through July 31 for songbirds and other species, pre-construction surveys for nesting birds will be conducted by a qualified biologist to ensure that no nests will be disturbed during vegetation clearing. During this survey, the biologist will inspect all trees and other potential appropriate nesting habitats, depending on the habitat (e.g., trees, shrubs, ruderal grasslands, buildings) within designated buffers surrounding impact areas for nests. These surveys will be conducted no more than 7 days prior to the initiation of vegetation clearing activities.
- To minimize Project-related impacts on non-listed terrestrial nesting birds and avoid the creation of potential conflicts or constraints that the presence of active nests would have on Project activities (vegetation clearing), biologists will remove nest-starts for any birds other than bald eagles or raptors when observed if found within the Project disturbance footprint and within 100 feet of a construction zone, and where feasible (ICFI and H. T. Harvey 2013). If any raptor nest

starts are observed within 300 feet of a construction zone, OSU will consult with ODFW and FWS to determine how to proceed. Nest-starts are nests that are under construction and do not contain eggs or young.

- If an active nest is found sufficiently close to work areas to be disturbed by these activities, the biologist will determine the extent of a construction-free buffer zone to be established around the nest (typically 300 feet for raptors and 100 feet for other species), to ensure that no nests of species protected by the MBTA will be disturbed during Project construction. The biologist(s) will conduct regular monitoring of the nest to determine success/failure and to ensure that Project activities are not conducted within the buffer(s) until the nesting cycle is complete or the nest fails.
- If nesting bald or golden eagles are identified, activities will be restricted near nest sites according to guidelines suggested in the National Bald Eagle Management Guidelines (FWS 2007). The guidelines suggest maintaining a 660-foot buffer for most activities visible from bald eagle nest sites during the nesting season.
- If construction activities will not be initiated until after the start of the nesting season, all potential nesting substrates (e.g., bushes, trees, snags, grasses, and other vegetation) that are planned to be removed, will be removed in late winter, prior to the start of the nesting season. This will preclude the initiation of nests in this vegetation, and prevent the potential delay of the Project due to the presence of active nests in these substrates.
- If necessary, the prescribed no-disturbance buffers may be adjusted to reflect existing conditions including ambient noise, topography, and disturbance with approval of ODFW.

OSU would implement the following measures to minimize, detect, and respond to potential effects of the Project on bats:

- Avoid to the extent practicable, disturbance or removal of snags and legacy trees including live or dead trees that are potential roost habitat for bats.
- Conduct preconstruction surveys for roosting bats in the maternity season prior to construction. Prior to any delimbing, tree removal, or construction activities, a qualified bat biologist (specifically permitted to capture and handle bats) will conduct surveys during the maternity season (May 1-August 31) in the construction disturbance area (i.e., UCMF property) to determine if bat maternity roosts occur in on-site trees or trees in designated buffer areas (see Table 5 below for buffer areas by type of construction activity). The bat biologist should evaluate each tree's potential to provide habitat for roosting bats based on that tree's crevices, cavities, loose bark, and tree bowls. All trees that provide a good potential for day-roosting bat habitat, in the opinion of the bat biologist, should either be: 1) assumed to contain day-roosting special status bat species; or 2) monitored to determine if bats are roosting and if so, which bat species (e.g., non-special status bats, special status bats). Potential bat maternity roosting habitat should be monitored to detect occupied roosts with a bat detector for a minimum of two nights of fair weather (above 50°, wind below 10 mph, and without rain). If the bat detector data suggests a maternity roost is nearby, an emergence survey will be conducted with the use of night-vision goggles to determine the specific locations of maternity roosting trees or structures. If no bat

maternity roosts are found in trees or structures in the construction area or within construction buffer zones in Table 5, no further mitigation or BMPs are required. If bats are found roosting in trees in the construction area or within construction buffer zones in Table 5, construction activities will be modified so that they will not result in the loss of the maternity roost and that they will occur outside the maternity season, or outside of buffer zones, or bats will be excluded, as described below.

- Avoid construction during the maternity season if maternity roosts are detected within or adjacent to the construction area, if possible. If construction must occur during the maternity season, implement bat roost buffer zones for terrestrial construction activities (Table 5). If preconstruction surveys indicate no roosts are in the construction area (i.e., UCMF property) or within the construction buffer zone as designated in Table 5, then no buffers will be required. However, if maternity roost trees or structures are observed, buffers will be implemented that are designed to protect bat maternity roosts from construction activities; these construction buffer zones are based on three tiers of bat species: 1) non-special status bats, 2) special-status bats (Table 4), and 3) Townsend's big-eared bat[3]. If OSU chooses not to conduct species surveys as described above, the construction buffers provided for special status bat species in Table 5 would be used, and it would be assumed that trees and structures identified as maternity roosts during pre-construction surveys are supporting special status bat roosts. If OSU elects to conduct bat species surveys, then construction buffer zone widths (Table 5) would be selected based on the results of surveys and occurrence of specific roosting bat species. A biological monitor shall be on-site during construction activities within proximity of maternity roosts to ensure the buffer zones are protected.
- If construction work must occur within the construction buffer zones during the maternity season, specific measures from the following list will be selected, based on preconstruction surveys and in consultation with USFWS and ODFW, prior to the end of the maternity season the year before construction activities are initiated, and used to minimize construction impacts to bats:
  1. Exclude the bats outside of the maternity season (May 1-August 31) and wintering period (October 15-February 15), between September 1 and October 15.
  2. Determine the frequency of sound produced during operation of each specific type of construction equipment planned for use at the site. Prior to construction activities, evaluate if equipment is likely to produce sound in the frequency range that would disturb potentially roosting bat species (see Table 4) from maternity roosts (e.g., California myotis is most sensitive to 45-55 kHz, and silver-haired bats are sensitive from about 25-30 kHz). High frequency sounds that bats are expected to be sensitive to would be modeled to determine the distance for the noise generated by the equipment to attenuate to ambient noise levels, which typically attenuates at short distances from the source. That distance would then become the buffer distance for the operational equipment during the maternity season.
  3. If sound is produced by specific construction equipment at frequencies likely to disturb maternity roosts within the buffer distance, OSU will develop appropriate noise controls to

[3] Townsend's big-eared bat emits quieter vocalizations and is more vulnerable to the masking effects of construction noise, necessitating larger buffers.

abate high frequency sounds to ambient, and evaluate noise controls for effectiveness before deployment. A biological monitor will monitor maternity roosts for effectiveness at the onset and periodically throughout construction. If the biological monitor finds that noise controls are not effective, they will recommend additional measures in consultation with OSU, USFWS and ODFW.

4. Conduct construction operations, employing measures above selected in consultation with USFWS and ODFW, and monitor bat maternity roosts using bat detectors to evaluate bat behavior at roosts and the efficacy of mitigation measures.

Table 5. Bat maternity roost buffer zones for PacWave South terrestrial construction activities occurring during the maternity season (May 1-August 31) (DTSC 2017)

	Buffer Zone (feet) if Maternity Roosting Habitat Present		
Construction activity	**Non-Special Status Species Only**	**Any Special Status Species (Table 4)**	**Townsend's big-eared bat**
Motor vehicles and foot traffic in transit.	65	90	200
Heavy equipment (e.g., large diesel construction vehicles)	90	120	400
Borehole trenching or trenching	150	150	200
Idling vehicles, generators, or equipment (idling >2 minutes)	250	250	250
Nighttime lighting - without shielding - with shielding	 250 N/A	 400 250	 400 250

Further details about the bat maternity roost buffer zones and measures are included below:

- **Motor vehicles and foot traffic.** To minimize effects of increased human activities, pedestrians shall not approach active roosts during the maternity season, and a 65, 90, or 200-foot buffer (depending on the bat species, see Table 5) shall be maintained between roosts and foot traffic and motor vehicles. The buffers for motor vehicles only apply to motor vehicles associated with construction and staging along NW Wenger Lane, and do not apply to any vehicle activity associated with the Project along Highway 101 (the grid connection location), given that vehicle traffic unrelated to the Project is frequent and regular.
- **Heavy equipment and trenching.** Project activities that will result in high frequency sound disturbance include the use of generators, drill rigs, trenching equipment, and the operation of non-construction and construction vehicles. Based on most construction equipment noise data (California Department of Transportation 2016, Johnston et al. 2017), a 90, 120, or 400-foot buffer (depending on the bat species, see Table 5) around each of identified roost sites should be maintained during the maternity season when generators, construction vehicles, and other noise-generating equipment are being used. Because trenching and borehole drills can encounter large rocks, causing auger bits or backhoe shovels to "skip" or scrape along the surface of the substrate

and thus generate much louder high frequency sounds, a buffer of 150 feet (200 feet for Townsend's big-eared bat maternity roosts) should be maintained between borehole drilling or trenching and any known bat maternity roost during the maternity season (Johnston et al. 2017).

- **Idling vehicles, generators, or equipment.** Project activities that will generate exhaust include generators, drill rigs, and idling trucks and other vehicles. Idling motor vehicles and generators should not operate within 250 feet of a bat maternity roost for more than 2 minutes.
- **Nighttime lighting.** If artificial sources of light are needed, any floodlights should be adjusted so that the angle of the beam is less than 70 degrees and directed away from roost sites (Fure 2006). All nighttime lights should be directed downward if possible. If lighting is required for minimum safety and security purposes, light barriers can be used to reduce the potential for light to reach roosts. For example, if lights are needed to ensure safety of a work area, the light could be positioned so that a hillside blocks the light reaching the roosts sites. Smaller barriers, such as plywood sheeting, can be used, but lighting should not surround a roost within the given buffer zones. To the maximum extent practicable, while allowing for the public safety, low intensity energy saving lighting will be used. Lights with high blue-white or ultraviolet content should be avoided because many species of bats are sensitive to ultraviolet light. To the maximum extent practicable, minimize illumination of lighting associated with construction by using motion sensors or heat sensors. When using nighttime lighting as outlined above, a buffer of 250 feet must be maintained between every light source and roost site (DTSC 2017).

REPORTING

Sightings of perched seabirds will be recorded during other vessel-based maintenance or other activities will be provided in the annual operations report to FERC, as well as to the FWS, ODFW, and BOEM, and will include a description of any environmental measures that were implemented. The results of pre-construction surveys for terrestrial bird nests and bat maternity roosts, and associated environmental measures (if any), will be provided in a report to FERC, the FWS, ODFW, and to the respective agencies.

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ATTACHMENT A

Memorandum

Project No. 3589-04

May 29, 2019

To: Justin Klure

From: Dave Johnston, Ph.D., Associate Wildlife Ecologist and Bat Biologist
Sharon Kramer, PhD., Principal

Subject: **PacWave South - Potential Bat Roosting Habitat Survey**

Background

Oregon State University (OSU) is developing PacWave South, a grid-connected wave energy test facility, and has submitted to the Federal Energy Regulatory Commission (FERC) a Draft License Application, which includes a Bird Bat Conservation Strategy that identifies measures to address effects of terrestrial construction activities on birds and bats.

As the Final License Application is being prepared for filing with FERC, OSU was requested by Oregon Department of Fish and Wildlife to conduct a preliminary bat roost habitat survey to establish the likelihood of encountering potential roosts throughout the project area and potentially affected by construction activities. This initial habitat survey was conducted in April 2019, as described below.

Methods

On April 17 and 18, 2019, H. T. Harvey & Associates' bat biologist, Dave Johnston, Ph.D., conducted surveys for Townsend's big-eared bat habitat within a 400 foot buffer and for species of special concern bat habitat within a 250 feet buffer of the construction zone for the Driftwood Beach State Recreation Site (Driftwood) and the UCMF property line (Figure 1). A distance of 400 feet is the minimum noise buffer distance as described in the Bird Bat Conservation Strategy [BBCS]) for Townsend's big-eared bats and 250 feet is the minimum distance needed to buffer for construction noise for bat species of special concern. Although Dr. Johnston did not physically walk on the private properties across the highway (east of U.S. Route 101) from Driftwood, the trees and structures viewed from the highway did not appear to support bat habitat. Likewise, the private properties across the highway west of the UCMF property were not walked, but the view from the highway suggested there were no trees or structures within the 400 foot buffer that would indicate there was potential habitat.

Table 5 from the BBCS below indicates buffer distances by type of construction activity and bat species. Dr. Johnston evaluated these trees' potential to provide habitat for roosting bats based on each tree's crevices, cavities, exfoliating bark, and tree bowls for bat species whose range overlaps with the project area. Because tree types with various potential bat habitat were clumped in distribution, and because of the high numbers of trees occurring on the project site and vicinity, tree groups were identified on a map and photographed. Several neighbors were interviewed for any of their observations of bats in the area. Based on the information from interviews, an SM4 bat detector (Wildlife Acoustics Inc., Maynard, Massachusetts) was placed in a metal shed on April 17, 2019 and near the southwest corner of Phil Bertholl and Polly Ivers's residence (1092 NW Camrose Dr,) to record any potential bats that might emerge from roost sites.


Legend
Project Locations
Potential Bat Roosting Locations
Potential Bat Roosting Habitat
400-ft Buffer Zone
NW Sunahama Pl
Wood shingle barn
Driftwood State Beach Recreation
NW Ray Ridge Dr
101
NW Terrace St
Metal barn
UCMF Property
NW Wenger Ln
Snags
Residence with active bat roost
N 400 200 0 400
Feet
H. T. HARVEY & ASSOCIATES
Ecological Consultants
Potential Bat Roosting Habitat
PMEC-SETS (3589-04)
May 2019

Table 1. Bat Maternity Roost Buffer Zones for PacWave South Terrestrial Construction Activities Occurring During the Maternity Season (May 1-August 31) (DTSC 2017) Buffer Zone (feet) if Maternity Roosting Habitat Present

Construction Activity	Non-Special Status Species Only	Any Special Status Species*	Townsend's Big-Eared Bat
Motor vehicles and foot traffic in transit	65	90	200
Heavy equipment (e.g., large diesel construction vehicles)	90	120	400
Borehole trenching or trenching	150	150	200
Idling vehicles, generators, or equipment (idling >2 minutes)	250	250	250
Nighttime lighting	250	400	400
- without shielding	N/A	250	250
- with shielding			

* Table 4 from the BBCS

Results

Driftwood Beach State Recreation Site

This site comprises a parking lot, sandy beach, a restroom, and forested areas with mostly shore pines (*Pinus contorta*). Although the eaves of the restroom had metal flashing that sometimes provides habitat for crevice-roosting bats, there was no bat sign on or in this structure. The bathroom is not expected to provide habitat for bats because the structure is in good condition and does not provide good opportunities for roosting habitat.

None of the trees or structures within 400 feet of the project impact area provide suitable habitat for the Townsend's big eared bat (*Corynorhinus townsendii*), a cavernous roosting bat. Although an abandoned barn (Figure 2) with shingle siding provides potential habitat for Townsend's big eared bats in the interior of the barn, this structure is just outside of the 400 foot buffer. Additionally, the homes to the north of the project site are occupied by humans and would not be tolerated by this sensitive species.

Most of the shore pines are low to the ground and have dense foliage; and thus, they provide no potential roosting habitat for bats (Figure 3). The shore pines and a very few Douglas fir trees (*Pseudotsuga menziesii*) become larger on the site when they occur away from the coast (closer to Highway 101). However, none of these larger trees at the state recreation area or inside the forests occurring within 400 feet of the construction area appear to provide potential habitat for crevice-roosting bats. When branches of these pines decay inside this wet forest, they are covered with moss and rot quickly without developing dry cavities that bats could otherwise use as roosts (Figure 4).

UCMF Property and Vicinity

This site comprises an open grassy area with a metal barn, shrubs, marsh, developed residential areas, and forested areas of mostly shore pines and Douglas fir trees. The relatively small unused barn is covered with metal sheeting and does not provide potential maternity roosting habitat. None of the trees or structures within

400 feet of the project impact area provide suitable habitat for the Townsend's big eared bat (*Corynorhinus townsendii*). A bat detector deployed at the small barn recorded three calls from likely a single California myotis (*Myotis californicus*) on the evening of April 17, 2019. The structure is too light inside and does not provide a consistently warm environment needed for a maternity colony (Figure 5).

The bat detector deployed at Phil Bertholl and Polly Ivers's residence (Figure 1) recorded 148 bat calls suggesting colonies of California myotis and silver-haired bats. Because silver-haired bats are considered a tree obligate, these bats likely emerged from a nearby tree and simply fly past the microphone that recorded their calls. The California myotis likely roost in the roof eave of the residence. Other roosts might occur in one or more of the nearby structures; however, most of these buildings were checked from the outsides and no bats or bat sign were detected during the time of the survey.

Reasonably tall Douglas fir trees occur in the forested areas to the south and north of the UCMF property within the buffer area (Figure 6). However, these trees have trunks situated in deep shade that would not provide the thermal qualities needed for a maternity colony. Further, these trees had very few cavities or exfoliating bark, and thus, do not exhibit the physical properties needed for roosting bats. Other smaller trees, such as red alders (*Alnus rubra*) distributed along the edge of forested areas, are young trees without features that provide potential roosting habitat for bats (Figure 7).

Two linear-shaped patches of pine snags on the southern border of the UCMF property provide potential roosting habitat for several species of crevice-roosting bats (Figure 8). Because of the proximity of these snags to the microphone deployed at the Bertholl-Ivers residence, the recorded calls from the silver haired bats may be roosting in one or more of these trees.

Figure 1. Shingled Barn at the Edge of the 400 Feet Buffer

Figure 2. Shore Pines along the Coast

Figure 3. Decaying Shore Pines with Dead Branches that are Damp, Not Hollow, and Do Not Provide Habitat for Bats

Figure 4. Interior of the Metal Barn Does Not Provide Thermal Qualities, nor is it Dark enough for a Maternity Colony

Figure 5. Tall Douglas Fir in Deep Shade and with Few Physical Features for Potential Bat Roosting Habitat

Figure 6. Small Red Alders in Foreground with No Potential for Potential Roosting Habitat for Crevice-Roosting Bats

Figure 7. Cluster of Snags that Provide Potential Bat Roosting Habitat for Maternity Colonies of Several Species

Discussion

There was no potential for roosting habitat for the Townsend's big-eared bat within the 400 foot buffer zone from construction activities. This species is an obligate cavernous-roosting species, and all of the structures within this buffer zone that include cavernous habitat are either too disturbed because of human activity or are not dark enough, and even temperatured enough, to provide adequate habitat. There was also no potential for maternity colonies to roost in trees within the buffer zones of the construction areas located at Driftwood.

The residential area immediately south of the UCMF property has potential for several species of crevice-roosting bats. Many echolocation calls from two commonly occurring species, the California myotis and the silver-haired bat, were recorded within a short distance of the UCMF property suggesting these species have formed maternity colonies adjacent to the construction site.

This early summer 2019, the snags that provide potential maternity colony roosting habitat should be surveyed for roosting bats, and all roosts within the buffer zones should be located. In order to proceed with the 2020 project construction activities, bats roosting within the buffer zone will need to be either excluded or specific buffers will need to be determined and implemented based on the location of the roost, the species involved, and the sounds generated by each piece of equipment used. Most bats are not very sensitive to low frequency sounds, but in order to operate equipment within a given buffer, sounds generated by the equipment will need to be modeled so that the adjusted buffer distance is determined by the distance needed for the operating equipment sounds to attenuate to ambient.

APPENDIX C

Terrestrial Habitat Characterization Report and Wetland Delineation Report

APPENDIX C-1
Terrestrial Habitat Characterization Report

Addendum to Appendix C1, Habitat Characterization Report

On April 20, 2018, Oregon State University (OSU) filed its draft License Application (DLA) and Preliminary Draft Environmental Assessment (PDEA) for PacWave South (formerly known as Pacific Marine Energy Center South Energy Test Site [PMEC-SETS]). In the DLA, OSU proposed burying the cables between Driftwood Beach State Recreation Site and the utility connection and monitoring facility (UCMF) along Highway 101. With this approach, the five cables would have been installed from the beach manholes at the Driftwood Beach Recreation Site for about 0.2 miles along the Driftwood access road out to Highway 101. Here they would pass under the highway and run about 0.3 miles south within the Highway 101 right-of-way, and then turn east and run about 0.2 miles across OSU's property to the UCMF. The total distance of the terrestrial cable route would be about 0.7 miles.

The alignment for the cable route has been modified from the original route. As presented in this final license application, OSU is now proposing to install the terrestrial cable conduits using horizontal directional drilling (HDD) from the Driftwood Beach State Recreation Site parking lot directly to the UCMF property, thus avoiding effects to wetlands, streams, terrestrial habitat, adjacent landowners, and Highway 101 users. The 2017 Habitat Characterization Report (Appendix C1) was conducted along the original terrestrial transmission line route (along Highway 101) (HDR 2017). The new route extends beyond the 2017 study area. As part of other field efforts, information related to the characterization of this new study area (referred to as the 2019 study area) was recorded. This memorandum (attached March 2019 *Supplemental Habitat Characterization for Additional Study Area* Memo) summarizes the habitat characterization for the 2019 study area as a supplement to the Habitat Characterization Report (HDR 2017).

Memo

Date:	Friday, March 22, 2019
Project:	PacWave South
To:	Dan Hellin, PacWave at OSU
From:	Leandra Cleveland, HDR Engineering, Inc.
Subject:	**Supplemental Habitat Characterization for Additional Study Area**

1.0 Introduction

On behalf of Oregon State University (OSU), HDR Engineering, Inc. (HDR) conducted terrestrial surveys of biological resources in order to determine potential siting and construction constraints for the proposed terrestrial cable route and related facilities associated with the PacWave South ("the Project"; formerly known as the Pacific Marine Energy Center South Energy Test Site [PMEC-SETS]). The previous study results were summarized in the December 2017 *Habitat Characterization Report* (HDR 2017).

As part of the project, subsea cables and auxiliary cables would run from the test site to the cable splice vaults located at Driftwood Beach State Recreation Park and then the terrestrial cables will continue to a utility connection and monitoring facility (UCMF) south of the park. These cables would all be bored by horizontal directional drill. The alignment for the cable route has been modified from the original route[1]. The new route extends beyond the 2017 study area. As part of other field efforts, information related to the characterization of this new study area (referred to as the 2019 study area) was recorded. This memorandum summarizes the habitat characterization for the 2019 study area as a supplement to the *Habitat Characterization Report* (HDR 2017).

2.0 Study Area Description

The 2019 study area is approximately 7.46 acres and would increase the overall study area size from 11.83 acres to 19.36 acres. While the currently proposed terrestrial transmission line route would be approximately 0.5 mile, and would be shorter than what was previously proposed (0.7 mile), the overall larger study area size is due to a wider study corridor being evaluated for the currently proposed route. The 2019 study area is located Township 13 South, Section 12 West, Section 1 and lies south of the entrance to Driftwood Beach State Recreation Park. The 2019 study area is located in a coastal, rural residential and recreational area, and is generally flat with slopes less than 5 percent. As part of Driftwood Beach State Recreation Park, the 2019 study area is undeveloped, vegetated land, and there are dirt trails throughout the area that connect to the main parking lot of the park.

[1] OSU originally proposed burying and trenching the cable next to Highway 101. However, based on additional environmental and engineering analysis OSU will be using HDD to run the terrestrial cables directly from the Driftwood Beach State Recreation Site to the UCMF, thus avoiding effects to wetlands, streams, terrestrial habitat, adjacent landowners, and traffic along Highway 101.

3.0 Habitat Characterization Results

3.1 2017 Results

As shown in Figure 5-2 of the *Habitat Characterization Report* (HDR 2017), the 2019 study area was classified as a combination of Category 2 (Friday/Buckley Creek), Category 3 and Category 4 habitat. These assessments were made based on limited field data from adjoining areas and a review of the aerial imagery.

3.2 2019 Results

On February 25, 2019, HDR biologists conducted a wetland and waterbodies delineation of the 2019 study area. Information regarding vegetative species composition was gathered at that time. Based on that information, the habitat characterization for the 2019 study area was updated to reflect the more site specific data as shown in revised Figure 5-2:

- Wetland D continues southwest through the 2019 study area and was mapped as a Category 2 habitat in the 2017 report (Photograph 1).
- Portions of the surrounding forest were recharacterized from Category 4 to Category 3 habitat (Photograph 2). The area nearest the parking lot and heavily used trails remain as Category 4 habitat.

Photograph 1: Wetland D within the 2019 study area (facing northwest)

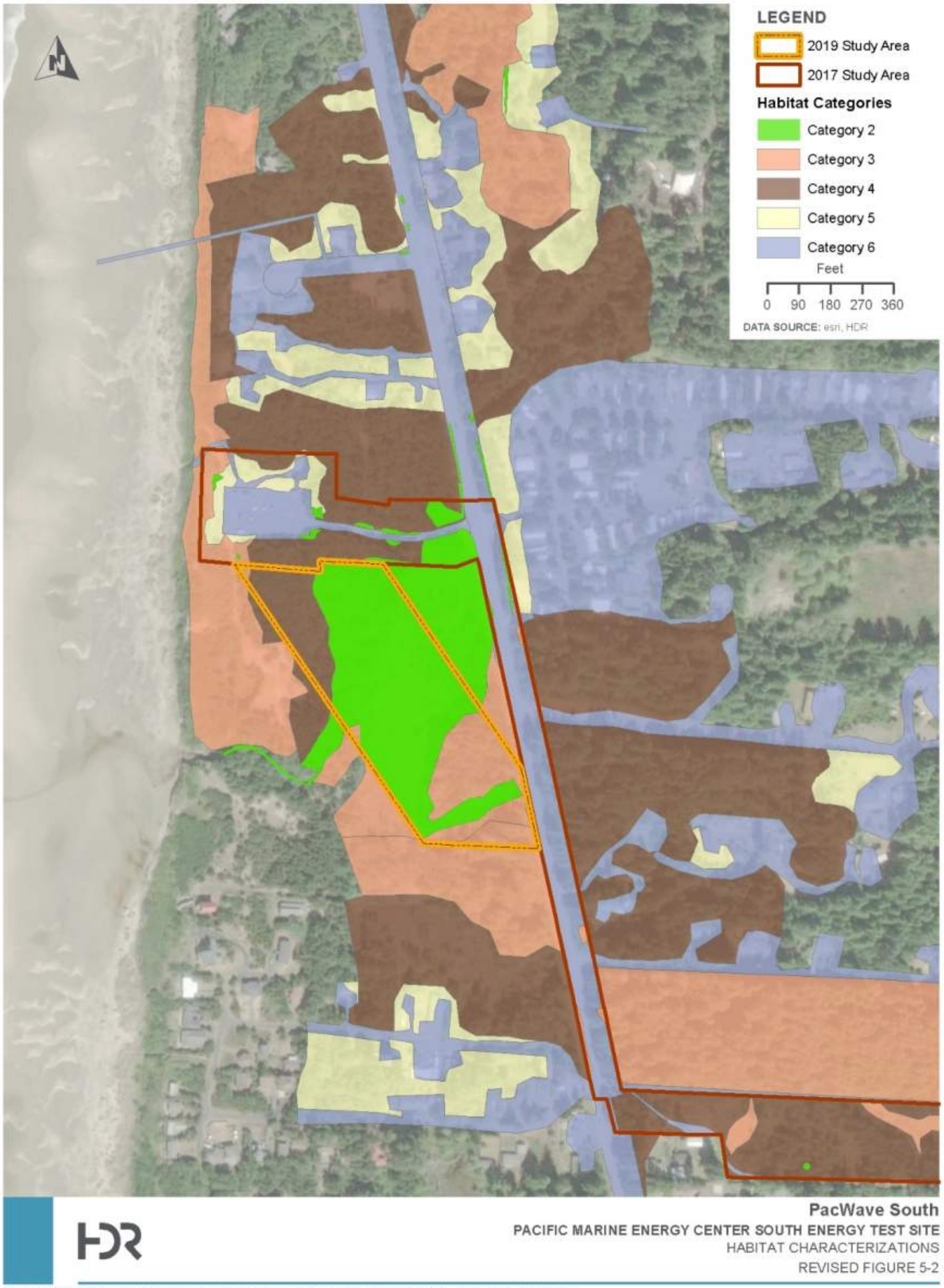
Photograph 2: Forested area formally characterized as Category 4 that has been modified to Category 2.

The changes in overall habitat category quantities resulting from the additional evaluation are shown in Table 1 below. The 2017 quantity represents the 2017 study area as presented in the 2017 *Habitat Characterization Report* (HDR 2017). The 2019 quantity represents the updated acreage of the combined 2017 and 2019 study areas.

Table 1. Summary of Habitat Categories in the Study Area

Habitat Category	2017 Quantity (acres)	2019 Quantity (acres)
Category 1	0	0
Category 2	0.55	5.28
Category 3	0.95	2.75
Category 4	5.45	6.45
Category 5	0.60	0.60
Category 6	4.28	4.28
Total Study Area	11.83	19.36

Revised Figure 5-1. Habitat Categorization of Study Area



4.0 References

HDR Engineering, Inc. (HDR)

2017 Habitat Characterization Report, Pacific Marine Energy Center South Energy Test Site, FERC Project No P-14616. Dated December 2017

Habitat Characterization Report

Pacific Marine Energy Center South Energy Test Site

FERC Project No. P-14616

Oregon State University
Corvallis, OR

December 2017

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Appendices

1 Introduction

Oregon State University (OSU) is developing the Pacific Marine Energy Center South Energy Test Site (PMEC-SETS or Project). PMEC-SETS will serve as the primary grid-connected ocean test facility for wave energy converters (WECs) in the U.S. OSU has been working with relevant state and federal agencies, along with other stakeholders, to implement a collaborative approach to the regulatory process. Construction of PMEC-SETS will require federal, state and local environmental clearances and permits. To support these clearances and permits, HDR conducted terrestrial surveys of biological resources in order to determine potential siting and construction constraints for the proposed terrestrial cable route and related facilities.

The Project would include both marine and terrestrial components, and span a total distance of approximately 12 miles. The marine portion of the Project would be located in the Pacific Ocean, approximately 6 nautical miles off the coast of Newport, Oregon on the Outer Continental Shelf and would occupy an area of approximately 2 square nautical miles where the WECs would be deployed and an additional 2 square nautical miles where the cables will be run to shore. The Project would support up to 20 commercial-scale WECs, deployed 50 to 200 m or more apart from each other within a test berth, and transfer power to a grid connection point with the Central Lincoln People's Utility District (CLPUD) in Lincoln County, Oregon.

Four subsea transmission cables are planned, one for each of the four test berths. In addition, a single, smaller, auxiliary cable would connect to the site. The subsea transmission cables would transfer power back to shore and allow for the monitoring and control of WECs via fiber optic cables incorporated into the transmission cables themselves. The cable route runs south of an area of rocky geology that extends along the coast to the north, and the cables would come ashore south of Seal Rock, with a landing site at Driftwood Beach State Recreation Site. The four transmission cables and auxiliary cable would each run through separate conduits to individual onshore cable landing points, known as a "beach manholes," where the subsea cables would transition to terrestrial cables. The conduits would be installed using horizontal directional drill (HDD) techniques.

From the landing site, the cables would run in an underground conduit or direct burial to a Utility Connection and Monitoring Facility (UCMF) located on private property. The specifications of the terrestrial transmission cables are dependent on the final subsea cable design and coordination with CLPUD to ensure compatibility with existing infrastructure (e.g., copper versus aluminum conductors).

1.1 Study Area

Terrestrial surveys were conducted within the study area shown on Figure 1-1. The study area included all areas currently being evaluated as potential routes for the terrestrial cable, as well as the horizontal directional drill laydown area and the Utility Connection and Monitoring Facility site. Surveys were restricted to parcels where project construction may occur, where rights-of-entry had been obtained, and the Highway 101 rights-of-way.

Figure 1-1. PMEC-SETS Study Area.

2 Regulatory Environment

2.1 Oregon Regulations

The State of Oregon has threatened, endangered, and sensitive species provisions that protect native vertebrates and plants on state lands and requires consideration of the impacts of any action on private land on threatened and endangered species (ORS sections 496, 517, 498, and 506).

2.2 Federal Regulations

Pursuant to the National Environmental Policy Act (NEPA) of 1969, as amended; Federal Energy Regulatory Commission's (FERC) regulations; and other applicable laws, FERC would evaluate the environmental effects of the Project and consider reasonable alternatives to the proposed action to determine whether, and under what conditions, to issue an original license for the Project. As such, potential site-specific and cumulative effects of the proposed action compared to a no-action alternative will be described and evaluated in a Preliminary Draft Environmental Assessment (PDEA), which will draw upon this Habitat Characterization Report to evaluate the potential effects on the terrestrial resources.

Other federal requirements, such as the Endangered Species Act (ESA) consultations and critical habitat procedural requirements are discussed in the relevant species sections. The following sections provide a list of relevant regulatory regulations.

2.2.1 Federal Endangered Species Act

Section 7 of the ESA (19 United States Code [USC] § 1536(c)), as amended, states that any action authorized, funded, or carried out by a federal agency does not jeopardize the continued existence of a federally-listed Threatened and Endangered (T&E) species, or result in the destruction or adverse modification of federally-listed designated critical habitat. The action agencies are required to consult with U.S. Fish and Wildlife Service (FWS) and/or the National Oceanic and Atmospheric Administration (NOAA) if federally-listed T&E species or designated critical habitats are found within the vicinity of the proposed project and the proposed action has a potential effect on T&E species or critical habitats.

2.2.2 Bald and Golden Eagle Protection Act

When first enacted in 1940, the Bald and Golden Eagle Protection Act (16 U.S.C.§ 668) (BGEPA) prohibited the take, transport or sale of bald eagles (*Haliaeetus leucocephalus*), their eggs, or any part of an eagle except where expressly allowed by the Secretary of Interior. The Act was amended in 1962 to extend the prohibitions to the golden eagle.

2.2.3 Migratory Bird Treaty Act

The Migratory Bird Treaty Act (16 U.S.C. §§ 703-712) (MBTA) implements various treaties and conventions for the protection of migratory birds. Under this act, taking, killing, or possessing migratory birds (including any part, nest, or egg) is unlawful.

3 Methodology

3.1 Literature Reviewed

The following literature and data sources were reviewed to develop methods and inform field surveys:

- State and Federal ESA and Sensitive Species listings:
    - Oregon Natural Heritage Database (1989). Rare, Threatened and Endangered Plants and Animals of Oregon.
    - Oregon Biodiversity Information Center (ORBIC). List of Rare, Threatened, and Endangered Species (2016).
    - U.S. Fish and Wildlife Service Information Planning and Consultation (IPaC) system (2016).
- Geographical Information System (GIS) Data layers
    - Oregon GAP Vegetation Data (USGS 2011)
    - ORBIC database (2016)
    - Oregon Spatial Data Library (2016)
- Survey methodologies
    - *Raptor Survey Techniques* in *Raptor Management Techniques Manual*. National Wildlife Federation, Washington, DC (Fuller and Mosher 1987).
    - Inventory Methods for Raptors: Standards for Components of British Columbia Biodiversity. (Ministry of Sustainable Resource Management 2001)
    - *Multiple species inventory and monitoring technical guide.* Gen. Tech. Rep. WO-73. Washington, DC: U.S. Department of Agriculture, Forest Service, Washington Office. (Manley et al. 2006).
    - *Survey Protocols for Vascular Plants. Version 2.0.*USDA Forest Service/USDI Bureau of Land Management, Region 6, Portland, OR. (Whiteaker et al. 1998).

3.2 Agency Consultation

In January 2013, OSU formed an advisory team comprised of federal and state agencies involved in the PMEC-SETS authorization process, as well as non-governmental organizations representing stakeholder interests, to collectively explore the Project and identify key regulatory and environmental considerations. This advisory group is called the Collaborative Workgroup (CWG). A Terrestrial Study Plan (HDR 2016) was developed in coordination with relevant agency personnel from the CWG, including the Oregon Department of Fish and Wildlife (ODFW), the U.S. Fish and Wildlife Service (FWS), and the Oregon Parks and Recreation Department (OPRD). A Scientific Research Permit was required prior to conducting surveys at Driftwood Beach State Recreation Site, and was issued on June 2, 2016. A draft summary report was submitted to ODFW on August 2, 2017, and ODFW provided comments on August 22, 2017. This report has been revised to address ODFW comments.

3.3 Field Surveys

HDR conducted the following field surveys May 31 to June 3, 2016, and June 21 - 22, 2017, in accordance with state and federal regulations. Studies were generally based on the literature sources listed in Section 3.1. A list of species found in the project area that are considered Special Status Species by ODFW or are listed under the ESA by the FWS is included in Appendix A.

Terrestrial impacts on biological resources include the proposed terrestrial developments, buried cable corridor, and any adjacent areas that may be indirectly affected by construction activities.

3.3.1 Habitat Characterization

Endangered and Special Status Wildlife Species

HDR reviewed state and federal threatened and endangered species potentially occurring in the terrestrial study area. HDR also identified state-designated significant wildlife habitat and FWS-designated Critical Habitat. For special status species that may occur in the project area (see Appendix A), suitable habitat was evaluated and identified during terrestrial surveys. Documented suitable habitat included areas with larger trees (greater than or equal to 24 inches at diameter breast height [DBH]), snags or tree cavities, wetlands, and streams. If present, suitable habitat and special status wildlife species were recorded using a GPS unit. If several large diameter trees and snags were present within a habitat type, locations of individual habitat features were not recorded, rather the overall habitat type was described and delineated.

Bat Hibernacula

HDR photo documented all large snags and live trees with sloughing bark that may provide habitat for roosting bats, which could be observed from the study corridor and public access points, except in areas where numerous features were observed, as described above.

Incidental Wildlife Observations

All wildlife observed during terrestrial surveys was recorded. Additional effort was given to the special status species noted by ODFW as being known to occur or potentially present in the project corridor (see Appendix A) and any additional special status species discovered through coordination with FWS and state parks as likely to be present within the project corridor.

Raptor and High Fidelity Nest Tree Surveys

HDR performed a nest survey of the terrestrial cable route for raptors and other high fidelity nesting bird species. Information collected from agency input, ORBIC data, and habitat characterization data was reviewed to determine if there are known raptor nests. Fieldwork consisted of verifying data reviewed and performing a walking survey of the study area. The nest survey was conducted from the ground and publicly accessible observation points. If present, nests were recorded using a GPS unit. Areas where potential habitat was suspected to be present but inaccessible to surveys were documented, so that these areas can be thoroughly evaluated during pre-construction surveys.

Nest surveys focused on the following species of concern with high nest fidelity in Oregon:

- Bald eagle (*Haliaeetus leucocephalus*)
- Osprey (*Pandion haliaetus*)
- Great blue heron (*Ardea Herodias*)
- Peregrine falcon (*Falco peregrinus*)
- Marbled murrelet (*Brachyramphus marmoratus)*
- Northern spotted owl (*Strix occidentalis caurina*)
- Pileated woodpecker (*Hylatomus pileatus*).

Any active non-raptor nests observed during terrestrial surveys, and all incidental observation of bird species identified were recorded, when at all possible.

3.3.2 Rare Plants

HDR performed a rare plant survey of the terrestrial cable route and study corridor. Information received from agency input and ORBIC data was cross-referenced with the state and federal species list and habitat characterization data to determine known populations or potential locations of rare plants to survey. Field work consisted of habitat characterization verification and performing rare plant surveys within identified suitable habitat using standard

Oregon Department of Agriculture (ODA) survey methods (ODA 2016a). Survey locations and rare plant populations identified were recorded using a GPS unit.

Rare plant surveys focused on the following special status species, which are known to occur in Lincoln County, and are therefore the most likely to occur within the project area:

- Pink sand-verbena (*Abronia umbellate var. breviflora*)
- Point Reyes bird's-beak (*Cordylanthus maritimus ssp. Palustris*)
- Coast Range fawn-lily (*Erythronium elegans*)
- Kinnikinnick (*Arctostaphylos uva-ursi*).

The following special status species have the potential to occur, but are not likely to occur in the project area due to range restrictions or limited suitable habitat:

- Cascade Head catchfly (*Silene douglasii* var. *oraria*)
- Clover species (*Trifolium* species)
- Early blue violet (*Viola adunca*)
- Nelson's checker-mallow (*Sidalcea nelsoniana*)
- Silvery phacelia (*Phacelia argentea*).

Potentially suitable habitat for all rare plants was identified during terrestrial surveys. If present, suitable habitat and rare plant populations were recorded using a GPS unit.

4 Existing Conditions

4.1 Infrastructure

The project area is located adjacent to Highway 101, a major north-south highway running along the west coast of the United States. Within the study area, Highway 101 consist of two 12.5-foot-wide lanes with an average total right-of-way width of 80 feet. Several public rights-of-way connect to Highway 101 in the project area including NW Sarkisian Drive, NW Terrace Street and NW Wenger Lane at the south end, and an unnamed road near the north end.

The study area includes Driftwood Beach State Recreation Site, a wayside that provides access to the ocean and picnic facilities on the west side of Highway 101. Developments at Driftwood include an access road, a 0.65-acre parking lot, several paved paths, and restroom facilities.

No houses or other architectural structures occur within the study area.

4.2 Vegetation and Habitat

Vegetation types in the project area were defined using the Northwest GAP Analysis Project ecological systems (NHI 1998). The study area is located within a mix of Westside Lowlands Conifer-Hardwood Forest and Westside Riparian-Wetland with several small streams classified as open water. General descriptions of each vegetation community and the conditions observed in the project area are included below.

4.2.1 Westside Lowlands Conifer Hardwood Forest

In Oregon, this forest habitat occurs on the western slopes of the Cascades, around the margins of the Willamette Valley, in the Coast Range, and along the outer coast. Along the coastline, it often occurs adjacent to Coastal Dunes and Beaches. This habitat is forest, or rarely woodland, dominated by evergreen conifers, deciduous broadleaf trees, or both. Late seral stands typically have an abundance of large (>164 feet [50 m] tall) coniferous trees, a multi-layered canopy structure, large snags, and many large logs on the ground. Early seral stands typically have smaller trees, single-storied canopies, and may be dominated by conifers, broadleaf trees, or both.

The most characteristic species in the study area included western hemlock (*Tsuga heterophylla*), Sitka spruce (*Picea sitchensis*), and shore pine (*Pinus contorta* var. *contorta*) with some western redcedar (*Thuja plicata*) and red alder (*Alnus rubra*) interspersed. Shore pines dominated the overstory west of Highway 101 and were less common on eastern parcels, where western hemlock and Sitka spruce were dominant. A common small subcanopy tree was cascara buckthorn (*Rhamnus purshiana*). Dominant shrub species consisted of salal (*Gaultheria shallon*), evergreen huckleberry (*Vaccinium ovatum*) and salmonberry (*Rubus spectabilis*) with interspersed Pacific rhododendron (*Rhododendron macrophyllum*), four-line honeysuckle (*Lonicera involucrate*), and vine maple (*Acer circinatum*). The most common herbaceous species was swordfern (*Polystichum munitum*), but other common forbs and ferns found in the understory include deerfern (*Blechnum spicant*), bracken fern (*Pteridium aquilinum*), twinflower (*Linnaea borealis*), and false lily-of-the-valley (*Maianthemum dilatatum*).

Forested habitat in the study area mostly consisted of early seral tree stands, with the majority of trees being less than 24 inches DBH. The forested areas west of Highway 101, surrounding the Driftwood Beach State Recreation Site, had fairly closed canopies (greater than 80 percent), whereas forested areas within the parcel on the east side of Highway 101 tended to have more open canopies, with more fragmented patches of forest. Areas adjacent to roads, wetlands, riparian areas, and more recently cleared sites had denser shrub cover with a more open canopy. The canopy level was generally uniform, with very few layers. No caves, bridges, or rocky outcrops were found in the study area. Older forested areas with a high percentage of large trees, snags, fallen trees, and woody debris were not observed within the study area, but were observed within adjacent parcels outside of the study area, specifically in the parcel immediately north of the proposed UCMF location (See Figure 5-1).

4.2.2 Westside Riparian-Wetlands

This habitat is patchily distributed in the lowlands and low mountains throughout the area west of the Cascade Crest south into northwestern California and north into British Columbia. This habitat is characterized by wetland hydrology or soils, periodic riverine flooding, or perennial flowing freshwater and typically occupies patches or linear strips within a matrix of forest or regrowing forest. The most frequent matrix habitat is Westside Lowlands Conifer-Hardwood Forest.

In forested wetlands where an overstory was present western hemlock, Sitka spruce, red alder, and shore pine were the dominant species. The shrub layer was commonly dominated by salmonberry, salal, four-line honeysuckle, and Douglas' meadowsweet (*Spiraea douglasii*) with Labrador-tea (*Rhododendron groenlandicum),* oceanspray (*Holodiscus discolor*), salmon raspberry (*Rubus spectabilis*), and Pacific ninebark (*Physocarpus capitatus*) present as co- or subdominants. Understory dominant herbs included yellow skunk cabbage (*Lysichiton americanus*), field horsetail (*Equisetum arvense*), slough sedge (*Carex obnupta*), American alpine lady fern (*Athyrium cyclosorum*), and slender rush (*Juncus tenuis*) with giant horsetail (*Equisetum telmateia*), American purple vetch (*Vicia americana*), deer fern, yellow water-flag (*Iris pseudacorus*), lamp rush (*Juncus effusus*), and Pacific water-dropwort (*Oenanthe sarmentosa*) present as subdominants.

Eight freshwater wetlands totaling 0.9 acre were delineated within the study area. Three wetlands were determined to be forested, totaling 0.14 acre; four were scrub-shrub, totaling 0.61 acre; and one was emergent, totaling 0.15 acre. A detailed description of each wetland is provided in Appendix B (Wetland Delineation Report).

4.2.3 Open Water

Streams and rivers are distributed statewide in Oregon and Washington, forming a continuous network connecting high mountain areas to lowlands and the Pacific coast. The western Cascades in Washington and Oregon are composed of volcanically derived rocks and are more stable than streams typically found in other parts of the Pacific Northwest. They have low sediment-transport rates and stable beds composed largely of cobbles and boulders, which move only during extreme events.

Two named streams (Stream 1 - Friday Creek and Stream 2 - Twombly Creek) and two unnamed streams (Stream 3, Stream 4) were identified within the study area. Streams in the project area were low gradient with high sediment loads and highly vegetated banks. Portions of each stream flowed in ditches adjacent to Highway 101, crossing in culverts. An additional roadside ditch with a surface water connection to Twombly Creek was also identified.

5 Study Results

5.1 Habitat Characterization

HDR evaluated existing habitat conditions within the study area in order to determine potential impacts from the Project terrestrial facilities. The habitat characterization consisted of categorizing habitats based on functional importance to fish and wildlife, evaluating the potential for federal and state listed special status species to occur, and identifying any high value habitat features within the study area. An overview of the field survey results are shown on Figure 5-1.

5.1.1 Habitat Categories

The vegetation/habitat types were qualitatively categorized based on their functional importance to fish and wildlife, in accordance with the *ODFW Fish and Wildlife Habitat Mitigation Policy*. Habitat categories as defined in Table 5-1 were assigned using a combination of aerial imagery interpretation, field assessment, Northwest Gap land cover classifications, and ODFW and FWS developed overlays for both ESA-listed and sensitive wildlife and plant species. A map of the habitat categories in the study area is provided in Figure 5-2 and recommended guidelines for mitigation, if appropriate, are provided in Table 5-1.

Category 6 Habitat

ODFW defines Category 6 habitat as having low potential to become essential or important habitat. Habitat in and around the study area that was considered Category 6 habitat included paved and dirt roads, parking lots, driveways, houses, and businesses. Approximately 36 percent of the study area was determined to be Category 6 habitat.

Photo 1. Category 6 Habitat Found in Study Area

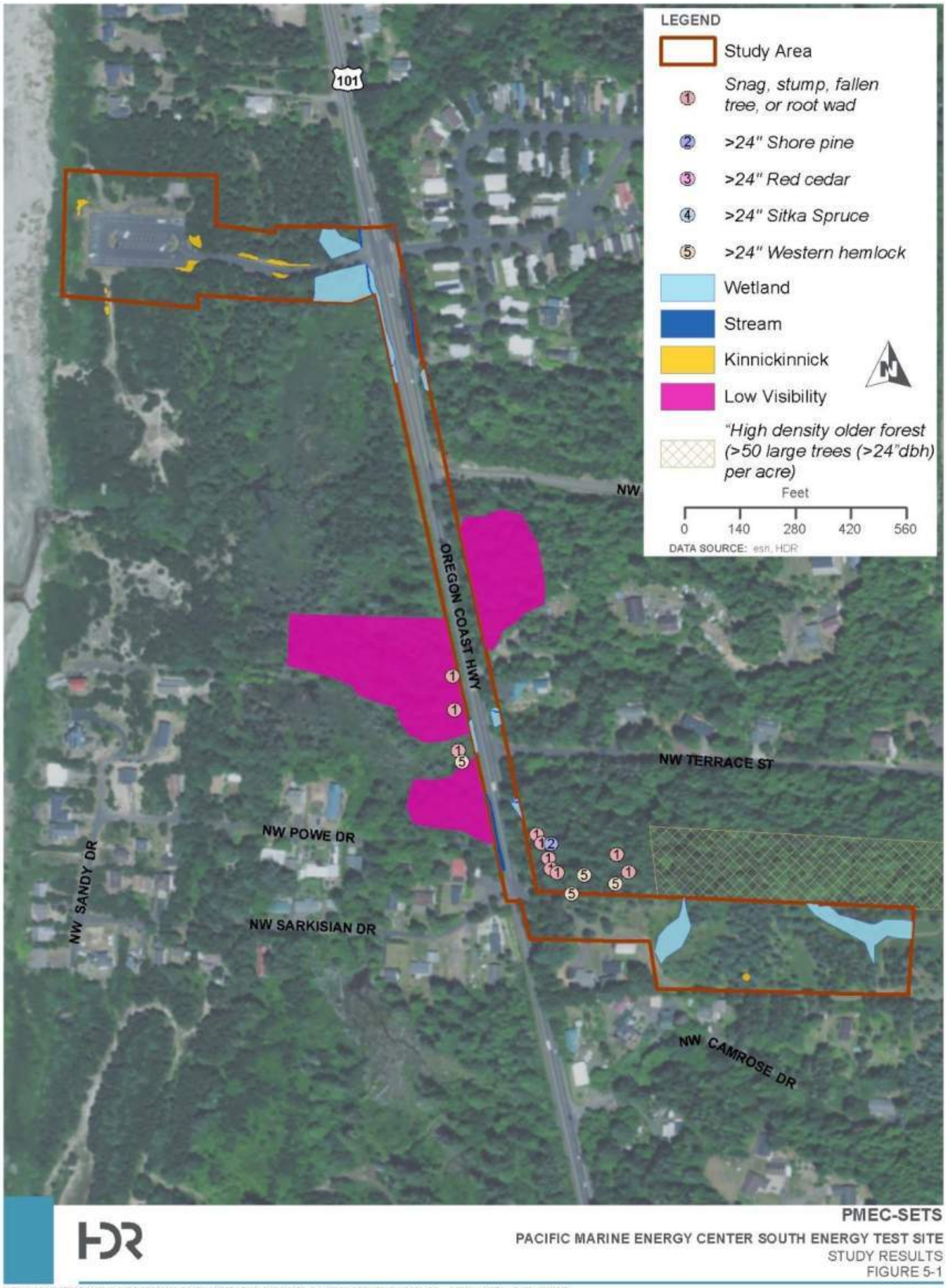

Figure 5-1. Study Results.

Table 5-1. Oregon Department of Fish and Wildlife Mitigation Goals and Implementation Standards by Habitat Category

Habitat Category	Habitat Importance	Mitigation Goal	Mitigation Strategy	Habitat Found in Project Area
Category 1	Irreplaceable, essential habitat; limited on a physiographic or site-specific basis	No loss of habitat quantity or quality	Avoidance	None.
Category 2	Essential and limited habitat	No net loss of habitat quantity or quality and to provide a net benefit of habitat quantity or quality	In-kind, in-proximity mitigation	Fish bearing streams and habitat important for rare species.
Category 3	Essential habitat or important and limited habitat	No net loss of habitat quantity or quality	In-kind, in-proximity mitigation	Older forested areas, wetlands, and dune habitat.
Category 4	Important habitat	No net loss of habitat quantity or quality	In-kind or out-of-kind, in-proximity or off-proximity mitigation	Isolated or degraded wetlands, recently disturbed forests, roadside ditches.
Category 5	Habitat having a high potential to become either essential or important habitat	Net benefit in habitat quantity or quality	Actions that improve habitat conditions	Landscaped or maintained areas.
Category 6	Low habitat value and low restoration potential. Not important in sustaining populations of wildlife species	Minimize impacts	Minimize direct habitat loss and avoid off-site impacts	Roads and existing rights-of-way, houses, and other paved areas.

Source: ODFW 2006

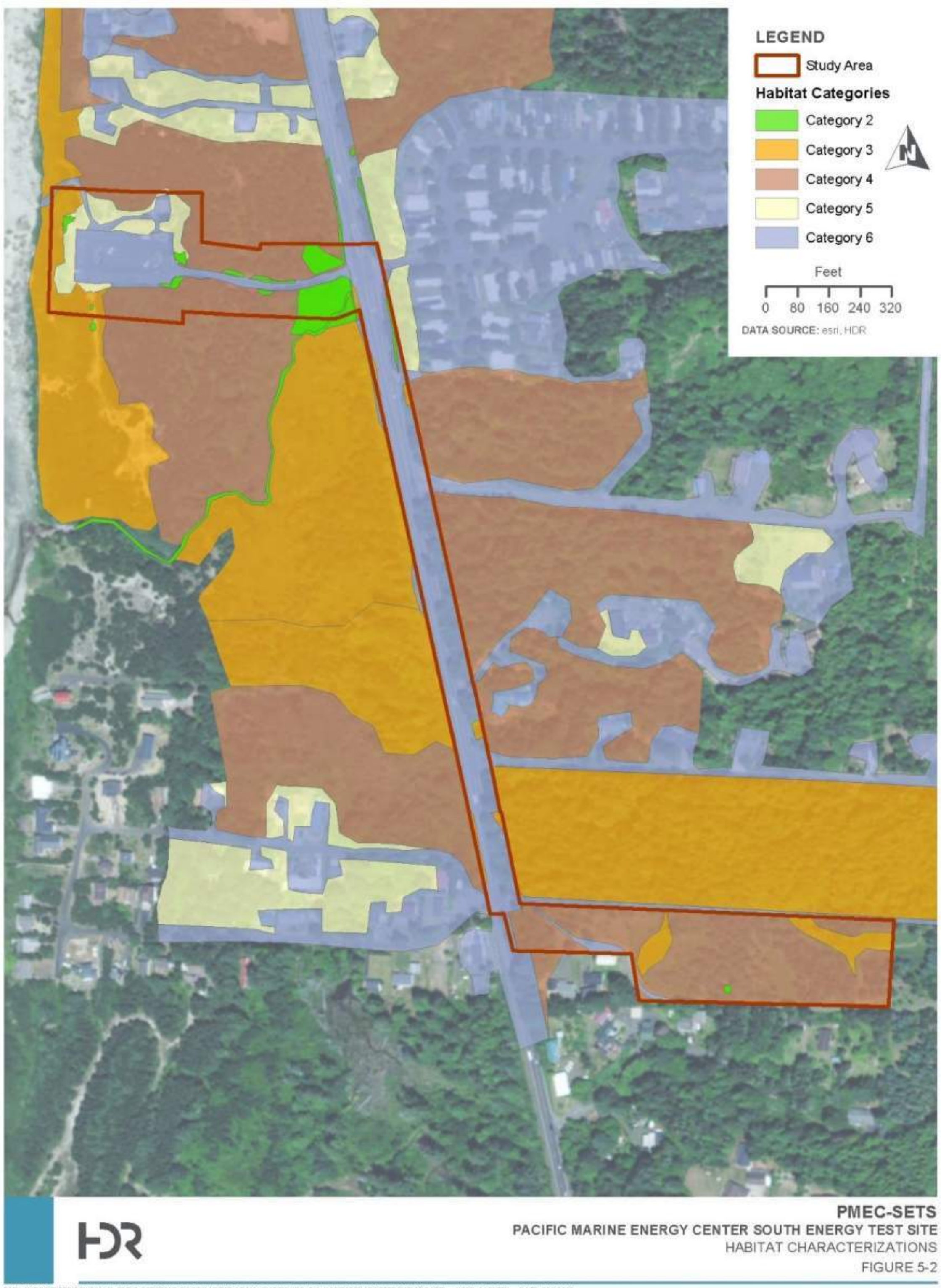

Figure 5-2. Habitat Categorization of Study Area.

Category 5 Habitat

ODFW defines Category 5 habitat as having high potential to become either essential or important habitat. Habitat in and around the study area that was considered Category 5 habitat included landscaped areas adjacent to houses, businesses, and rights-of-way, and areas maintained with few trees. Approximately 5 percent of the study areas was determined to be Category 5 habitat.

Photo 2. Category 5 Habitat Found in Study Area

Category 4 Habitat

ODFW defines Category 4 habitat as important habitat, or any habitat recognized as a contributor to sustaining fish and wildlife populations over time. Habitat in and around the study area that was considered Category 4 habitat included isolated or degraded wetlands, roadside ditches that were not connected to other streams, recently disturbed forested areas with few or no large trees, and shore pine forests which provide limited habitat. Approximately 46 percent of the study area was determined to be Category 4 habitat.

Photo 3. Category 4 Habitat Found in Study Area – Disturbed Forest

Photo 4. Category 4 Habitat Found in Study Area – Shore Pine

Category 3 Habitat

ODFW defines Category 3 habitat as essential habitat, or important and limited habitat. Essential habitat includes any habitat conditions which would result in depletion of fish or wildlife species if the quality or quantity is diminished. Important and limited habitat includes any insufficient or barely sufficient amount of habitat recognized as a contributor to sustaining fish and wildlife populations over time. Habitat in and around the study area that was considered Category 3 habitat included most wetlands, and areas adjacent to coastal dune habitat. Approximately 8 percent of the study area was determined to be Category 3 habitat.

Photo 5. Category 3 Habitat Found in Study Area – Wetland

Photo 6. Category 2 Habitat Found in Study Area – Fish Bearing Stream

Category 2 Habitat

ODFW defines Category 2 habitat as essential and limited habitat, or any insufficient or barely sufficient amount of habitat or habitat conditions which would result in depletion of fish or wildlife species if the quality or quantity is diminished. Habitat in and around the study area that was considered Category 2 habitat was limited to fish bearing streams documented within the study area, wetlands adjacent to fish bearing streams, and areas where kinnikinnick, a host plant for the rare seaside hoary elfin, was documented. Approximately 5 percent of the study area was determined to be Category 2 habitat.

Category 1 Habitat

ODFW defines Category 1 habitat as irreplaceable, essential and limited habitat, such as bogs, fens, and certain springs and pools. No Category 1 habitat was documented within the study area.

5.1.2 Endangered and Special Status Species

A review of the Oregon Biodiversity Information Center (ORBIC) data for rare, threatened and endangered plant and animal returned 33 occurrence records for 18 species within 2 miles of the study area. These species included many non-listed species that are either globally or state ranked as rare, threatened, or endangered. The majority of species were restricted to habitats not found within the study area (marine, nearshore, bogs, or major streams), and many were last observed more than 20 years ago and the populations are presumed extirpated. Table 5-2 shows the federal and state listed species that have been documented within 2 miles of the study area.

Table 5-2. ORBIC Data Results

Species	Federal Status	State Status	Habitat	Distance from Study Area (miles)	Date Last Documented
Fish					
Green sturgeon *Acinpenser medirostris*	SOC	-	Marine/freshwater rivers	1.2	Unknown
Chum salmon (Pacific Coast ESU) *Oncorhynchus keta*	-	SC	Marine/freshwater rivers	1.2	2009
Coho salmon (Oregon Coast ESU) *Oncorhynchus kisutch*	T	SV	Marine/freshwater rivers	1.0	2009
Steelhead (Oregon Coast ESU – winter run) *Oncorhynchus mykiss*	SOC	SV	Marine/freshwater rivers	1.2	2009
Chinook salmon (Oregon Coast ESU – spring run) *Oncorhynchus tshawytscha*	-	SC	Marine/freshwater rivers	1.7	2009
Birds					
Bald eagle *Haliaeetus leucocephalus*	-	SV	Near aquatic or wetland habitat	1.0	2006
Amphibians and reptiles					
Northern red-legged frog *Rana aurora*	SOC	SV	Slow moving ponds, marshes, or pools in streams.	2.4	2010
Plants					
Seaside gilia *Gilia millefoliata*	SOC	-	Sand dunes	0	1961

Source: ORBIC data (2016)

SOC=Federal Species of Concern; SC=State Species of Concern; SV=Sensitive Vulnerable; E=Endangered; T=Threatened

According to the Oregon Department of State Parks, the seaside hoary elfin (*Incisalia polia maritime*) butterfly is found in Driftwood Beach State Recreation Site, and its habitat is found throughout the park in upland areas. OPRD reported that recent taxonomic work revealed the population at Driftwood was found to be distinct from other populations (personal communication with K. Duzik, OPRD, October 29, 2014). This species is ranked as Critically Imperiled in Oregon by the Oregon Biodiversity Center, and the genetically distinct population in Lincoln County is presently the only known location in Oregon. This butterfly is associated with its host plant, kinnikinnick (bearberry).

The study area did not extend to the nearshore or marine environments, and thus did not provide habitat for sea and shorebirds or marine mammals.

Wetlands and streams documented within the study area could provide habitat for special status species associated with ponded water or slow moving streams including great blue heron (*Ardea Herodias*), snowy egret (*Egretta thula*), western pond turtle (*Actinemys marmorata*), northern red-legged frog (*Rana aurora*), and western toad (*Bufo boreas*). Habitat for the coastal tailed frog, which prefers cold, clear, rocky streams, does not occur in the study area. Fish presence was documented in Stream 4, a tributary to Friday Creek which likely provides habitat for anadromous cutthroat trout, but fish species could not be confirmed. Fish presence is assumed in Twombly and Friday Creek, both of which pass through the study area.

Mixed conifer/deciduous forest in the study area could provide habitat for special status arboreal species such as clouded salamander (*Aneides ferreus),* little willow flycatcher (*Empidonax traillii brewsteri*), olive-sided flycatcher (*Contopus cooperi*), purple martin (*Progne subis*), western bluebird (*Sialia mexicana*), and willow flycatcher (*Empidonax traillii adastus*). More heavily wooded portions of the study area could also provide habitat for species that nest or roost in snags and fallen trees such as the pileated woodpecker (*Dryocopus pileatus),* hoary bat (*Lasiurus cinereus*), long-eared bat *(Myotis septentrionalis*), and silver-haired bat (*Lasionycteris noctivagans*). Habitat for species that are specialized for old growth forests, such as the red tree vole (*Arborimus longicaudus*) is not present within the study area. No caves, rock outcroppings, or bridges were documented in the study area, limiting habitat for bat species that roost in crevices.

No special status species were observed during the site visits on May 31 through June 3, 2016, or June 21 through 22, 2017.

ESA-Listed Threatened and Endangered Species

Short-tailed albatross

The short-tailed albatross (*Phoebastria albatrus*) was federally listed as endangered in 2000 (65 FR 46643). Critical habitat has not been designated for the species. The species is also listed as endangered by the State of Oregon. Current potential threats to the short-tailed albatross include breeding colony habitat degradation due to volcanic activity, typhoons, flash floods, erosion, and invasive species; oil contaminants; plastics ingestion; and bycatch in commercial fisheries (FWS 2009). Short-tailed albatrosses feed in areas of the North Pacific and rarely make use of terrestrial habitat. Habitat for this species was not documented in the study area.

Western snowy plover

The western snowy plover (*Charadrius alexandrinus nivosus*) was federally listed as threatened in 1993 due to loss of nesting habitat and declines in breeding populations (58 FR 12864). Critical habitat was revised in 2012 and there are critical habitat units in California, Oregon, and Washington (77 FR 36728); however, there is no critical habitat designated in the Project area. The main threats to the species include habitat loss and degradation from human disturbance, urban development, introduced beachgrass (*Ammophilia* spp.), and expanding predator populations (FWS 2007). The species is also listed as threatened by the State of Oregon.

The Pacific coast population of the western snowy plover breeds primarily on coastal beaches and forage for small invertebrates in wet or dry beach-sand, among surf-cast kelp, and along the edges of salt marshes, salt ponds, and lagoons (FWS 2001). Habitat for this species was not documented in the study area.

Marbled murrelet

The FWS listed marbled murrelet (*Brachyramphus marmoratus*) as threatened in 1992 (57 FR 45328). Marbled murrelets occur in Alaska, British Columbia, Washington, Oregon, and California. Although only a small percentage of the population (2 percent) occurs in Washington, Oregon, and California, this area represents 18 percent of the species' linear coastal range and likely supported far greater murrelet numbers historically (McShane et al. 2004). During the breeding season (April-September), marbled murrelets fly between coastal/ocean habitat where they feed and inland forest habitat where they nest, and at-sea abundance has been strongly correlated with inland areas containing contiguous old-growth forest (Miller et al. 2002). Typical nesting habitat consists of lower elevation old growth and mature conifer forests, with multi-layered canopies, a high composition of coniferous tress, and low canopy closure (Hamer and Nelson 1995). Population declines have been attributed to forest fragmentation and loss of nesting habitat from the harvest of old-growth coniferous forests, and from mortality associated with gillnet fisheries and oil pollution. Critical habitat has been revised several times since the first designation in 1996, with the most recent designation in 2011 (76 FR 61599). There is no critical habitat in the study area. The species is also listed as threatened by the State of Oregon.

Mixed conifer/deciduous forests found in the study area support western hemlock and Sitka spruce, trees commonly associated with marbled murrelet breeding habitat. The study area is dominated by stands of younger trees, measuring between 6 inches and 20 inches DBH, and generally lacks any large trees greater than 24 inches DBH. Canopy layering was limited and closure was generally high (greater than 80 percent). While the study area could provide potential stopover habitat for dispersing murrelets, nesting habitat is limited. If marbled murrelets use the mixed conifer/deciduous forest in the study area for stopover habitat, they could be affected by sound and human disturbance (e.g., movement of equipment and personnel) during construction activities. These effects would likely be limited to short-term, temporary disturbance of individuals, which could result in temporary displacement from stopover areas. However, the terrestrial facilities are located along Highway 101, so disturbance from vehicles and other human interactions are already present.

Northern spotted owl

The northern spotted owl (*Strix occidentalis caurina*) was federally listed as threatened in 1990 due to habitat loss from timber harvest (55 FR 26114). The main threats to this species are past and current habitat loss, and competition from the barred owl (*Strix varia*). Critical habitat was designated in 1992 and revised in 2008 and 2012 and there are critical habitat units in California, Oregon, and Washington (77 FR 71875); however, there is no critical habitat designated in the study area. The species is also listed as threatened by the State of Oregon. Northern spotted owl nesting, roosting, and foraging habitat occurs in structurally complex, older coniferous forests (FWS 2011). Important habitat features include a moderate to high canopy closure (60 to 90 percent); multilayered, multi-species canopy with large overstory trees; a prevalence of large trees with various deformities (large cavities, broken tops, mistletoe infections, and other evidence of decadence); presence of large snags; accumulations of fallen trees and other woody debris on the ground; and sufficient open space below the canopy for spotted owls to fly (Thomas et al. 1990). Spotted owls spend most of the day roosting in trees; they forage at night between sunset and sunrise, although they may also forage opportunistically during the day (Forsman et al. 1984, Sovern et al. 1994). Spotted owls exhibit high site fidelity, generally retaining the same breeding territories from year to year (Forsman et al. 2002). Courtship behavior begins in February or March, and eggs are typically laid in late March or April (Forsman et al. 1984, FWS 2011). Nests are usually found in old-growth coniferous trees (i.e., exceeding 200 years), and Douglas fir is the most common nest tree species (Forsman et al. 1984, LaHaye and Gutierrez 1999).

Northern spotted owls could occur in the mixed conifer/deciduous forest along the inland cable route, although it would be unlikely given that the surrounding forest is fairly fragmented due to housing developments and timber harvesting. If northern spotted owls use the mixed conifer/deciduous forest in the study area for foraging, they could be affected by sound and human disturbance (e.g., movement of equipment and personnel) during construction activities. These effects would likely be limited to short-term, temporary disturbance of individuals, which could result in temporary displacement from foraging areas. However, the inland cable route is located along Highway 101 and NW Terrace Street, so disturbance from vehicles is already present. The inland cable route does not contain suitable nesting habitat. For these reasons, there is little risk to individuals or the population of northern spotted owls as a result of exposure to sound and human disturbance from construction activities.

5.1.3 Bat Hibernacula

Forested areas within the study area contained very few snags and fallen trees, but woody debris was generally left in place. These structures provide habitat for cavity roosting bats such as California myotis (*Myotis californicus*), hoary bat (*Lasiurus cinereus*), Northern long-eared bat (*Myotis septentrionalis*), long-legged myotis (*Myotis volaris*), and silver-haired bat (*Lasionycteris noctivagans*). No caves, bridges, or rocky outcrops were found in the study area, but buildings and structures adjacent to the study area could provide limited habitat to bats that roost on artificial structures such as fringed myotis (*Myotis thysanodes*) and Yuma myotis (*Myotis yumanensis*).

Photo 7. Potential Bat Hibernacula Found in Study Area

Project construction activities have the potential to temporarily displace or disturb bats in the immediate vicinity of the Project. Construction of above-ground onshore Project structures, specifically the UCMF, would result in alteration and loss of habitat. Effects of construction activities on terrestrial resources would be temporary, and use of the area would be expected to return to normal following completion of construction and site restoration activities. Although bats could be permanently displaced from the area occupied by the UCMF, there is ample habitat around the proposed UCMF site for bats to relocate.

5.1.4 Incidental Wildlife Observations

Incidental wildlife observations documented in and around the study area during the terrestrial surveys conducted on May 31 through June 3, 2016, included the species listed in Table 5-3. No incidental wildlife observations were recorded during site visits on June 21 through 22, 2017.

Table 5-3. Incidental Wildlife Observations

Species	Date	Location and Comments
Birds		
Bald eagle *Haliaeetus leucocephalus*	6/2/2016	Observed from Driftwood Beach State Recreation Site, flying north along shoreline
Peregrine falcon *Falco peregrinus*	6/2/2016	Observed from Driftwood Beach State Recreation Site, flying north along shoreline
American goldfinch *Spinus tristis*	6/2/2016	Driftwood Beach State Recreation Site
Spotted towhee *Pipilo maculatus*	6/1/2016 – 6/3/2016	Multiple observations
Rufous hummingbird *Selasphorus rufus*	6/2/2016 and 6/3/2016	Multiple observations
Black-capped chickadee *Poecile atricapillus*	6/1/2016 – 6/3/2016	Multiple observations
Amphibians and reptiles		
Rough skinned newt *Taricha granulosa*	6/1/2016	Multiple observations
Northwestern salamander *Ambystoma gracile*	6/2/2016	Egg masses observed in Stream 4 (See Appendix B).

5.2 Raptor and High Fidelity Nest Tree Surveys

Information collected from agency input, ORBIC data, and habitat characterization data was reviewed, and no nests have been documented within the study area. The closest documented raptor nest is a bald eagle located approximately 1 mile southeast of the study area. This nest was verified in 2006, and is presumably still being used for breeding. The data was reviewed in the field using a walking survey of the route. No nests, raptors, or high fidelity nesting species were observed within the study area. Species including bald eagle, turkey vulture (*Cathartes aura*), and peregrine falcon were observed along the beach, west of the study area, but were likely using the coastline as a foraging or migratory corridor. The nest survey was conducted from the ground and publicly accessible observation points. HDR documented areas where habitat is potentially present but was inaccessible to survey so that these areas can be thoroughly evaluated during pre-construction surveys. These potential habitat areas are labeled as “low visibility areas” on Figure 5-1.

5.3 Rare Plants

5.3.1 Pink Sand-verbena

Pink sand-verbena is a federal species of concern and an Oregon endangered species. Pink sand-verbena can be either an annual or occasionally a short-lived perennial. In the northern portion of its range, from Oregon north to Vancouver Island, populations occur on broad beaches and/or near the mouths of creeks and rivers. The species usually occurs on beaches in fine sand between the high-tide line and the driftwood zone, in areas of active sand movement below the foredune. Surveys for pink sand-verbena should be completed when the species is in flower, from June through September, when it can be readily distinguished from the yellow-flowered *Abronia latifolia*, which occupies the same habitat and is vegetatively quite similar. Flowering times vary depending on site conditions and have been reported as early as April and as late as November (ODA 2016b).

No populations or individuals of pink sand-verbena were observed during rare plant surveys conducted between May 31 and June 3, 2016, or June 21-22, 2017.

5.3.2 Point Reyes Bird's Beak

Point Reyes bird's-beak is a federal species of concern and an Oregon endangered species. In Oregon, the species is restricted to Netarts Bay, Yaquina Bay, and Coos Bay, with the majority of known occurrences located in Coos Bay. Point Reye's bird's-beak inhabits the upper end of maritime salt marshes at approximately 2.3-2.6 m (7.5-8.5 feet) above Mean Lower Low Water (MLLW, the mean height of water at the lowest of the daily low tides), in sandy substrates with soil salinity 34-55 parts per trillion (ppt), and less than 30 percent bare soil in summer. Surveys for Point Reyes bird's-beak should be conducted when the species is flowering, from June to October (ODA 2016c).

No populations or individuals of Point Reyes bird's beak were observed during the rare plant surveys. No maritime salt marshes were documented within the terrestrial study area, and suitable habitat for Point Reyes bird's beak was not observed during the rare plant surveys conducted between May 31 and June 3, 2016, or June 21-22, 2017.

5.3.3 Coast Range Fawn-lily

Coast Range fawn-lily is a federal species of concern and an Oregon threatened species. Coast Range fawn lily is restricted to the Coast Range of northern Oregon. It is known from six primary sites, each occurring on prominent peaks and ridges separated by up to 48 km (30 miles), resulting in a fragmented distribution among high-elevation islands of habitat separated by lower elevation coniferous forests. This species is found in a variety of Coast Range habitats, including meadows, rocky cliffs, brushland, open and closed coniferous forest, and the edges of sphagnum bogs at elevations above 790 m (2,600 feet). Surveys for Coast Range fawn lily should be completed when the species is in flower, from the beginning of May to early June (ODA 2016d).

No populations or individuals of coast range fawn-lily were observed during rare plant surveys conducted between May 31 and June 3, 2016, or June 21-22, 2017. The terrestrial study area did not extend to elevations above 790 m, and therefore, suitable habitat for coast range fawn-lily was not documented.

5.3.4 Kinnikinnick

Kinnikinnick is a host plant for seaside hoary elfin, a butterfly that is known to occur in the project area. Kinnikinnick is native on the west coast from Northern California to Alaska, and grows on sandy slopes, exposed rocky banks, dry subalpine meadows, and coniferous forests. It spreads slowly but can grow into a mat as big as 15 feet (OSU 2016). HDR documented kinnikinnick in several locations throughout the study area. All kinnikinnick was found in disturbed areas adjacent to paved areas, on the west side of Highway 101, or adjacent to a dirt road (NW Wenger Lane), on the east side of Highway 101. The majority of kinnikinnick was found within Driftwood Beach State Recreation Site, and was likely previously documented by Oregon State Parks and Recreation studies. In their scoping comments, OPRD stated that the seaside hoary elfin butterfly is found in Driftwood Beach State Recreation Site, and its habitat is found throughout the park in upland areas.

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Appendix A. Special Status Species that May Occur in the Project Area

State Listed or Special Status Species or Species of State Management Concern Along the PMEC-SETS Terrestrial Cable Route					
Name	**Federal Status [a]**	**State ESA Status[a]**	**State Sensitive Status [b]**	**State ONS (OCS) [c]**	**Additional Management Concerns [d]**
Invertebrates					
Insular blue butterfly *Plebeius saepiolus littoralis*				(Strategy)	
Oregon silverspot butterfly *Speyeria zerene hippolyta*				(Strategy)	
Algae and Plants (CONTACT ODA FOR FULL LISTING)					
Cascade Head catchfly *Silene douglasii var. oraria*		ODA - T		(Strategy)	
Clover species *Trifolium* species					host plant for insular blue butterfly, delineate and avoid where butterfly is known or suspected to occur
Coast range fawn-lily *Erythronium elegans*		ODA - T		(Strategy)	
Early blue violet *Viola adunca*					host plant for Oregon silverspot butterfly, delineate and avoid where butterfly is known or suspected to occur
Kinnikinnick (bearberry) *Arctostaphylos uva-ursi*					host plant for seaside hoary elfin, delineate and avoid where butterfly is known or suspected to occur
Nelson's checker-mallow *Sidalcea nelsoniana*		ODA - T		(Strategy)	
Pink sand-verbena *Abronia unbellata ssp. breviflora*		ODA - E		(Strategy)	
Saltmarch bird's-beak (Point Reyes bird's-beak) *Cordylanthus maritimus* ssp. *Palustris*		ODA - E		(Strategy)	
Silvery phacelia *Phacelia argentea*		ODA - T		(Strategy)	

State Listed or Special Status Species or Species of State Management Concern Along the PMEC-SETS Terrestrial Cable Route

Name	Federal Status [a]	State ESA Status[a]	State Sensitive Status [b]	State ONS (OCS) [c]	Additional Management Concerns [d]
Birds					
Aleutian Canada goose *Branta canadensis*				(Strategy)	
Bald eagle *Haliaeetus leucocephalus*				(Strategy)	Breeds in Oregon Site specific data occupied site within area of interest.
Black brant *Branta bernicla nigricans*				(Strategy)	
Black oystercatcher *Haematopus bachmani*			SV	(Strategy)	Breeding Bird Colonies
Brown pelican *Pelecanus occientalis*		SE		(Strategy)	Fishery Limiting
Bufflehead *Bucephala albeola*				(Strategy)	Sea Duck (ocean duck) Breeds in Oregon
California least tern *Sterna antillarum browni*		SE			
Caspian tern *Sterna caspia*				(Strategy)	Breeding Bird Colonies
Cassin's auklet *Ptychoramphus aleuticus*			SV		Breeding Bird Colonies
Fork-tailed storm-petrel *Oceanodroma furcata*				(Strategy)	Breeding Bird Colonies
Great blue heron *Ardea herodias*					Breeds in Oregon Rookery activity north of Alsea Bay
Leach's storm-petrel *Oceanodroma leucorhoa*				(Strategy)	Breeding Bird Colonies
Little willow flycatcher *Empidonax traillii brewsteri*			SV	(Strategy)	
Long-billed curlew *Numenius americanus*			SV (inland only)	(Strategy)	Breeds in Oregon
Marbled murrelet *Brachyramphus marmoratus*	T	ST		(Strategy)	Breeding Bird Colonies
Northern goshawk *Accipiter gentilis*			SV		
Northern spotted owl *Strix occidentalis caurina*	T	ST		(Strategy)	
Olive-sided flycatcher *Contopus cooperi*			SV	(Strategy)	

State Listed or Special Status Species or Species of State Management Concern Along the PMEC-SETS Terrestrial Cable Route					
Name	**Federal Status [a]**	**State ESA Status[a]**	**State Sensitive Status [b]**	**State ONS (OCS) [c]**	**Additional Management Concerns [d]**
Osprey *Pandion haliaetus*					Breeds in Oregon Nests detected near to the area of interest.
Peregrine falcon *Falco peregrinus*			SV	(Strategy)	Breeds in Oregon Present between Yaquina Bay and Alsea Bay
Pileated woodpecker *Dryocopus pileatus*			SV		
Purple martin *Progne subis*			SC		
Red-necked grebe *Podiceps grisegena*			SC (breeding population)	(Strategy)	Breeds in Oregon
Rhinoceros auklet *Cerorhinca monocerata*			SV		Breeding Bird Colonies
Rock sandpiper *Calidris ptilocnemis*				(Strategy)	
Short-tailed albatross *Phoebastria albatrus*	E	SE			Fishery Limiting
Snowy egret *Egretta thula*			SV (breeding population)		
Tufted puffin *Fratercula cirrhata*			SV	(Strategy)	Breeding Bird Colonies
Western bluebird *Sialia mexicana*			SV	(Strategy)	
Western snowy plover *Charadrius alexandrinus nivosus*	T	ST		(Strategy)	Breeds in Oregon
Willow flycatcher *Empidonax traillii adastus*			SV		
Xantus's murrelet *Synthliboramphus hypoleucus*	C				
Terrestrial Mammals					
California myotis *Myotis californicus*			SV	(Strategy)	
Fringed myotis *Myotis thysanodes*			SV	(Strategy)	
Hoary bat *Lasiurus cinereus*			SV	(Strategy)	
Long-eared bat *Myotis septentrionalis*	SOC				

State Listed or Special Status Species or Species of State Management Concern Along the PMEC-SETS Terrestrial Cable Route					
Name	**Federal Status [a]**	**State ESA Status[a]**	**State Sensitive Status [b]**	**State ONS (OCS) [c]**	**Additional Management Concerns [d]**
Long-legged myotis *Myotis volaris*			SV	(Strategy)	
Red tree vole *Arborimus longicaudus*	C				
Yuma Myotis *Myotis yumanensis*	SOC				
Silver-haired bat *Lasionycteris noctivagans*	SOC				
Reptiles					
Western pond turtle *Actinemys marmorata*			SC	(Strategy)	Site specific data indicates potential habitat within the area of interest.
Amphibians					
Clouded salamander *Aneides ferreus*			SV	(Strategy)	Forests of Lincoln County
Coastal tailed frog *Ascaphus truei*			SV	(Strategy)	Fast streams in forests of Lincoln County
Northern red-legged frog *Rana aurora*			SV	(Strategy)	Slow streams with coarse gravel in Coast Range
Western toad *Bufo boreas*			SV	(Strategy)	Wetlands, ponds, and lakes in Coast Range.

Notes:

a. Full state and federal Threatened and Endangered Species List available at http://www.dfw.state.or.us/wildlife/diversity/species/docs/Threatened_and_Endangered_Species.pdf
T=threatened, E=endangered, C=candidate, ODA – T = Oregon Department of Agriculture Threatened, ODA – E = Oregon Department of Agriculture Endangered, SC = state candidate, SV = state vulnerable

b. 2008 Oregon Sensitive Species List: "Sensitive" refers to naturally-reproducing fish and wildlife species, subspecies, or populations which are facing one or more threats to their populations and/or habitats. Implementation of appropriate conservation measures to address the threats may prevent them from declining to the point of qualifying for threatened or endangered status. To provide a positive, proactive approach to species conservation, a “sensitive” species classification was created under Oregon’s Sensitive Species Rule (OAR 635-100-040). The Sensitive Species List focuses fish and wildlife management and research activities on species that need conservation attention. ODFW uses the sensitive species designations primarily to encourage voluntary actions that will improve species status. Although the intent of the Sensitive Species List is to prevent species from declining to the point of qualifying as threatened or endangered, this list is not used as a “candidate” list for species to be considered for listing under the Oregon Threatened and Endangered Species rules. "Critical" sensitive (SC) species are imperiled with extirpation from a specific geographic area of the state because of small population sizes, habitat loss or degradation, and/or immediate threats, and may decline to the point of qualifying for T&E status if conservation actions are not taken. "Vulnerable" (SV) sensitive species are facing one or more threats to their populations and/or habitats, and are not currently imperiled but could become so with continued or increased threats to populations and/or habitats. For the most part, only native species that reproduce in Oregon are considered. 2008 ODFW Sensitive Species List available online at http://www.dfw.state.or.us/wildlife/diversity/species/sensitive_species.asp

State Listed or Special Status Species or Species of State Management Concern Along the PMEC-SETS Terrestrial Cable Route

Name	Federal Status [a]	State ESA Status[a]	State Sensitive Status [b]	State ONS (OCS) [c]	Additional Management Concerns [d]

c. Oregon Nearshore Strategy was published in 2006 as the initial result of ODFW's planning effort to develop a strategy for the long-term management of nearshore resources in Oregon, and is available online at http://www.dfw.state.or.us/mrp/nearshore/document.asp
Oregon Conservation Strategy offers a blueprint for the long-term conservation of Oregon's native fish and wildlife and their habitats through a proactive, non-regulatory and statewide approach to conservation, and is available online at http://www.dfw.state.or.us/conservationstrategy/

d. Management Priority Species: Species may be a management priority to Oregon for one or more reasons. Species may be linked to state interests via a conservation, management, or policy connection such as harvest species. Fishery Limiting species are those that are taken in fisheries off Oregon, and therefore have the potential be become fishery limiting if populations decrease. Important Forage species are those that support marine life off Oregon. Commercially valuable species are those that contribute >$10,000/year on average. Recreationally important species are those that occur with the highest frequency in reported recreational catch. Fishery Management Plans (FMP) are in place for Groundfish, Salmon, Pacific Halibut, Highly Migratory Species, Coastal Pelagic Species, and are available online at http://www.pcouncil.org/groundfish/fishery-management-plan/

Appendix B. Wetland Delineation Report

(See APEA Appendix C-2)

APPENDIX C-2

Wetlands and Waterbodies Delineation Report

Addendum to Appendix C2, Wetlands and Waterbodies Delineation Report

On April 20, 2018, Oregon State University (OSU) filed its draft License Application (DLA) and Preliminary Draft Environmental Assessment (PDEA) for PacWave South (formerly known as Pacific Marine Energy Center South Energy Test Site [PMEC-SETS]). In the DLA, OSU proposed burying the cables between Driftwood Beach State Recreation Site and the utility connection and monitoring facility (UCMF) along Highway 101. With this approach, the five cables would have been installed from the beach manholes at the Driftwood Beach Recreation Site for about 0.2 miles along the Driftwood access road out to Highway 101. Here they would pass under the highway and run about 0.3 miles south within the Highway 101 right-of-way, and then turn east and run about 0.2 miles across OSU's property to the UCMF. The total distance of the terrestrial cable route would be about 0.7 miles.

The alignment for the cable route has been modified from the original route. As presented in this final license application, OSU will install the terrestrial cables using horizontal directional drilling (HDD) from the Driftwood Beach State Recreation Site parking lot directly to the UCMF property, thus avoiding effects to wetlands, streams, terrestrial habitat, adjacent landowners, and Highway 101 users. A wetland and waterway survey was conducted along the original terrestrial transmission line route (along Highway 101) in May 2016 and June 2017, the results of which are presented in the attached December 2017 *Wetlands and Waterbodies Delineation Report* (HDR 2017). The new route extends beyond the 2017 study area. In 2019, a wetland and waterway survey was also conducted along this new study area (referred to as the 2019 study area), the results of which are presented in the attached April 2019 *Supplemental Delineation Report for WD #2018-0355* Memo.

Memo

Date:	Thursday, April 11, 2019
Project:	PacWave South
To:	Dan Hellin, PacWave at OSU
From:	Leandra Cleveland, HDR Engineering, Inc.
Subject:	**Supplemental Delineation Report for WD #2018-0355**

1.0 Introduction

On behalf of Oregon State University (OSU), HDR Engineering, Inc. (HDR) conducted a wetland and waterways delineation in 2016 and 2017 to identify potentially jurisdictional wetlands and other waters of the United States for PacWave South ("the Project"; formerly known as the Pacific Marine Energy Center South Energy Test Site [PMEC-SETS]) in Lincoln County, Oregon (Figure 1; all figures are located in Appendix A). PacWave South will serve as the primary grid-connected ocean test facility for wave energy converters (WECs) in the United States and is being developed by PacWave at Oregon State University (PacWave). The Oregon Department of State Lands (DSL) concurred with the 2016 and 2017 delineation effort findings in September 2018 (WD#2018-0355) and this concurrence included the areas proposed for development of the facility. The study area that was previously reviewed by DSL in September 2018 is referred to as the 2017 study area.

As part of the project, subsea cables and auxiliary cables would run from the test site to the cable splice vaults located at Driftwood Beach State Recreation Park and then continue to a utility connection and monitoring facility (UCMF) south of the site. These cables would all be buried cables. The alignment for the cable route has been modified to a new route that extends beyond the 2017 study area[1]. To verify the presence of wetlands and waterbodies, the additional area that is now subject to disturbance under the new plan is referred to in this supplement as the 2019 study area as shown on Figure 2.

PacWave requests that DSL amend the previous jurisdictional determination (JD) WD#2018-0355 to include the new 2019 study area per OAR 141-90-0045(5) based on field verification and supplemental information presented in this technical memorandum.

2.0 Landscape Setting and Land Use

The combined study areas are located in Lincoln County, Oregon, approximately 1.5 miles north of the city of Waldport and approximately 5.5 miles south of the city of Newport. The 2017 study area encompassed approximately 11.83 acres. The 2019 study area is approximately 7.46

[1] OSU originally proposed burying the cable next to Highway 101. OSU is now proposing to use horizontal directional drilling (HDD) to run the terrestrial cables directly from the Driftwood Beach State Recreation Site to the UCMF, thus avoiding effects to wetlands, streams, terrestrial habitat, adjacent landowners, and traffic along Highway 101.

acres; this increases the overall study area size from 11.83 acres to 19.36 acres[2]. The 2019 study area is located in Township 13 South, Section 12 West, Section 1. An overall description of landscape setting and land use is in Section 2 of the 2017 delineation report (HDR 2017).

3.0 Site Alternatives

The 2019 study area is located in a coastal, rural residential and recreational area, and is generally flat with slopes less than 5 percent. The 2019 study area is part of the Driftwood Beach State Recreation Park and is undeveloped, vegetated land with dirt trails throughout that connect to the main parking lot of the park. An overall description of site alterations is in Section 3 of the 2017 delineation report (HDR 2017).

4.0 Precipitation Data and Analysis

An overall description of the climate in the 2019 study area is in Section 4 of the delineation report (HDR 2017). Precipitation amounts during the three months prior to the field investigations in 2019 are shown in Table 1. Observed precipitation data in the months leading up to the field investigation were analyzed using the Direct Antecedent Rainfall Evaluation Method (NRCS 2015). Precipitation was considered normal for the field investigations in 2019. Therefore, observing wetland hydrology indicators or indicators of stream flow duration would be consistent with normal conditions.

Table 1. Summary of Precipitation between March and May 2019 in Newport, Oregon

Month	Recorded Precipitation (inches)	Monthly Precipitation Average (inches)	Percent of Average Recorded	30% chance less than or more than ranges for normal precipitation (inches)
December	10.37	11.51	90%	<7.99 >13.69
January	6.24	10.22	61%	<6.71 >12.27
February	9.89	8.69	114%	<6.04 >10.33
Water Year to Date (October 1, 2018 through February 28, 2019)	36.74	46.21	79%	
Rainfall two weeks prior to the site visit (February 10-24, 2019)	7.50			
Rainfall day of the site visit	0.28			

5.0 Methods

Methods used are consistent with those described in Section 5 of the 2017 delineation report (HDR 2017). Field investigations were conducted in the 2019 study area on February 25, 2019 by the following HDR staff: Leandra Cleveland and Jennifer Maze.

[2] While the currently proposed terrestrial transmission line route would be approximately 0.5 mile, and would be shorter than what was previously proposed (0.7 mile), the larger overall study area size is due to a wider study corridor being evaluated for the currently proposed route.

6.0 Description of All Wetlands and Other Non-Wetland Waters

The 2017 study area identified the following features:

- Eight freshwater wetlands (Wetlands A through E, G, H, and I) totaling 0.9 acres
- Four streams (Twombly Creek, Friday Creek, Stream 3 and Stream 4)
- Roadside ditch with a surface water connection to Twombly Creek.

Four features were identified and delineated within the 2019 study area. Three of these features (Wetland D, Friday Creek, and Stream 4) are extensions of features delineated in the 2017 study area. Only one new feature, Buckley Creek, was identified.

Data sheets, including SDAM forms, are in Appendix B and ground level photographs of the wetland are in Appendix C.

6.1 Wetlands (2019 Study Area)

WETLAND D – 2.93 ACRE

Wetland D is a saturated, depressional forested/scrub-shrub wetland (PFO4/SS1B) within the Driftwood State Recreation Site (Figure 6). The tree stratum is dominated by shore pine with salal and salmon raspberry along the northeast edges and spirea dominating throughout much of the rest of the wetland. The herb stratum is dominated by slough sedge.

The hydric soil indicator observed was the presence of a histic epipedon and histosol. Saturation in the upper 12 inches of the soil profile was present during the fieldwork including shallow surface saturation. In a few locations a distinct hydrogen sulfide odor was also observed. The wetland boundary was determined by a distinct break in topography along the boundary extents except where the wetland continues offsite. Friday Creek and Stream 4 flow through Wetland D from northeast to southwest.

6.2 Waterbodies (2019 Study Area)

BUCKLEY CREEK

Buckley Creek flows from southeast to west through the 2019 study area (Figure 6). The confluence of both Friday Creek and Stream 4 with Buckley Creek occurs at the western edge of Wetland D. Buckley Creek flows along the western edge of Wetland D in an open channel where it leaves the study area and west to the Pacific Ocean. Buckley Creek is reported by Oregon Department of Fish and Wildlife (ODFW) to support anadromous coastal cutthroat trout (*Oncorhynchus clarkia clarkii* [Kelly 2016]). The ordinary high water mark (OHWM) of Buckley Creek was identified by the clear limits of bed and bank in the undisturbed portions of the stream and the limits of hydrophytic vegetation in the ditched portion of the stream. The channel width is approximately 4 to 5 feet wide and ranged from 1 to 2 feet deep.

FRIDAY CREEK

Friday Creek flows from northeast to southwest through the 2019 study area (Figure 6). The stream flows through Wetland D in an open channel where it leaves the study area and flows into Buckley Creek. The OHWM of Friday Creek was identified by the clear limits of bed and bank in the undisturbed portions of the stream and the limits of hydrophytic vegetation in the ditched portion of the stream. The channel width just south of the park entrance is approximately 2 feet wide and ranges from 5 to 10 feet wide north of the entrance. Depth of water during the survey ranged from 1 to 1.5 feet.

STREAM 4 – UNNAMED

Stream 4 flows into the study area from the northeast through Wetland D in an open channel before flowing into Friday Creek and Buckley Creek on the west side of Wetland D (Figure 6). The OHWM was identified by the clear limits of bed and bank in the undisturbed portion of the stream, and by the limits of hydrophytic vegetation in the ditched portion of the stream. Flowing water in the channel was approximately 4 feet wide and 6 inches deep during the field survey.

7.0 Mapping Methods

Mapping methods are the same as those described in the 2017 delineation report in Section 8 (HDR 2017).

8.0 Results and Conclusions

The 2019 study area includes one wetland and three streams, all of which except Buckley Creek are extensions of features included in the 2017 study area. Table 2 summarizes the findings of the 2019 study area.

Table 2. Summary and Anticipated Jurisdictional Determination

Feature	Size Total*	Size within 2019 Study Area	NWI	Likely Jurisdiction
Wetland D	3.24 acres	2.93 acres	PFO4/SS1B	DSL and USACE
Buckley Creek	112 feet	112 feet	R3UBF	DSL and USACE
Friday Creek	740 feet	375 feet	R3UBF	DSL and USACE
Stream 4	830 feet	370 feet	R3UBF	DSL and USACE

Notes:
*Size total refers to the combined size of the feature within both the 2017 and 2019 study areas.

9.0 Disclaimer

This report documents the investigation, best professional judgment, and conclusions of the investigators. It should be considered a Preliminary Jurisdictional Determination and used at your own risk until it has been approved in writing by the DSL in accordance with OAR 141-090-0005 through 141-090-0055, and USACE in accordance with Section 404 of the CWA (OAR 141-090-0035 [7][k]).

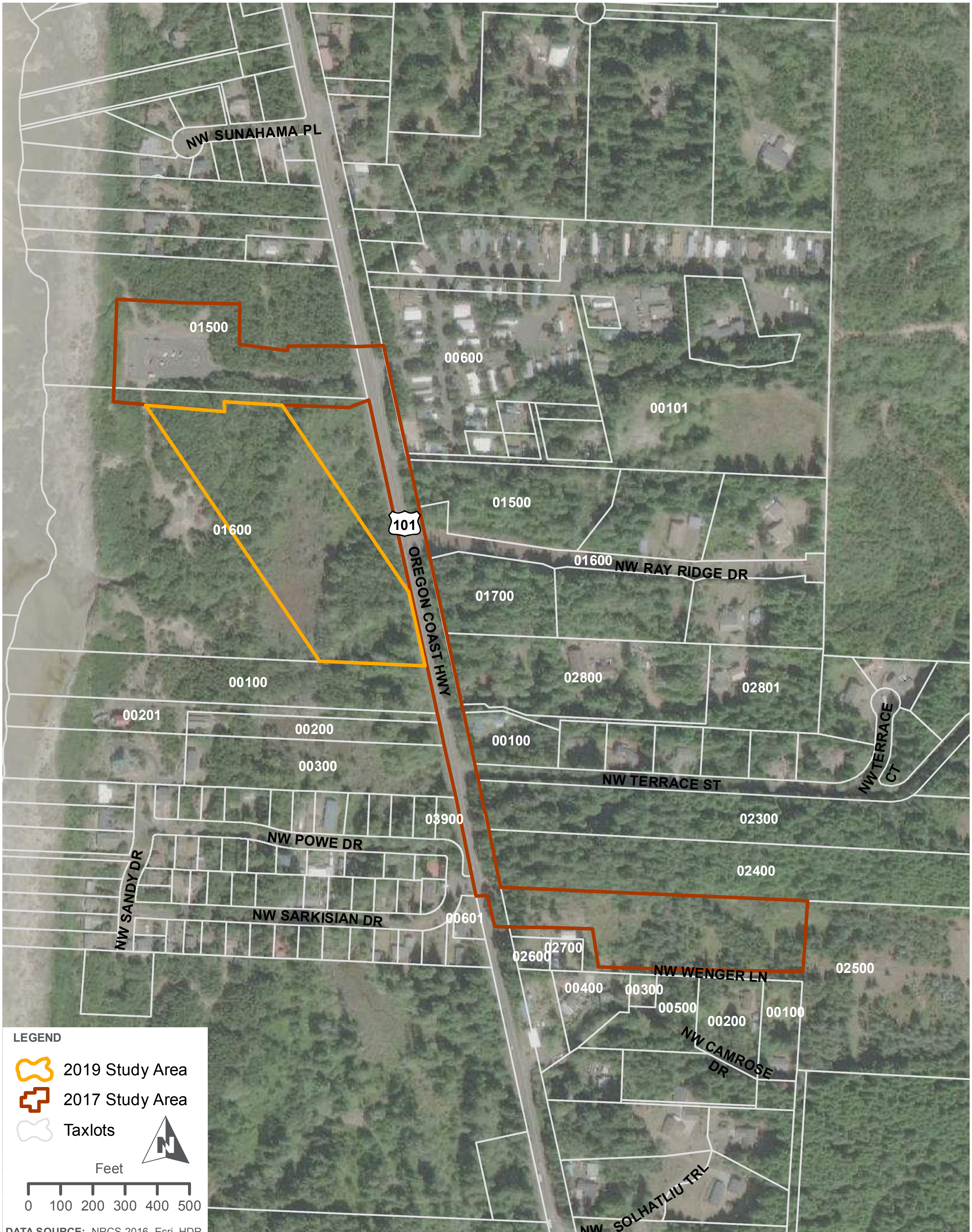
Appendix A. Figures

HDR

Study Area Location - Lincoln County, Oregon
Latitude:44.462, Longitude:-124.077
Public Land Survey System Location
NW 1/4 of T13S, R11W Section 7
SW 1/4 of T13S, R11W Section 6
SE 1/4 of T13S, R12W Section 1

PacWave South
PACIFIC MARINE ENERGY CENTER SOUTH ENERGY TEST SITE
PROJECT VICINITY
REVISED FIGURE 1

PATH: X:\PROJECTS\OSU\282143_PMEC_SETS\MAP_DOCS\WETLAND_REPORT_2019\FIGURE_1_VICINITY.MXD - USER: LLSMITH - DATE: 3/21/2019



HDR

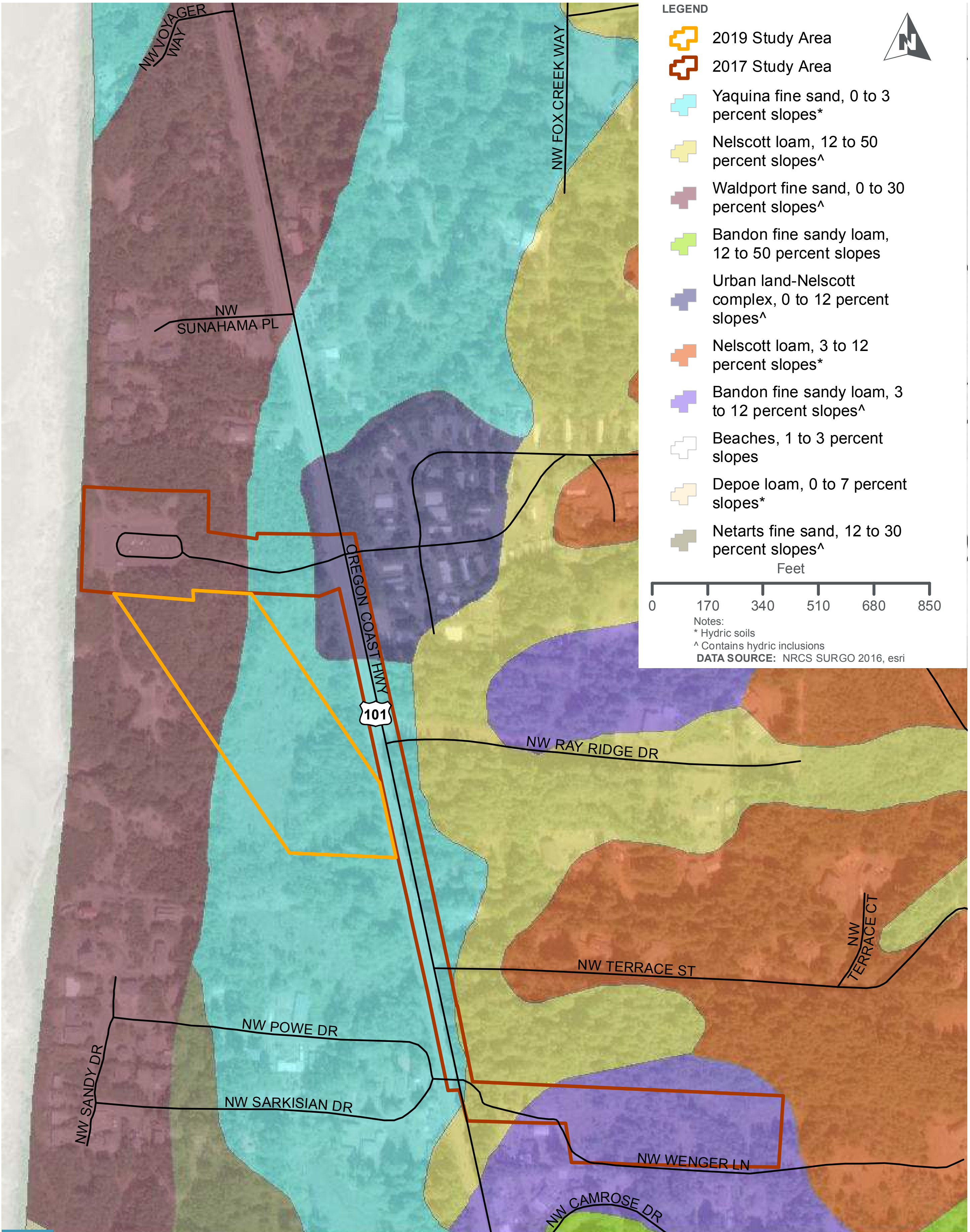
PacWave South

PACIFIC MARINE ENERGY CENTER SOUTH ENERGY TEST SITE

TAXLOTS

REVISED FIGURE 2

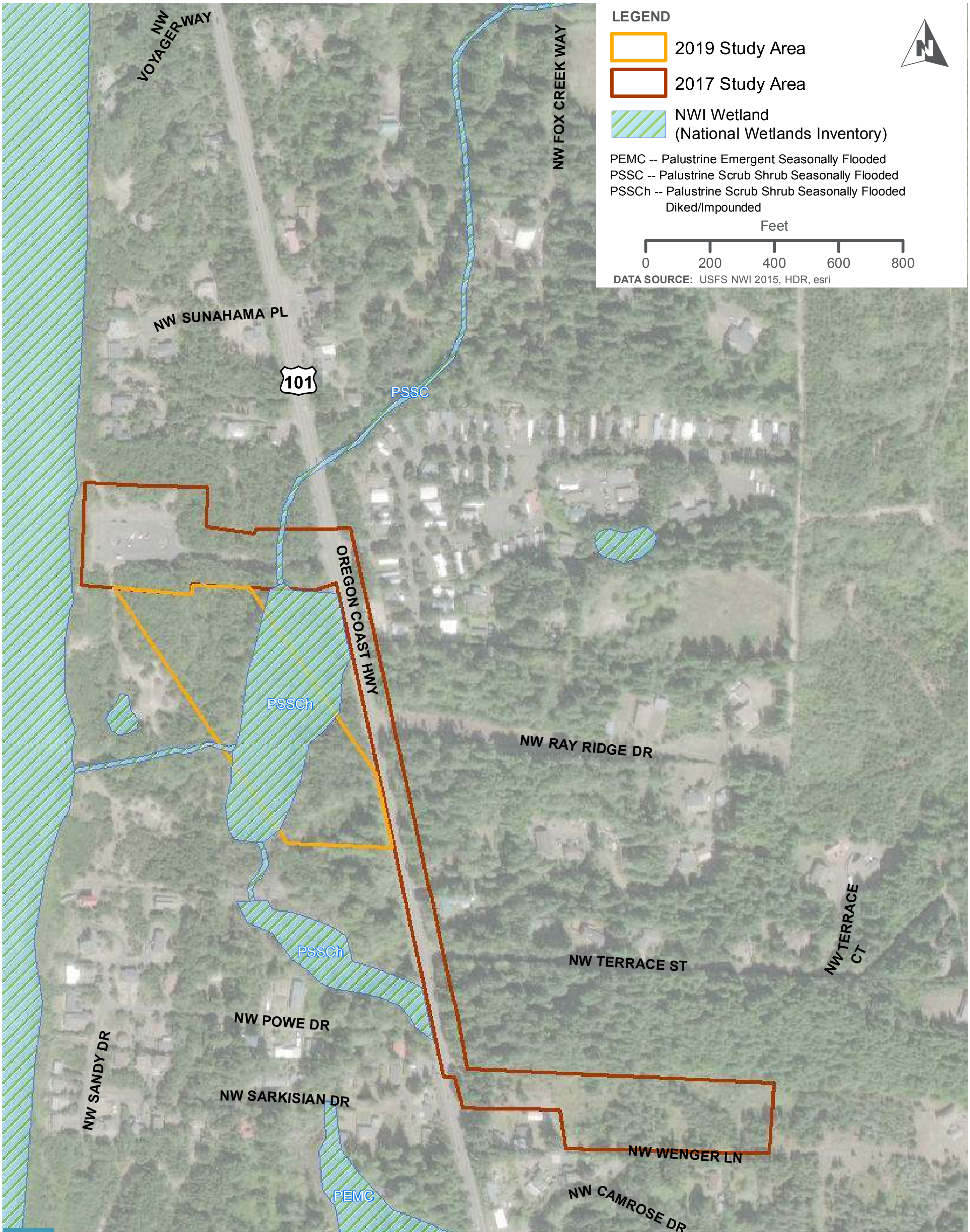
PATH: X:\PROJECTS\OSU\282143_PMEC_SETS\MAP_DOCS\WETLAND_REPORT_2019\FIGURE_2_TAXLOTS.MXD - USER: LLSMITH - DATE: 3/21/2019



HDR

PacWave South
PACIFIC MARINE ENERGY CENTER SOUTH ENERGY TEST SITE
NRCS SOILS
REVISED FIGURE 3

PATH: X:\PROJECTS\OSU\282143_PMEC_SETS\MAP_DOCS\WETLAND_REPORT_2019\FIGURE_3_NRCS_SOILS.MXD - USER: LLSMITH - DATE: 3/21/2019



HDR

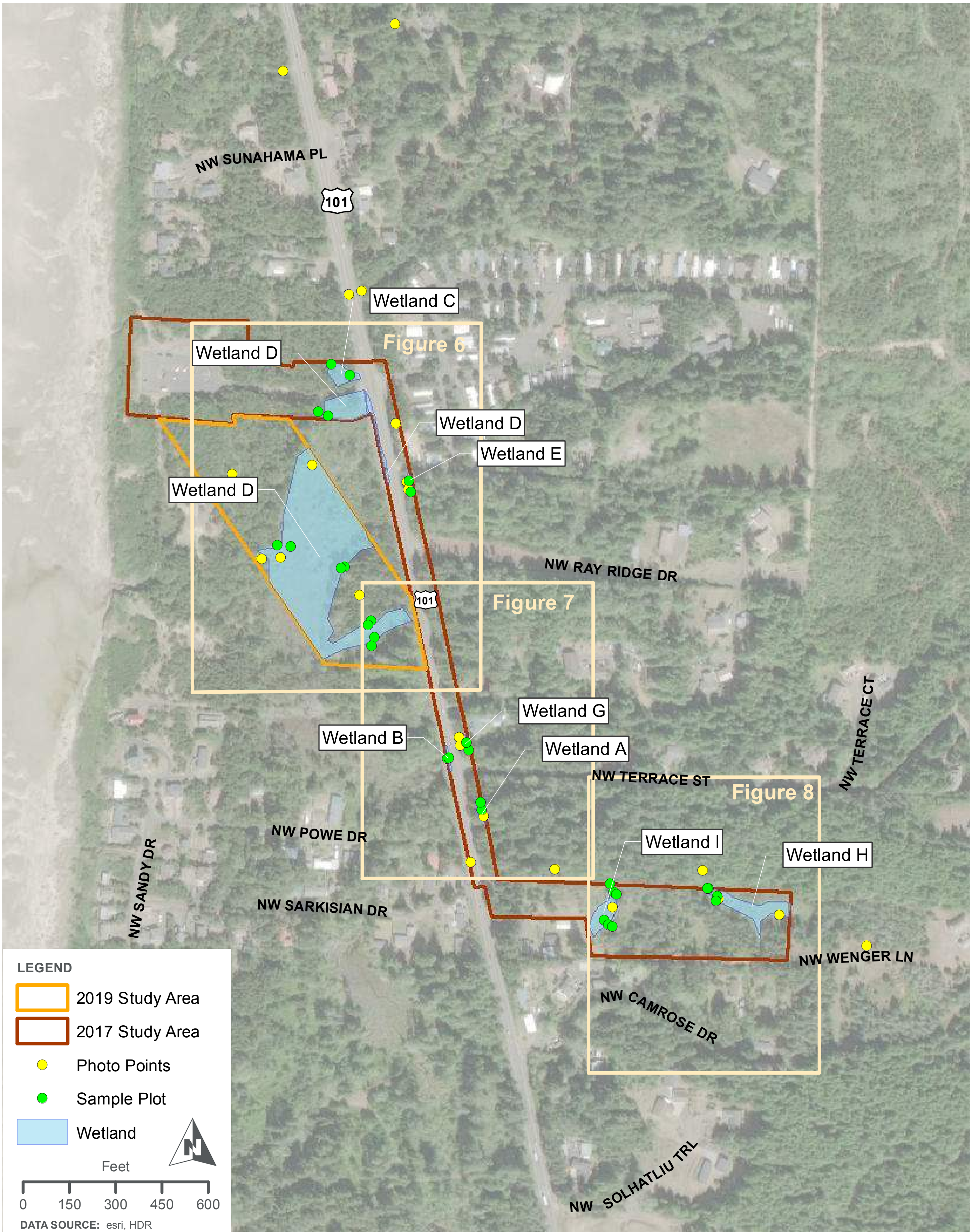
PacWave South

PACIFIC MARINE ENERGY CENTER SOUTH ENERGY TEST SITE

NATIONAL AND LOCAL WETLANDS INVENTORY

REVISED FIGURE 4

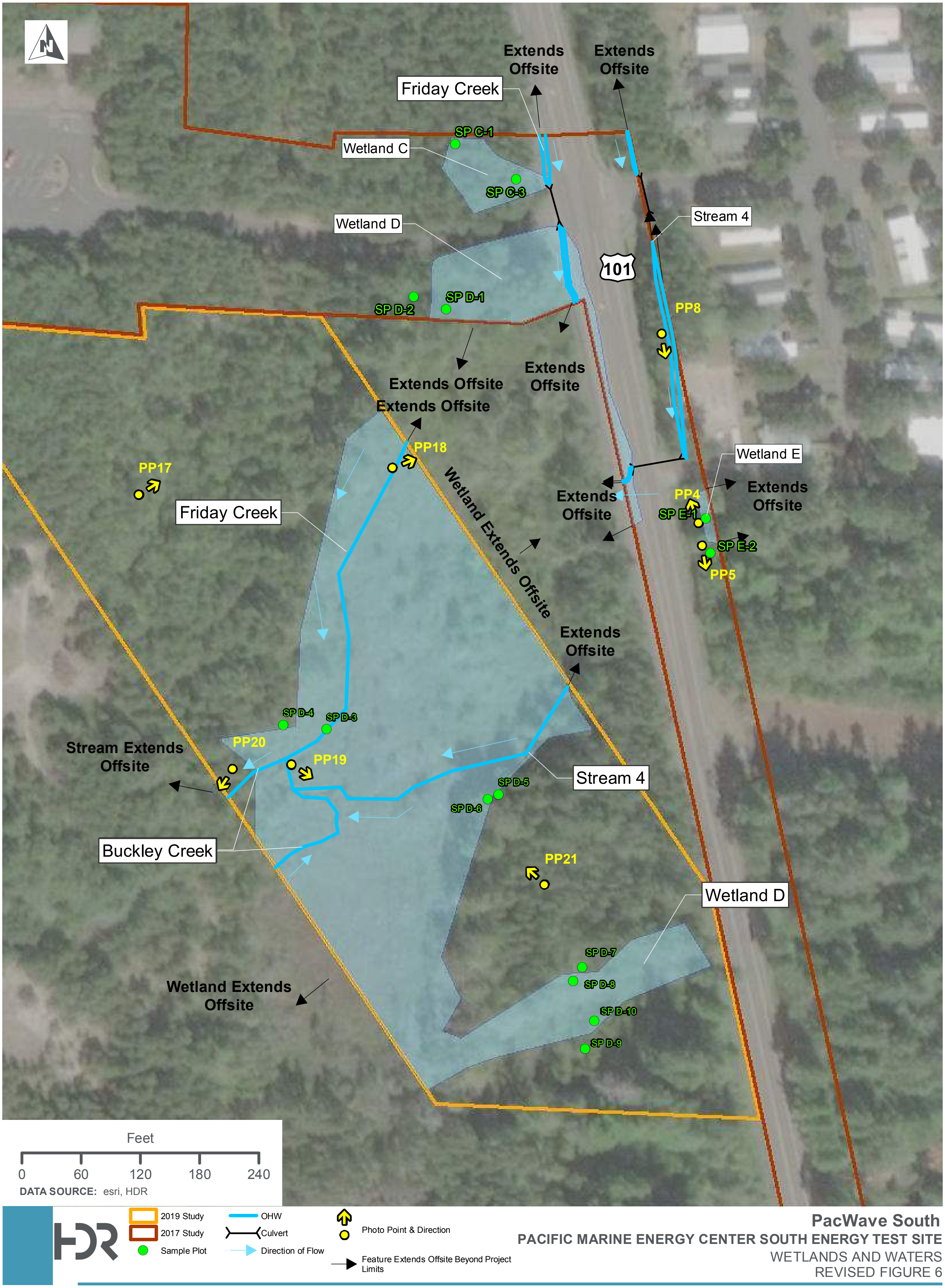
PATH: X:\PROJECTS\OSU\282143_PMEC_SETS\MAP_DOCS\WETLAND_REPORT_2019\FIGURE_4_NWI.MXD - USER: LLSMITH - DATE: 3/21/2019



HDR

PacWave South
PACIFIC MARINE ENERGY CENTER SOUTH ENERGY TEST SITE
WETLANDS AND WATERS
REVISED FIGURE 5

PATH: X:\PROJECTS\OSU\282143_PMEC_SETS\MAP_DOCS\WETLAND_REPORT_2019\FIGURE_5_WETLAND_INDEX1 10.5.MXD - USER: LLSMITH - DATE: 3/21/2019



PacWave South
PACIFIC MARINE ENERGY CENTER SOUTH ENERGY TEST SITE
WETLANDS AND WATERS
REVISED FIGURE 6

PATH: X:\PROJECTS\OSU\282143_PMEC_SETS\MAP_DOCS\WETLAND_REPORT_2019\FIGURE_6_9_WETLAND_SURVEY1 10.5.MXD - USER: LLSMITH - DATE: 3/21/2019

Appendix B. Data Forms

WETLAND DETERMINATION DATA FORM – Western Mountains, Valleys, and Coast Region

Project/Site: Pacific Marine Energy Center City/County: Lincoln County Sampling Date: 02/25/19
Applicant/Owner: Oregon State University State: OR Sampling Point: SP D–3
Investigator(s): L. Cleveland, J. Maze Section, Township, Range: T13S R12W S01
Landform (hillslope, terrace, etc.): Marine Terrace Local relief (concave, convex, none): Convex Slope (%): <1%
Subregion (LRR): A Lat: 44.462803 Long: -124.078779 Datum: NAD83
Soil Map Unit Name: Yaquina fine sand, 0-3% slopes NWI classification: PSS/EMB
Are climatic / hydrologic conditions on the site typical for this time of year? Yes X No ___ (If no, explain in Remarks.)
Are Vegetation N , Soil N , or Hydrology N significantly disturbed? Are "Normal Circumstances" present? Yes X No ___
Are Vegetation N , Soil N , or Hydrology N naturally problematic? (If needed, explain any answers in Remarks.)

SUMMARY OF FINDINGS – Attach site map showing sampling point locations, transects, important features, etc.

Hydrophytic Vegetation Present?	Yes X	No ___
Hydric Soil Present?	Yes X	No ___
Wetland Hydrology Present?	Yes X	No ___

Is the Sampled Area within a Wetland? Yes X No ___

Remarks:

VEGETATION – Use scientific names of plants.

Tree Stratum (Plot size: 20')	Absolute % Cover	Dominant Species?	Indicator Status
1.			
2.			
3.			
4.			
= Total Cover			
Sapling/Shrub Stratum (Plot size: 10')			
1. Gaultheria shallon	5	Y	FACU
2. Holodiscus discolor	10	Y	FACU
3.			
4.			
5.			
= Total Cover	15		
Herb Stratum (Plot size: 10')			
1. Carex obnupta	90	Y	OBL
2.			
3.			
4.			
5.			
6.			
7.			
8.			
9.			
10.			
11.			
= Total Cover	90		
Woody Vine Stratum (Plot size: 10')			
1. Rubus ursinus	5	Y	FACU
2.			
= Total Cover	5		

% Bare Ground in Herb Stratum 10

Dominance Test worksheet:

Number of Dominant Species That Are OBL, FACW, or FAC: 1 (A)
Total Number of Dominant Species Across All Strata: 4 (B)
Percent of Dominant Species That Are OBL, FACW, or FAC: 25 (A/B)

Prevalence Index worksheet:

Total % Cover of:		Multiply by:	
OBL species	90	x 1 =	90
FACW species		x 2 =	
FAC species		x 3 =	
FACU species	20	x 4 =	80
UPL species		x 5 =	
Column Totals:	110 (A)		270 (B)

Prevalence Index = B/A = 2.45

Hydrophytic Vegetation Indicators:

- ___ 1 - Rapid Test for Hydrophytic Vegetation
- ___ 2 - Dominance Test is >50%
- x 3 - Prevalence Index is ≤3.0[1]
- ___ 4 - Morphological Adaptations[1] (Provide supporting data in Remarks or on a separate sheet)
- ___ 5 - Wetland Non-Vascular Plants[1]
- ___ Problematic Hydrophytic Vegetation[1] (Explain)

[1]Indicators of hydric soil and wetland hydrology must be present, unless disturbed or problematic.

Hydrophytic Vegetation Present? Yes X No ___

Remarks:

SOIL

Sampling Point: SP D–3

Profile Description: (Describe to the depth needed to document the indicator or confirm the absence of indicators.)

Depth (inches)	Matrix Color (moist)	Matrix %	Redox Features Color (moist)	Redox Features %	Type[1]	Loc[2]	Texture	Remarks
0-11	10YR 4/3	50	2.5Y 2.5/1	20	RM	M	Sand	
	10YR 3/2	30						
11-14	10YR 2.5/1	100					Mucky Sand	

[1]Type: C=Concentration, D=Depletion, RM=Reduced Matrix, CS=Covered or Coated Sand Grains. [2]Location: PL=Pore Lining, M=Matrix.

Hydric Soil Indicators: (Applicable to all LRRs, unless otherwise noted.)

___ Histosol (A1)
___ Histic Epipedon (A2)
___ Black Histic (A3)
___ Hydrogen Sulfide (A4)
___ Depleted Below Dark Surface (A11)
___ Thick Dark Surface (A12)
___ Sandy Mucky Mineral (S1)
___ Sandy Gleyed Matrix (S4)
___ Sandy Redox (S5)
X Stripped Matrix (S6)
___ Loamy Mucky Mineral (F1) (**except MLRA 1**)
___ Loamy Gleyed Matrix (F2)
___ Depleted Matrix (F3)
___ Redox Dark Surface (F6)
___ Depleted Dark Surface (F7)
___ Redox Depressions (F8)

Indicators for Problematic Hydric Soils[3]:

___ 2 cm Muck (A10)
___ Red Parent Material (TF2)
___ Very Shallow Dark Surface (TF12)
___ Other (Explain in Remarks)

[3]Indicators of hydrophytic vegetation and wetland hydrology must be present, unless disturbed or problematic

Restrictive Layer (if present):
Type: None
Depth (inches):

Hydric Soil Present? **Yes** X **No** ___

Remarks:

HYDROLOGY

Wetland Hydrology Indicators:

Primary Indicators (minimum of one required; check all that apply)

___ Surface Water (A1)
___ High Water Table (A2)
X Saturation (A3)
___ Water Marks (B1)
___ Sediment Deposits (B2)
___ Drift Deposits (B3)
___ Algal Mat or Crust (B4)
___ Iron Deposits (B5)
___ Surface Soil Cracks (B6)
___ Inundation Visible on Aerial Imagery (B7)
___ Sparsely Vegetated Concave Surface (B8)
___ Water-Stained Leaves (B9) (**except MLRA 1, 2, 4A, and 4B**)
___ Salt Crust (B11)
___ Aquatic Invertebrates (B13)
___ Hydrogen Sulfide Odor (C1)
___ Oxidized Rhizospheres along Living Roots (C3)
___ Presence of Reduced Iron (C4)
___ Recent Iron Reduction in Tilled Soils (C6)
___ Stunted or Stressed Plants (D1) (**LRR A**)
___ Other (Explain in Remarks)

Secondary Indicators (2 or more required)

___ Water-Stained Leaves (B9) (**MLRA 1, 2, 4A, and 4B**)
___ Drainage Patterns (B10)
___ Dry-Season Water Table (C2)
___ Saturation Visible on Aerial Imagery (C9)
___ Geomorphic Position (D2)
___ Shallow Aquitard (D3)
___ FAC-Neutral Test (D5)
___ Raised Ant Mounds (D6) (**LRR A**)
___ Frost-Heave Hummocks (D7)

Field Observations:

	Yes	No	Depth (inches)
Surface Water Present?		X	
Water Table Present?		X	
Saturation Present? (includes capillary fringe)	X		10

Wetland Hydrology Present? **Yes** X **No** ___

Describe Recorded Data (stream gauge, monitoring well, aerial photos, previous inspections), if available:

Remarks:

WETLAND DETERMINATION DATA FORM – Western Mountains, Valleys, and Coast Region

Project/Site: Pacific Marine Energy Center City/County: Lincoln County Sampling Date: 02/25/19
Applicant/Owner: Oregon State University State: OR Sampling Point: SP D–4
Investigator(s): L. Cleveland, J. Maze Section, Township, Range: T13S R12W S01
Landform (hillslope, terrace, etc.): Marine Terrace Local relief (concave, convex, none): Convex Slope (%): <1%
Subregion (LRR): A Lat: 44.462807 Long: -124.078943 Datum: NAD83
Soil Map Unit Name: Yaquina fine sand, 0-3% slopes NWI classification: Upland
Are climatic / hydrologic conditions on the site typical for this time of year? Yes X No ___ (If no, explain in Remarks.)
Are Vegetation N , Soil N , or Hydrology N significantly disturbed? Are "Normal Circumstances" present? Yes X No ___
Are Vegetation N , Soil N , or Hydrology N naturally problematic? (If needed, explain any answers in Remarks.)

SUMMARY OF FINDINGS – Attach site map showing sampling point locations, transects, important features, etc.

Hydrophytic Vegetation Present?	Yes X	No ___
Hydric Soil Present?	Yes ___	No X
Wetland Hydrology Present?	Yes ___	No X

Is the Sampled Area within a Wetland? Yes ___ No X

Remarks:

VEGETATION – Use scientific names of plants.

Tree Stratum (Plot size: 20')	Absolute % Cover	Dominant Species?	Indicator Status
1. Picea sitchensis	30	Y	FAC
2.			
3.			
4.			
	30	= Total Cover	
Sapling/Shrub Stratum (Plot size: 10')			
1. Gaultheria shallon	55	Y	FAC
2. Ledum glandulosum	10	N	UPL
3.			
4.			
5.			
	65	= Total Cover	
Herb Stratum (Plot size: 10')			
1. Carex obnupta	5	Y	OBL
2.			
3.			
4.			
5.			
6.			
7.			
8.			
9.			
10.			
11.			
	5	= Total Cover	
Woody Vine Stratum (Plot size: 10')			
1.			
2.			
		= Total Cover	

% Bare Ground in Herb Stratum 95

Dominance Test worksheet:

Number of Dominant Species That Are OBL, FACW, or FAC: 3 (A)
Total Number of Dominant Species Across All Strata: 3 (B)
Percent of Dominant Species That Are OBL, FACW, or FAC: 100 (A/B)

Prevalence Index worksheet:

Total % Cover of:		Multiply by:	
OBL species		x 1 =	
FACW species		x 2 =	
FAC species		x 3 =	
FACU species		x 4 =	
UPL species		x 5 =	
Column Totals:		(A)	(B)

Prevalence Index = B/A =

Hydrophytic Vegetation Indicators:

- ___ 1 - Rapid Test for Hydrophytic Vegetation
- X 2 - Dominance Test is >50%
- ___ 3 - Prevalence Index is ≤3.0[1]
- ___ 4 - Morphological Adaptations[1] (Provide supporting data in Remarks or on a separate sheet)
- ___ 5 - Wetland Non-Vascular Plants[1]
- ___ Problematic Hydrophytic Vegetation[1] (Explain)

[1]Indicators of hydric soil and wetland hydrology must be present, unless disturbed or problematic.

Hydrophytic Vegetation Present? Yes X No ___

Remarks:

SOIL

Sampling Point: SP D–4

Profile Description: (Describe to the depth needed to document the indicator or confirm the absence of indicators.)

Depth (inches)	Matrix Color (moist)	Matrix %	Redox Features Color (moist)	Redox Features %	Type[1]	Loc[2]	Texture	Remarks
0-3	10YR 2.5/1	100					Oi	
3-16	10YR 4/3	100					Sand	

[1]Type: C=Concentration, D=Depletion, RM=Reduced Matrix, CS=Covered or Coated Sand Grains. [2]Location: PL=Pore Lining, M=Matrix.

Hydric Soil Indicators: (Applicable to all LRRs, unless otherwise noted.)

___ Histosol (A1)
___ Histic Epipedon (A2)
___ Black Histic (A3)
___ Hydrogen Sulfide (A4)
___ Depleted Below Dark Surface (A11)
___ Thick Dark Surface (A12)
___ Sandy Mucky Mineral (S1)
___ Sandy Gleyed Matrix (S4)
___ Sandy Redox (S5)
___ Stripped Matrix (S6)
___ Loamy Mucky Mineral (F1) (**except MLRA 1**)
___ Loamy Gleyed Matrix (F2)
___ Depleted Matrix (F3)
___ Redox Dark Surface (F6)
___ Depleted Dark Surface (F7)
___ Redox Depressions (F8)

Indicators for Problematic Hydric Soils[3]:

___ 2 cm Muck (A10)
___ Red Parent Material (TF2)
___ Very Shallow Dark Surface (TF12)
___ Other (Explain in Remarks)

[3]Indicators of hydrophytic vegetation and wetland hydrology must be present, unless disturbed or problematic

Restrictive Layer (if present):
Type: None
Depth (inches): ___

Hydric Soil Present? **Yes** ___ **No** X

Remarks:

HYDROLOGY

Wetland Hydrology Indicators:

Primary Indicators (minimum of one required; check all that apply)

___ Surface Water (A1)
___ High Water Table (A2)
___ Saturation (A3)
___ Water Marks (B1)
___ Sediment Deposits (B2)
___ Drift Deposits (B3)
___ Algal Mat or Crust (B4)
___ Iron Deposits (B5)
___ Surface Soil Cracks (B6)
___ Inundation Visible on Aerial Imagery (B7)
___ Sparsely Vegetated Concave Surface (B8)
___ Water-Stained Leaves (B9) (**except MLRA 1, 2, 4A, and 4B**)
___ Salt Crust (B11)
___ Aquatic Invertebrates (B13)
___ Hydrogen Sulfide Odor (C1)
___ Oxidized Rhizospheres along Living Roots (C3)
___ Presence of Reduced Iron (C4)
___ Recent Iron Reduction in Tilled Soils (C6)
___ Stunted or Stressed Plants (D1) (**LRR A**)
___ Other (Explain in Remarks)

Secondary Indicators (2 or more required)

___ Water-Stained Leaves (B9) (**MLRA 1, 2, 4A, and 4B**)
___ Drainage Patterns (B10)
___ Dry-Season Water Table (C2)
___ Saturation Visible on Aerial Imagery (C9)
___ Geomorphic Position (D2)
___ Shallow Aquitard (D3)
___ FAC-Neutral Test (D5)
___ Raised Ant Mounds (D6) (**LRR A**)
___ Frost-Heave Hummocks (D7)

Field Observations:

	Yes		No		Depth (inches):
Surface Water Present?	Yes		No	X	
Water Table Present?	Yes		No	X	
Saturation Present? (includes capillary fringe)	Yes		No	X	

Wetland Hydrology Present? **Yes** ___ **No** X

Describe Recorded Data (stream gauge, monitoring well, aerial photos, previous inspections), if available:

Remarks:

+WETLAND DETERMINATION DATA FORM – Western Mountains, Valleys, and Coast Region

Project/Site: Pacific Marine Energy Center City/County: Lincoln County Sampling Date: 02/25/19
Applicant/Owner: Oregon State University State: OR Sampling Point: SP D–5
Investigator(s): L. Cleveland, J. Maze Section, Township, Range: T13S R12W S01
Landform (hillslope, terrace, etc.): Marine Terrace Local relief (concave, convex, none): Convex Slope (%): <1%
Subregion (LRR): A Lat: 44.46264 Long: -124.078098 Datum: NAD83
Soil Map Unit Name: Yaquina fine sand, 0-3% slopes NWI classification: PSS/EMC
Are climatic / hydrologic conditions on the site typical for this time of year? Yes X No ___ (If no, explain in Remarks.)
Are Vegetation N , Soil N , or Hydrology N significantly disturbed? Are "Normal Circumstances" present? Yes X No ___
Are Vegetation N , Soil N , or Hydrology N naturally problematic? (If needed, explain any answers in Remarks.)

SUMMARY OF FINDINGS – Attach site map showing sampling point locations, transects, important features, etc.

Hydrophytic Vegetation Present?	Yes X No ___	**Is the Sampled Area within a Wetland? Yes X No ___**
Hydric Soil Present?	Yes X No ___	
Wetland Hydrology Present?	Yes X No ___	

Remarks:

VEGETATION – Use scientific names of plants.

Tree Stratum (Plot size: 20')	Absolute % Cover	Dominant Species?	Indicator Status
1.			
2.			
3.			
4.			
		= Total Cover	
Sapling/Shrub Stratum (Plot size: 10')			
1. Ledum glandulosum	10	Y	UPL
2.			
3.			
4.			
5.			
	10	= Total Cover	
Herb Stratum (Plot size: 10')			
1. Carex obnupta	100	Y	OBL
2. Blechnum spicant	1	N	FAC
3. Lysichiton americanus	1	N	OBL
4.			
5.			
6.			
7.			
8.			
9.			
10.			
11.			
	102	= Total Cover	
Woody Vine Stratum (Plot size: 10')			
1.			
2.			
		= Total Cover	

% Bare Ground in Herb Stratum 0

Dominance Test worksheet:

Number of Dominant Species That Are OBL, FACW, or FAC: 1 (A)
Total Number of Dominant Species Across All Strata: 2 (B)
Percent of Dominant Species That Are OBL, FACW, or FAC: 50 (A/B)

Prevalence Index worksheet:

Total % Cover of:		Multiply by:	
OBL species	101	x 1 =	101
FACW species		x 2 =	
FAC species	1	x 3 =	3
FACU species		x 4 =	
UPL species	10	x 5 =	50
Column Totals:	112 (A)		154 (B)

Prevalence Index = B/A = 1.37

Hydrophytic Vegetation Indicators:

- [ ] 1 - Rapid Test for Hydrophytic Vegetation
- [ ] 2 - Dominance Test is >50%
- [X] 3 - Prevalence Index is ≤3.0[1]
- [ ] 4 - Morphological Adaptations[1] (Provide supporting data in Remarks or on a separate sheet)
- [ ] 5 - Wetland Non-Vascular Plants[1]
- [ ] Problematic Hydrophytic Vegetation[1] (Explain)

[1]Indicators of hydric soil and wetland hydrology must be present, unless disturbed or problematic.

Hydrophytic Vegetation Present? Yes X No ___

Remarks:

SOIL

Sampling Point: SP D–5

Profile Description: (Describe to the depth needed to document the indicator or confirm the absence of indicators.)

Depth (inches)	Matrix Color (moist)	Matrix %	Redox Features Color (moist)	Redox Features %	Type[1]	Loc[2]	Texture	Remarks
0-15	10YR 2.5/1	100					Oe	

[1]Type: C=Concentration, D=Depletion, RM=Reduced Matrix, CS=Covered or Coated Sand Grains. [2]Location: PL=Pore Lining, M=Matrix.

Hydric Soil Indicators: (Applicable to all LRRs, unless otherwise noted.)

- X Histosol (A1)
- ___ Histic Epipedon (A2)
- ___ Black Histic (A3)
- X Hydrogen Sulfide (A4)
- ___ Depleted Below Dark Surface (A11)
- ___ Thick Dark Surface (A12)
- ___ Sandy Mucky Mineral (S1)
- ___ Sandy Gleyed Matrix (S4)
- ___ Sandy Redox (S5)
- ___ Stripped Matrix (S6)
- ___ Loamy Mucky Mineral (F1) (**except MLRA 1**)
- ___ Loamy Gleyed Matrix (F2)
- ___ Depleted Matrix (F3)
- ___ Redox Dark Surface (F6)
- ___ Depleted Dark Surface (F7)
- ___ Redox Depressions (F8)

Indicators for Problematic Hydric Soils[3]:

- ___ 2 cm Muck (A10)
- ___ Red Parent Material (TF2)
- ___ Very Shallow Dark Surface (TF12)
- ___ Other (Explain in Remarks)

[3]Indicators of hydrophytic vegetation and wetland hydrology must be present, unless disturbed or problematic

Restrictive Layer (if present):
Type: None
Depth (inches):

Hydric Soil Present? **Yes** X **No**

Remarks:

HYDROLOGY

Wetland Hydrology Indicators:

Primary Indicators (minimum of one required; check all that apply)

- X Surface Water (A1)
- X High Water Table (A2)
- X Saturation (A3)
- ___ Water Marks (B1)
- ___ Sediment Deposits (B2)
- ___ Drift Deposits (B3)
- ___ Algal Mat or Crust (B4)
- ___ Iron Deposits (B5)
- ___ Surface Soil Cracks (B6)
- ___ Inundation Visible on Aerial Imagery (B7)
- ___ Sparsely Vegetated Concave Surface (B8)
- ___ Water-Stained Leaves (B9) (**except MLRA 1, 2, 4A, and 4B**)
- ___ Salt Crust (B11)
- ___ Aquatic Invertebrates (B13)
- X Hydrogen Sulfide Odor (C1)
- ___ Oxidized Rhizospheres along Living Roots (C3)
- ___ Presence of Reduced Iron (C4)
- ___ Recent Iron Reduction in Tilled Soils (C6)
- ___ Stunted or Stressed Plants (D1) (**LRR A**)
- ___ Other (Explain in Remarks)

Secondary Indicators (2 or more required)

- ___ Water-Stained Leaves (B9) (**MLRA 1, 2, 4A, and 4B**)
- ___ Drainage Patterns (B10)
- ___ Dry-Season Water Table (C2)
- ___ Saturation Visible on Aerial Imagery (C9)
- ___ Geomorphic Position (D2)
- ___ Shallow Aquitard (D3)
- ___ FAC-Neutral Test (D5)
- ___ Raised Ant Mounds (D6) (**LRR A**)
- ___ Frost-Heave Hummocks (D7)

Field Observations:

Surface Water Present?	Yes	X	No		Depth (inches): 1
Water Table Present?	Yes	X	No		Depth (inches): 0
Saturation Present? (includes capillary fringe)	Yes	X	No		Depth (inches): 0

Wetland Hydrology Present? **Yes** X **No**

Describe Recorded Data (stream gauge, monitoring well, aerial photos, previous inspections), if available:

Remarks:

WETLAND DETERMINATION DATA FORM – Western Mountains, Valleys, and Coast Region

Project/Site: Pacific Marine Energy Center City/County: Lincoln County Sampling Date: 02/25/19
Applicant/Owner: Oregon State University State: OR Sampling Point: SP D–6
Investigator(s): L. Cleveland, J. Maze Section, Township, Range: T13S R12W S01
Landform (hillslope, terrace, etc.): Marine Terrace Local relief (concave, convex, none): Convex Slope (%): <1%
Subregion (LRR): A Lat: 44.462625 Long: -124.078143 Datum: NAD83
Soil Map Unit Name: Yaquina fine sand, 0-3% slopes NWI classification: Upland
Are climatic / hydrologic conditions on the site typical for this time of year? Yes X No ___ (If no, explain in Remarks.)
Are Vegetation N , Soil N , or Hydrology N significantly disturbed? Are "Normal Circumstances" present? Yes X No ___
Are Vegetation N , Soil N , or Hydrology N naturally problematic? (If needed, explain any answers in Remarks.)

SUMMARY OF FINDINGS – Attach site map showing sampling point locations, transects, important features, etc.

Hydrophytic Vegetation Present?	Yes X	No ___	Is the Sampled Area within a Wetland?	Yes ___ No X
Hydric Soil Present?	Yes ___	No X		
Wetland Hydrology Present?	Yes X	No ___		

Remarks:

VEGETATION – Use scientific names of plants.

Tree Stratum (Plot size: 20')	Absolute % Cover	Dominant Species?	Indicator Status
1. Picea sitchensis	90	Y	FAC
2.			
3.			
4.			
	90	= Total Cover	
Sapling/Shrub Stratum (Plot size: 10')			
1. Gaultheria shallon	50	Y	FAC
2. Physocarpus capitatus	10	N	FACW
3.			
4.			
5.			
	60	= Total Cover	
Herb Stratum (Plot size: 10')			
1.			
2.			
3.			
4.			
5.			
6.			
7.			
8.			
9.			
10.			
11.			
		= Total Cover	
Woody Vine Stratum (Plot size: 10')			
1.			
2.			
		= Total Cover	

% Bare Ground in Herb Stratum 100

Dominance Test worksheet:

Number of Dominant Species That Are OBL, FACW, or FAC: 2 (A)
Total Number of Dominant Species Across All Strata: 2 (B)
Percent of Dominant Species That Are OBL, FACW, or FAC: 100 (A/B)

Prevalence Index worksheet:

Total % Cover of:		Multiply by:	
OBL species		x 1 =	
FACW species		x 2 =	
FAC species		x 3 =	
FACU species		x 4 =	
UPL species		x 5 =	
Column Totals:	(A)		(B)

Prevalence Index = B/A =

Hydrophytic Vegetation Indicators:

- [ ] 1 - Rapid Test for Hydrophytic Vegetation
- [X] 2 - Dominance Test is >50%
- [ ] 3 - Prevalence Index is ≤3.0[1]
- [ ] 4 - Morphological Adaptations[1] (Provide supporting data in Remarks or on a separate sheet)
- [ ] 5 - Wetland Non-Vascular Plants[1]
- [ ] Problematic Hydrophytic Vegetation[1] (Explain)

[1]Indicators of hydric soil and wetland hydrology must be present, unless disturbed or problematic.

Hydrophytic Vegetation Present? Yes X No ___

Remarks:

SOIL

Sampling Point: SP D–6

Profile Description: (Describe to the depth needed to document the indicator or confirm the absence of indicators.)

Depth (inches)	Matrix Color (moist)	Matrix %	Redox Features Color (moist)	Redox Features %	Type[1]	Loc[2]	Texture	Remarks
0-13	10YR 2.5/1	100					Sandy Loam	

[1]Type: C=Concentration, D=Depletion, RM=Reduced Matrix, CS=Covered or Coated Sand Grains. [2]Location: PL=Pore Lining, M=Matrix.

Hydric Soil Indicators: (Applicable to all LRRs, unless otherwise noted.)

___ Histosol (A1)
___ Histic Epipedon (A2)
___ Black Histic (A3)
___ Hydrogen Sulfide (A4)
___ Depleted Below Dark Surface (A11)
___ Thick Dark Surface (A12)
___ Sandy Mucky Mineral (S1)
___ Sandy Gleyed Matrix (S4)
___ Sandy Redox (S5)
___ Stripped Matrix (S6)
___ Loamy Mucky Mineral (F1) (**except MLRA 1**)
___ Loamy Gleyed Matrix (F2)
___ Depleted Matrix (F3)
___ Redox Dark Surface (F6)
___ Depleted Dark Surface (F7)
___ Redox Depressions (F8)

Indicators for Problematic Hydric Soils[3]:

___ 2 cm Muck (A10)
___ Red Parent Material (TF2)
___ Very Shallow Dark Surface (TF12)
___ Other (Explain in Remarks)

[3]Indicators of hydrophytic vegetation and wetland hydrology must be present, unless disturbed or problematic

Restrictive Layer (if present):
Type: None
Depth (inches): ______

Hydric Soil Present? **Yes** ___ **No** X

Remarks:

HYDROLOGY

Wetland Hydrology Indicators:

Primary Indicators (minimum of one required; check all that apply)

___ Surface Water (A1)
___ High Water Table (A2)
X Saturation (A3)
___ Water Marks (B1)
___ Sediment Deposits (B2)
___ Drift Deposits (B3)
___ Algal Mat or Crust (B4)
___ Iron Deposits (B5)
___ Surface Soil Cracks (B6)
___ Inundation Visible on Aerial Imagery (B7)
___ Sparsely Vegetated Concave Surface (B8)
___ Water-Stained Leaves (B9) (**except MLRA 1, 2, 4A, and 4B**)
___ Salt Crust (B11)
___ Aquatic Invertebrates (B13)
___ Hydrogen Sulfide Odor (C1)
___ Oxidized Rhizospheres along Living Roots (C3)
___ Presence of Reduced Iron (C4)
___ Recent Iron Reduction in Tilled Soils (C6)
___ Stunted or Stressed Plants (D1) (**LRR A**)
___ Other (Explain in Remarks)

Secondary Indicators (2 or more required)

___ Water-Stained Leaves (B9) (**MLRA 1, 2, 4A, and 4B**)
___ Drainage Patterns (B10)
___ Dry-Season Water Table (C2)
___ Saturation Visible on Aerial Imagery (C9)
___ Geomorphic Position (D2)
___ Shallow Aquitard (D3)
___ FAC-Neutral Test (D5)
___ Raised Ant Mounds (D6) (**LRR A**)
___ Frost-Heave Hummocks (D7)

Field Observations:

	Yes	No	Depth (inches)
Surface Water Present?		X	
Water Table Present?		X	
Saturation Present? (includes capillary fringe)	X		10

Wetland Hydrology Present? **Yes** X **No** ___

Describe Recorded Data (stream gauge, monitoring well, aerial photos, previous inspections), if available:

Remarks:

WETLAND DETERMINATION DATA FORM – Western Mountains, Valleys, and Coast Region

Project/Site: Pacific Marine Energy Center City/County: Lincoln County Sampling Date: 02/25/19
Applicant/Owner: Oregon State University State: OR Sampling Point: SP D–7
Investigator(s): L. Cleveland, J. Maze Section, Township, Range: T13S R12W S01
Landform (hillslope, terrace, etc.): Marine Terrace Local relief (concave, convex, none): Convex Slope (%): <1%
Subregion (LRR): A Lat: 44.462173 Long: -124.077746 Datum: NAD83
Soil Map Unit Name: Yaquina fine sand, 0-3% slopes NWI classification: Upland
Are climatic / hydrologic conditions on the site typical for this time of year? Yes X No ___ (If no, explain in Remarks.)
Are Vegetation N , Soil N , or Hydrology N significantly disturbed? Are "Normal Circumstances" present? Yes X No ___
Are Vegetation N , Soil N , or Hydrology N naturally problematic? (If needed, explain any answers in Remarks.)

SUMMARY OF FINDINGS – Attach site map showing sampling point locations, transects, important features, etc.

Hydrophytic Vegetation Present?	Yes X	No ___
Hydric Soil Present?	Yes ___	No X
Wetland Hydrology Present?	Yes ___	No X

Is the Sampled Area within a Wetland? Yes ___ No X

Remarks:

VEGETATION – Use scientific names of plants.

Tree Stratum (Plot size: 20')	Absolute % Cover	Dominant Species?	Indicator Status
1. Picea sitchensis	10	Y	FAC
2. Pinus contorta	10	Y	FAC
3.			
4.			
	20	= Total Cover	
Sapling/Shrub Stratum (Plot size: 10')			
1. Gaultheria shallon	40	Y	FAC
2. Physocarpus capitatus	20	Y	FACW
3.			
4.			
5.			
	60	= Total Cover	
Herb Stratum (Plot size: 10')			
1. Blechnum spicant	5	Y	FAC
2.			
3.			
4.			
5.			
6.			
7.			
8.			
9.			
10.			
11.			
	5	= Total Cover	
Woody Vine Stratum (Plot size: 10')			
1.			
2.			
		= Total Cover	

% Bare Ground in Herb Stratum 95

Dominance Test worksheet:

Number of Dominant Species That Are OBL, FACW, or FAC: 5 (A)
Total Number of Dominant Species Across All Strata: 5 (B)
Percent of Dominant Species That Are OBL, FACW, or FAC: 100 (A/B)

Prevalence Index worksheet:

Total % Cover of:		Multiply by:	
OBL species		x 1 =	
FACW species		x 2 =	
FAC species		x 3 =	
FACU species		x 4 =	
UPL species		x 5 =	
Column Totals:	(A)		(B)

Prevalence Index = B/A = ___

Hydrophytic Vegetation Indicators:

- [ ] 1 - Rapid Test for Hydrophytic Vegetation
- [X] 2 - Dominance Test is >50%
- [ ] 3 - Prevalence Index is ≤3.0[1]
- [ ] 4 - Morphological Adaptations[1] (Provide supporting data in Remarks or on a separate sheet)
- [ ] 5 - Wetland Non-Vascular Plants[1]
- [ ] Problematic Hydrophytic Vegetation[1] (Explain)

[1]Indicators of hydric soil and wetland hydrology must be present, unless disturbed or problematic.

Hydrophytic Vegetation Present? Yes X No ___

Remarks:

SOIL

Sampling Point: SP D–7

Profile Description: (Describe to the depth needed to document the indicator or confirm the absence of indicators.)

Depth (inches)	Matrix Color (moist)	Matrix %	Redox Features Color (moist)	Redox %	Type[1]	Loc[2]	Texture	Remarks
0-12	10YR 2.5/1	100					Sandy Loam	

[1]Type: C=Concentration, D=Depletion, RM=Reduced Matrix, CS=Covered or Coated Sand Grains. [2]Location: PL=Pore Lining, M=Matrix.

Hydric Soil Indicators: (Applicable to all LRRs, unless otherwise noted.)

___ Histosol (A1)
___ Histic Epipedon (A2)
___ Black Histic (A3)
___ Hydrogen Sulfide (A4)
___ Depleted Below Dark Surface (A11)
___ Thick Dark Surface (A12)
___ Sandy Mucky Mineral (S1)
___ Sandy Gleyed Matrix (S4)
___ Sandy Redox (S5)
___ Stripped Matrix (S6)
___ Loamy Mucky Mineral (F1) (**except MLRA 1**)
___ Loamy Gleyed Matrix (F2)
___ Depleted Matrix (F3)
___ Redox Dark Surface (F6)
___ Depleted Dark Surface (F7)
___ Redox Depressions (F8)

Indicators for Problematic Hydric Soils[3]:

___ 2 cm Muck (A10)
___ Red Parent Material (TF2)
___ Very Shallow Dark Surface (TF12)
___ Other (Explain in Remarks)

[3]Indicators of hydrophytic vegetation and wetland hydrology must be present, unless disturbed or problematic

Restrictive Layer (if present):
Type: None
Depth (inches): ___

Hydric Soil Present? **Yes** ___ **No** **X**

Remarks:

HYDROLOGY

Wetland Hydrology Indicators:

Primary Indicators (minimum of one required; check all that apply)

___ Surface Water (A1)
___ High Water Table (A2)
___ Saturation (A3)
___ Water Marks (B1)
___ Sediment Deposits (B2)
___ Drift Deposits (B3)
___ Algal Mat or Crust (B4)
___ Iron Deposits (B5)
___ Surface Soil Cracks (B6)
___ Inundation Visible on Aerial Imagery (B7)
___ Sparsely Vegetated Concave Surface (B8)
___ Water-Stained Leaves (B9) (**except MLRA 1, 2, 4A, and 4B**)
___ Salt Crust (B11)
___ Aquatic Invertebrates (B13)
___ Hydrogen Sulfide Odor (C1)
___ Oxidized Rhizospheres along Living Roots (C3)
___ Presence of Reduced Iron (C4)
___ Recent Iron Reduction in Tilled Soils (C6)
___ Stunted or Stressed Plants (D1) (**LRR A**)
___ Other (Explain in Remarks)

Secondary Indicators (2 or more required)

___ Water-Stained Leaves (B9) (**MLRA 1, 2, 4A, and 4B**)
___ Drainage Patterns (B10)
___ Dry-Season Water Table (C2)
___ Saturation Visible on Aerial Imagery (C9)
___ Geomorphic Position (D2)
___ Shallow Aquitard (D3)
X FAC-Neutral Test (D5)
___ Raised Ant Mounds (D6) (**LRR A**)
___ Frost-Heave Hummocks (D7)

Field Observations:

Surface Water Present?	Yes ___	No X	Depth (inches):	___
Water Table Present?	Yes ___	No X	Depth (inches):	___
Saturation Present? (includes capillary fringe)	Yes ___	No X	Depth (inches):	___

Wetland Hydrology Present? **Yes** ___ **No** **X**

Describe Recorded Data (stream gauge, monitoring well, aerial photos, previous inspections), if available:

Remarks:

WETLAND DETERMINATION DATA FORM – Western Mountains, Valleys, and Coast Region

Project/Site: Pacific Marine Energy Center City/County: Lincoln County Sampling Date: 02/25/19
Applicant/Owner: Oregon State University State: OR Sampling Point: SP D–8
Investigator(s): L. Cleveland, J. Maze Section, Township, Range: T13S R12W S01
Landform (hillslope, terrace, etc.): Marine Terrace Local relief (concave, convex, none): Convex Slope (%): <1%
Subregion (LRR): A Lat: 44.462133 Long: -124.077779 Datum: NAD83
Soil Map Unit Name: Yaquina fine sand, 0-3% slopes NWI classification: PSS/EMC
Are climatic / hydrologic conditions on the site typical for this time of year? Yes X No ___ (If no, explain in Remarks.)
Are Vegetation N , Soil N , or Hydrology N significantly disturbed? Are "Normal Circumstances" present? Yes X No ___
Are Vegetation N , Soil N , or Hydrology N naturally problematic? (If needed, explain any answers in Remarks.)

SUMMARY OF FINDINGS – Attach site map showing sampling point locations, transects, important features, etc.

Hydrophytic Vegetation Present?	Yes X No ___	Is the Sampled Area within a Wetland? Yes X No ___
Hydric Soil Present?	Yes X No ___	
Wetland Hydrology Present?	Yes X No ___	

Remarks:

VEGETATION – Use scientific names of plants.

Tree Stratum (Plot size: 20')	Absolute % Cover	Dominant Species?	Indicator Status
1. Alnus rubra	30	Y	FAC
2.			
3.			
4.			
	30	= Total Cover	
Sapling/Shrub Stratum (Plot size: 10')			
1. Spirea douglasii	50	Y	FACW
2. Gaultheria shallon	5	N	FACU
3. Frangula purshiana	30	Y	FAC
4.			
5.			
	85	= Total Cover	
Herb Stratum (Plot size: 10')			
1. Carex obnupta	15	Y	OBL
2. Blechnum spicant	5	Y	FAC
3.			
4.			
5.			
6.			
7.			
8.			
9.			
10.			
11.			
	20	= Total Cover	
Woody Vine Stratum (Plot size: 10')			
1.			
2.			
		= Total Cover	

% Bare Ground in Herb Stratum 80

Dominance Test worksheet:

Number of Dominant Species That Are OBL, FACW, or FAC: 5 (A)
Total Number of Dominant Species Across All Strata: 5 (B)
Percent of Dominant Species That Are OBL, FACW, or FAC: 100 (A/B)

Prevalence Index worksheet:

Total % Cover of:		Multiply by:	
OBL species		x 1 =	
FACW species		x 2 =	
FAC species		x 3 =	
FACU species		x 4 =	
UPL species		x 5 =	
Column Totals:		(A)	(B)

Prevalence Index = B/A =

Hydrophytic Vegetation Indicators:

- ___ 1 - Rapid Test for Hydrophytic Vegetation
- X 2 - Dominance Test is >50%
- ___ 3 - Prevalence Index is ≤3.0[1]
- ___ 4 - Morphological Adaptations[1] (Provide supporting data in Remarks or on a separate sheet)
- ___ 5 - Wetland Non-Vascular Plants[1]
- ___ Problematic Hydrophytic Vegetation[1] (Explain)

[1]Indicators of hydric soil and wetland hydrology must be present, unless disturbed or problematic.

Hydrophytic Vegetation Present? **Yes** X **No** ___

Remarks:

SOIL

Sampling Point: SP D–8

Profile Description: (Describe to the depth needed to document the indicator or confirm the absence of indicators.)

Depth (inches)	Matrix Color (moist)	Matrix %	Redox Features Color (moist)	Redox Features %	Type[1]	Loc[2]	Texture	Remarks
0-12	10YR 2.5/1	100					Oe	

[1]Type: C=Concentration, D=Depletion, RM=Reduced Matrix, CS=Covered or Coated Sand Grains. [2]Location: PL=Pore Lining, M=Matrix.

Hydric Soil Indicators: (Applicable to all LRRs, unless otherwise noted.)

X Histosol (A1)
___ Histic Epipedon (A2)
___ Black Histic (A3)
___ Hydrogen Sulfide (A4)
___ Depleted Below Dark Surface (A11)
___ Thick Dark Surface (A12)
___ Sandy Mucky Mineral (S1)
___ Sandy Gleyed Matrix (S4)
___ Sandy Redox (S5)
___ Stripped Matrix (S6)
___ Loamy Mucky Mineral (F1) (**except MLRA 1**)
___ Loamy Gleyed Matrix (F2)
___ Depleted Matrix (F3)
___ Redox Dark Surface (F6)
___ Depleted Dark Surface (F7)
___ Redox Depressions (F8)

Indicators for Problematic Hydric Soils[3]:

___ 2 cm Muck (A10)
___ Red Parent Material (TF2)
___ Very Shallow Dark Surface (TF12)
___ Other (Explain in Remarks)

[3]Indicators of hydrophytic vegetation and wetland hydrology must be present, unless disturbed or problematic

Restrictive Layer (if present):
Type: None
Depth (inches):

Hydric Soil Present? **Yes** X **No** ___

Remarks:

HYDROLOGY

Wetland Hydrology Indicators:

Primary Indicators (minimum of one required; check all that apply)

X Surface Water (A1)
X High Water Table (A2)
X Saturation (A3)
___ Water Marks (B1)
___ Sediment Deposits (B2)
___ Drift Deposits (B3)
___ Algal Mat or Crust (B4)
___ Iron Deposits (B5)
___ Surface Soil Cracks (B6)
___ Inundation Visible on Aerial Imagery (B7)
___ Sparsely Vegetated Concave Surface (B8)
___ Water-Stained Leaves (B9) (**except MLRA 1, 2, 4A, and 4B**)
___ Salt Crust (B11)
___ Aquatic Invertebrates (B13)
___ Hydrogen Sulfide Odor (C1)
___ Oxidized Rhizospheres along Living Roots (C3)
___ Presence of Reduced Iron (C4)
___ Recent Iron Reduction in Tilled Soils (C6)
___ Stunted or Stressed Plants (D1) (**LRR A**)
___ Other (Explain in Remarks)

Secondary Indicators (2 or more required)

___ Water-Stained Leaves (B9) (**MLRA 1, 2, 4A, and 4B**)
___ Drainage Patterns (B10)
___ Dry-Season Water Table (C2)
___ Saturation Visible on Aerial Imagery (C9)
___ Geomorphic Position (D2)
___ Shallow Aquitard (D3)
X FAC-Neutral Test (D5)
___ Raised Ant Mounds (D6) (**LRR A**)
___ Frost-Heave Hummocks (D7)

Field Observations:

Surface Water Present?	Yes	X	No		Depth (inches):	2
Water Table Present?	Yes	X	No		Depth (inches):	0
Saturation Present? (includes capillary fringe)	Yes	X	No		Depth (inches):	0

Wetland Hydrology Present? **Yes** X **No** ___

Describe Recorded Data (stream gauge, monitoring well, aerial photos, previous inspections), if available:

Remarks:

WETLAND DETERMINATION DATA FORM – Western Mountains, Valleys, and Coast Region

Project/Site: Pacific Marine Energy Center City/County: Lincoln County Sampling Date: 02/25/19
Applicant/Owner: Oregon State University State: OR Sampling Point: SP D–9
Investigator(s): L. Cleveland, J. Maze Section, Township, Range: T13S R12W S01
Landform (hillslope, terrace, etc.): Marine Terrace Local relief (concave, convex, none): Convex Slope (%): <1%
Subregion (LRR): A Lat: 44.461945 Long: -124.077717 Datum: NAD83
Soil Map Unit Name: Yaquina fine sand, 0-3% slopes NWI classification: Upland
Are climatic / hydrologic conditions on the site typical for this time of year? Yes X No ___ (If no, explain in Remarks.)
Are Vegetation N , Soil N , or Hydrology N significantly disturbed? Are "Normal Circumstances" present? Yes X No ___
Are Vegetation N , Soil N , or Hydrology N naturally problematic? (If needed, explain any answers in Remarks.)

SUMMARY OF FINDINGS – Attach site map showing sampling point locations, transects, important features, etc.

Hydrophytic Vegetation Present?	Yes X No ___	
Hydric Soil Present?	Yes ___ No X	**Is the Sampled Area within a Wetland? Yes ___ No X**
Wetland Hydrology Present?	Yes ___ No X	

Remarks:

VEGETATION – Use scientific names of plants.

Tree Stratum (Plot size: 20')	Absolute % Cover	Dominant Species?	Indicator Status
1. Picea sitchensis	10	Y	FAC
2. Pinus contorta	10	Y	FAC
3.			
4.			
	20	= Total Cover	
Sapling/Shrub Stratum (Plot size: 10')			
1. Gaultheria shallon	35	Y	FAC
2. Physocarpus capitatus	20	Y	FACW
3.			
4.			
5.			
	55	= Total Cover	
Herb Stratum (Plot size: 10')			
1. Blechnum spicant	10	Y	FAC
2.			
3.			
4.			
5.			
6.			
7.			
8.			
9.			
10.			
11.			
	10	= Total Cover	
Woody Vine Stratum (Plot size: 10')			
1.			
2.			
		= Total Cover	

% Bare Ground in Herb Stratum 90

Dominance Test worksheet:

Number of Dominant Species That Are OBL, FACW, or FAC: 5 (A)
Total Number of Dominant Species Across All Strata: 5 (B)
Percent of Dominant Species That Are OBL, FACW, or FAC: 100 (A/B)

Prevalence Index worksheet:

Total % Cover of:		Multiply by:	
OBL species		x 1 =	
FACW species		x 2 =	
FAC species		x 3 =	
FACU species		x 4 =	
UPL species		x 5 =	
Column Totals:	(A)		(B)

Prevalence Index = B/A =

Hydrophytic Vegetation Indicators:

- ___ 1 - Rapid Test for Hydrophytic Vegetation
- X 2 - Dominance Test is >50%
- ___ 3 - Prevalence Index is ≤3.0[1]
- ___ 4 - Morphological Adaptations[1] (Provide supporting data in Remarks or on a separate sheet)
- ___ 5 - Wetland Non-Vascular Plants[1]
- ___ Problematic Hydrophytic Vegetation[1] (Explain)

[1]Indicators of hydric soil and wetland hydrology must be present, unless disturbed or problematic.

Hydrophytic Vegetation Present? Yes X No ___

Remarks:

SOIL

Sampling Point: SP D–9

Profile Description: (Describe to the depth needed to document the indicator or confirm the absence of indicators.)

Depth (inches)	Matrix Color (moist)	Matrix %	Redox Features Color (moist)	Redox Features %	Type[1]	Loc[2]	Texture	Remarks
0-12	10YR 2.5/1	100					Sandy Loam	

[1]Type: C=Concentration, D=Depletion, RM=Reduced Matrix, CS=Covered or Coated Sand Grains. [2]Location: PL=Pore Lining, M=Matrix.

Hydric Soil Indicators: (Applicable to all LRRs, unless otherwise noted.)

___ Histosol (A1)
___ Histic Epipedon (A2)
___ Black Histic (A3)
___ Hydrogen Sulfide (A4)
___ Depleted Below Dark Surface (A11)
___ Thick Dark Surface (A12)
___ Sandy Mucky Mineral (S1)
___ Sandy Gleyed Matrix (S4)
___ Sandy Redox (S5)
___ Stripped Matrix (S6)
___ Loamy Mucky Mineral (F1) (**except MLRA 1**)
___ Loamy Gleyed Matrix (F2)
___ Depleted Matrix (F3)
___ Redox Dark Surface (F6)
___ Depleted Dark Surface (F7)
___ Redox Depressions (F8)

Indicators for Problematic Hydric Soils[3]:

___ 2 cm Muck (A10)
___ Red Parent Material (TF2)
___ Very Shallow Dark Surface (TF12)
___ Other (Explain in Remarks)

[3]Indicators of hydrophytic vegetation and wetland hydrology must be present, unless disturbed or problematic

Restrictive Layer (if present):
Type: None
Depth (inches): ___

Hydric Soil Present? **Yes** ___ **No** X

Remarks:

HYDROLOGY

Wetland Hydrology Indicators:

Primary Indicators (minimum of one required; check all that apply)

___ Surface Water (A1)
___ High Water Table (A2)
___ Saturation (A3)
___ Water Marks (B1)
___ Sediment Deposits (B2)
___ Drift Deposits (B3)
___ Algal Mat or Crust (B4)
___ Iron Deposits (B5)
___ Surface Soil Cracks (B6)
___ Inundation Visible on Aerial Imagery (B7)
___ Sparsely Vegetated Concave Surface (B8)
___ Water-Stained Leaves (B9) (**except MLRA 1, 2, 4A, and 4B**)
___ Salt Crust (B11)
___ Aquatic Invertebrates (B13)
___ Hydrogen Sulfide Odor (C1)
___ Oxidized Rhizospheres along Living Roots (C3)
___ Presence of Reduced Iron (C4)
___ Recent Iron Reduction in Tilled Soils (C6)
___ Stunted or Stressed Plants (D1) (**LRR A**)
___ Other (Explain in Remarks)

Secondary Indicators (2 or more required)

___ Water-Stained Leaves (B9) (**MLRA 1, 2, 4A, and 4B**)
___ Drainage Patterns (B10)
___ Dry-Season Water Table (C2)
___ Saturation Visible on Aerial Imagery (C9)
___ Geomorphic Position (D2)
___ Shallow Aquitard (D3)
X FAC-Neutral Test (D5)
___ Raised Ant Mounds (D6) (**LRR A**)
___ Frost-Heave Hummocks (D7)

Field Observations:

Surface Water Present? Yes ___ No X Depth (inches): ___
Water Table Present? Yes ___ No X Depth (inches): ___
Saturation Present? (includes capillary fringe) Yes ___ No X Depth (inches): ___

Wetland Hydrology Present? **Yes** ___ **No** X

Describe Recorded Data (stream gauge, monitoring well, aerial photos, previous inspections), if available:

Remarks:

WETLAND DETERMINATION DATA FORM – Western Mountains, Valleys, and Coast Region

Project/Site: Pacific Marine Energy Center City/County: Lincoln County Sampling Date: 02/25/19
Applicant/Owner: Oregon State University State: OR Sampling Point: SP D–10
Investigator(s): L. Cleveland, J. Maze Section, Township, Range: T13S R12W S01
Landform (hillslope, terrace, etc.): Marine Terrace Local relief (concave, convex, none): Convex Slope (%): <1%
Subregion (LRR): A Lat: 44.462024 Long: -124.07769 Datum: NAD83
Soil Map Unit Name: Yaquina fine sand, 0-3% slopes NWI classification: PSSEMC
Are climatic / hydrologic conditions on the site typical for this time of year? Yes X No ___ (If no, explain in Remarks.)
Are Vegetation N , Soil N , or Hydrology N significantly disturbed? Are "Normal Circumstances" present? Yes X No ___
Are Vegetation N , Soil N , or Hydrology N naturally problematic? (If needed, explain any answers in Remarks.)

SUMMARY OF FINDINGS – Attach site map showing sampling point locations, transects, important features, etc.

Hydrophytic Vegetation Present?	Yes X No ___	**Is the Sampled Area within a Wetland? Yes X No ___**
Hydric Soil Present?	Yes X No ___	
Wetland Hydrology Present?	Yes X No ___	

Remarks:

VEGETATION – Use scientific names of plants.

Tree Stratum (Plot size: 20')	Absolute % Cover	Dominant Species?	Indicator Status
1. Alnus rubra	30	Y	FAC
2.			
3.			
4.			
	30	= Total Cover	
Sapling/Shrub Stratum (Plot size: 10')			
1. Spirea douglasii	50	Y	FACW
2. Gaultheria shallon	10	N	FACU
3. Frangula purshiana	30	Y	FAC
4.			
5.			
	90	= Total Cover	
Herb Stratum (Plot size: 10')			
1. Carex obnupta	20	Y	OBL
2. Blechnum spicant	5	Y	FAC
3.			
4.			
5.			
6.			
7.			
8.			
9.			
10.			
11.			
	25	= Total Cover	
Woody Vine Stratum (Plot size: 10')			
1.			
2.			
		= Total Cover	

% Bare Ground in Herb Stratum 75

Dominance Test worksheet:

Number of Dominant Species That Are OBL, FACW, or FAC: 5 (A)
Total Number of Dominant Species Across All Strata: 5 (B)
Percent of Dominant Species That Are OBL, FACW, or FAC: 100 (A/B)

Prevalence Index worksheet:

Total % Cover of:		Multiply by:	
OBL species		x 1 =	
FACW species		x 2 =	
FAC species		x 3 =	
FACU species		x 4 =	
UPL species		x 5 =	
Column Totals:	(A)		(B)

Prevalence Index = B/A = ___

Hydrophytic Vegetation Indicators:

- ___ 1 - Rapid Test for Hydrophytic Vegetation
- X 2 - Dominance Test is >50%
- ___ 3 - Prevalence Index is ≤3.0[1]
- ___ 4 - Morphological Adaptations[1] (Provide supporting data in Remarks or on a separate sheet)
- ___ 5 - Wetland Non-Vascular Plants[1]
- ___ Problematic Hydrophytic Vegetation[1] (Explain)

[1]Indicators of hydric soil and wetland hydrology must be present, unless disturbed or problematic.

Hydrophytic Vegetation Present? Yes X No ___

Remarks:

SOIL

Sampling Point: SP D–10

Profile Description: (Describe to the depth needed to document the indicator or confirm the absence of indicators.)

Depth (inches)	Matrix Color (moist)	Matrix %	Redox Features Color (moist)	Redox Features %	Type[1]	Loc[2]	Texture	Remarks
0-12	10YR 2.5/1	100					Oe	

[1]Type: C=Concentration, D=Depletion, RM=Reduced Matrix, CS=Covered or Coated Sand Grains. [2]Location: PL=Pore Lining, M=Matrix.

Hydric Soil Indicators: (Applicable to all LRRs, unless otherwise noted.)

X Histosol (A1)
___ Histic Epipedon (A2)
___ Black Histic (A3)
___ Hydrogen Sulfide (A4)
___ Depleted Below Dark Surface (A11)
___ Thick Dark Surface (A12)
___ Sandy Mucky Mineral (S1)
___ Sandy Gleyed Matrix (S4)
___ Sandy Redox (S5)
___ Stripped Matrix (S6)
___ Loamy Mucky Mineral (F1) (**except MLRA 1**)
___ Loamy Gleyed Matrix (F2)
___ Depleted Matrix (F3)
___ Redox Dark Surface (F6)
___ Depleted Dark Surface (F7)
___ Redox Depressions (F8)

Indicators for Problematic Hydric Soils[3]:

___ 2 cm Muck (A10)
___ Red Parent Material (TF2)
___ Very Shallow Dark Surface (TF12)
___ Other (Explain in Remarks)

[3]Indicators of hydrophytic vegetation and wetland hydrology must be present, unless disturbed or problematic

Restrictive Layer (if present):
Type: None
Depth (inches): ___

Hydric Soil Present? **Yes** X **No** ___

Remarks:

HYDROLOGY

Wetland Hydrology Indicators:

Primary Indicators (minimum of one required; check all that apply)

X Surface Water (A1)
X High Water Table (A2)
X Saturation (A3)
___ Water Marks (B1)
___ Sediment Deposits (B2)
___ Drift Deposits (B3)
___ Algal Mat or Crust (B4)
___ Iron Deposits (B5)
___ Surface Soil Cracks (B6)
___ Inundation Visible on Aerial Imagery (B7)
___ Sparsely Vegetated Concave Surface (B8)
___ Water-Stained Leaves (B9) (**except MLRA 1, 2, 4A, and 4B**)
___ Salt Crust (B11)
___ Aquatic Invertebrates (B13)
___ Hydrogen Sulfide Odor (C1)
___ Oxidized Rhizospheres along Living Roots (C3)
___ Presence of Reduced Iron (C4)
___ Recent Iron Reduction in Tilled Soils (C6)
___ Stunted or Stressed Plants (D1) (**LRR A**)
___ Other (Explain in Remarks)

Secondary Indicators (2 or more required)

___ Water-Stained Leaves (B9) (**MLRA 1, 2, 4A, and 4B**)
___ Drainage Patterns (B10)
___ Dry-Season Water Table (C2)
___ Saturation Visible on Aerial Imagery (C9)
___ Geomorphic Position (D2)
___ Shallow Aquitard (D3)
X FAC-Neutral Test (D5)
___ Raised Ant Mounds (D6) (**LRR A**)
___ Frost-Heave Hummocks (D7)

Field Observations:

Surface Water Present?	Yes	X	No		Depth (inches): 1
Water Table Present?	Yes	X	No		Depth (inches): 0
Saturation Present? (includes capillary fringe)	Yes	X	No		Depth (inches): 0

Wetland Hydrology Present? **Yes** X **No** ___

Describe Recorded Data (stream gauge, monitoring well, aerial photos, previous inspections), if available:

Remarks:

Streamflow Duration Field Assessment Form

Project # / Name: **Pacific Marine Energy Center**	Assessor: **Cleveland**
Address	Date: **06-01-16**
Waterway Name: **Buckley Creek**	Coordinates at downstream end (ddd.mm.ss): Lat. 44°27'38.455" N; Long. 124°4'53.076" W
Reach Boundaries	

Precipitation w/in 48 hours (cm) 2.54	Channel Width (m) 1.5	☐ Disturbed Site / Difficult Situation (Describe in "Notes")

Observed Hydrology

% of reach w/observed surface flow 100

% of reach w/any flow (surface or hyporheic) 100

# of pools observed 0

Observations

Observed Wetland Plants (and indicator status):

Channel itself was largely devoid of vegetation but small patches of slough sedge were present (Carex obnupta-OBL).

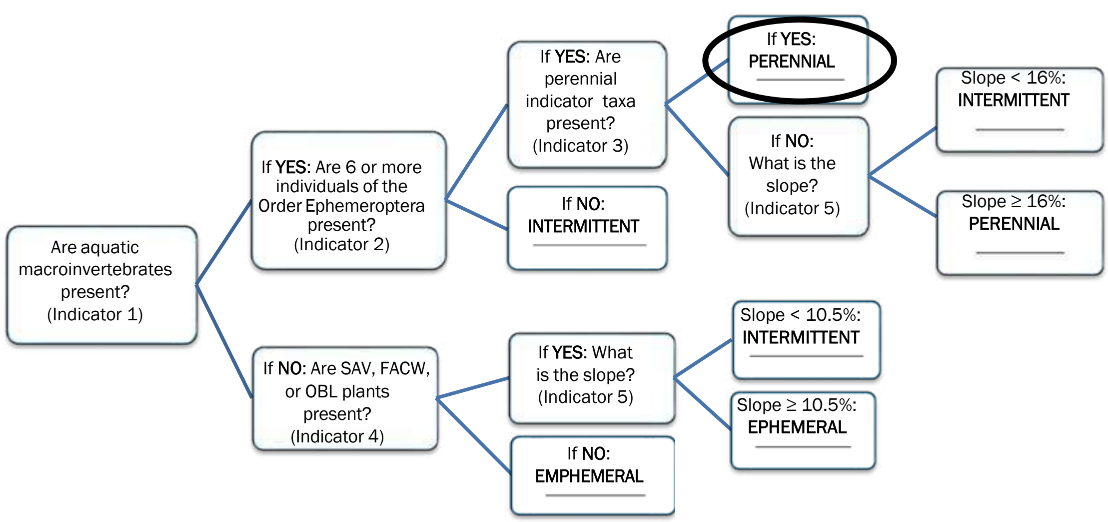
Observed Macroinvertebrates:

Taxon	Indicator Status	Ephemeroptera?	# of Individuals
Plecoptera		No	4
Ephemeroptera		Yes	6

Indicators

1. Are aquatic macroinvertebrates present?	☒ Yes	☐ No
2. Are 6 or more individuals of the Order Ephemeroptera present?	☐ Yes	☒ No
3. Are perennial indicator taxa present? (refer to Table 1)	☒ Yes	☐ No
4. Are FACW, OBL, or SAV plants present? (Within ½ channel width)	☒ Yes	☐ No
5. What is the slope? (In percent, measured for the valley, not the stream)	2 %	

Conclusions



Single Indicators:
☒ Fish
☐ Amphibians

Finding:
☐ Ephemeral
☐ Intermittent
☒ Perennial

Notes: (explanation of any single indicator co nclusions, description of disturbances or modifications that may interfere with indicators, etc.)

Difficult Situation:

Describe situation. For disturbed streams, note extent, type, and history of disturbance.

☐ Prolonged Abnormal Rainfall / Snowpack

☐ Below Average

☐ Above Average

☐ Natural or Anthropogenic Disturbance

☐ Other: ___________________________

Additional Notes: (sketch of site, description of photos, comments on hydrological observations, etc.) Attach additional sheets as necessary.

Defined bed and bank present and signs of erosion.

Ancillary Information:

☐ Riparian Corridor

☐ Erosion and Deposition

☐ Floodplain Connectivity

Observed Amphibians, Snake, and Fish:

Taxa	Life History Stage	Location Observed	Number of Individuals Observed

Streamflow Duration Field Assessment Form

Project # / Name	Pacific Marine Energy Center	Assessor	Halstead
Address		Date	06-01-16
Waterway Name	Friday Creek	Coordinates at downstream end (ddd.mm.ss)	Lat. 44°28'2.972" N Long. 124°4'39.900" W
Reach Boundaries			

Precipitation w/in 48 hours (cm) none	Channel Width (m) 2.5	☐ Disturbed Site / Difficult Situation (Describe in "Notes")

Observed Hydrology

% of reach w/observed surface flow 100

% of reach w/any flow (surface or hyporheic) 100

# of pools observed 0

Observations

Observed Wetland Plants (and indicator status):

None. No plants present in channel.

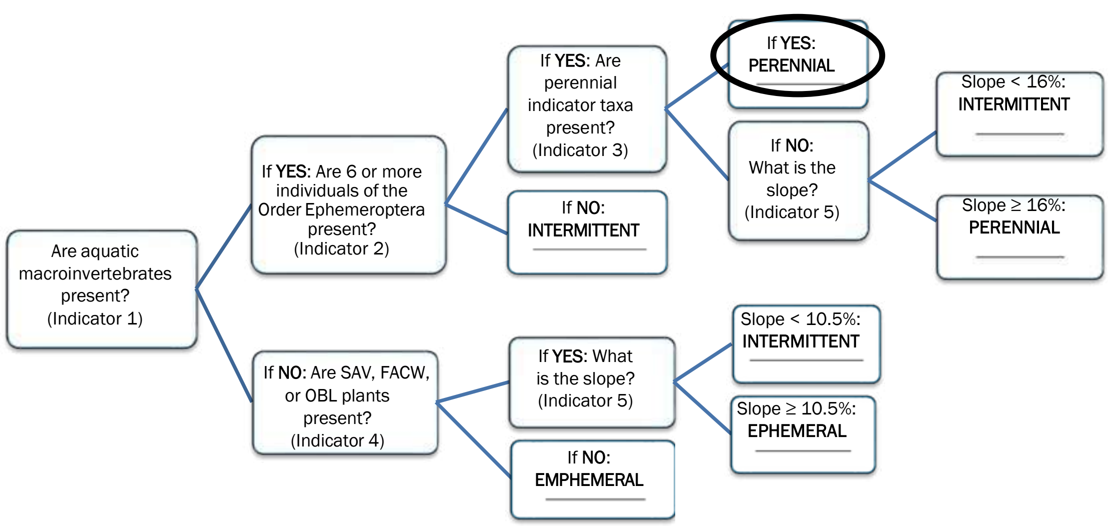
Observed Macroinvertebrates:

Taxon	Indicator Status	Ephemeroptera?	# of Individuals
Fish are present - did not review stream for macroinvertebrates			

Indicators

1. Are aquatic macroinvertebrates present?	☐ Yes	☒ No
2. Are 6 or more individuals of the Order Ephemeroptera present?	☐ Yes	☒ No
3. Are perennial indicator taxa present? (refer to Table 1)	☒ Yes	☒ No
4. Are FACW, OBL, or SAV plants present? (Within ½ channel width)	☐ Yes	☒ No
5. What is the slope? (In percent, measured for the valley, not the stream)	2 %	

Conclusions



Single Indicators:
☒ Fish
☐ Amphibians

Finding:
☐ Ephemeral
☐ Intermittent
☒ Perennial

Notes: (explanation of any single indicator co nclusions, description of disturbances or modifications that may interfere with indicators, etc.)

Difficult Situation:

Describe situation. For disturbed streams, note extent, type, and history of disturbance.

- ☐ Prolonged Abnormal Rainfall / Snowpack
  - ☐ Below Average
  - ☐ Above Average
- ☐ Natural or Anthropogenic Disturbance
- ☐ Other: ___________________________

Additional Notes: (sketch of site, description of photos, comments on hydrological observations, etc.) Attach additional sheets as necessary.

Defined bed and bank present.

Ancillary Information:

- ☐ Riparian Corridor
- ☐ Erosion and Deposition
- ☐ Floodplain Connectivity

Observed Amphibians, Snake, and Fish:

Taxa	Life History Stage	Location Observed	Number of Individuals Observed

Streamflow Duration Field Assessment Form

Project # / Name: **Pacific Marine Energy Center**	Assessor: **Halstead**
Address	Date: **06-01-16**
Waterway Name: **Stream 4**	Coordinates at downstream end (ddd.mm.ss) Lat. 44°27'50.146" N
Reach Boundaries	Long. 124°4'39.145" W
Precipitation w/in 48 hours (cm) none	Channel Width (m) 1.25
☐ Disturbed Site / Difficult Situation (Describe in "Notes")	

Observed Hydrology

% of reach w/observed surface flow 100

% of reach w/any flow (surface or hyporheic) 100

# of pools observed 0

Observations

Observed Wetland Plants (and indicator status):

Some areas of channel included yellow water flag (*Iris pseudacorus*-OBL), yellow skunk cabbage (*Lysichiton americanus*-OBL), and yellow pond lily (*Nuphar polysepala*-OBL).

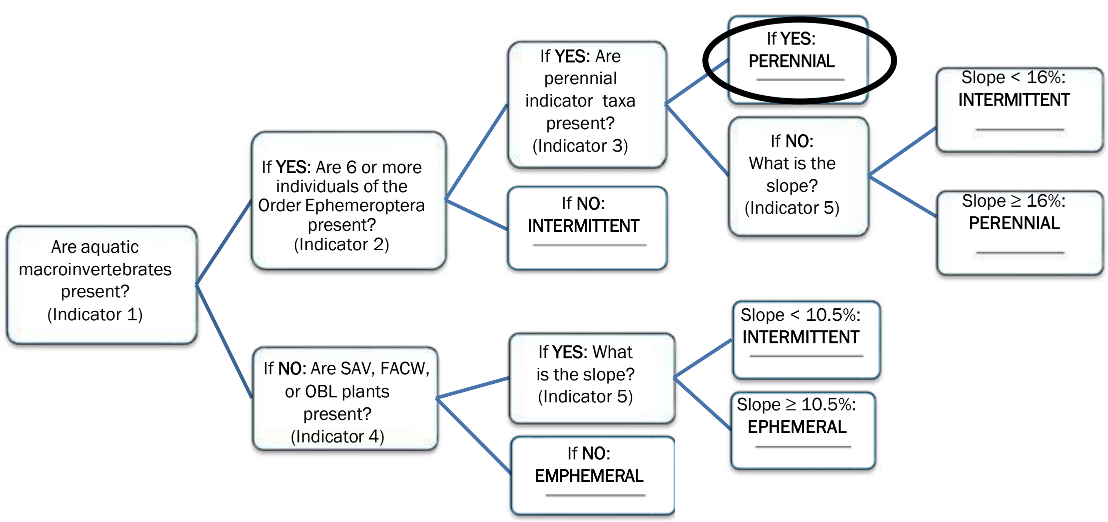
Observed Macroinvertebrates:

Taxon	Indicator Status	Ephemeroptera?	# of Individuals
did not review stream for macroinvertebrates			

Indicators

1. Are aquatic macroinvertebrates present?	☒ Yes	☐ No
2. Are 6 or more individuals of the Order Ephemeroptera present?	☐ Yes	☒ No
3. Are perennial indicator taxa present? (refer to Table 1)	☒ Yes	☐ No
4. Are FACW, OBL, or SAV plants present? (Within ½ channel width)	☒ Yes	☐ No
5. What is the slope? (In percent, measured for the valley, not the stream)	2 %	

Conclusions



Single Indicators:
☒ Fish
☒ Amphibians

Finding:
☐ Ephemeral
☐ Intermittent
☒ Perennial

Notes: (explanation of any single indicator co nclusions, description of disturbances or modifications that may interfere with indicators, etc.)

Difficult Situation:

Describe situation. For disturbed streams, note extent, type, and history of disturbance.

☐ Prolonged Abnormal Rainfall / Snowpack

☐ Below Average

☐ Above Average

☐ Natural or Anthropogenic Disturbance

☐ Other: ____________________________

Additional Notes: (sketch of site, description of photos, comments on hydrological observations, etc.) Attach additional sheets as necessary.

Defined bed and bank present and signs of erosion.

Adult rough skinned newts (*Taricha granulosa*), Northwest salamander (*Ambystoma gracile*) egg masses, and small fish were observed.

Ancillary Information:

☐ Riparian Corridor

☐ Erosion and Deposition

☐ Floodplain Connectivity

Observed Amphibians, Snake, and Fish:

Taxa	Life History Stage	Location Observed	Number of Individuals Observed

Appendix C. Ground Level Photographs

Photo Point 17: Representative upland facing northeast

Photo Point 18: Friday Creek facing northeast (upstream)

Photo Point 19: Stream 4 facing southeast (upstream)

Photo Point 20: Buckley Creek facing southwest (downstream)

Photo Point 21: Wetland D facing northwest

Appendix D. WETS Table

WETS Table

WETS Station: NEWPORT MUNI AP, OR								
Requested years: 1971 - 2000								
Month	Avg Max Temp	Avg Min Temp	Avg Mean Temp	Avg Precip	30% chance precip less than	30% chance precip more than	Avg number days precip 0.10 or more	Avg Snowfall
Jan	51.0	38.6	44.8	10.22	6.71	12.27	16	0.3
Feb	53.0	39.2	46.1	8.69	6.04	10.33	15	0.2
Mar	54.1	39.8	47.0	7.74	5.54	9.15	15	0.0
Apr	56.1	41.0	48.5	4.95	3.49	5.88	12	0.0
May	59.1	44.8	52.0	3.68	2.44	4.41	9	0.0
Jun	62.0	48.5	55.2	2.72	1.70	3.29	7	0.0
Jul	64.8	50.7	57.8	1.04	0.54	1.27	2	0.0
Aug	65.7	50.9	58.3	1.02	0.45	1.24	3	0.0
Sep	65.4	49.0	57.2	2.39	0.83	2.88	5	0.0
Oct	61.3	45.0	53.1	5.12	2.78	6.25	9	0.0
Nov	54.8	41.8	48.3	10.67	7.29	12.72	17	0.0
Dec	51.1	38.9	45.0	11.51	7.99	13.69	16	0.6
Annual:					61.69	77.39		
Average	58.2	44.0	51.1	-	-	-	-	-
Total	-	-	-	69.76			126	1.0

GROWING SEASON DATES			
Years with missing data:	24 deg = 2	28 deg = 1	32 deg = 1
Years with no occurrence:	24 deg = 19	28 deg = 10	32 deg = 0
Data years used:	24 deg = 28	28 deg = 29	32 deg = 29
Probability	24 F or higher	28 F or higher	32 F or higher
50 percent *	No occurrence	2/6 to 12/29: 326 days	3/19 to 11/28: 254 days
70 percent *	No occurrence	No occurrence	3/3 to 12/15: 287 days
* Percent chance of the growing season occurring between the Beginning and Ending dates.			

STATS TABLE - total precipitation (inches)													
Yr	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annl
1951								0.28	4.82	9.21	M8.30	10.15	32.76
1952	15.20	9.14	12.46	2.37	0.75	1.27	0.07	0.74	0.67	1.26	3.82	12.23	59.98
1953	24.24	7.97	M8.96	4.60	M5.25	3.09	0.54	2.91	2.48	5.84	14.22	13.45	93.55
1954	15.01	9.98	7.47	5.54	1.40	3.65	1.05	2.93	2.44	6.42	6.98	12.75	75.62
1955	5.97	6.62	7.91	10.17	1.56	1.55	1.98	0.08	3.20	11.72	M9.35	16.90	77.01
1956	20.64	9.53	M12.03	1.49	1.84	2.46	0.24	0.66	2.17	10.86	M1.87	9.76	73.55
1957	5.71	7.48	13.60	3.90	4.09	1.63	0.36	1.37	1.15	M6.79	M3.93	M13.12	63.13
1958	11.85	13.76	5.78	8.77	1.78	1.99	0.13	0.74	3.55	3.89	15.55	8.49	76.28

1959	15.51	10.11	8.83	2.76	3.68	4.86	1.18	0.68	5.78	5.95	4.86	6.73	70.93
1960	9.52	11.54	8.68	5.71	7.13	1.18	0.20	2.52	0.50	7.46	15.72	4.73	74.89
1961	9.22	16.64	14.47	5.08	5.77	1.04	0.27	1.21	1.12	7.61	10.10	10.20	82.73
1962	3.94	7.19	7.03	4.78	3.92	1.04	0.39	2.33	3.22	5.16	16.20	5.52	60.72
1963	5.29	8.39	7.61	9.55	4.34	2.22	1.27	0.61	2.84	6.65	11.52	7.24	67.53
1964	M11.98	M3.12	M7.44	2.97	M1.39	M2.55	1.87	M2.03	M1.15		14.17	18.89	67.56
1965	21.24	3.83	1.35	6.63	2.80	1.25	0.25	M0.53	0.46	M2.87	10.36	13.64	65.21
1966	10.97	3.24	12.57	2.14	0.94	1.65	1.16	0.78	3.17	6.03	11.52	M7.04	61.21
1967	M5.28	5.16	9.83	6.98	2.21	1.25	0.00	0.05	1.55	9.37	7.86	12.86	62.40
1968	11.41	12.70	11.36	3.01	5.07	6.78	0.84	7.60	3.24	9.22	17.12	22.68	111.03
1969	14.66	7.15	4.09	5.91	3.96	5.68	0.56	0.36	4.45	5.65	5.24	15.34	73.05
1970	19.20	8.25	3.26	6.90	2.50	1.00	0.36	0.37	4.41	5.36	8.83	14.03	74.47
1971	15.43	7.15	8.97	7.55	2.02	3.75	1.13	1.51	6.32	6.19	10.45	20.00	90.47
1972	13.99	7.26	11.42	6.83	2.13	1.73	0.53	0.41	3.22	1.32	6.40	14.72	69.96
1973	8.72	2.69	8.40	1.61	2.80	4.86	0.13	1.17	5.69	6.33	22.13	17.96	82.49
1974	13.77	11.04	13.60	4.48	2.92	2.48	3.30	0.47	0.66	1.98	12.70	13.35	80.75
1975	13.93	10.26	9.14	5.98	3.47	1.94	1.12	2.43	0.03	11.39	13.15	13.83	86.67
1976	12.02	11.30	6.79	4.20	2.53	1.06	1.53	1.88	1.47	2.34	2.06	2.88	50.06
1977	2.31	7.09	8.82	1.20	6.21	1.15	0.25	3.07	5.38	4.18	11.94	15.55	67.15
1978	9.65	5.55	2.55	8.06	5.83	2.67	0.97	3.19	4.53	1.01	7.12	7.39	58.52
1979	5.02	12.42	6.67	4.96	4.22	1.84	0.77	1.00	3.09	8.84	8.18	15.70	72.71
1980	10.02	M5.37	6.68	4.76	2.71	2.95	0.35	0.45	1.60	3.27	9.47	15.90	63.53
1981	2.80	6.86	7.03	5.29	4.68	5.54	0.71	0.44	3.74	10.58	11.51	13.39	72.57
1982	M13.39	10.33	8.95	6.62	0.66	1.92	1.12	0.58	2.95	6.44	7.42	14.73	75.11
1983	16.54	14.79	13.84	3.32	3.00	3.20	3.24	1.31	0.52	2.36	17.66	11.10	90.88
1984	5.38	9.35	6.19	6.40	7.04	5.75	0.46	0.23	1.64	8.70	18.81	8.52	78.47
1985	0.68	5.67	8.33	2.21	2.05	5.86	0.72	0.40	4.50	7.14	8.80	3.87	50.23
1986	8.29	11.73	5.04	4.33	M3.31	1.10	2.51	0.14	3.63	4.39	9.44	M4.08	57.99
1987	11.94	7.12	11.00	M2.52	M2.75	0.63	M2.41	0.55	0.66	0.13	4.47		44.18
1988	13.50	M2.37	M6.82	4.01	7.21	2.23	1.12	0.36	1.61	1.42	17.03	M7.10	64.78
1989	9.32	6.90	13.08	1.85	2.94	2.66	0.82	1.04	0.52	4.52	5.57	4.99	54.21
1990	14.31	9.63	4.03	5.13	3.38	2.87	0.88	0.85	1.25	6.98	8.83	4.41	62.55
1991	4.35	7.21	6.57	7.27	3.81	0.61	0.36	2.22	0.05	2.90	10.06	8.38	53.79
1992	8.11	6.20	1.22	7.94	0.34	0.41	0.24	0.74	1.93	4.73	7.20	11.35	50.41

1993	6.65	1.56	M6.43	8.16	6.05	3.70	1.52	0.20	0.05	1.22	2.17	8.54	46.25
1994	6.57	9.26	3.58	3.31	2.47	3.11	0.20	0.20	0.91	9.03	12.15	12.21	63.00
1995	14.93	7.68	8.16	5.75	1.96	4.04	0.39	0.94	4.09	5.25	13.83	11.81	78.83
1996	11.21	16.28	4.13	8.41	5.03	1.06	1.27	0.38	2.56	8.02	13.65	22.44	94.44
1997	13.15	3.54	12.75	6.55	4.62	4.12	1.39	2.78	6.26	9.00	8.80	7.61	80.57
1998	15.23	13.18	9.34	2.09	5.07	2.60	0.41	0.07	1.05	6.18	17.96	17.60	90.78
1999	12.71	16.81	8.93	2.54	5.80	2.61	0.91	1.42	0.17	3.41	16.91	14.61	86.83
2000	12.80	10.71	3.86	2.88	3.36	3.18	0.38	0.16	1.74	4.46	4.10	5.32	52.95
2001	4.09	4.05	5.30	5.19	1.94	3.37	0.27	1.54	0.71	4.14	10.99	12.41	54.00
2002	14.85	M6.16	M7.40	M5.05	M2.20	2.36	0.10	0.23	M1.05	M1.04	M4.95	M15.04	60.43
2003	M10.15	M5.08	M11.95	M8.07	1.33	0.77	M0.20	0.08	2.04	3.41	8.97	15.48	67.53
2004	M13.46	6.40	M3.96	3.77	2.67	1.08	0.02	3.22	3.08	7.39	3.93	7.00	55.98
2005	M4.96	M1.06	M5.57	M4.42	M1.13	M5.02	M0.32	M0.04	M1.93	M2.65	M5.94	M10.88	43.92
2006	M12.48	3.40	M6.48	M3.16	M1.32	M0.92	0.37	MT	M1.17	M0.79	M17.15	M5.98	53.22
2007	M4.08	M7.20	7.29	M2.56	M1.14	M1.68	M0.73	M0.60	M1.37	M5.70	M4.55	M7.00	43.90
2008	M4.33	M1.82	M3.82	M2.08	M0.24	M0.37	MT	M0.00	0.26	3.57	11.09	10.85	38.43
2009	M2.47	M1.76	M1.72	M2.46	M2.03	M1.19	M0.29	M0.99	M1.82	M0.31	M6.62	M2.82	24.48
2010	M5.59	M5.99	M4.10	M4.61	M2.26	M4.97	0.51	M0.04	M1.96	M0.77	M8.49	M8.40	47.69
2011	M8.69	M5.03	M10.52	M7.25	M3.18	MT	M0.59	M0.00	M0.07	M2.97	6.65	M0.23	45.18
2012	M0.57	M2.31	M8.71	M4.75	2.51	2.63	0.46	M0.17	0.10	8.88	8.52	M11.00	50.61
2013	4.92	2.92	2.36	2.61	M3.68	2.51	T	M1.62	5.71	1.52	M3.27	2.38	33.50
2014	3.15	M6.77	5.74	3.43	2.41	M1.33	0.63	0.39	1.66	7.69	5.82	9.74	48.76
2015	3.52	6.45	4.64	3.54	1.36	0.22	0.03	M0.92	0.61	M3.07	M6.63	M16.13	47.12
2016	M8.43	4.85	8.35	M2.16	0.65	M1.25	0.99	0.06	M1.01	M9.79	12.53	6.10	56.17
2017	5.28	M14.18	10.32	M5.65	2.46	2.04	M0.03						39.96
Notes: Data missing in any month have an "M" flag. A "T" indicates a trace of precipitation.													
Data missing for all days in a month or year is blank.													
Creation date: 2016-07-22													

Appendix E. References

HDR Engineering, Inc. (HDR)

2017 Wetlands and Waterbodies Delineation Report, Pacific Marine Energy Center South Energy Test Site, FERC Project No P-14616. Dated November 30, 2017

National Resources Conservation Service (NRCS)

2015 Hydric Soils Technical Note 11: Hydric Soils Technical Standard and Data SubmissionRequirements for Field Indicators of Hydric Soils. https://www.nrcs.usda.gov/Internet/FSE_DOCUMENTS/nrcs142p2_051608.pdf. Revised December 2015.

2018 USDA Field Office Climate Data – WETS Station Newport Municipal Airport OR285: 1971 to 2000. Accessed March 11, 2019: http://agacis.rcc-acis.org/41041/wets.

Kelly, Delia

2016 Ocean Energy Coordinator, Oregon Department of Fish and Wildlife. Personal Communication. Email transmittal dated May 16, 2016.

WETLAND DELINEATION / DETERMINATION REPORT COVER FORM

This form must be included with any wetland delineation report submitted to the Department of State Lands for review and approval. A wetland delineation report submittal is not "complete" unless the fully completed and signed report cover form and the required fee are submitted. Attach this form to the front of an unbound report or include a hard copy of the completed form with a CD/DVD that includes a single PDF file of the report cover form and report (minimum 300 dpi resolution) and submit to: **Oregon Department of State Lands, 775 Summer Street NE, Suite 100, Salem, OR 97301-1279.** A single PDF attachment of the completed cover from and report may be e-mailed to **Wetland_Delineation@dsl.state.or.us**. For submittal of PDF files larger than 10 MB, e-mail instructions on how to access the file from your ftp or other file sharing website. Fees can be paid by check or credit card. Make the check payable to the Oregon Department of State Lands. To pay the fee by credit card, call 503-986-5200.

☒ Applicant ☐ Owner Name, Firm and Address: Belinda Batten Oregon State University 350 Batcheller Hall Corvallis, OR 97331	Business phone # 541.737.9492 Mobile phone # (optional) E-mail: belinda.batten@oregonstate.edu
☐ Authorized Legal Agent, Name and Address: same as applicant	Business phone # Mobile phone # E-mail:

I either own the property described below or I have legal authority to allow access to the property. I authorize the Department to access the property for the purpose of confirming the information in the report, after prior notification to the primary contact.

Typed/Printed Name: ______________________ Signature: ______________________

Date: Special instructions regarding site access:

Project and Site Information (using decimal degree format for lat/long.,enter centroid of site or start & end points of linear project)

Project Name: Pacific Marine Energy Center South Energy Test Site	Latitude: 44.468 (N); 44.460 (S) Longitude: -124.079 (N); -124.076 (S)
Proposed Use: NNMREC-OSU is developing the Pacific Marine Energy Center South Energy Test Site.	Tax Map # 131201DA, 131201DO, 131107BO
Project Street Address (or other descriptive location): 200 feet north of intersection of Hwy 101 / NW Wenger Avenue (south end) and 500 feet north of intersection of Hwy 101 /NW Sunahama Place (north end)	Township 13S Range 12W/11W Section 01/07 Tax Lot(s) Section 01: 1500, 1600; Section 7: 02500
City: Newport County: Lincoln	Waterway: Not applicable River Mile: NWI Quad(s): Waldport

Wetland Delineation Information

Wetland Consultant Name, Firm and Address: Leandra Cleveland, PWS HDR Engineering, Inc. 700 Washington Street Suite 405 Vancouver, WA 98660	Phone # 360.975.6831 Mobile phone # 360.901.1410 E-mail: leandra.cleveland@hdrinc.com

The information and conclusions on this form and in the attached report are true and correct to the best of my knowledge.

Consultant Signature: Date: 11/30/17

Primary Contact for report review and site access is ☒ Consultant ☐ Applicant/Owner ☐ Authorized Agent

Wetland/Waters Present? ☒ Yes ☐ No | Study Area size: 11.9 acres | Total Wetland Acreage: 0.9 acres

Check Box Below if Applicable:	**Fees:**
☐ R-F permit application submitted	☒ Fee payment submitted **$** 419
☐ Mitigation bank site	☐ Fee ($100) for resubmittal of rejected report
☐ Wetland restoration/enhancement project (not mitigation)	☐ No fee for request for reissuance of an expired report
☐ Industrial Land Certification Program Site	
☐ Reissuance of a recently expired delineation	
Previous DSL # Expiration date _____	

Other Information:	Y	N	
Has previous delineation/application been made on parcel?	☐	☒	If known, previous DSL #
Does LWI, if any, show wetland or waters on parcel?	☐	☒	

For Office Use Only

DSL Reviewer: ______________ Fee Paid Date: _____ / _____ / _____ DSL WD # ______________

Date Delineation Received: ___ / ____ / ____ DSL Project # ____________ DSL Site # ______________

Scanned: ☐ Final Scan: ☐ DSL WN # ______________ DSL App. # ______________

Wetlands and Waterbodies Delineation Report

Pacific Marine Energy Center
South Energy Test Site

FERC Project No. P-14616

Oregon State University
Corvallis, OR

December 2017

Contents

Tables

Appendices

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1 Project Overview

Oregon State University (OSU) is developing the Pacific Marine Energy Center South Energy Test Site (PMEC-SETS or Project). PMEC-SETS will serve as the primary grid-connected ocean test facility for wave energy converters (WECs) in the United States (U.S.). OSU has been working with relevant state and federal agencies, along with other stakeholders, to implement a collaborative approach to the regulatory process. Construction of PMEC-SETS will require federal, state, and local environmental clearances and permits. To support these clearances and permits, HDR conducted a survey of wetlands and waters of the State/U.S. in order to determine potential siting and construction constraints for the proposed terrestrial cable route and related facilities.

The Project would include both marine and terrestrial components, and span a total distance of approximately 12 miles. The marine portion of the Project would be located in the Pacific Ocean, approximately 6 nautical miles off the coast of Newport, Oregon, on the Outer Continental Shelf and would occupy an area of approximately 2 square nautical miles where the WECs will be deployed, and 2 square nautical miles where the cables will be run to shore. The Project would support up to 20 commercial-scale WECs, deployed 50 to 200 meters or more apart from each other within a test berth, and transfer power to a grid connection point with the Central Lincoln People's Utility District (CLPUD) in Lincoln County, Oregon.

Four subsea transmission cables are planned, one for each of the four test berths. In addition, a single, smaller auxiliary cable would connect to the site. The subsea transmission cables would transfer power back to shore and allow for the monitoring and control of WECs via fiber optic cables incorporated into the transmission cables themselves. The preferred cable route runs south of an area of rocky geology that extends along the coast to the north, and the cables would come ashore south of Seal Rock with a landing site at Driftwood Beach State Recreation Site. The four transmission cables and auxiliary cable would each run through separate conduits to individual onshore cable landing points, known as "beach manholes", where the subsea cables would transition to terrestrial cables. The conduits would be installed using Horizontal Directional Drilling (HDD) techniques.

From the landing site, the cables would run in an underground conduit or direct burial to a Utility Connection and Monitoring Facility (UCMF) located on private property. The specifications of the terrestrial transmission cables are dependent on the final subsea cable design and coordination with CLPUD to ensure compatibility with existing infrastructure (e.g., copper versus aluminum conductors).

This report summarizes the field investigations to determine the presence of jurisdictional wetlands and waters of the State/U.S. within areas being considered for the on-shore portion of the Project (study area).

2 Landscape Setting and Land Use

The study area is located in Lincoln County, Oregon, approximately 1.5 miles north of the City of Waldport and approximately 5.5 miles south of the City of Newport (Figure 1; all figures are located in Appendix A). The study area includes all areas currently being evaluated as potential routes for the terrestrial cable, as well as the HDD laydown area and the UCMF site. Surveys were restricted to parcels where Project construction may occur, where rights-of-entry had been obtained, and the U.S. Highway 101 (Highway 101, highway) right-of-way.

The study area encompasses approximately 11.9 acres and is located in the following township, sections, and ranges (Figure 2):

- Township 13 South, Section 12 West, Section 1
- Township 13 South, Section 11 West, Sections 6 and 7

The approximate site location is at latitude 44° 27’ 51.41” north and longitude 124° 4’ 40.00” west. The study area begins approximately 430 feet south of the intersection of Highway 101 and NW Voyager Way and extends approximately 2,900 feet (0.5 mile) south, ending at the intersection of Highway 101 and NW Wenger Lane. The study area also includes a few select parcels adjacent to Highway 101, which extend east or west of the highway by approximately 300 to 1,500 feet. These parcels occur near intersections of the highway with NW Wenger Lane, Driftwood Beach Park Drive, and NW Sunahama Place. Additional discussion of landscape setting and land use in relation to site alterations is provided below.

3 Site Alterations

The study area is located in a coastal, rural residential and recreational area, and is generally flat with slopes less than 5 percent. Localized areas east and west of the highway at the northern extent of the study area and at the southeastern extent of the study area have slopes between 5 and 15 percent. The study area includes the existing highway right-of-way corridor which is approximately 80 feet wide, as well as portions of three parcels adjacent to the highway:

- 13-11-07-BO-02500-00
- 13-12-01-DO-01600-00
- 13-12-01-DO-01500-00

Adjacent parcels contain rural residential (RR-2) or public facilities (PF) zoning designations and land uses. Most of the parcels contain a large proportion of undeveloped, vegetated space, while most of the right-of-way is occupied by the two-lane, paved highway. The existing right-of-way extends approximately 10 feet west of the highway embankment and approximately 20 feet east of the existing highway embankment.

Approximately one third of the study area consists of paved and impervious roadways, parking lots, and driveways. Remaining undeveloped areas consist of coniferous evergreen forest, broad-leaved deciduous forest, and coastal shrub communities. The presence of invasive species is relatively low, and is mostly concentrated within roadside areas of the right-of-way. One named stream, Twombly Creek, is mapped as occurring in the study area (USFWS 2016). General stream direction in the vicinity is from east to west. Portions of each stream occur in ditches adjacent to the highway and all streams pass under the highway through culverts.

The study area is located in the Coastal Uplands (1b) Level IV ecoregion, in the Coast Range of Oregon. The Pacific Ocean is located approximately 900 feet west of the site. The climate in this ecoregion is heavily influenced by its proximity to the Pacific Ocean, with extended winter rainy seasons, minimal seasonal temperature extremes, and abundant fog in the summer. Common vegetative communities include Sitka spruce and Douglas-fir forests, many of which are currently managed for logging (Thorson et al. 2003).

Lincoln County, established in 1893, was largely isolated from the rest of the state during the first decades of its existence. In the early twentieth century (1920s and 30s), construction of Highway 101 and bridges across the bays in Waldport and Newport facilitated increased development in the area and resulted in the fragmentation of coastal habitats and channelization of some coastal streams. Historically, the county was dominated by fishing and timber industries, however, as of 2012, those industries have diminished, and tourism, manufacturing, retail, health services, and construction are now the dominant industries (U.S. Census Bureau 2012). Historic and ongoing development of the area has generally impacted the overall quality of the vegetation and habitat in the region. Within the study area itself, development is generally limited to the footprint of Highway 101, paved residential driveway entrances, and lateral access road intersections. The study area also includes a protected state park (Driftwood Beach State Recreation Site).

4 Precipitation Data and Analysis

The study area lies within Lincoln County, which has a growing season from February 6 to December 29 (326 days; NRCS 2017a, Appendix D). Annual average precipitation recorded at the closest Natural Resources Conservation Service (NRCS) Climate Analysis for Wetlands station, also known as WETS stations, at Newport's Municipal Airport (Station ID 24285) is 69.76 inches (NRCS 2017a, Appendix D).

Annual average temperatures recorded at the same station range from 45.0˚F to 58.2˚F (NRCS 2017a). The cooler months are the wettest. The majority of annual rainfall occurs between November and February. Conversely, the warmer months are driest; average rainfall is less than 1 inch per month between July and August (NRCS 2017a). Precipitation data were gathered at the nearest weather station in Newport, Oregon (Station 24285, NEWPORT MUNI AP), and compared to the normal precipitation range from the years 1971 through 2000, as calculated from the WETS table for the 2016 and 2017 site visits (Table 1 and Table 2).

4.1 June 1 through 3, 2016 Site Visit

Rainfall throughout the study area was above average during March (above normal) and below average during April and May (below normal; Table 1). Approximately 0.37 inch of rainfall was recorded during the 2 weeks prior to the field survey (May 18 through May 31), and 0.11 inch of rainfall was recorded during the field survey (June 1 through June 3). Overall, precipitation for the 3-month time period preceding the field survey was drier than normal, which could have resulted in false negatives for primary and secondary hydrologic indicators. However, it is not expected that these conditions affected the presence or absence of wetlands in the study area.

Table 1. Summary of Precipitation between March and May 2016 in Newport, Oregon

Month	Recorded Precipitation (inches)	Monthly Precipitation Average (inches)	Percent of Average Recorded	30% chance less than or more than ranges for normal precipitation (inches)
March	8.35	7.74	108%	<5.54 >9.15
April	2.16	4.95	44%	<3.49 >5.88
May	0.65	3.68	18%	<2.44 >4.41
Water Year to Date (October 1, 2015 through May 31, 2016)	50.27	62.52	80%	-----

Source: NRCS 2017a

4.2 June 21 through 22, 2017 Site Visit

Rainfall throughout the study area was above average during April (within normal) and below average during May and June (within normal; Table 2). Approximately 1.9 inches of rainfall was recorded during the 2 weeks prior to the field survey (June 6 through June 20), and no rainfall was recorded during the field survey (June 21 through June 22). Overall, precipitation for the 3-month time period preceding the field survey was within normal and would not affect primary and secondary hydrologic indicators.

Table 2. Summary of Precipitation between April and June 2017 in Newport, Oregon

Month	Recorded Precipitation (inches)	Monthly Precipitation Average (inches)	Percent of Average Recorded	30% chance less than or more than ranges for normal precipitation (inches)
April	5.65	4.95	114%	<3.49 >5.88
May	2.46	3.68	67%	<2.44 >4.41
June	2.04	2.72	75%	<1.70 >3.29
Water Year to Date (October 1, 2016 through June 30, 2017)	68.35	65.3	105%	-----

Source: NRCS 2017a

5 Methods

5.1 Wetlands

Field investigations were conducted by HDR on June 1-3, 2016, and June 21-22, 2017. Wetland areas were delineated using the methods described in the United States Army Corps of Engineers' (USACE) Wetlands Delineation Manual (Environmental Laboratory 1987) and using the Regional Supplement to the USACE Wetland Delineation Manual: Western Mountains, Valleys, and Coast Region (Environmental Laboratory 2010).

Plots were selected by initial observation of topographic depressions, wetland vegetation, visual evidence of hydrology, and examination of soil samples. At sites exhibiting positive indicators of wetland characteristics, multiple soil pits were dug in conjunction with vegetative and hydrologic indicators to aid in the determination of wetland boundaries. Once a plot site was selected, a soil pit was dug, soils, hydrology, and vegetation were investigated, and results recorded on standard data sheets. In addition to the plots associated with each wetland, sample plots and photo points were also recorded.

Sample plots (labeled SP on figures) were established in areas to confirm the presence and characteristics of wetlands and uplands. Data forms associated with sample plots are included in Appendix B and locations are shown on Figure 5 through Figure 8. Representative site photographs from data plots are included in Appendix C. Methods used to determine the presence of hydric soil, hydrology, and hydrophytic vegetation are discussed below. Variations to the standard methodology, if necessary, are indicated on the data forms.

5.1.1 Soils

Soils at each representative wetland and upland sample plot were typically inspected to a depth of 20 inches to determine the presence or absence of hydric soil indicators based on the NRCS Indicators of Hydric Soils (NRCS 2017b). Soil samples were moistened when necessary to aid in the determination of the hue, value, and chroma of the soil matrix and redoximorphic features (if present; Munsell Color Services 2009). Soil texture was evaluated using field methods described by USACE and NRCS.

In addition to the formal data plots that were recorded, various auger samples were taken throughout the wetlands and along the wetland boundaries to provide an accurate delineation. The results of these auger samples were not formally documented, but rather used as a method of field verification.

Figure 3 identifies six soils in the study area. Table 3 provides soil names and the hydric status of each soil in the study area.

Table 3. Study Area Soils

Soil Type	Hydric Status
Waldport fine sand, 0 to 30 percent slopes	Non-hydric – contains hydric inclusions
Yaquina fine sand, 0 to 3 percent slopes	Hydric
Urban land – Nelscott complex, 0 to 12 percent slopes	Non-hydric – contains hydric inclusions
Nelscott loam, 3 to 12 percent slopes	Hydric
Nelscott loam, 12 to 50 percent slopes	Non-hydric
Bandon fine sandy loam, 3 to 12 percent slopes	Non-hydric – contains hydric inclusions

Source: NRCS 2017c

5.1.2 Hydrology

To evaluate wetland hydrology characteristics, primary and secondary indicators were investigated at each of the sample plots. Primary hydrology indicators observed included the presence of surface water, high water table, saturation, sediment deposits, sulfidic odor, oxidized rhizospheres on living roots, or the presence of reduced iron. Secondary hydrology indicators observed included drainage patterns, geomorphic position, and positive facultative species (FAC)-neutral test.

Due to the drier than normal conditions in 2016, false negatives for primary and secondary hydrologic indicators may have occurred during the 2016 field survey. For instance, saturation in the upper 12 inches of the soil profile was absent in two areas identified as wetlands (Wetlands C and D), but other indicators of wetland hydrology were observed.

5.1.3 Vegetation

At each plot, the percent cover for each plant species was visually estimated and recorded. Due to the linear nature of much of the study area and confinement to the Highway 101 right of way, plot sizes for percent cover estimates were tailored to each plot as indicated on the data sheets. In accordance with USACE methodology, greater than 50 percent of the dominant plant species must be classified as hydrophytic, or the plot must have a prevalence index of less than 3.00 for a site to display a positive wetland vegetation indicator.

The dominant plant species were identified using standard taxonomic references (Cooke 1997; Guard 1995; and Hitchcock and Cronquist 1973). The wetland indicator status for each species was determined in accordance with the National Wetland Plant List (Lichvar et al. 2016). Vegetation was recorded as obligate (OBL), facultative-wetland (FACW), facultative (FAC), facultative-upland (FACU), or upland (UPL). The field surveys were conducted in late spring (2016) and early summer (2017), when plant species' characteristics were readily identifiable.

5.2 Ordinary High Water Mark

The ordinary high water mark (OHWM) for waterways in the study area was determined in the field using the methodology outlined in the USACE Regulatory Guidance Letter 05-05 (USACE 2005). The USACE guidance is consistent with the definition of OHWM put forth by the Oregon Department of State Lands (DSL). For purposes of the Clean Water Act, OHWM is "that line on the shore established by the fluctuation of water and indicated by physical characteristics such as a clear, natural line impressed on the bank, shelving, changes in the character of soil, destruction of terrestrial vegetation, the presence of litter and debris, or other appropriate means that consider the characteristics of the surrounding areas" (USACE 2005). These indicators were observed in the field and used to determine the location of the OHWM.

Streams identified as having an OHWM were further evaluated using some criteria identified in the Streamflow Duration Assessment Method (SDAM) for Oregon (Nadeau 2015). This methodology is used to distinguish between perennial, intermittent, and ephemeral streams. Field investigators recorded observations of fish or amphibians, wetland plants in or near the streambed, and slope of the stream within the study area to determine likely seasonality of the stream. Macroinvertebrates were not sampled. All streams had plants with a wetland indicator status of FACW or OBL present and slopes of less than 10.5 percent, indicating all delineated streams are at least intermittent. Additional single indicator criteria such as the presence of fish, adult amphibians, and amphibian egg masses were also observed in one stream, described below in Section 6.2.

6 Description of All Wetlands and Other Non-Wetland Waters

6.1 Delineated Wetlands

Eight freshwater wetlands (Wetlands A through E, G, H, and I) totaling 0.9 acres were delineated within the study area (Figure 5 through 8).

WETLAND A – 0.01 ACRE

Wetland A is a saturated, riparian-forested wetland (PFO4B) located within a shallow ravine (Figure 7). Twombly Creek flows from east to west through the wetland and discharges through a culvert under Highway 101. Groundwater discharge is likely the dominant hydrologic source of the stream and Wetland A. Sediment deposits were observed in the wetland, indicating overflow from the creek has some contribution to local hydrology. The tree stratum is dominated by Sitka spruce (*Picea sitchensis*) and western hemlock (*Tsuga heterophylla*). The shrub stratum is dominated by salal (*Gaultheria shallon*) and four-line honeysuckle (*Lonicera involucrata*). Individual salal and evergreen blueberry (*Vaccinium ovatum*) plants were observed growing on downed wood and decaying logs and were not included in the percent cover estimate. The herb stratum is dominated by yellow skunk cabbage (*Lysichiton americanus*) and field horsetail (*Equisetum arvense*). Tree diameter at breast height (dbh) within the wetland is less than 18 inches, which does not qualify as a mature forested wetland.

Hydric soil indicators observed include hydrogen sulfide odor and loamy mucky mineral. Primary wetland hydrology indicators observed include high water table, saturation, sediment deposits, hydrogen sulfide odor, oxidized rhizospheres on living roots, and presence of reduced iron. The wetland boundary was identified by an abrupt topographic break to the north and south and a lack of hydric soil and hydrology indicators. The western boundary was identified by the toe of the Highway 101 road prism. Wetland A continues outside the study area to the east.

WETLAND B – 0.02 ACRE

Wetland B is a saturated, depressional scrub-shrub wetland (PSS1B) located west of Highway 101 (Figure 7). The shrub stratum is dominated by Douglas' meadowsweet (*Spiraea douglasii*), with Sitka willow (*Salix sitchensis*), salal, salmon raspberry (*Rubus spectabilis*), and Pacific ninebark (*Physocarpus capitatus*) present as subdominants. The herb stratum is dominated by slough sedge (*Carex obnupta*) and American alpine lady fern (*Athyrium cyclosorum*), with giant horsetail (*Equisetum telmateia*) and American purple vetch (*Vicia americana*) present as subdominants.

The hydric soil indicator observed was loamy mucky mineral. Primary hydrology indicators observed include high water table, saturation, oxidized rhizospheres on living roots, and presence of reduced iron. The wetland boundary was identified by topographic breaks to the north and south. The eastern boundary was identified by the toe of the Highway 101 road prism. Wetland B continues outside the study area boundary to the west.

WETLAND C – 0.11 ACRE

Wetland C is a saturated, depressional, forested wetland (PFO4/EM1B, PFO4B/SS1B) within the Driftwood Beach State Recreation Site (Figure 6). The herb stratum and shrub stratum are codominants with the tree stratum. The tree stratum is dominated by shore pine (*Pinus contorta*), with salal and four-line honeysuckle dominant in the shrub stratum. The herb stratum is dominated by slough sedge, with American alpine lady fern present as a subdominant. The dbh of trees within the wetland is less than 18 inches, which does not qualify as a mature forested wetland.

Hydric soil indicators observed include sandy mucky mineral and sandy redox. The primary hydrology indicator observed includes oxidized rhizospheres on living roots. Two secondary hydrology indicators, geomorphic position and FAC–neutral test, were also observed. Saturation in the upper 12 inches of the soil profile was absent during the fieldwork, however, Wetland C is located in a depressional area that is likely saturated during the wet season. Local topography slopes up to the west and the wetland boundary was identified by a distinct topographic break to the west, north, and northeast, resulting in the presence of northern bracken fern, an increase in percent cover of salal, and a decrease in percent cover of slough sedge. The southern boundary was identified by the limit of fill placed for the paved entrance into the State Park. Wetland C was likely contiguous, with Wetland D to the south prior to construction of the park entrance. A culvert through the paved entrance was not observed during the fieldwork.

WETLAND D – 0.31 ACRE

Wetland D is a saturated, depressional scrub-shrub/emergent wetland (PFO4/SS1B) within the Driftwood Beach State Recreation Site (Figure 6). The tree stratum is dominated by shore pine with salal and salmon raspberry dominant in the shrub stratum. The herb stratum is dominated by slough sedge, with American alpine lady fern present as a subdominant.

The hydric soil indicator observed was the presence of a histic epipedon. Similar to Wetland C, the primary hydrology indicator observed was oxidized rhizospheres on living roots. Saturation in the upper 12 inches of the soil profile was absent during the fieldwork, however, Wetland D is located in a depressional area that is likely saturated during the wet season. The wetland boundary was identified by a distinct break in topography to the west, the limit of fill of the paved park entrance to the north, and the toe of the Highway 101 road prism to the east. Wetland D continues outside the study area boundary to the south and west of Highway 101. Friday Creek flows through Wetland D from north to south.

WETLAND E – 0.01 ACRE

Wetland E is a seasonally-flooded scrub-shrub/emergent wetland (PSS1/EM1C) located on a toe slope east of Highway 101 (Figure 6). Trees are absent and the shrub stratum is dominated by Douglas’ meadowsweet and four-line honeysuckle, with oceanspray (*Holodiscus discolor*), rusty Labrador-tea (*Rhododendron groenlandicum*), salmon raspberry, and salal present as subdominants. The herb stratum is dominated by slough sedge and yellow skunk cabbage, with American alpine lady fern and deer fern (*Blechnum spicant*) present as subdominants.

Hydric soil indicators observed include the presence of a histosol and hydrogen sulfide odor. Primary hydrology indicators observed include 2 inches of surface water, high water table, saturation, and hydrogen sulfide odor. Non-channelized surface water flows through the wetland from east to west and discharges into the adjacent Highway 101 roadside ditch. Surface water in the ditch flows north through a culvert under a driveway, merges with a ditched stream flowing south, then flows west under Highway 101 via a culvert and is channelized through Wetland D. The wetland boundary was identified by the limits of fill of the adjacent driveway to the north, a transition to a non-hydrophytic vegetation community to the south, and the toe of the Highway 101 road prism to the west. Wetland E continues outside the study area boundary to the east.

WETLAND G – 0.02 ACRE

Wetland G is a saturated, forested wetland (PFO1B) located on a toe slope east of Highway 101 (Figure 7). An unnamed stream flows through the wetland from east to west. The stream discharges through a culvert under Highway 101 and is channelized through Wetland B. The tree stratum is dominated by red alder (*Alnus rubra*). The shrub stratum is dominated by salal and four-line honeysuckle, with Douglas' meadowsweet, salmon raspberry, red alder, and oceanspray present as subdominants. Himalayan blackberry (*Rubus armeniacus*) is present in the woody vine stratum and the understory consists of slough sedge.

Hydric soil indicators observed include loamy gleyed matrix and depleted matrix. Primary hydrology indicators observed include high water table, saturation, oxidized rhizospheres on living roots, and presence of reduced iron. The wetland boundary was identified by topographic breaks to the north and south, a transition to non-hydric soils, and lack of hydrology indicators. The western boundary was identified by the toe of the Highway 101 road prism. Wetland G continues outside of the study area boundary to the east.

WETLAND H – 0.27 ACRE

Wetland H is a scrub-shrub, emergent wetland (PSS/EM1C) located in a small depressional area that is the headwaters for an unnamed stream outside the study area to the north (Figure 8). Trees and shrubs are present along the periphery and the shrub stratum in the wetland is sparse and dominated by Sitka alder (*Alnus crispa*). The herb stratum is dense and is dominated by jointed rush (*Juncus articulates*), lamp rush (*Juncus effusus*), vernal grass (*Anthoxanthum odoratum*), and creeping buttercup (*Ranunculus repens*). Himalayan blackberry (*Rubus armeniacus*) is present in the woody vine stratum.

Hydric soil indicators observed include the presence of redox features and hydrogen sulfide. Primary hydrology indicators observed includes surface water, high water table, saturation, and hydrogen sulfide. The wetland boundary was identified by distinct changes in topography and transition from hydrophytic vegetation to upland vegetation.

WETLAND I – 0.15 ACRE

Wetland I is an emergent wetland (PEM1C) located in a small depressional area (Figure 8). Trees and shrubs are present along the periphery. The herb stratum is dense and is dominated by spreading rush (*Juncus patens*), slough sedge (*Carex obnupta*), and garden bird's foot trefoil (*Lotus corniculatus*). Himalayan blackberry is present in the woody vine stratum. Lamp rush, vernal grass, and creeping buttercup are present as subdominants in the herb stratum.

Hydric soil indicators observed include the presence of redox features. Primary hydrology indicators were not observed. Secondary indicators for Dry Season Water Table and FAC-neutral test were observed. The wetland boundary was identified by distinct changes in topography and transition from hydrophytic vegetation to upland vegetation.

6.2 Waters of the State/United States

Two named streams (Twombly Creek and Friday Creek) and two unnamed streams (Stream 3 and Stream 4) were identified within the study area. An additional roadside ditch with a surface water connection to Twombly Creek was also identified. StreamNet fish distribution data (StreamNet 2017) does not indicate the presence of fish in Friday Creek or Stream 4. No information is available in the database for Twombly Creek or Stream 3.

FRIDAY CREEK

Friday Creek flows from north to south at the eastern extent of northern end of the study area (Figure 6). The stream leaves the study area at this location and reenters the study area further south, flows west through a culvert under Highway 101, then flows south in a roadside ditch for approximately 270 feet on the west side of the highway. The stream enters a culvert under the entrance to the Driftwood Beach State Recreation Site, daylights on the south side of the entrance, and continues to flow south through Wetland D in an open channel where it leaves the study area and flows into Buckley Creek. Buckley Creek is a direct tributary to the Pacific Ocean and is reported by Oregon Department of Fish and Wildlife (ODFW) to support anadromous coastal cutthroat trout [*Oncorhynchus clarkia clarkii* (Kelly 2016)]. OHWM of Friday Creek was identified by the clear limits of bed and bank in the undisturbed portions of the stream and the limits of hydrophytic vegetation in the ditched portion of the stream. The channel width just south of the park entrance is approximately 2 feet wide and ranges from 5 to 10 feet wide north of the entrance. Depth of water during the survey ranged from 1 to 1.5 feet.

TWOMBLY CREEK

Twombly Creek flows from east to west through Wetland A, passes under Highway 101 through a culvert, then flows north in a roadside ditch for approximately 40 feet on the west side of the highway before exiting the study area to the west (Figure 7). Based on aerial photo interpretation and existing mapping, Twombly Creek flows into Buckley Creek approximately 300 feet west of the study area. The OHWM was identified by bed, banks, and scour line. Surface water was absent during the field survey, except for a small pool of inundation at the culvert entrance. The Oregon Department of Fish and Wildlife observed flow in August indicative of possible year round, perennial flow. Approximately 160 linear feet of roadside ditch that has a surface water connection to Twombly Creek is present on the west side of Highway 101 (0.03 acre). During the survey, the OHWM ranged from approximately 15 feet wide at the southern extent and narrowed to 5 feet wide at the confluence with Twombly Creek to the north. The OHWM was identified by bed and banks and an abrupt transition to non-hydrophytic vegetation (lack of slough sedge). Approximately 3 inches of stagnant water was observed during the field survey. The ditch is excavated in mapped hydric soils and likely receives subsurface discharge under Highway 101 from the upgradient slope located east of Highway 101.

STREAM 3 – UNNAMED

Stream 3 flows from east to west through Wetland G, passes under Highway 101 through a culvert, then flows west through Wetland B, exits the study area (Figure 7), and flows into Buckley Creek approximately 400 feet to the west. During the field survey flowing water in the channel was approximately 2 feet wide and 3 inches deep. The OHWM was identified by bed, banks, and scour line. The Oregon Department of Fish and Wildlife observed flow in August indicative of year round, perennial flow.

STREAM 4 – UNNAMED

Stream 4 flows into the study area from the east and discharges into a roadside ditch on the east side of Highway 101 (Figure 6). The main flow direction at this location is to the south, however, due to limited slope of the local topography, surface water backs up in the ditch for approximately 380 feet to the north. The main flow travels south for approximately 115 feet, where the stream flows west under Highway 101 through a culvert, then flows through Wetland D in an open channel and exits the study area. Stream 4 discharges into Friday Creek approximately 230 feet west of the study area. The OHWM was identified by the clear limits of bed and bank in the undisturbed portion of the stream, and by the limits of hydrophytic vegetation in the ditched portion of the stream. Flowing water in the channel was approximately 4 feet wide and 6 inches deep during the field survey. Portions of the channel were densely vegetated with yellow water flag, yellow skunk cabbage, and yellow pond-lily (*Nuphar polysepala*). Adult rough skinned newts (*Taricha granulosa*), Northwest salamander (*Ambystoma gracile*) egg masses, and small fish were observed.

7 Deviation from LWI or NWI

A Local Wetland Inventory has been completed for the Newport, Oregon, area, but the geographic extent does not cover the study area. National Wetland Inventory (NWI) mapping indicates the presence of scrub-shrub wetlands at the eastern extent of the Driftwood Beach State Recreation Site and at the southwestern extent of the study area (Figure 4). Wetlands were identified at both locations during the field survey and at seven additional locations. NWI mapping indicates Friday Creek flows through the northern portion of the Driftwood Beach State Recreation Site, however, results of the field investigation found that Friday Creek is present in a roadside ditch adjacent to Highway 101 at this location.

8 Mapping Methods

During the field delineation, data plot locations, wetland boundaries, and OHWM boundaries were recorded using a resource grade Trimble GeoXH 6000 Global Positioning System (GPS). Mapping accuracy of the unit is 50 cm (1.64 feet) using post-processed differential data correction. GPS data was post-processed and corrected after data was downloaded. Once post-processing was completed, the data was overlain onto the National Agriculture Imagery Program (NAIP) aerial photographs used for the field maps with Project and GPS data using GIS software. The data illustrated on Figure 5 through Figure 8 has a sub-meter mapping accuracy using post-processed differential data correction.

9 Additional Information

USACE and DSL will assert jurisdiction over water and wetland features if they meet regulatory authority as defined by the following:

- USACE will assert jurisdiction over traditional navigable waters, which includes all the waters described in 33 C.F.R. § 328.3(a)(1), and 40 C.F.R. § 230.3 (s)(1) The agencies will assert jurisdiction over wetlands adjacent to traditional navigable waters, including over adjacent wetlands that do not have a continuous surface connection to traditional navigable waters.
- DSL regulates "waters" (including rivers and wetlands) for the State of Oregon. DSL regulates waters using volume amounts of materials (i.e., sediments) removed or filled into a regulated water resource and location of activity. Waters of the state regulated under the Removal/Fill Law (Oregon Revised Statue [ORS] 196-795-990) are defined under OAR 141-085-0515.

Based on observations made at the site of surface or clear subsurface connections to regulated waters and best professional judgment, all wetlands, streams, and the roadside ditch would be considered jurisdictional and regulated by both USACE and DSL. The delineated wetlands meet the jurisdictional definition of a wetland by both USACE and DSL as defined in 33 C.F.R. § 328.7 and OAR 141-085-0515(4).

Friday Creek is connected to Buckley Creek, a fish bearing stream and direct tributary to the Pacific Ocean, which is considered jurisdictional to USACE and DSL. All other identified streams flow into Friday Creek or Buckley Creek and would also be jurisdictional to USACE and DSL per 33 C.F.R. § 328.3 and OAR 141-085-0515(3). The roadside ditch has a free and open connection to Twombly Creek and would also be considered jurisdictional to USACE and DSL per 33 C.F.R. § 328.3 and OAR 141-085-0515(3).

10 Results and Conclusions

Eight wetlands totaling 0.9 acre and four streams were delineated within the study area (Table 4). All wetlands are classified as palustrine and include forested, scrub-shrub, and emergent wetlands. All streams identified are considered intermittent and ultimately discharge into Buckley Creek, a direct tributary to the Pacific Ocean. An additional roadside ditch was delineated. This ditch has a free and open surface water connection to Twombly Creek. All features would be considered jurisdictional to USACE and DSL.

Table 4. Summary and Anticipated Jurisdictional Determination

Feature	Size (acre)	NWI	Likely Jurisdiction
Wetland A	0.01	PFO4B	DSL and USACE
Wetland B	0.02	PSS1B	DSL and USACE
Wetland C	0.11	PFO4/EM1B	DSL and USACE
Wetland D	0.31	PFO4/SS1B	DSL and USACE
Wetland E	0.01	PSS1/EM1C	DSL and USACE
Wetland G	0.02	PFO1B	DSL and USACE
Wetland H	0.27	PSS/EM1C	DSL and USACE
Wetland I	0.15	PEM1C	DSL and USACE
Friday Creek	---	R3UBF	DSL and USACE
Twombly Creek	---	R4SBC	DSL and USACE
Stream 3	---	R4SBC	DSL and USACE
Stream 4	---	R3UBF	DSL and USACE
Ditch	---	N/A	DSL and USACE

11 Disclaimer

This report documents the investigation, best professional judgment, and conclusions of the investigators. It should be considered a Preliminary Jurisdictional Determination and used at your own risk until it has been approved in writing by the DSL in accordance with OAR 141-090-0005 through 141-090-0055, and USACE in accordance with Section 404 of the CWA (OAR 141-090-0035 [7][k]).

Appendix A. Figures

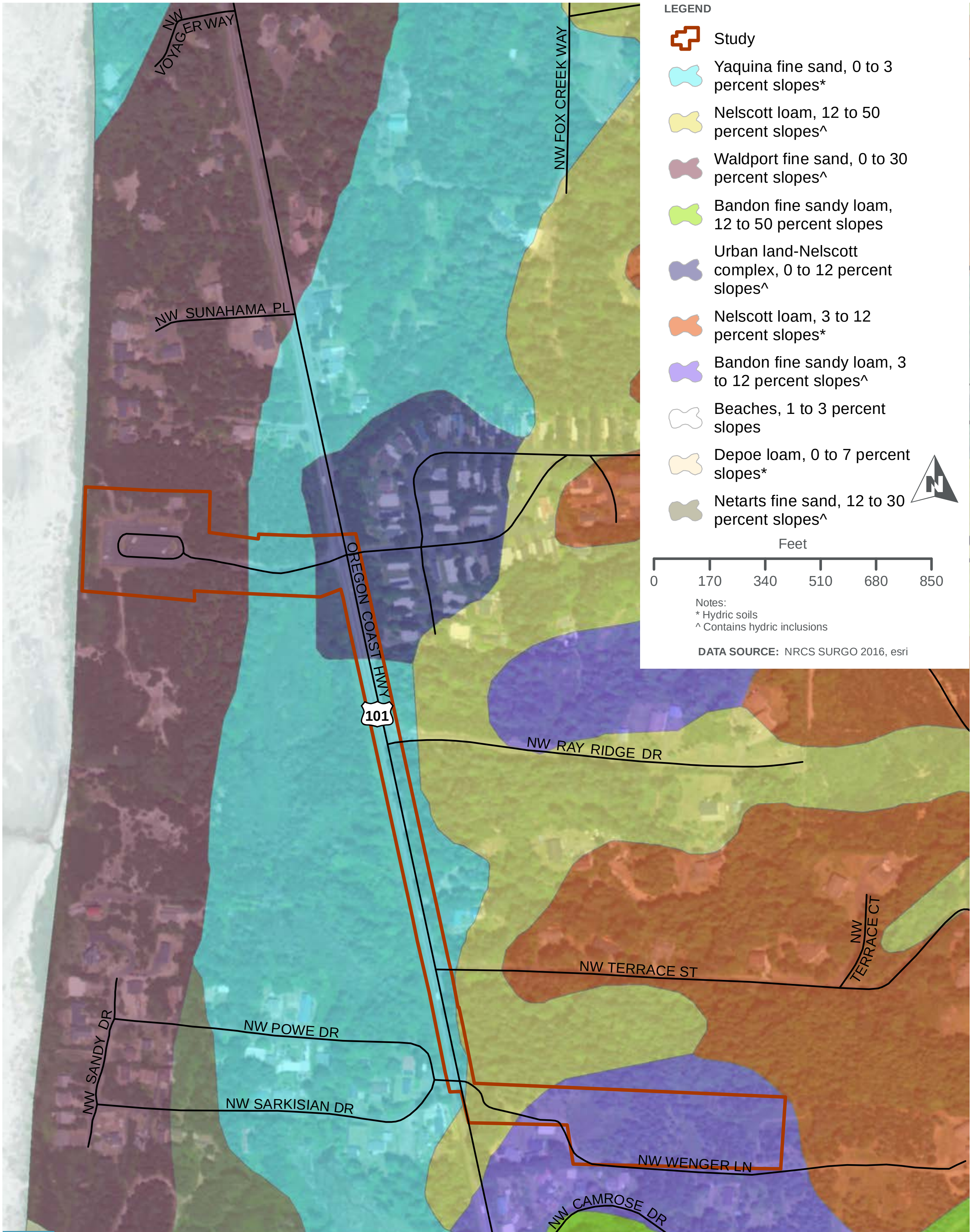
Study Area Location - Lincoln County, Oregon
Latitude:44.462, Longitude:-124.077
Public Land Survey System Location
NW 1/4 of T13S, R11W Section 7
SW 1/4 of T13S, R11W Section 6
SE 1/4 of T13S, R12W Section 1

PMEC-SETS
PACIFIC MARINE ENERGY CENTER SOUTH ENERGY TEST SITE
PROJECT VICINITY
FIGURE 1

PATH: X:\PROJECTS\OSU\282143_PMEC_SETS\MAP_DOCS\WETLAND_REPORT_2017\FIGURE_1_VICINITY.MXD - USER: LLSMITH - DATE: 11/29/2017

PMEC-SETS
PACIFIC MARINE ENERGY CENTER SOUTH ENERGY TEST SITE
TAXLOTS
FIGURE 2

PATH: X:\PROJECTS\OSU\282143_PMEC_SETS\MAP_DOCS\WETLAND_REPORT_2017\FIGURE_2_TAXLOTS.MXD - USER: LLSMITH - DATE: 11/29/2017



HDR

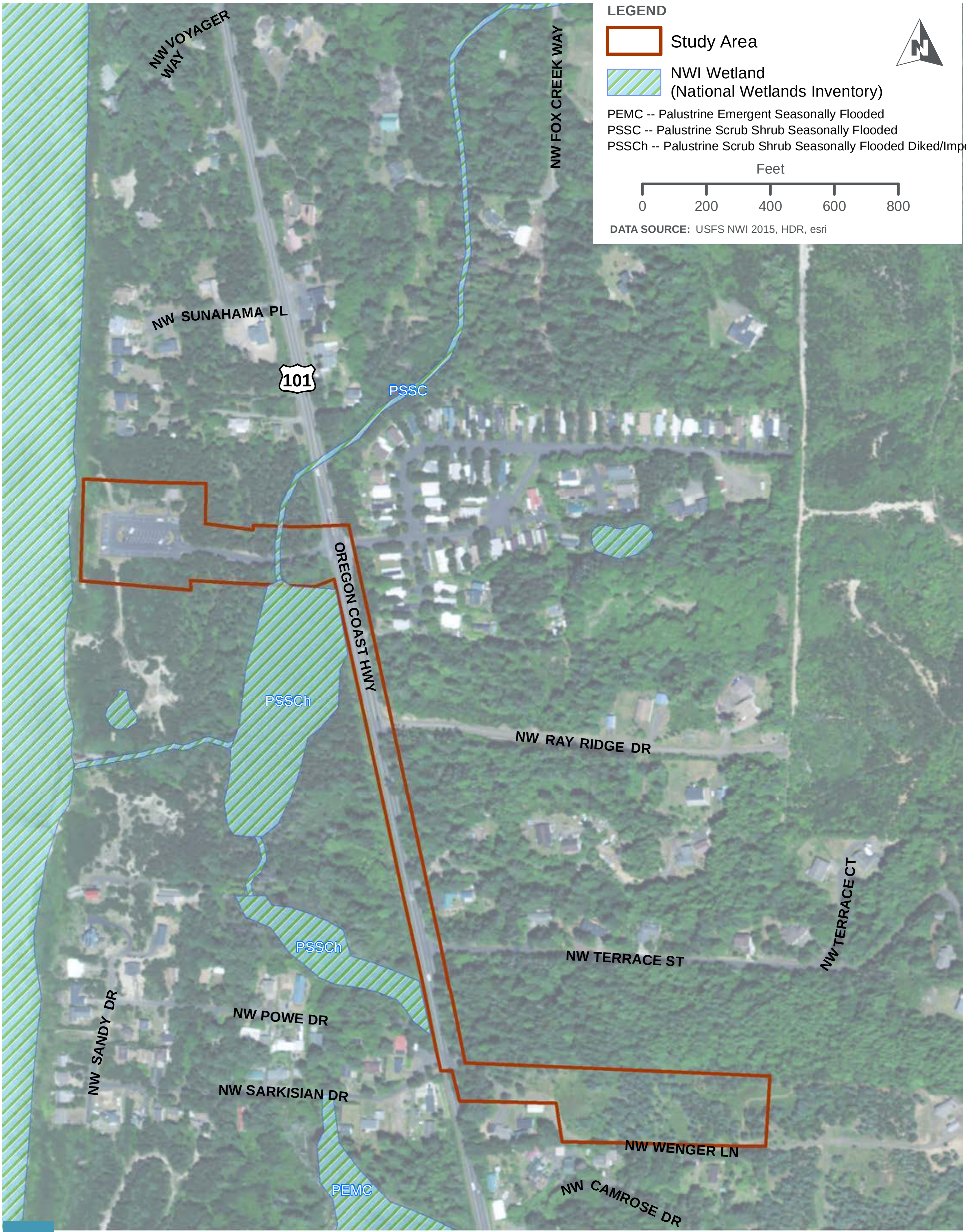
PMEC-SETS

PACIFIC MARINE ENERGY CENTER SOUTH ENERGY TEST SITE

NRCS SOILS

FIGURE 3

PATH: X:\PROJECTS\OSU\282143_PMEC_SETS\MAP_DOCS\WETLAND_REPORT_2017\FIGURE_3_NRCS_SOILS.MXD - USER: LLSMITH - DATE: 11/29/2017



HDR

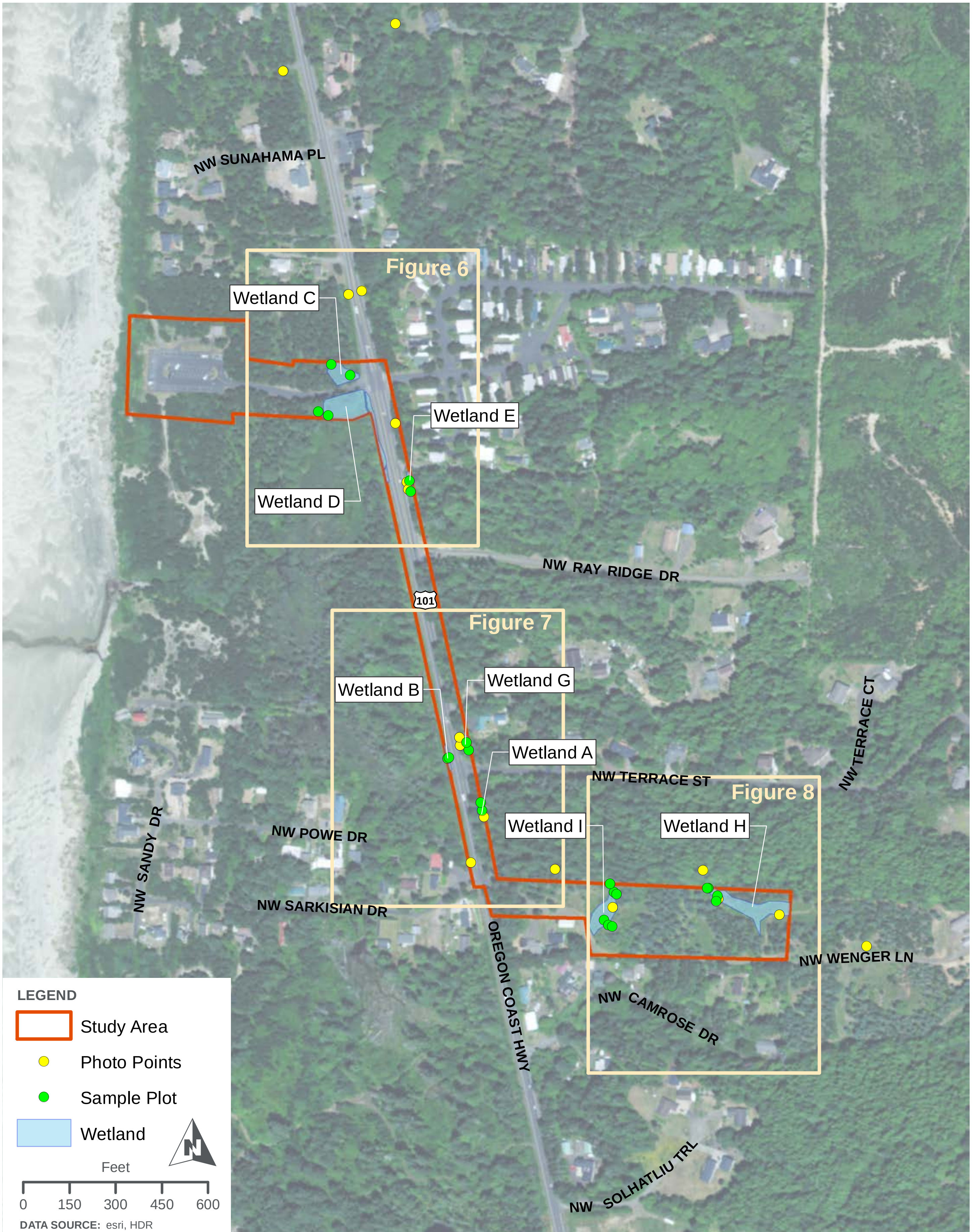
PMEC-SETS

PACIFIC MARINE ENERGY CENTER SOUTH ENERGY TEST SITE

NATIONAL AND LOCAL WETLANDS INVENTORY

FIGURE 4

PATH: X:\PROJECTS\OSU\282143_PMEC_SETS\MAP_DOCS\WETLAND_REPORT_2017\FIGURE_4_NWI.MXD - USER: LLSMITH - DATE: 11/29/2017



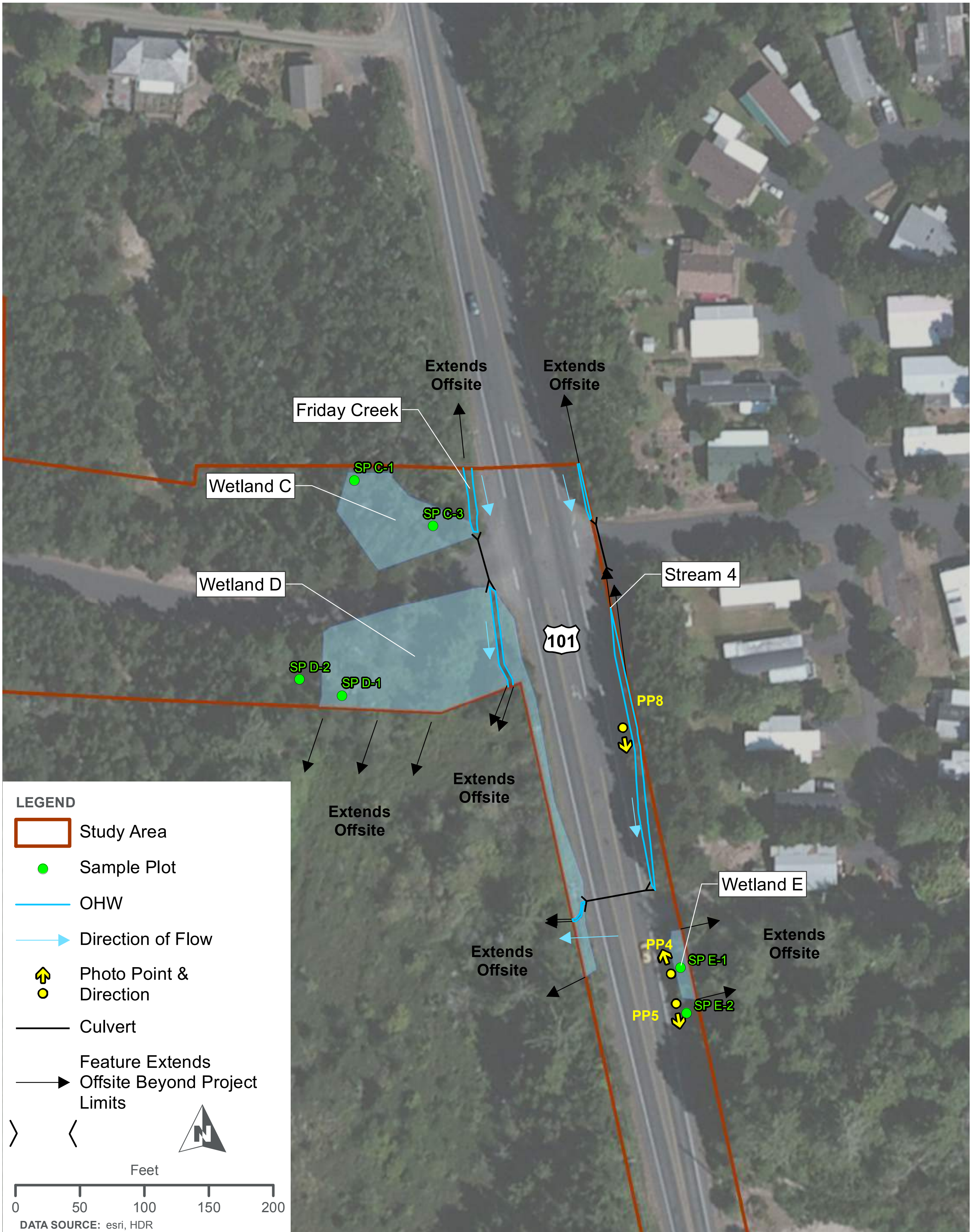
PMEC-SETS

PACIFIC MARINE ENERGY CENTER SOUTH ENERGY TEST SITE

WETLANDS AND WATERS

FIGURE 5

PATH: X:\PROJECTS\OSU\282143_PMEC_SETS\MAP_DOCS\WETLAND_REPORT_2017\FIGURE_5_WETLAND_INDEX.MXD - USER: LLSMITH - DATE: 11/29/2017



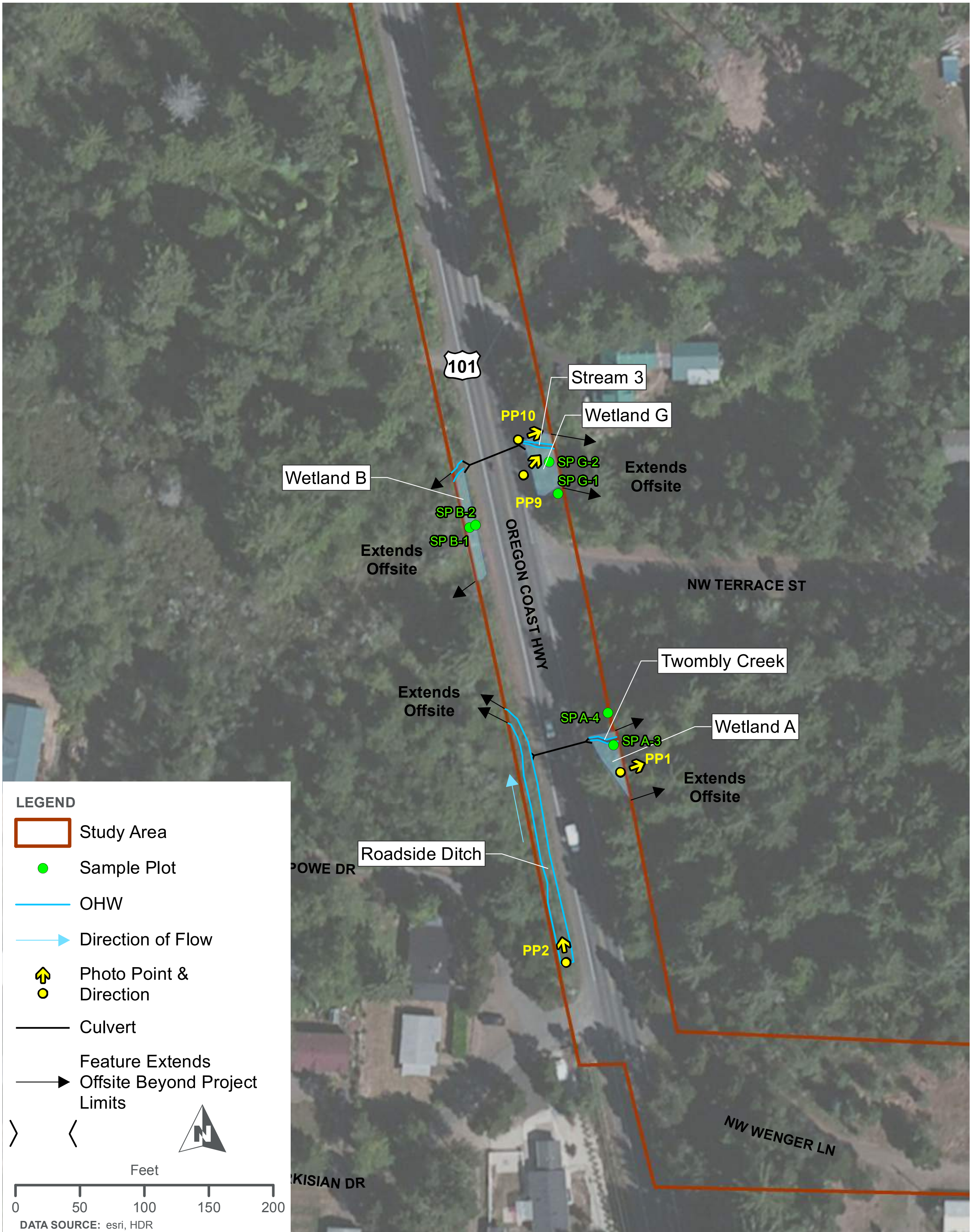
PMEC-SETS

PACIFIC MARINE ENERGY CENTER SOUTH ENERGY TEST SITE

WETLANDS AND WATERS

FIGURE 6

PATH: X:\PROJECTS\OSU\282143_PMEC_SETS\MAP_DOCS\WETLAND_REPORT_2017\FIGURE_6_8_WETLAND_SURVEY.MXD - USER: LLSMITH - DATE: 11/30/2017



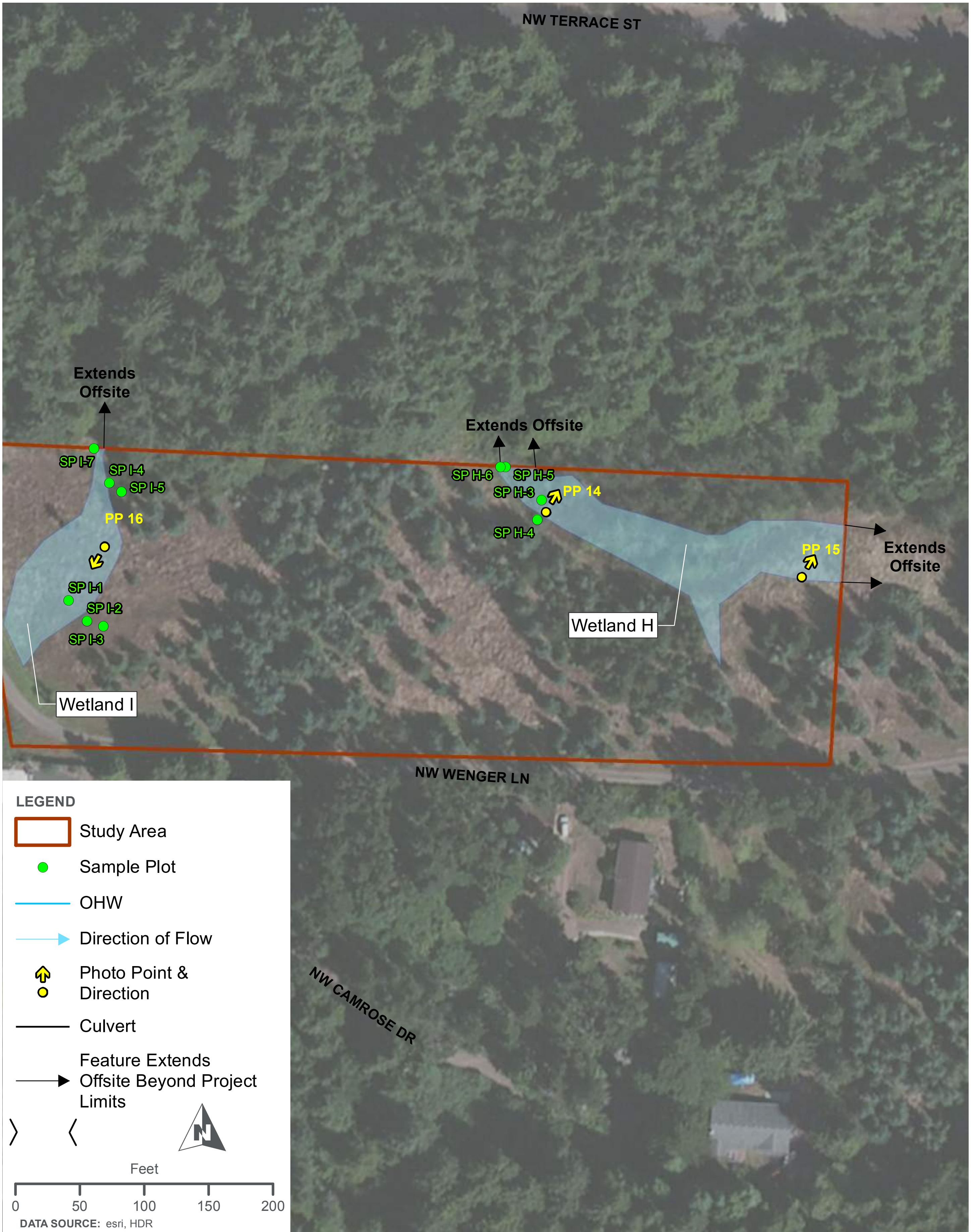
PMEC-SETS

PACIFIC MARINE ENERGY CENTER SOUTH ENERGY TEST SITE

WETLANDS AND WATERS

FIGURE 7

PATH: X:\PROJECTS\OSU\282143_PMEC_SETS\MAP_DOCS\WETLAND_REPORT_2017\FIGURE_6_8_WETLAND_SURVEY.MXD - USER: LLSMITH - DATE: 11/30/2017



PMEC-SETS

PACIFIC MARINE ENERGY CENTER SOUTH ENERGY TEST SITE

WETLANDS AND WATERS

FIGURE 8

Appendix B. Data Forms

Wetland Data Sheet Summary

Associated Wetland	Plot ID	Met Vegetation Criteria	Met Soils Criteria	Met Hydrology Criteria	Is Plot within a Wetland?
Wetland A	SP A – 3	Yes	Yes	Yes	Yes
Wetland A	SP A – 4	Yes	No	No	No
Wetland B	SP B – 1	Yes	Yes	Yes	Yes
Wetland B	SP B – 2	Yes	No	No	No
Wetland C	SP C – 1	Yes	Yes	Yes	Yes
Wetland C	SP C – 2	No	No	No	No
Wetland C	SP C – 3	Yes	Yes	Yes	Yes
Wetland D	SP D – 1	Yes	Yes	Yes	Yes
Wetland D	SP D – 2	Yes	No	No	No
Wetland E	SP E – 1	Yes	Yes	Yes	Yes
Wetland E	SP E – 2	No	No	No	No
Wetland H	SP H – 1	No	No	No	No
Wetland H	SP H – 2	Yes	Yes	Yes	Yes
Wetland H	SP H – 3	Yes	Yes	Yes	Yes
Wetland H	SP H – 4	No	No	No	No
Wetland H	SP H – 5	Yes	Yes	Yes	Yes
Wetland H	SP H – 6	No	No	No	No
Wetland H	SP I – 1	Yes	Yes	Yes	Yes
Wetland H	SP I – 2	Yes	No	No	No
Wetland H	SP I – 3	Yes	Yes	No	Yes
Wetland H	SP I – 4	No	No	No	No
Wetland H	SP I – 5	No	No	No	No
Wetland I	SP I – 6	Yes	Yes	Yes	Yes
Wetland I	SP I – 7	No	No	No	No

WETLAND DETERMINATION DATA FORM – Western Mountains, Valleys, and Coast Region

Project/Site: Pacific Marine Energy Center City/County: Lincoln County Sampling Date: 06/01/2016
Applicant/Owner: Oregon State University State: OR Sampling Point: SP A - 3
Investigator(s): Z. Halstead, B. Sahatjian Section, Township, Range: T13S R11W S7
Landform (hillslope, terrace, etc.): Swale Local relief (concave, convex, none): concave Slope (%): 2%
Subregion (LRR): A Lat: 44.46052 Long: -124.07625 Datum: NAD83
Soil Map Unit Name: Nelscott loam, 12 to 50% slopes NWI classification: PFO4B
Are climatic / hydrologic conditions on the site typical for this time of year? Yes ___ No X (If no, explain in Remarks.)
Are Vegetation N , Soil N , or Hydrology N significantly disturbed? Are "Normal Circumstances" present? Yes X No ___
Are Vegetation N , Soil N , or Hydrology N naturally problematic? (If needed, explain any answers in Remarks.)

SUMMARY OF FINDINGS – Attach site map showing sampling point locations, transects, important features, etc.

Hydrophytic Vegetation Present?	Yes X	No ___	Is the Sampled Area within a Wetland?	Yes X No ___
Hydric Soil Present?	Yes X	No ___		
Wetland Hydrology Present?	Yes X	No ___		

Remarks: Drier than normal antecedent precipitation.

VEGETATION – Use scientific names of plants.

Tree Stratum (Plot size: 20')	Absolute % Cover	Dominant Species?	Indicator Status
1. Picea sitchensis	35	Y	FAC
2. Tsuga heterophylla	10	Y	FACU
3.			
4.			
	45	= Total Cover	
Sapling/Shrub Stratum (Plot size: 10')			
1. Gaultheria shallon	10	Y	FACU
2. Rubus spectabilis	5	Y	FAC
3. Lonicera involucrata	5	Y	FAC
4.			
5.			
	20	= Total Cover	
Herb Stratum (Plot size: 10')			
1. Lysichiton americanus	10	Y	OBL
2. Equisetum arvense	5	Y	FAC
3. Blechnum spicant	2	N	FAC
4.			
5.			
6.			
7.			
8.			
9.			
10.			
11.			
	17	= Total Cover	
Woody Vine Stratum (Plot size: ___)			
1.			
2.			
		= Total Cover	
% Bare Ground in Herb Stratum ___			

Dominance Test worksheet:

Number of Dominant Species That Are OBL, FACW, or FAC: 5 (A)
Total Number of Dominant Species Across All Strata: 7 (B)
Percent of Dominant Species That Are OBL, FACW, or FAC: 71.4 (A/B)

Prevalence Index worksheet:

Total % Cover of:		Multiply by:	
OBL species		x 1 =	
FACW species		x 2 =	
FAC species		x 3 =	
FACU species		x 4 =	
UPL species		x 5 =	
Column Totals:	(A)		(B)

Prevalence Index = B/A = ___

Hydrophytic Vegetation Indicators:

- ___ 1 - Rapid Test for Hydrophytic Vegetation
- X 2 - Dominance Test is >50%
- ___ 3 - Prevalence Index is ≤3.0[1]
- ___ 4 - Morphological Adaptations[1] (Provide supporting data in Remarks or on a separate sheet)
- ___ 5 - Wetland Non-Vascular Plants[1]
- ___ Problematic Hydrophytic Vegetation[1] (Explain)

[1]Indicators of hydric soil and wetland hydrology must be present, unless disturbed or problematic.

Hydrophytic Vegetation Present? Yes X No ___

Remarks: Plot located in bottom of swale. Gaultheria shallon and Vaccinium ovatum growing on old downed logs not included in percent cover. Carex obnubpta located at culvert entrance near road.

SOIL

Sampling Point: SP A - 3

Profile Description: (Describe to the depth needed to document the indicator or confirm the absence of indicators.)

Depth (inches)	Matrix Color (moist)	Matrix %	Redox Features Color (moist)	Redox Features %	Type[1]	Loc[2]	Texture	Remarks
0 - 5	10YR 4/2	50					LOSA	
	10YR 4/3	50						
5 - 20	7.5YR 2.5/1	90	5YR3/4	10	C	M, RC	SILO	Mucky
								+aa

[1]Type: C=Concentration, D=Depletion, RM=Reduced Matrix, CS=Covered or Coated Sand Grains. [2]Location: PL=Pore Lining, M=Matrix.

Hydric Soil Indicators: (Applicable to all LRRs, unless otherwise noted.)

- ___ Histosol (A1)
- ___ Histic Epipedon (A2)
- ___ Black Histic (A3)
- X Hydrogen Sulfide (A4)
- ___ Depleted Below Dark Surface (A11)
- ___ Thick Dark Surface (A12)
- ___ Sandy Mucky Mineral (S1)
- ___ Sandy Gleyed Matrix (S4)
- ___ Sandy Redox (S5)
- ___ Stripped Matrix (S6)
- X Loamy Mucky Mineral (F1) (**except MLRA 1**)
- ___ Loamy Gleyed Matrix (F2)
- ___ Depleted Matrix (F3)
- ___ Redox Dark Surface (F6)
- ___ Depleted Dark Surface (F7)
- ___ Redox Depressions (F8)

Indicators for Problematic Hydric Soils[3]:

- ___ 2 cm Muck (A10)
- ___ Red Parent Material (TF2)
- ___ Very Shallow Dark Surface (TF12)
- ___ Other (Explain in Remarks)

[3]Indicators of hydrophytic vegetation and wetland hydrology must be present, unless disturbed or problematic

Restrictive Layer (if present):

Type: None

Depth (inches): ______

Hydric Soil Present? **Yes** X **No** ___

Remarks: Recent deposition from small stream located in bottom of swale.

HYDROLOGY

Wetland Hydrology Indicators:

Primary Indicators (minimum of one required; check all that apply)

- ___ Surface Water (A1)
- X High Water Table (A2)
- X Saturation (A3)
- ___ Water Marks (B1)
- X Sediment Deposits (B2)
- ___ Drift Deposits (B3)
- ___ Algal Mat or Crust (B4)
- ___ Iron Deposits (B5)
- ___ Surface Soil Cracks (B6)
- ___ Inundation Visible on Aerial Imagery (B7)
- ___ Sparsely Vegetated Concave Surface (B8)
- ___ Water-Stained Leaves (B9) (**except MLRA 1, 2, 4A, and 4B**)
- ___ Salt Crust (B11)
- ___ Aquatic Invertebrates (B13)
- X Hydrogen Sulfide Odor (C1)
- X Oxidized Rhizospheres along Living Roots (C3)
- X Presence of Reduced Iron (C4)
- ___ Recent Iron Reduction in Tilled Soils (C6)
- ___ Stunted or Stressed Plants (D1) (**LRR A**)
- ___ Other (Explain in Remarks)

Secondary Indicators (2 or more required)

- ___ Water-Stained Leaves (B9) (**MLRA 1, 2, 4A, and 4B**)
- X Drainage Patterns (B10)
- ___ Dry-Season Water Table (C2)
- ___ Saturation Visible on Aerial Imagery (C9)
- X Geomorphic Position (D2)
- ___ Shallow Aquitard (D3)
- ___ FAC-Neutral Test (D5)
- ___ Raised Ant Mounds (D6) (**LRR A**)
- ___ Frost-Heave Hummocks (D7)

Field Observations:

	Yes		No		Depth (inches):
Surface Water Present?	Yes		No	X	
Water Table Present?	Yes	X	No		10
Saturation Present? (includes capillary fringe)	Yes	X	No		7

Wetland Hydrology Present? **Yes** X **No** ___

Describe Recorded Data (stream gauge, monitoring well, aerial photos, previous inspections), if available:

Remarks:

WETLAND DETERMINATION DATA FORM – Western Mountains, Valleys, and Coast Region

Project/Site: Pacific Marine Energy Center City/County: Lincoln County Sampling Date: 06/01/2016
Applicant/Owner: Oregon State University State: OR Sampling Point: SP A - 4
Investigator(s): Z. Halstead, B. Sahatjian Section, Township, Range: T13S R11W S7
Landform (hillslope, terrace, etc.): Hillslope Local relief (concave, convex, none): convex Slope (%): 5%
Subregion (LRR): A Lat: 44.46059 Long: -124.07626 Datum: NAD83
Soil Map Unit Name: Nelscott loam, 12 to 50% slopes NWI classification: Upland
Are climatic / hydrologic conditions on the site typical for this time of year? Yes ___ No X (If no, explain in Remarks.)
Are Vegetation N , Soil N , or Hydrology N significantly disturbed? Are "Normal Circumstances" present? Yes X No ___
Are Vegetation N , Soil N , or Hydrology N naturally problematic? (If needed, explain any answers in Remarks.)

SUMMARY OF FINDINGS – Attach site map showing sampling point locations, transects, important features, etc.

Hydrophytic Vegetation Present?	Yes X No ___	Is the Sampled Area within a Wetland? Yes ___ No X
Hydric Soil Present?	Yes ___ No X	
Wetland Hydrology Present?	Yes ___ No X	

Remarks: Drier than normal antecedent precipitation.

VEGETATION – Use scientific names of plants.

Tree Stratum (Plot size: 20')	Absolute % Cover	Dominant Species?	Indicator Status
1. Picea sitchensis	10	Y	FAC
2. Frangula purshiana	10	Y	FAC
3. Alnus rubra	5	Y	FAC
4.			
	25	= Total Cover	
Sapling/Shrub Stratum (Plot size: 10')			
1. Gaultheria shallon	30	Y	FACU
2. Rubus spectabilis	15	Y	FAC
3. Rhododendron macrophyllum	5	N	FACU
4.			
5.			
	51	= Total Cover	
Herb Stratum (Plot size: 10')			
1.			
2.			
3.			
4.			
5.			
6.			
7.			
8.			
9.			
10.			
11.			
		= Total Cover	
Woody Vine Stratum (Plot size: 10')			
1. Rubus ursinus	1	N	FACU
2.			
	1	= Total Cover	
% Bare Ground in Herb Stratum ___			

Dominance Test worksheet:

Number of Dominant Species That Are OBL, FACW, or FAC: 4 (A)
Total Number of Dominant Species Across All Strata: 5 (B)
Percent of Dominant Species That Are OBL, FACW, or FAC: 80 (A/B)

Prevalence Index worksheet:

Total % Cover of:		Multiply by:	
OBL species		x 1 =	
FACW species		x 2 =	
FAC species		x 3 =	
FACU species		x 4 =	
UPL species		x 5 =	
Column Totals:	(A)		(B)

Prevalence Index = B/A = ___

Hydrophytic Vegetation Indicators:

- [ ] 1 - Rapid Test for Hydrophytic Vegetation
- [X] 2 - Dominance Test is >50%
- [ ] 3 - Prevalence Index is ≤3.0[1]
- [ ] 4 - Morphological Adaptations[1] (Provide supporting data in Remarks or on a separate sheet)
- [ ] 5 - Wetland Non-Vascular Plants[1]
- [ ] Problematic Hydrophytic Vegetation[1] (Explain)

[1]Indicators of hydric soil and wetland hydrology must be present, unless disturbed or problematic.

Hydrophytic Vegetation Present? Yes X No ___

Remarks: Rub. urs. included in shrub stratum for dominance test. Polystichum munitum located just outside of plot. Plot located approximately 5 feet higher in elevation than SP A – 3.

SOIL

Sampling Point: SP A - 4

Profile Description: (Describe to the depth needed to document the indicator or confirm the absence of indicators.)

Depth (inches)	Matrix Color (moist)	Matrix %	Redox Features Color (moist)	Redox %	Type[1]	Loc[2]	Texture	Remarks
0 - 3							Organic	Fibric
3 - 10	10YR 3/2	100					SILO	
10 - 14	10YR 4/3	95	7.5RY 4/4	5	C	M	SILO	
14 - 20	7.5YR 3/1	100					SILO	

[1]Type: C=Concentration, D=Depletion, RM=Reduced Matrix, CS=Covered or Coated Sand Grains. [2]Location: PL=Pore Lining, M=Matrix.

Hydric Soil Indicators: (Applicable to all LRRs, unless otherwise noted.)

___ Histosol (A1)
___ Histic Epipedon (A2)
___ Black Histic (A3)
___ Hydrogen Sulfide (A4)
___ Depleted Below Dark Surface (A11)
___ Thick Dark Surface (A12)
___ Sandy Mucky Mineral (S1)
___ Sandy Gleyed Matrix (S4)
___ Sandy Redox (S5)
___ Stripped Matrix (S6)
___ Loamy Mucky Mineral (F1) (**except MLRA 1**)
___ Loamy Gleyed Matrix (F2)
___ Depleted Matrix (F3)
___ Redox Dark Surface (F6)
___ Depleted Dark Surface (F7)
___ Redox Depressions (F8)

Indicators for Problematic Hydric Soils[3]:

___ 2 cm Muck (A10)
___ Red Parent Material (TF2)
___ Very Shallow Dark Surface (TF12)
___ Other (Explain in Remarks)

[3]Indicators of hydrophytic vegetation and wetland hydrology must be present, unless disturbed or problematic

Restrictive Layer (if present):

Type: None

Depth (inches):

Hydric Soil Present? **Yes** ___ **No** X

Remarks: No hydric soil indicators observed.

HYDROLOGY

Wetland Hydrology Indicators:

Primary Indicators (minimum of one required; check all that apply)

___ Surface Water (A1)
___ High Water Table (A2)
___ Saturation (A3)
___ Water Marks (B1)
___ Sediment Deposits (B2)
___ Drift Deposits (B3)
___ Algal Mat or Crust (B4)
___ Iron Deposits (B5)
___ Surface Soil Cracks (B6)
___ Inundation Visible on Aerial Imagery (B7)
___ Sparsely Vegetated Concave Surface (B8)
___ Water-Stained Leaves (B9) (**except MLRA 1, 2, 4A, and 4B**)
___ Salt Crust (B11)
___ Aquatic Invertebrates (B13)
___ Hydrogen Sulfide Odor (C1)
___ Oxidized Rhizospheres along Living Roots (C3)
___ Presence of Reduced Iron (C4)
___ Recent Iron Reduction in Tilled Soils (C6)
___ Stunted or Stressed Plants (D1) (**LRR A**)
___ Other (Explain in Remarks)

Secondary Indicators (2 or more required)

___ Water-Stained Leaves (B9) (**MLRA 1, 2, 4A, and 4B**)
___ Drainage Patterns (B10)
___ Dry-Season Water Table (C2)
___ Saturation Visible on Aerial Imagery (C9)
___ Geomorphic Position (D2)
___ Shallow Aquitard (D3)
___ FAC-Neutral Test (D5)
___ Raised Ant Mounds (D6) (**LRR A**)
___ Frost-Heave Hummocks (D7)

Field Observations:

	Yes		No		Depth (inches):
Surface Water Present?	Yes		No	X	
Water Table Present?	Yes		No	X	
Saturation Present? (includes capillary fringe)	Yes		No	X	

Wetland Hydrology Present? **Yes** ___ **No** X

Describe Recorded Data (stream gauge, monitoring well, aerial photos, previous inspections), if available:

Remarks: Soil profile dry throughout. No hydrology indicators observed.

WETLAND DETERMINATION DATA FORM – Western Mountains, Valleys, and Coast Region

Project/Site: Pacific Marine Energy Center City/County: Lincoln County Sampling Date: 06/01/2016
Applicant/Owner: Oregon State University State: OR Sampling Point: SP B-1
Investigator(s): Z. Halstead, B. Sahatjian Section, Township, Range: T13S R11W S7
Landform (hillslope, terrace, etc.): Marine Terrace Local relief (concave, convex, none): concave Slope (%): 1%
Subregion (LRR): A Lat: 44.46097 N Long: -124.07670 W Datum: NAD83
Soil Map Unit Name: Yaquina fine sand, 0 – 3% slopes NWI classification: PSS1B
Are climatic / hydrologic conditions on the site typical for this time of year? Yes ___ No X (If no, explain in Remarks.)
Are Vegetation N , Soil N , or Hydrology N significantly disturbed? Are "Normal Circumstances" present? Yes X No ___
Are Vegetation N , Soil N , or Hydrology N naturally problematic? (If needed, explain any answers in Remarks.)

SUMMARY OF FINDINGS – Attach site map showing sampling point locations, transects, important features, etc.

Hydrophytic Vegetation Present?	Yes X No ___	**Is the Sampled Area within a Wetland? Yes X No ___**
Hydric Soil Present?	Yes X No ___	
Wetland Hydrology Present?	Yes X No ___	

Remarks: Drier than normal antecedent precipitation.

VEGETATION – Use scientific names of plants.

Tree Stratum (Plot size: ___)	Absolute % Cover	Dominant Species?	Indicator Status
1.			
2.			
3.			
4.			
		= Total Cover	
Sapling/Shrub Stratum (Plot size: 5)			
1. Spiraea douglasii	35	Y	FACW
2. Rubus spectabilis	5	N	FAC
3. Gaultheria shallon	10	N	FACU
4. Salix sitchensis	10	N	FACW
5. Physocarpus capitatus	5	N	FACW
	65	= Total Cover	
Herb Stratum (Plot size: 5)			
1. Carex obnubpta	25	Y	OBL
2. Athyrium cyclosorum	10	Y	FAC
3. Equisetum telmateia	5	N	FACW
4. Vicia americana	5	N	FAC
5.			
6.			
7.			
8.			
9.			
10.			
11.			
	45	= Total Cover	
Woody Vine Stratum (Plot size: ___)			
1.			
2.			
		= Total Cover	

% Bare Ground in Herb Stratum ___

Dominance Test worksheet:

Number of Dominant Species That Are OBL, FACW, or FAC: 3 (A)
Total Number of Dominant Species Across All Strata: 3 (B)
Percent of Dominant Species That Are OBL, FACW, or FAC: 100 (A/B)

Prevalence Index worksheet:

Total % Cover of:		Multiply by:	
OBL species		x 1 =	
FACW species		x 2 =	
FAC species		x 3 =	
FACU species		x 4 =	
UPL species		x 5 =	
Column Totals:		(A)	(B)

Prevalence Index = B/A = ___

Hydrophytic Vegetation Indicators:

- [ ] 1 - Rapid Test for Hydrophytic Vegetation
- [X] 2 - Dominance Test is >50%
- [ ] 3 - Prevalence Index is ≤3.0[1]
- [ ] 4 - Morphological Adaptations[1] (Provide supporting data in Remarks or on a separate sheet)
- [ ] 5 - Wetland Non-Vascular Plants[1]
- [ ] Problematic Hydrophytic Vegetation[1] (Explain)

[1]Indicators of hydric soil and wetland hydrology must be present, unless disturbed or problematic.

Hydrophytic Vegetation Present? Yes X No ___

Remarks: Plot located very close to wetland boundary marked by toe of slope of the Highway 101 road prism. Plot size for vegetation cover is a 5' half circle extending to west.

SOIL

Sampling Point: SP B-1

Profile Description: (Describe to the depth needed to document the indicator or confirm the absence of indicators.)

Depth (inches)	Matrix Color (moist)	Matrix %	Redox Features Color (moist)	Redox Features %	Type[1]	Loc[2]	Texture	Remarks
0 - 6							Organic	Fibric
6 - 20	2.5Y 3/2	90	7.5YR 3/4	10	C	M, RC	SiLo, Mucky Mineral	+aa

[1]Type: C=Concentration, D=Depletion, RM=Reduced Matrix, CS=Covered or Coated Sand Grains. [2]Location: PL=Pore Lining, M=Matrix.

Hydric Soil Indicators: (Applicable to all LRRs, unless otherwise noted.)

___ Histosol (A1)
___ Histic Epipedon (A2)
___ Black Histic (A3)
___ Hydrogen Sulfide (A4)
___ Depleted Below Dark Surface (A11)
___ Thick Dark Surface (A12)
___ Sandy Mucky Mineral (S1)
___ Sandy Gleyed Matrix (S4)
___ Sandy Redox (S5)
___ Stripped Matrix (S6)
X Loamy Mucky Mineral (F1) (**except MLRA 1**)
___ Loamy Gleyed Matrix (F2)
___ Depleted Matrix (F3)
___ Redox Dark Surface (F6)
___ Depleted Dark Surface (F7)
___ Redox Depressions (F8)

Indicators for Problematic Hydric Soils[3]:

___ 2 cm Muck (A10)
___ Red Parent Material (TF2)
___ Very Shallow Dark Surface (TF12)
___ Other (Explain in Remarks)

[3]Indicators of hydrophytic vegetation and wetland hydrology must be present, unless disturbed or problematic

Restrictive Layer (if present):
Type: None
Depth (inches):

Hydric Soil Present? **Yes** X **No**

Remarks:

HYDROLOGY

Wetland Hydrology Indicators:

Primary Indicators (minimum of one required; check all that apply)

___ Surface Water (A1)
X High Water Table (A2)
X Saturation (A3)
___ Water Marks (B1)
___ Sediment Deposits (B2)
___ Drift Deposits (B3)
___ Algal Mat or Crust (B4)
___ Iron Deposits (B5)
___ Surface Soil Cracks (B6)
___ Inundation Visible on Aerial Imagery (B7)
___ Sparsely Vegetated Concave Surface (B8)
___ Water-Stained Leaves (B9) (**except MLRA 1, 2, 4A, and 4B**)
___ Salt Crust (B11)
___ Aquatic Invertebrates (B13)
___ Hydrogen Sulfide Odor (C1)
X Oxidized Rhizospheres along Living Roots (C3)
X Presence of Reduced Iron (C4)
___ Recent Iron Reduction in Tilled Soils (C6)
___ Stunted or Stressed Plants (D1) (**LRR A**)
___ Other (Explain in Remarks)

Secondary Indicators (2 or more required)

___ Water-Stained Leaves (B9) (**MLRA 1, 2, 4A, and 4B**)
___ Drainage Patterns (B10)
___ Dry-Season Water Table (C2)
___ Saturation Visible on Aerial Imagery (C9)
X Geomorphic Position (D2)
___ Shallow Aquitard (D3)
X FAC-Neutral Test (D5)
___ Raised Ant Mounds (D6) (**LRR A**)
___ Frost-Heave Hummocks (D7)

Field Observations:

Surface Water Present?	Yes		No	X	Depth (inches):
Water Table Present?	Yes	X	No		Depth (inches): Weeping @11
Saturation Present? (includes capillary fringe)	Yes	X	No		Depth (inches): 8

Wetland Hydrology Present? **Yes** X **No**

Describe Recorded Data (stream gauge, monitoring well, aerial photos, previous inspections), if available:

Remarks:

WETLAND DETERMINATION DATA FORM – Western Mountains, Valleys, and Coast Region

Project/Site: Pacific Marine Energy Center City/County: Lincoln County Sampling Date: 06/01/2016
Applicant/Owner: Oregon State University State: OR Sampling Point: SP B-2
Investigator(s): Z. Halstead, B. Sahatjian Section, Township, Range: T13S R11W S7
Landform (hillslope, terrace, etc.): Marine Terrace Local relief (concave, convex, none): convex Slope (%): 5%
Subregion (LRR): A Lat: 44.46098 N Long: -124.07669 W Datum: NAD83
Soil Map Unit Name: Yaquina fine sand, 0 – 3% slopes NWI classification: Upland
Are climatic / hydrologic conditions on the site typical for this time of year? Yes ___ No X (If no, explain in Remarks.)
Are Vegetation N , Soil N , or Hydrology N significantly disturbed? Are "Normal Circumstances" present? Yes X No ___
Are Vegetation N , Soil N , or Hydrology N naturally problematic? (If needed, explain any answers in Remarks.)

SUMMARY OF FINDINGS – Attach site map showing sampling point locations, transects, important features, etc.

Hydrophytic Vegetation Present?	Yes X No ___	Is the Sampled Area within a Wetland? Yes ___ No X
Hydric Soil Present?	Yes ___ No X	
Wetland Hydrology Present?	Yes ___ No X	

Remarks: Drier than normal antecedent precipitation.

VEGETATION – Use scientific names of plants.

Tree Stratum (Plot size:)	Absolute % Cover	Dominant Species?	Indicator Status
1.			
2.			
3.			
4.			
= Total Cover			
Sapling/Shrub Stratum (Plot size:)			
1. Lonicera involucrata	5	Y	FAC
2. Spiraea douglasii	5	Y	FACW
3. Gaultheria shallon	2	N	FACU
4. Salix sitchensis	5	Y	FACW
5.			
= Total Cover	17		
Herb Stratum (Plot size:)			
1. Polystichum munitum	5	N	FACU
2. Equisetum arvense	7	N	FAC
3. Vicia americana	3	N	FAC
4. Athyrium cyclosorum	3	N	FAC
5. Carex obnupta	10	Y	OBL
6. Taraxacum officinale	2	N	FACU
7. Anthoxanthum odoratum	25	Y	FACU
8. Holcus lanatus	10	Y	FAC
9.			
10.			
11.			
= Total Cover	67		
Woody Vine Stratum (Plot size:)			
1. Rubus armeniacus	2	N	FAC
2.			
= Total Cover	2		

% Bare Ground in Herb Stratum ______

Dominance Test worksheet:

Number of Dominant Species That Are OBL, FACW, or FAC: 5 (A)
Total Number of Dominant Species Across All Strata: 6 (B)
Percent of Dominant Species That Are OBL, FACW, or FAC: 83.3 (A/B)

Prevalence Index worksheet:

Total % Cover of:		Multiply by:
OBL species		x 1 =
FACW species		x 2 =
FAC species		x 3 =
FACU species		x 4 =
UPL species		x 5 =
Column Totals:	(A)	(B)

Prevalence Index = B/A =

Hydrophytic Vegetation Indicators:

- [ ] 1 - Rapid Test for Hydrophytic Vegetation
- [X] 2 - Dominance Test is >50%
- [ ] 3 - Prevalence Index is ≤3.0[1]
- [ ] 4 - Morphological Adaptations[1] (Provide supporting data in Remarks or on a separate sheet)
- [ ] 5 - Wetland Non-Vascular Plants[1]
- [ ] Problematic Hydrophytic Vegetation[1] (Explain)

[1]Indicators of hydric soil and wetland hydrology must be present, unless disturbed or problematic.

Hydrophytic Vegetation Present? Yes X No ___

Remarks: Mowed road prism. Linear plot 5'X10' for vegetation. Rub. arm. Included in herb stratum for dominance test.

SOIL

Sampling Point: SP B-2

Profile Description: (Describe to the depth needed to document the indicator or confirm the absence of indicators.)

Depth (inches)	Matrix Color (moist)	Matrix %	Redox Features Color (moist)	Redox %	Type[1]	Loc[2]	Texture	Remarks
0 - 7	10YR 3/2	100					GRSALO	Fill
7 - 20	10YR3/2	98	10YR 5/6	1	C	PL	SALO	Fill
			10YR 3/6	1	C	PL	SALO	Fill

[1]Type: C=Concentration, D=Depletion, RM=Reduced Matrix, CS=Covered or Coated Sand Grains. [2]Location: PL=Pore Lining, M=Matrix.

Hydric Soil Indicators: (Applicable to all LRRs, unless otherwise noted.)

___ Histosol (A1)
___ Histic Epipedon (A2)
___ Black Histic (A3)
___ Hydrogen Sulfide (A4)
___ Depleted Below Dark Surface (A11)
___ Thick Dark Surface (A12)
___ Sandy Mucky Mineral (S1)
___ Sandy Gleyed Matrix (S4)
___ Sandy Redox (S5)
___ Stripped Matrix (S6)
___ Loamy Mucky Mineral (F1) (**except MLRA 1**)
___ Loamy Gleyed Matrix (F2)
___ Depleted Matrix (F3)
___ Redox Dark Surface (F6)
___ Depleted Dark Surface (F7)
___ Redox Depressions (F8)

Indicators for Problematic Hydric Soils[3]:

___ 2 cm Muck (A10)
___ Red Parent Material (TF2)
___ Very Shallow Dark Surface (TF12)
___ Other (Explain in Remarks)

[3]Indicators of hydrophytic vegetation and wetland hydrology must be present, unless disturbed or problematic

Restrictive Layer (if present):
Type: None
Depth (inches): ___

Hydric Soil Present? **Yes** ___ **No** X

Remarks: Well drained road prism fill.

HYDROLOGY

Wetland Hydrology Indicators:

Primary Indicators (minimum of one required; check all that apply)

___ Surface Water (A1)
___ High Water Table (A2)
___ Saturation (A3)
___ Water Marks (B1)
___ Sediment Deposits (B2)
___ Drift Deposits (B3)
___ Algal Mat or Crust (B4)
___ Iron Deposits (B5)
___ Surface Soil Cracks (B6)
___ Inundation Visible on Aerial Imagery (B7)
___ Sparsely Vegetated Concave Surface (B8)
___ Water-Stained Leaves (B9) (**except MLRA 1, 2, 4A, and 4B**)
___ Salt Crust (B11)
___ Aquatic Invertebrates (B13)
___ Hydrogen Sulfide Odor (C1)
___ Oxidized Rhizospheres along Living Roots (C3)
___ Presence of Reduced Iron (C4)
___ Recent Iron Reduction in Tilled Soils (C6)
___ Stunted or Stressed Plants (D1) (**LRR A**)
___ Other (Explain in Remarks)

Secondary Indicators (2 or more required)

___ Water-Stained Leaves (B9) (**MLRA 1, 2, 4A, and 4B**)
___ Drainage Patterns (B10)
___ Dry-Season Water Table (C2)
___ Saturation Visible on Aerial Imagery (C9)
___ Geomorphic Position (D2)
___ Shallow Aquitard (D3)
X FAC-Neutral Test (D5)
___ Raised Ant Mounds (D6) (**LRR A**)
___ Frost-Heave Hummocks (D7)

Field Observations:

Surface Water Present?	Yes	No	Depth (inches):		
Water Table Present?	Yes	No	Depth (inches):		
Saturation Present? (includes capillary fringe)	Yes	No	Depth (inches):		

Wetland Hydrology Present? **Yes** ___ **No** X

Describe Recorded Data (stream gauge, monitoring well, aerial photos, previous inspections), if available:

Remarks: Profile dry throughout.

WETLAND DETERMINATION DATA FORM – Western Mountains, Valleys, and Coast Region

Project/Site: Pacific Marine Energy Center City/County: Lincoln County Sampling Date: 06/02/2016
Applicant/Owner: Oregon State University State: OR Sampling Point: SP C - 1
Investigator(s): Z. Halstead, B. Sahatjian Section, Township, Range: T13S R12W S1
Landform (hillslope, terrace, etc.): Marine Terrace Local relief (concave, convex, none): concave Slope (%): 1%
Subregion (LRR): A Lat: 44.46443 Long: -124.07836 Datum: NAD83
Soil Map Unit Name: Yaquina fine sand, 0 – 3% slopes NWI classification: PFO4/EM1B
Are climatic / hydrologic conditions on the site typical for this time of year? Yes ___ No X (If no, explain in Remarks.)
Are Vegetation N , Soil N , or Hydrology N significantly disturbed? Are "Normal Circumstances" present? Yes Y No ___
Are Vegetation N , Soil N , or Hydrology N naturally problematic? (If needed, explain any answers in Remarks.)

SUMMARY OF FINDINGS – Attach site map showing sampling point locations, transects, important features, etc.

Hydrophytic Vegetation Present?	Yes X No ___	**Is the Sampled Area within a Wetland?** **Yes** X **No** ___
Hydric Soil Present?	Yes X No ___	
Wetland Hydrology Present?	Yes X No ___	

Remarks: Drier than normal antecedent precipitation.

VEGETATION – Use scientific names of plants.

	Absolute % Cover	Dominant Species?	Indicator Status
Tree Stratum (Plot size: 20')			
1. Pinus contorta	40	Y	FAC
2.			
3.			
4.			
	40	= Total Cover	
Sapling/Shrub Stratum (Plot size: 10')			
1. Gaultheria shallon	10	Y	FAC
2. Lonicera involucrata	5	Y	FAC
3.			
4.			
5.			
	15	= Total Cover	
Herb Stratum (Plot size: 10')			
1. Carex obnupta	70	Y	OBL
2. Athyrium cyclosorum	5	N	FAC
3.			
4.			
5.			
6.			
7.			
8.			
9.			
10.			
11.			
	75	= Total Cover	
Woody Vine Stratum (Plot size: ___)			
1.			
2.			
		= Total Cover	
% Bare Ground in Herb Stratum ___			

Dominance Test worksheet:

Number of Dominant Species That Are OBL, FACW, or FAC: 4 (A)
Total Number of Dominant Species Across All Strata: 4 (B)
Percent of Dominant Species That Are OBL, FACW, or FAC: 100 (A/B)

Prevalence Index worksheet:

Total % Cover of:		Multiply by:
OBL species		x 1 =
FACW species		x 2 =
FAC species		x 3 =
FACU species		x 4 =
UPL species		x 5 =
Column Totals:	(A)	(B)

Prevalence Index = B/A = ___

Hydrophytic Vegetation Indicators:

- [ ] 1 - Rapid Test for Hydrophytic Vegetation
- [X] 2 - Dominance Test is >50%
- [ ] 3 - Prevalence Index is ≤3.0[1]
- [ ] 4 - Morphological Adaptations[1] (Provide supporting data in Remarks or on a separate sheet)
- [ ] 5 - Wetland Non-Vascular Plants[1]
- [ ] Problematic Hydrophytic Vegetation[1] (Explain)

[1]Indicators of hydric soil and wetland hydrology must be present, unless disturbed or problematic.

Hydrophytic Vegetation Present? **Yes** X **No** ___

Remarks:

SOIL

Sampling Point: SP C - 1

Profile Description: (Describe to the depth needed to document the indicator or confirm the absence of indicators.)

Depth (inches)	Matrix Color (moist)	Matrix %	Redox Features Color (moist)	Redox %	Type[1]	Loc[2]	Texture	Remarks
0 – 2							Organic	Fibric
2 - 5							Organic	Sapric
5 - 17	2.5Y 4/2	80	7.5YR 3/4	20	C	M, RC	LOSA	
17 - 20	2.5Y 4/1	93	7.5YR 3/3	5	C	M	LOSA	
			10YR 4/4	2	C	M	LOSA	

[1]Type: C=Concentration, D=Depletion, RM=Reduced Matrix, CS=Covered or Coated Sand Grains. [2]Location: PL=Pore Lining, M=Matrix.

Hydric Soil Indicators: (Applicable to all LRRs, unless otherwise noted.)

- ___ Histosol (A1)
- ___ Histic Epipedon (A2)
- ___ Black Histic (A3)
- ___ Hydrogen Sulfide (A4)
- ___ Depleted Below Dark Surface (A11)
- ___ Thick Dark Surface (A12)
- X Sandy Mucky Mineral (S1)
- ___ Sandy Gleyed Matrix (S4)
- X Sandy Redox (S5)
- ___ Stripped Matrix (S6)
- ___ Loamy Mucky Mineral (F1) (**except MLRA 1**)
- ___ Loamy Gleyed Matrix (F2)
- ___ Depleted Matrix (F3)
- ___ Redox Dark Surface (F6)
- ___ Depleted Dark Surface (F7)
- ___ Redox Depressions (F8)

Indicators for Problematic Hydric Soils[3]:

- ___ 2 cm Muck (A10)
- ___ Red Parent Material (TF2)
- ___ Very Shallow Dark Surface (TF12)
- ___ Other (Explain in Remarks)

[3]Indicators of hydrophytic vegetation and wetland hydrology must be present, unless disturbed or problematic

Restrictive Layer (if present):
Type: None
Depth (inches):

Hydric Soil Present? **Yes** X **No** ___

Remarks:

HYDROLOGY

Wetland Hydrology Indicators:

Primary Indicators (minimum of one required; check all that apply)

- ___ Surface Water (A1)
- ___ High Water Table (A2)
- ___ Saturation (A3)
- ___ Water Marks (B1)
- ___ Sediment Deposits (B2)
- ___ Drift Deposits (B3)
- ___ Algal Mat or Crust (B4)
- ___ Iron Deposits (B5)
- ___ Surface Soil Cracks (B6)
- ___ Inundation Visible on Aerial Imagery (B7)
- ___ Sparsely Vegetated Concave Surface (B8)
- ___ Water-Stained Leaves (B9) (**except MLRA 1, 2, 4A, and 4B**)
- ___ Salt Crust (B11)
- ___ Aquatic Invertebrates (B13)
- ___ Hydrogen Sulfide Odor (C1)
- X Oxidized Rhizospheres along Living Roots (C3)
- ___ Presence of Reduced Iron (C4)
- ___ Recent Iron Reduction in Tilled Soils (C6)
- ___ Stunted or Stressed Plants (D1) (**LRR A**)
- ___ Other (Explain in Remarks)

Secondary Indicators (2 or more required)

- ___ Water-Stained Leaves (B9) (**MLRA 1, 2, 4A, and 4B**)
- ___ Drainage Patterns (B10)
- ___ Dry-Season Water Table (C2)
- ___ Saturation Visible on Aerial Imagery (C9)
- X Geomorphic Position (D2)
- ___ Shallow Aquitard (D3)
- X FAC-Neutral Test (D5)
- ___ Raised Ant Mounds (D6) (**LRR A**)
- ___ Frost-Heave Hummocks (D7)

Field Observations:

	Yes		No		Depth (inches)
Surface Water Present?	Yes		No	X	
Water Table Present?	Yes		No	X	
Saturation Present? (includes capillary fringe)	Yes	X	No		20

Wetland Hydrology Present? **Yes** X **No** ___

Describe Recorded Data (stream gauge, monitoring well, aerial photos, previous inspections), if available:

Remarks: Plot located in depressional area on marine terrace. Saturation within upper 12 inches of the soil profile likely present during wet season. Distinct topo break approx. 1 – 2 feet between SP C-1 and SP C-2. Southern boundary of wetland marked by paved entryway into State park.

WETLAND DETERMINATION DATA FORM – Western Mountains, Valleys, and Coast Region

Project/Site: Pacific Marine Energy Center City/County: Lincoln County Sampling Date: 06/02/2016
Applicant/Owner: Oregon State University State: OR Sampling Point: SP C - 2
Investigator(s): Z. Halstead, B. Sahatjian Section, Township, Range: T13S R12W S1
Landform (hillslope, terrace, etc.): Marine Terrace Local relief (concave, convex, none): none Slope (%): 1%
Subregion (LRR): A Lat: 44.46446 Long: -124.07844 Datum: NAD83
Soil Map Unit Name: Yaquina fine sand, 0 – 3% slopes NWI classification: Upland
Are climatic / hydrologic conditions on the site typical for this time of year? Yes ___ No X (If no, explain in Remarks.)
Are Vegetation N , Soil N , or Hydrology N significantly disturbed? Are "Normal Circumstances" present? Yes N No ___
Are Vegetation N , Soil N , or Hydrology N naturally problematic? (If needed, explain any answers in Remarks.)

SUMMARY OF FINDINGS – Attach site map showing sampling point locations, transects, important features, etc.

Hydrophytic Vegetation Present? Yes ___ No X	Is the Sampled Area within a Wetland?	Yes ___ No X
Hydric Soil Present? Yes ___ No X		
Wetland Hydrology Present? Yes ___ No X		

Remarks: Drier than normal antecedent precipitation.

VEGETATION – Use scientific names of plants.

Tree Stratum (Plot size: 30')	Absolute % Cover	Dominant Species?	Indicator Status
1. Pinus contorta	10	Y	FAC
2.			
3.			
4.			
	10	= Total Cover	
Sapling/Shrub Stratum (Plot size: 10')			
1. Gaultheria shallon	50	Y	FACU
2. Salix sitchensis	2	N	FACW
3. Vaccinium ovatum	2	N	FACU
4. Lonicera involucrata	2	N	FAC
5.			
	56	= Total Cover	
Herb Stratum (Plot size: 10')			
1. Pteridium aquilinum	80	Y	FACU
2. Carex obnupta	5	N	OBL
3.			
4.			
5.			
6.			
7.			
8.			
9.			
10.			
11.			
	87	= Total Cover	
Woody Vine Stratum (Plot size: 10')			
1. Rubus armeniacus	2	N	FAC
2.			
	2	= Total Cover	

% Bare Ground in Herb Stratum ______

Dominance Test worksheet:

Number of Dominant Species That Are OBL, FACW, or FAC: 1 (A)
Total Number of Dominant Species Across All Strata: 3 (B)
Percent of Dominant Species That Are OBL, FACW, or FAC: 33.3 (A/B)

Prevalence Index worksheet:

Total % Cover of:		Multiply by:	
OBL species	5	x 1 =	5
FACW species	2	x 2 =	4
FAC species	14	x 3 =	42
FACU species	132	x 4 =	528
UPL species		x 5 =	
Column Totals:	153 (A)		579 (B)

Prevalence Index = B/A = 3.78

Hydrophytic Vegetation Indicators:

- ___ 1 - Rapid Test for Hydrophytic Vegetation
- ___ 2 - Dominance Test is >50%
- ___ 3 - Prevalence Index is ≤3.0[1]
- ___ 4 - Morphological Adaptations[1] (Provide supporting data in Remarks or on a separate sheet)
- ___ 5 - Wetland Non-Vascular Plants[1]
- ___ Problematic Hydrophytic Vegetation[1] (Explain)

[1]Indicators of hydric soil and wetland hydrology must be present, unless disturbed or problematic.

Hydrophytic Vegetation Present? Yes ___ No X

Remarks: Rub. arm. included in herb stratum for dominance test.

SOIL

Sampling Point: SP C - 2

Profile Description: (Describe to the depth needed to document the indicator or confirm the absence of indicators.)

Depth (inches)	Matrix Color (moist)	Matrix %	Redox Features Color (moist)	Redox Features %	Type[1]	Loc[2]	Texture	Remarks
0 - 20	10YR 4/3	70					SA	
	10YR 4/2	30					SA	

[1]Type: C=Concentration, D=Depletion, RM=Reduced Matrix, CS=Covered or Coated Sand Grains. [2]Location: PL=Pore Lining, M=Matrix.

Hydric Soil Indicators: (Applicable to all LRRs, unless otherwise noted.)

___ Histosol (A1)
___ Histic Epipedon (A2)
___ Black Histic (A3)
___ Hydrogen Sulfide (A4)
___ Depleted Below Dark Surface (A11)
___ Thick Dark Surface (A12)
___ Sandy Mucky Mineral (S1)
___ Sandy Gleyed Matrix (S4)
___ Sandy Redox (S5)
___ Stripped Matrix (S6)
___ Loamy Mucky Mineral (F1) (**except MLRA 1**)
___ Loamy Gleyed Matrix (F2)
___ Depleted Matrix (F3)
___ Redox Dark Surface (F6)
___ Depleted Dark Surface (F7)
___ Redox Depressions (F8)

Indicators for Problematic Hydric Soils[3]:

___ 2 cm Muck (A10)
___ Red Parent Material (TF2)
___ Very Shallow Dark Surface (TF12)
___ Other (Explain in Remarks)

[3]Indicators of hydrophytic vegetation and wetland hydrology must be present, unless disturbed or problematic

Restrictive Layer (if present):
Type: None
Depth (inches):

Hydric Soil Present? **Yes** ___ **No** X

Remarks: No hydric soil indicators observed.

HYDROLOGY

Wetland Hydrology Indicators:

Primary Indicators (minimum of one required; check all that apply)

___ Surface Water (A1)
___ High Water Table (A2)
___ Saturation (A3)
___ Water Marks (B1)
___ Sediment Deposits (B2)
___ Drift Deposits (B3)
___ Algal Mat or Crust (B4)
___ Iron Deposits (B5)
___ Surface Soil Cracks (B6)
___ Inundation Visible on Aerial Imagery (B7)
___ Sparsely Vegetated Concave Surface (B8)
___ Water-Stained Leaves (B9) (**except MLRA 1, 2, 4A, and 4B**)
___ Salt Crust (B11)
___ Aquatic Invertebrates (B13)
___ Hydrogen Sulfide Odor (C1)
___ Oxidized Rhizospheres along Living Roots (C3)
___ Presence of Reduced Iron (C4)
___ Recent Iron Reduction in Tilled Soils (C6)
___ Stunted or Stressed Plants (D1) (**LRR A**)
___ Other (Explain in Remarks)

Secondary Indicators (2 or more required)

___ Water-Stained Leaves (B9) (**MLRA 1, 2, 4A, and 4B**)
___ Drainage Patterns (B10)
___ Dry-Season Water Table (C2)
___ Saturation Visible on Aerial Imagery (C9)
___ Geomorphic Position (D2)
___ Shallow Aquitard (D3)
___ FAC-Neutral Test (D5)
___ Raised Ant Mounds (D6) (**LRR A**)
___ Frost-Heave Hummocks (D7)

Field Observations:

Surface Water Present? Yes ___ No X Depth (inches): ___
Water Table Present? Yes ___ No X Depth (inches): ___
Saturation Present? (includes capillary fringe) Yes ___ No X Depth (inches): ___

Wetland Hydrology Present? **Yes** ___ **No** X

Describe Recorded Data (stream gauge, monitoring well, aerial photos, previous inspections), if available:

Remarks: Soil profile dry throughout. No hydro indicators observed.

WETLAND DETERMINATION DATA FORM – Western Mountains, Valleys, and Coast Region

Project/Site: Pacific Marine Energy Center City/County: Lincoln County Sampling Date: 06/02/2016
Applicant/Owner: Oregon State University State: OR Sampling Point: SP C – 3
Investigator(s): Z. Halstead, B. Sahatjian Section, Township, Range: T13S R11W S6
Landform (hillslope, terrace, etc.): Marine Terrace Local relief (concave, convex, none): concave Slope (%): 1%
Subregion (LRR): A Lat: 44.46434 Long: -124.07812 Datum: NAD83
Soil Map Unit Name: Urban land-Nelscott complex, 0 – 12% slopes NWI classification: PFO4/SS1B
Are climatic / hydrologic conditions on the site typical for this time of year? Yes ___ No X (If no, explain in Remarks.)
Are Vegetation N , Soil N , or Hydrology N significantly disturbed? Are "Normal Circumstances" present? Yes N No ___
Are Vegetation N , Soil N , or Hydrology N naturally problematic? (If needed, explain any answers in Remarks.)

SUMMARY OF FINDINGS – Attach site map showing sampling point locations, transects, important features, etc.

Hydrophytic Vegetation Present?	Yes X No ___	Is the Sampled Area within a Wetland? Yes X No ___
Hydric Soil Present?	Yes X No ___	
Wetland Hydrology Present?	Yes X No ___	

Remarks: Drier than normal antecedent precipitation.

VEGETATION – Use scientific names of plants.

Tree Stratum (Plot size: 20’)	Absolute % Cover	Dominant Species?	Indicator Status
1. Pinus contorta	30	Y	FAC
2.			
3.			
4.			
	30	= Total Cover	
Sapling/Shrub Stratum (Plot size: 10’)			
1. Lonicera involucrata	50	Y	FAC
2. Gaultheria shallon	20	Y	FACU
3. Spiraea douglasii	5	N	FACW
4. Rubus spectabilis	5	N	FAC
5.			
	80	= Total Cover	
Herb Stratum (Plot size: 10’)			
1. Carex obnupta	35	Y	OBL
2. Athyrium cyclosorum	5	N	FAC
3.			
4.			
5.			
6.			
7.			
8.			
9.			
10.			
11.			
	40	= Total Cover	
Woody Vine Stratum (Plot size: ___)			
1. Rubus armeniacus	10	Y	FAC
2.			
	10	= Total Cover	
% Bare Ground in Herb Stratum ___			

Dominance Test worksheet:

Number of Dominant Species That Are OBL, FACW, or FAC: 4 (A)
Total Number of Dominant Species Across All Strata: 5 (B)
Percent of Dominant Species That Are OBL, FACW, or FAC: 80 (A/B)

Prevalence Index worksheet:

Total % Cover of:		Multiply by:	
OBL species		x 1 =	
FACW species		x 2 =	
FAC species		x 3 =	
FACU species		x 4 =	
UPL species		x 5 =	
Column Totals:	(A)		(B)

Prevalence Index = B/A = ___

Hydrophytic Vegetation Indicators:

- [ ] 1 - Rapid Test for Hydrophytic Vegetation
- [X] 2 - Dominance Test is >50%
- [ ] 3 - Prevalence Index is ≤3.0[1]
- [ ] 4 - Morphological Adaptations[1] (Provide supporting data in Remarks or on a separate sheet)
- [ ] 5 - Wetland Non-Vascular Plants[1]
- [ ] Problematic Hydrophytic Vegetation[1] (Explain)

[1]Indicators of hydric soil and wetland hydrology must be present, unless disturbed or problematic.

Hydrophytic Vegetation Present? **Yes** X **No** ___

Remarks:

SOIL

Sampling Point: SP C - 3

Profile Description: (Describe to the depth needed to document the indicator or confirm the absence of indicators.)

Depth (inches)	Matrix Color (moist)	Matrix %	Redox Features Color (moist)	Redox Features %	Type[1]	Loc[2]	Texture	Remarks
0 - 2							Organic	Fibric
2 - 6							Organic	Sapric
6 - 20	2.5Y 4/1	83	10YR 4/4	15	C	M, RC	LOSA	
			7.5YR 3/4	2	C	M	LOSA	

[1]Type: C=Concentration, D=Depletion, RM=Reduced Matrix, CS=Covered or Coated Sand Grains. [2]Location: PL=Pore Lining, M=Matrix.

Hydric Soil Indicators: (Applicable to all LRRs, unless otherwise noted.)

___ Histosol (A1)
___ Histic Epipedon (A2)
___ Black Histic (A3)
___ Hydrogen Sulfide (A4)
___ Depleted Below Dark Surface (A11)
___ Thick Dark Surface (A12)
_X_ Sandy Mucky Mineral (S1)
___ Sandy Gleyed Matrix (S4)
_X_ Sandy Redox (S5)
___ Stripped Matrix (S6)
___ Loamy Mucky Mineral (F1) (**except MLRA 1**)
___ Loamy Gleyed Matrix (F2)
___ Depleted Matrix (F3)
___ Redox Dark Surface (F6)
___ Depleted Dark Surface (F7)
___ Redox Depressions (F8)

Indicators for Problematic Hydric Soils[3]:

___ 2 cm Muck (A10)
___ Red Parent Material (TF2)
___ Very Shallow Dark Surface (TF12)
___ Other (Explain in Remarks)

[3]Indicators of hydrophytic vegetation and wetland hydrology must be present, unless disturbed or problematic

Restrictive Layer (if present):
Type: None
Depth (inches): ______

Hydric Soil Present? Yes X No ___

Remarks:

HYDROLOGY

Wetland Hydrology Indicators:

Primary Indicators (minimum of one required; check all that apply)

___ Surface Water (A1)
___ High Water Table (A2)
___ Saturation (A3)
___ Water Marks (B1)
___ Sediment Deposits (B2)
___ Drift Deposits (B3)
___ Algal Mat or Crust (B4)
___ Iron Deposits (B5)
___ Surface Soil Cracks (B6)
___ Inundation Visible on Aerial Imagery (B7)
___ Sparsely Vegetated Concave Surface (B8)
___ Water-Stained Leaves (B9) (**except MLRA 1, 2, 4A, and 4B**)
___ Salt Crust (B11)
___ Aquatic Invertebrates (B13)
___ Hydrogen Sulfide Odor (C1)
_X_ Oxidized Rhizospheres along Living Roots (C3)
___ Presence of Reduced Iron (C4)
___ Recent Iron Reduction in Tilled Soils (C6)
___ Stunted or Stressed Plants (D1) (**LRR A**)
___ Other (Explain in Remarks)

Secondary Indicators (2 or more required)

___ Water-Stained Leaves (B9) (**MLRA 1, 2, 4A, and 4B**)
___ Drainage Patterns (B10)
___ Dry-Season Water Table (C2)
___ Saturation Visible on Aerial Imagery (C9)
_X_ Geomorphic Position (D2)
___ Shallow Aquitard (D3)
_X_ FAC-Neutral Test (D5)
___ Raised Ant Mounds (D6) (**LRR A**)
___ Frost-Heave Hummocks (D7)

Field Observations:

	Yes	No	Depth (inches):
Surface Water Present?		X	
Water Table Present?		X	
Saturation Present? (includes capillary fringe)		X	

Wetland Hydrology Present? Yes X No ___

Describe Recorded Data (stream gauge, monitoring well, aerial photos, previous inspections), if available:

Remarks: Soil profile moist but not saturated. Saturation likely present in upper 12 inches of soil profile during wet season.

WETLAND DETERMINATION DATA FORM – Western Mountains, Valleys, and Coast Region

Project/Site: Pacific Marine Energy Center City/County: Lincoln County Sampling Date: 06/02/2016
Applicant/Owner: Oregon State University State: OR Sampling Point: SP D - 1
Investigator(s): Z. Halstead, B. Sahatjian Section, Township, Range: T13S R12W S1
Landform (hillslope, terrace, etc.): Marine Terrace Local relief (concave, convex, none): concave Slope (%): 1%
Subregion (LRR): A Lat: 44.46397 Long: -124.07837 Datum: NAD83
Soil Map Unit Name: Yaquina fine sand, 0 – 3% slopes NWI classification: PSS1/EM1B
Are climatic / hydrologic conditions on the site typical for this time of year? Yes ___ No X (If no, explain in Remarks.)
Are Vegetation N , Soil N , or Hydrology N significantly disturbed? Are "Normal Circumstances" present? Yes X No ___
Are Vegetation N , Soil N , or Hydrology N naturally problematic? (If needed, explain any answers in Remarks.)

SUMMARY OF FINDINGS – Attach site map showing sampling point locations, transects, important features, etc.

Hydrophytic Vegetation Present?	Yes X No ___	Is the Sampled Area within a Wetland? Yes X No ___
Hydric Soil Present?	Yes X No ___	
Wetland Hydrology Present?	Yes X No ___	

Remarks: Drier than normal antecedent precipitation.

VEGETATION – Use scientific names of plants.

Tree Stratum (Plot size: 20')	Absolute % Cover	Dominant Species?	Indicator Status
1. Pinus contorta	15	Y	FAC
2.			
3.			
4.			
	15	= Total Cover	
Sapling/Shrub Stratum (Plot size: 10')			
1. Gaultheria shallon	25	Y	FACU
2. Rubus spectabilis	10	Y	FAC
3. Lonicera involucrata	5	N	FAC
4.			
5.			
	45	= Total Cover	
Herb Stratum (Plot size: 10')			
1. Carex obnupta	60	Y	OBL
2. Athyrium cyclosorum	10	N	FAC
3.			
4.			
5.			
6.			
7.			
8.			
9.			
10.			
11.			
	72	= Total Cover	
Woody Vine Stratum (Plot size: 10')			
1. Rubus armeniacus	2	N	FAC
2.			
		= Total Cover	

% Bare Ground in Herb Stratum ___

Dominance Test worksheet:

Number of Dominant Species That Are OBL, FACW, or FAC: 3 (A)
Total Number of Dominant Species Across All Strata: 4 (B)
Percent of Dominant Species That Are OBL, FACW, or FAC: 75 (A/B)

Prevalence Index worksheet:

Total % Cover of:		Multiply by:	
OBL species		x 1 =	
FACW species		x 2 =	
FAC species		x 3 =	
FACU species		x 4 =	
UPL species		x 5 =	
Column Totals:	(A)		(B)

Prevalence Index = B/A = ___

Hydrophytic Vegetation Indicators:

- ___ 1 - Rapid Test for Hydrophytic Vegetation
- X 2 - Dominance Test is >50%
- ___ 3 - Prevalence Index is ≤3.0[1]
- ___ 4 - Morphological Adaptations[1] (Provide supporting data in Remarks or on a separate sheet)
- ___ 5 - Wetland Non-Vascular Plants[1]
- ___ Problematic Hydrophytic Vegetation[1] (Explain)

[1]Indicators of hydric soil and wetland hydrology must be present, unless disturbed or problematic.

Hydrophytic Vegetation Present? Yes X No ___

Remarks: Rub. arm. included in herb stratum for dominance test.

SOIL

Sampling Point: SP D - 1

Profile Description: (Describe to the depth needed to document the indicator or confirm the absence of indicators.)

Depth (inches)	Matrix Color (moist)	Matrix %	Redox Features Color (moist)	Redox %	Type[1]	Loc[2]	Texture	Remarks
0 - 6							Organic	Fibric
6 - 9							Organic	Hemic
9 - 20	2.5Y 4/1	85	7.5YR 3/4	15	C	M, RC	LOSA	

[1]Type: C=Concentration, D=Depletion, RM=Reduced Matrix, CS=Covered or Coated Sand Grains. [2]Location: PL=Pore Lining, M=Matrix.

Hydric Soil Indicators: (Applicable to all LRRs, unless otherwise noted.)

___ Histosol (A1)
_X_ Histic Epipedon (A2)
___ Black Histic (A3)
___ Hydrogen Sulfide (A4)
___ Depleted Below Dark Surface (A11)
___ Thick Dark Surface (A12)
___ Sandy Mucky Mineral (S1)
___ Sandy Gleyed Matrix (S4)
___ Sandy Redox (S5)
___ Stripped Matrix (S6)
___ Loamy Mucky Mineral (F1) (**except MLRA 1**)
___ Loamy Gleyed Matrix (F2)
___ Depleted Matrix (F3)
___ Redox Dark Surface (F6)
___ Depleted Dark Surface (F7)
___ Redox Depressions (F8)

Indicators for Problematic Hydric Soils[3]:

___ 2 cm Muck (A10)
___ Red Parent Material (TF2)
___ Very Shallow Dark Surface (TF12)
___ Other (Explain in Remarks)

[3]Indicators of hydrophytic vegetation and wetland hydrology must be present, unless disturbed or problematic

Restrictive Layer (if present):
Type: None
Depth (inches): ___

Hydric Soil Present? **Yes** X **No** ___

Remarks:

HYDROLOGY

Wetland Hydrology Indicators:

Primary Indicators (minimum of one required; check all that apply)

___ Surface Water (A1)
___ High Water Table (A2)
___ Saturation (A3)
___ Water Marks (B1)
___ Sediment Deposits (B2)
___ Drift Deposits (B3)
___ Algal Mat or Crust (B4)
___ Iron Deposits (B5)
___ Surface Soil Cracks (B6)
___ Inundation Visible on Aerial Imagery (B7)
___ Sparsely Vegetated Concave Surface (B8)
___ Water-Stained Leaves (B9) (**except MLRA 1, 2, 4A, and 4B**)
___ Salt Crust (B11)
___ Aquatic Invertebrates (B13)
___ Hydrogen Sulfide Odor (C1)
_X_ Oxidized Rhizospheres along Living Roots (C3)
___ Presence of Reduced Iron (C4)
___ Recent Iron Reduction in Tilled Soils (C6)
___ Stunted or Stressed Plants (D1) (**LRR A**)
___ Other (Explain in Remarks)

Secondary Indicators (2 or more required)

___ Water-Stained Leaves (B9) (**MLRA 1, 2, 4A, and 4B**)
___ Drainage Patterns (B10)
___ Dry-Season Water Table (C2)
___ Saturation Visible on Aerial Imagery (C9)
_X_ Geomorphic Position (D2)
___ Shallow Aquitard (D3)
___ FAC-Neutral Test (D5)
___ Raised Ant Mounds (D6) (**LRR A**)
___ Frost-Heave Hummocks (D7)

Field Observations:

Surface Water Present?	Yes ___	No X	Depth (inches):	___
Water Table Present?	Yes ___	No X	Depth (inches):	___
Saturation Present? (includes capillary fringe)	Yes ___	No X	Depth (inches):	___

Wetland Hydrology Present? **Yes** X **No** ___

Describe Recorded Data (stream gauge, monitoring well, aerial photos, previous inspections), if available:

Remarks: Saturation within upper 12 inches of the soil profile likely during wet season.

WETLAND DETERMINATION DATA FORM – Western Mountains, Valleys, and Coast Region

Project/Site: Pacific Marine Energy Center City/County: Lincoln County Sampling Date: 06/02/2016
Applicant/Owner: Oregon State University State: OR Sampling Point: SP D - 2
Investigator(s): Z. Halstead, B. Sahatjian Section, Township, Range: T13S R12W S1
Landform (hillslope, terrace, etc.): Marine Terrace Local relief (concave, convex, none): convex Slope (%): 2%
Subregion (LRR): A Lat: 44.46400 Long: -124.07850 Datum: NAD83
Soil Map Unit Name: Yaquina fine sand, 0 – 3% slopes NWI classification: Upland
Are climatic / hydrologic conditions on the site typical for this time of year? Yes ___ No X (If no, explain in Remarks.)
Are Vegetation N , Soil N , or Hydrology N significantly disturbed? Are "Normal Circumstances" present? Yes N No ___
Are Vegetation N , Soil N , or Hydrology N naturally problematic? (If needed, explain any answers in Remarks.)

SUMMARY OF FINDINGS – Attach site map showing sampling point locations, transects, important features, etc.

Hydrophytic Vegetation Present?	Yes X	No ___
Hydric Soil Present?	Yes ___	No X
Wetland Hydrology Present?	Yes ___	No X

Is the Sampled Area within a Wetland? Yes ___ No X

Remarks: Drier than normal antecedent precipitation.

VEGETATION – Use scientific names of plants.

Tree Stratum (Plot size: 30')	Absolute % Cover	Dominant Species?	Indicator Status
1. Pinus contorta	15	Y	FAC
2. Picea sitchensis	5	N	FAC
3.			
4.			
	20	= Total Cover	
Sapling/Shrub Stratum (Plot size: 10')			
1. Gaultheria shallon	35	Y	FACU
2. Lonicera involucrata	35	Y	FAC
3.			
4.			
5.			
	70	= Total Cover	
Herb Stratum (Plot size: 10')			
1. Pteridium aquilinum	10	Y	FACU
2. Polystichum munitum	2	N	FACU
3. Athyrium cyclosorum	2	N	FAC
4. Carex obnupta	5	Y	OBL
5.			
6.			
7.			
8.			
9.			
10.			
11.			
	22	= Total Cover	
Woody Vine Stratum (Plot size: 10')			
1. Rubus armeniacus	3	N	FAC
2.			
	3	= Total Cover	

% Bare Ground in Herb Stratum ______

Dominance Test worksheet:

Number of Dominant Species That Are OBL, FACW, or FAC: 3 (A)
Total Number of Dominant Species Across All Strata: 5 (B)
Percent of Dominant Species That Are OBL, FACW, or FAC: 60 (A/B)

Prevalence Index worksheet:

Total % Cover of:		Multiply by:	
OBL species		x 1 =	
FACW species		x 2 =	
FAC species		x 3 =	
FACU species		x 4 =	
UPL species		x 5 =	
Column Totals:	(A)		(B)

Prevalence Index = B/A = ______

Hydrophytic Vegetation Indicators:

- [ ] 1 - Rapid Test for Hydrophytic Vegetation
- [X] 2 - Dominance Test is >50%
- [ ] 3 - Prevalence Index is ≤3.0[1]
- [ ] 4 - Morphological Adaptations[1] (Provide supporting data in Remarks or on a separate sheet)
- [ ] 5 - Wetland Non-Vascular Plants[1]
- [ ] Problematic Hydrophytic Vegetation[1] (Explain)

[1]Indicators of hydric soil and wetland hydrology must be present, unless disturbed or problematic.

Hydrophytic Vegetation Present? Yes X No ___

Remarks: Rub. arm. added to herb stratum for dominance test. Property slopes up to the west.

SOIL

Sampling Point: SP D - 2

Profile Description: (Describe to the depth needed to document the indicator or confirm the absence of indicators.)

Depth (inches)	Matrix Color (moist)	Matrix %	Redox Features Color (moist)	Redox %	Type[1]	Loc[2]	Texture	Remarks
0 - 6	10YR 4/2	100					SA	
6 - 20	10YR 4/4	60					SA	
	10YR 4/3	40					SA	

[1]Type: C=Concentration, D=Depletion, RM=Reduced Matrix, CS=Covered or Coated Sand Grains. [2]Location: PL=Pore Lining, M=Matrix.

Hydric Soil Indicators: (Applicable to all LRRs, unless otherwise noted.)

- ___ Histosol (A1)
- ___ Histic Epipedon (A2)
- ___ Black Histic (A3)
- ___ Hydrogen Sulfide (A4)
- ___ Depleted Below Dark Surface (A11)
- ___ Thick Dark Surface (A12)
- ___ Sandy Mucky Mineral (S1)
- ___ Sandy Gleyed Matrix (S4)
- ___ Sandy Redox (S5)
- ___ Stripped Matrix (S6)
- ___ Loamy Mucky Mineral (F1) (**except MLRA 1**)
- ___ Loamy Gleyed Matrix (F2)
- ___ Depleted Matrix (F3)
- ___ Redox Dark Surface (F6)
- ___ Depleted Dark Surface (F7)
- ___ Redox Depressions (F8)

Indicators for Problematic Hydric Soils[3]:

- ___ 2 cm Muck (A10)
- ___ Red Parent Material (TF2)
- ___ Very Shallow Dark Surface (TF12)
- ___ Other (Explain in Remarks)

[3]Indicators of hydrophytic vegetation and wetland hydrology must be present, unless disturbed or problematic

Restrictive Layer (if present):
Type: None
Depth (inches):

Hydric Soil Present? **Yes** ___ **No** X

Remarks: No hydric soil indicators observed.

HYDROLOGY

Wetland Hydrology Indicators:

Primary Indicators (minimum of one required; check all that apply)

- ___ Surface Water (A1)
- ___ High Water Table (A2)
- ___ Saturation (A3)
- ___ Water Marks (B1)
- ___ Sediment Deposits (B2)
- ___ Drift Deposits (B3)
- ___ Algal Mat or Crust (B4)
- ___ Iron Deposits (B5)
- ___ Surface Soil Cracks (B6)
- ___ Inundation Visible on Aerial Imagery (B7)
- ___ Sparsely Vegetated Concave Surface (B8)
- ___ Water-Stained Leaves (B9) (**except MLRA 1, 2, 4A, and 4B**)
- ___ Salt Crust (B11)
- ___ Aquatic Invertebrates (B13)
- ___ Hydrogen Sulfide Odor (C1)
- ___ Oxidized Rhizospheres along Living Roots (C3)
- ___ Presence of Reduced Iron (C4)
- ___ Recent Iron Reduction in Tilled Soils (C6)
- ___ Stunted or Stressed Plants (D1) (**LRR A**)
- ___ Other (Explain in Remarks)

Secondary Indicators (2 or more required)

- ___ Water-Stained Leaves (B9) (**MLRA 1, 2, 4A, and 4B**)
- ___ Drainage Patterns (B10)
- ___ Dry-Season Water Table (C2)
- ___ Saturation Visible on Aerial Imagery (C9)
- ___ Geomorphic Position (D2)
- ___ Shallow Aquitard (D3)
- ___ FAC-Neutral Test (D5)
- ___ Raised Ant Mounds (D6) (**LRR A**)
- ___ Frost-Heave Hummocks (D7)

Field Observations:

	Yes	No	Depth (inches)
Surface Water Present?		X	
Water Table Present?		X	
Saturation Present? (includes capillary fringe)		X	

Wetland Hydrology Present? **Yes** ___ **No** X

Describe Recorded Data (stream gauge, monitoring well, aerial photos, previous inspections), if available:

Remarks: Soil profile dry throughout. No hydrology indicators observed.

WETLAND DETERMINATION DATA FORM – Western Mountains, Valleys, and Coast Region

Project/Site: Pacific Marine Energy Center City/County: Lincoln County Sampling Date: 06/02/2016
Applicant/Owner: Oregon State University State: OR Sampling Point: SP E - 1
Investigator(s): Z. Halstead, B. Sahatjian Section, Township, Range: T13S R11W S6
Landform (hillslope, terrace, etc.): Marine Terrace Local relief (concave, convex, none): concave Slope (%): 1%
Subregion (LRR): A Lat: 44.46342 Long: -124.07733 Datum: NAD83
Soil Map Unit Name: Yaquina fine sand, 0 – 3% slopes NWI classification: PSS1/EM1C
Are climatic / hydrologic conditions on the site typical for this time of year? Yes ___ No X (If no, explain in Remarks.)
Are Vegetation N , Soil N , or Hydrology N significantly disturbed? Are "Normal Circumstances" present? Yes X No ___
Are Vegetation N , Soil N , or Hydrology N naturally problematic? (If needed, explain any answers in Remarks.)

SUMMARY OF FINDINGS – Attach site map showing sampling point locations, transects, important features, etc.

Hydrophytic Vegetation Present? Yes X No ___		
Hydric Soil Present? Yes X No ___	Is the Sampled Area within a Wetland?	Yes X No ___
Wetland Hydrology Present? Yes X No ___		

Remarks: Drier than normal antecedent precipitation.

VEGETATION – Use scientific names of plants.

	Absolute % Cover	Dominant Species?	Indicator Status
Tree Stratum (Plot size: ___)			
1.			
2.			
3.			
4.			
= Total Cover			
Sapling/Shrub Stratum (Plot size: 10')			
1. Spiraea douglasii	20	Y	FACW
2. Lonicera involucrata	10	Y	FAC
3. Holodiscus discolor	5	N	FACU
4. Rhododendron groenlandicum	5	N	OBL
5. Gaultheria shallon	2	N	FACU
6. Rubus spectabilis	5	N	FAC
= Total Cover	47		
Herb Stratum (Plot size: 10')			
1. Carex obnupta	35	Y	OBL
2. Lysichiton americanus	25	Y	OBL
3. Athyrium cyclosorum	5	N	FAC
4. Blechnum spicant	1	N	FAC
5.			
6.			
7.			
8.			
9.			
10.			
11.			
= Total Cover	67		
Woody Vine Stratum (Plot size: ___)			
1.			
2.			
= Total Cover			

% Bare Ground in Herb Stratum ___

Dominance Test worksheet:

Number of Dominant Species That Are OBL, FACW, or FAC: 4 (A)
Total Number of Dominant Species Across All Strata: 4 (B)
Percent of Dominant Species That Are OBL, FACW, or FAC: 100 (A/B)

Prevalence Index worksheet:

Total % Cover of:		Multiply by:	
OBL species		x 1 =	
FACW species		x 2 =	
FAC species		x 3 =	
FACU species		x 4 =	
UPL species		x 5 =	
Column Totals:	(A)		(B)

Prevalence Index = B/A = ___

Hydrophytic Vegetation Indicators:

- [ ] 1 - Rapid Test for Hydrophytic Vegetation
- X 2 - Dominance Test is >50%
- [ ] 3 - Prevalence Index is ≤3.0[1]
- [ ] 4 - Morphological Adaptations[1] (Provide supporting data in Remarks or on a separate sheet)
- [ ] 5 - Wetland Non-Vascular Plants[1]
- [ ] Problematic Hydrophytic Vegetation[1] (Explain)

[1]Indicators of hydric soil and wetland hydrology must be present, unless disturbed or problematic.

Hydrophytic Vegetation Present? Yes X No ___

Remarks:

SOIL

Sampling Point: SP E - 1

Profile Description: (Describe to the depth needed to document the indicator or confirm the absence of indicators.)

Depth (inches)	Matrix Color (moist)	Matrix %	Redox Features Color (moist)	Redox Features %	Type[1]	Loc[2]	Texture	Remarks
0 - 8							Organic	Hemic
8 - 20							Organic	Sapric

[1]Type: C=Concentration, D=Depletion, RM=Reduced Matrix, CS=Covered or Coated Sand Grains. [2]Location: PL=Pore Lining, M=Matrix.

Hydric Soil Indicators: (Applicable to all LRRs, unless otherwise noted.)

X Histosol (A1)
___ Histic Epipedon (A2)
___ Black Histic (A3)
X Hydrogen Sulfide (A4)
___ Depleted Below Dark Surface (A11)
___ Thick Dark Surface (A12)
___ Sandy Mucky Mineral (S1)
___ Sandy Gleyed Matrix (S4)
___ Sandy Redox (S5)
___ Stripped Matrix (S6)
___ Loamy Mucky Mineral (F1) (**except MLRA 1**)
___ Loamy Gleyed Matrix (F2)
___ Depleted Matrix (F3)
___ Redox Dark Surface (F6)
___ Depleted Dark Surface (F7)
___ Redox Depressions (F8)

Indicators for Problematic Hydric Soils[3]:

___ 2 cm Muck (A10)
___ Red Parent Material (TF2)
___ Very Shallow Dark Surface (TF12)
___ Other (Explain in Remarks)

[3]Indicators of hydrophytic vegetation and wetland hydrology must be present, unless disturbed or problematic

Restrictive Layer (if present):
Type: None
Depth (inches):

Hydric Soil Present? **Yes** X **No**

Remarks:

HYDROLOGY

Wetland Hydrology Indicators:

Primary Indicators (minimum of one required; check all that apply)

X Surface Water (A1)
X High Water Table (A2)
X Saturation (A3)
___ Water Marks (B1)
___ Sediment Deposits (B2)
___ Drift Deposits (B3)
___ Algal Mat or Crust (B4)
___ Iron Deposits (B5)
___ Surface Soil Cracks (B6)
___ Inundation Visible on Aerial Imagery (B7)
___ Sparsely Vegetated Concave Surface (B8)
___ Water-Stained Leaves (B9) (**except MLRA 1, 2, 4A, and 4B**)
___ Salt Crust (B11)
___ Aquatic Invertebrates (B13)
X Hydrogen Sulfide Odor (C1)
___ Oxidized Rhizospheres along Living Roots (C3)
___ Presence of Reduced Iron (C4)
___ Recent Iron Reduction in Tilled Soils (C6)
___ Stunted or Stressed Plants (D1) (**LRR A**)
___ Other (Explain in Remarks)

Secondary Indicators (2 or more required)

___ Water-Stained Leaves (B9) (**MLRA 1, 2, 4A, and 4B**)
X Drainage Patterns (B10)
___ Dry-Season Water Table (C2)
___ Saturation Visible on Aerial Imagery (C9)
X Geomorphic Position (D2)
___ Shallow Aquitard (D3)
X FAC-Neutral Test (D5)
___ Raised Ant Mounds (D6) (**LRR A**)
___ Frost-Heave Hummocks (D7)

Field Observations:

	Yes		No		Depth (inches)
Surface Water Present?	Yes	X	No		2
Water Table Present?	Yes	X	No		1
Saturation Present? (includes capillary fringe)	Yes	X	No		Surface

Wetland Hydrology Present? **Yes** X **No**

Describe Recorded Data (stream gauge, monitoring well, aerial photos, previous inspections), if available:

Remarks: Depressional area on flat bench at toeslope. Discharges surface water into roadside ditch, flows north through culvert under driveway, unions with ditched stream that flows to south then flows west through culvert under Highway 101.

WETLAND DETERMINATION DATA FORM – Western Mountains, Valleys, and Coast Region

Project/Site: Pacific Marine Energy Center City/County: Lincoln County Sampling Date: 06/02/2016
Applicant/Owner: Oregon State University State: OR Sampling Point: SP E - 2
Investigator(s): Z. Halstead, B. Sahatjian Section, Township, Range: T13S R11W S6
Landform (hillslope, terrace, etc.): Hillslope Local relief (concave, convex, none): convex Slope (%): 3%
Subregion (LRR): A Lat: 44.46333 Long: -124.07731 Datum: NAD83
Soil Map Unit Name: Yaquina fine sand, 0 – 3% slopes NWI classification: Upland
Are climatic / hydrologic conditions on the site typical for this time of year? Yes ___ No X (If no, explain in Remarks.)
Are Vegetation N , Soil N , or Hydrology N significantly disturbed? Are "Normal Circumstances" present? Yes X No ___
Are Vegetation N , Soil N , or Hydrology N naturally problematic? (If needed, explain any answers in Remarks.)

SUMMARY OF FINDINGS – Attach site map showing sampling point locations, transects, important features, etc.

	Yes	No
Hydrophytic Vegetation Present?		X
Hydric Soil Present?		X
Wetland Hydrology Present?		X

Is the Sampled Area within a Wetland? Yes ___ No X

Remarks: Drier than normal antecedent precipitation.

VEGETATION – Use scientific names of plants.

Tree Stratum (Plot size: 20')	Absolute % Cover	Dominant Species?	Indicator Status
1. Frangula purshiana	15	Y	FAC
2.			
3.			
4.			
	15	= Total Cover	
Sapling/Shrub Stratum (Plot size: 10')			
1. Gaultheria shallon	60	Y	FACU
2. Frangula purshiana	15	N	FAC
3. Lonicera involucrata	10	N	FAC
4.			
5.			
	87	= Total Cover	
Herb Stratum (Plot size: 10')			
1. Pteridium aquilinum	2	N	FACU
2.			
3.			
4.			
5.			
6.			
7.			
8.			
9.			
10.			
11.			
		= Total Cover	
Woody Vine Stratum (Plot size:)			
1.			
2.			
		= Total Cover	
% Bare Ground in Herb Stratum			

Dominance Test worksheet:

Number of Dominant Species That Are OBL, FACW, or FAC: 1 (A)
Total Number of Dominant Species Across All Strata: 2 (B)
Percent of Dominant Species That Are OBL, FACW, or FAC: 50 (A/B)

Prevalence Index worksheet:

Total % Cover of:		Multiply by:	
OBL species		x 1 =	
FACW species		x 2 =	
FAC species	40	x 3 =	120
FACU species	62	x 4 =	248
UPL species		x 5 =	
Column Totals:	102	(A)	368 (B)

Prevalence Index = B/A = 3.61

Hydrophytic Vegetation Indicators:

- ___ 1 - Rapid Test for Hydrophytic Vegetation
- ___ 2 - Dominance Test is >50%
- ___ 3 - Prevalence Index is ≤3.0[1]
- ___ 4 - Morphological Adaptations[1] (Provide supporting data in Remarks or on a separate sheet)
- ___ 5 - Wetland Non-Vascular Plants[1]
- ___ Problematic Hydrophytic Vegetation[1] (Explain)

[1]Indicators of hydric soil and wetland hydrology must be present, unless disturbed or problematic.

Hydrophytic Vegetation Present? Yes ___ No X

Remarks: Pte. aqu. included in sapling/shrub stratum for dominance test. Plot size is half circle to east due to proximity to road. Plot approximately 2 feet higher in elevation than SP E-1.

SOIL

Sampling Point: SP E - 2

Profile Description: (Describe to the depth needed to document the indicator or confirm the absence of indicators.)

Depth (inches)	Matrix Color (moist)	Matrix %	Redox Features Color (moist)	Redox Features %	Type[1]	Loc[2]	Texture	Remarks
0 - 20	7.5YR 3/2						SALO	Roots from 0 – 10”.

[1]Type: C=Concentration, D=Depletion, RM=Reduced Matrix, CS=Covered or Coated Sand Grains. [2]Location: PL=Pore Lining, M=Matrix.

Hydric Soil Indicators: (Applicable to all LRRs, unless otherwise noted.)

___ Histosol (A1)
___ Histic Epipedon (A2)
___ Black Histic (A3)
___ Hydrogen Sulfide (A4)
___ Depleted Below Dark Surface (A11)
___ Thick Dark Surface (A12)
___ Sandy Mucky Mineral (S1)
___ Sandy Gleyed Matrix (S4)
___ Sandy Redox (S5)
___ Stripped Matrix (S6)
___ Loamy Mucky Mineral (F1) (**except MLRA 1**)
___ Loamy Gleyed Matrix (F2)
___ Depleted Matrix (F3)
___ Redox Dark Surface (F6)
___ Depleted Dark Surface (F7)
___ Redox Depressions (F8)

Indicators for Problematic Hydric Soils[3]:

___ 2 cm Muck (A10)
___ Red Parent Material (TF2)
___ Very Shallow Dark Surface (TF12)
___ Other (Explain in Remarks)

[3]Indicators of hydrophytic vegetation and wetland hydrology must be present, unless disturbed or problematic

Restrictive Layer (if present):

Type: None
Depth (inches):

Hydric Soil Present? **Yes** ___ **No** X

Remarks: No hydric soil indicators observed.

HYDROLOGY

Wetland Hydrology Indicators:

Primary Indicators (minimum of one required; check all that apply)

___ Surface Water (A1)
___ High Water Table (A2)
___ Saturation (A3)
___ Water Marks (B1)
___ Sediment Deposits (B2)
___ Drift Deposits (B3)
___ Algal Mat or Crust (B4)
___ Iron Deposits (B5)
___ Surface Soil Cracks (B6)
___ Inundation Visible on Aerial Imagery (B7)
___ Sparsely Vegetated Concave Surface (B8)
___ Water-Stained Leaves (B9) (**except MLRA 1, 2, 4A, and 4B**)
___ Salt Crust (B11)
___ Aquatic Invertebrates (B13)
___ Hydrogen Sulfide Odor (C1)
___ Oxidized Rhizospheres along Living Roots (C3)
___ Presence of Reduced Iron (C4)
___ Recent Iron Reduction in Tilled Soils (C6)
___ Stunted or Stressed Plants (D1) (**LRR A**)
___ Other (Explain in Remarks)

Secondary Indicators (2 or more required)

___ Water-Stained Leaves (B9) (**MLRA 1, 2, 4A, and 4B**)
___ Drainage Patterns (B10)
___ Dry-Season Water Table (C2)
___ Saturation Visible on Aerial Imagery (C9)
___ Geomorphic Position (D2)
___ Shallow Aquitard (D3)
___ FAC-Neutral Test (D5)
___ Raised Ant Mounds (D6) (**LRR A**)
___ Frost-Heave Hummocks (D7)

Field Observations:

Surface Water Present?	Yes		No	X	Depth (inches):
Water Table Present?	Yes		No	X	Depth (inches):
Saturation Present? (includes capillary fringe)	Yes		No	X	Depth (inches):

Wetland Hydrology Present? **Yes** ___ **No** X

Describe Recorded Data (stream gauge, monitoring well, aerial photos, previous inspections), if available:

Remarks: Soil profile dry throughout. No hydrology indicators observed.

WETLAND DETERMINATION DATA FORM – Western Mountains, Valleys, and Coast Region

Project/Site: Pacific Marine Energy Center City/County: Lincoln County Sampling Date: 06/02/2016
Applicant/Owner: Oregon State University State: OR Sampling Point: SP G - 1
Investigator(s): Z. Halstead, B. Sahatjian Section, Township, Range: T13S R11W S7
Landform (hillslope, terrace, etc.): Slope Local relief (concave, convex, none): convex Slope (%): 1%
Subregion (LRR): A Lat: 44.46105 Long: -124.07645 Datum: NAD83
Soil Map Unit Name: Yaquina fine sand, 0 – 3% slopes NWI classification: Upland
Are climatic / hydrologic conditions on the site typical for this time of year? Yes ___ No X (If no, explain in Remarks.)
Are Vegetation N , Soil N , or Hydrology N significantly disturbed? Are "Normal Circumstances" present? Yes X No ___
Are Vegetation N , Soil N , or Hydrology N naturally problematic? (If needed, explain any answers in Remarks.)

SUMMARY OF FINDINGS – Attach site map showing sampling point locations, transects, important features, etc.

Hydrophytic Vegetation Present? Yes X No ___	Is the Sampled Area within a Wetland? Yes ___ No X	
Hydric Soil Present? Yes ___ No X		
Wetland Hydrology Present? Yes ___ No X		

Remarks: Drier than normal antecedent precipitation.

VEGETATION – Use scientific names of plants.

Tree Stratum (Plot size: 20')	Absolute % Cover	Dominant Species?	Indicator Status
1. Alnus rubra	65	Y	FAC
2. Pinus contorta	25	Y	FAC
3.			
4.			
	90	= Total Cover	
Sapling/Shrub Stratum (Plot size: 10')			
1. Gaultheria shallon	25	Y	FACU
2. Spiraea douglasii	25	Y	FACW
3. Lonicera involucrata	25	Y	FAC
4.			
5.			
	75	= Total Cover	
Herb Stratum (Plot size: 10')			
1. Carex obnupta	50	Y	OBL
2.			
3.			
4.			
5.			
6.			
7.			
8.			
9.			
10.			
11.			
	50	= Total Cover	
Woody Vine Stratum (Plot size: 10')			
1. Rubus armeniacus	10	Y	FAC
2.			
	10	= Total Cover	
% Bare Ground in Herb Stratum ___			

Dominance Test worksheet:

Number of Dominant Species That Are OBL, FACW, or FAC: 6 (A)
Total Number of Dominant Species Across All Strata: 7 (B)
Percent of Dominant Species That Are OBL, FACW, or FAC: 85.7 (A/B)

Prevalence Index worksheet:

Total % Cover of:		Multiply by:	
OBL species		x 1 =	
FACW species		x 2 =	
FAC species		x 3 =	
FACU species		x 4 =	
UPL species		x 5 =	
Column Totals:	(A)		(B)

Prevalence Index = B/A = ___

Hydrophytic Vegetation Indicators:

- [ ] 1 - Rapid Test for Hydrophytic Vegetation
- [X] 2 - Dominance Test is >50%
- [ ] 3 - Prevalence Index is ≤3.0[1]
- [ ] 4 - Morphological Adaptations[1] (Provide supporting data in Remarks or on a separate sheet)
- [ ] 5 - Wetland Non-Vascular Plants[1]
- [ ] Problematic Hydrophytic Vegetation[1] (Explain)

[1]Indicators of hydric soil and wetland hydrology must be present, unless disturbed or problematic.

Hydrophytic Vegetation Present? Yes X No ___

Remarks:

SOIL

Sampling Point: SP G - 1

Profile Description: (Describe to the depth needed to document the indicator or confirm the absence of indicators.)

Depth (inches)	Matrix Color (moist)	Matrix %	Redox Features Color (moist)	Redox %	Type[1]	Loc[2]	Texture	Remarks
0 - 20	10YR 4/4	70					SALO	
	10YR 4/3	30					SALO	

[1]Type: C=Concentration, D=Depletion, RM=Reduced Matrix, CS=Covered or Coated Sand Grains. [2]Location: PL=Pore Lining, M=Matrix.

Hydric Soil Indicators: (Applicable to all LRRs, unless otherwise noted.)

___ Histosol (A1)
___ Histic Epipedon (A2)
___ Black Histic (A3)
___ Hydrogen Sulfide (A4)
___ Depleted Below Dark Surface (A11)
___ Thick Dark Surface (A12)
___ Sandy Mucky Mineral (S1)
___ Sandy Gleyed Matrix (S4)
___ Sandy Redox (S5)
___ Stripped Matrix (S6)
___ Loamy Mucky Mineral (F1) (**except MLRA 1**)
___ Loamy Gleyed Matrix (F2)
___ Depleted Matrix (F3)
___ Redox Dark Surface (F6)
___ Depleted Dark Surface (F7)
___ Redox Depressions (F8)

Indicators for Problematic Hydric Soils[3]:

___ 2 cm Muck (A10)
___ Red Parent Material (TF2)
___ Very Shallow Dark Surface (TF12)
___ Other (Explain in Remarks)

[3]Indicators of hydrophytic vegetation and wetland hydrology must be present, unless disturbed or problematic

Restrictive Layer (if present):
Type: None
Depth (inches): ___

Hydric Soil Present? Yes ___ No X

Remarks: No hydric soil indicators observed.

HYDROLOGY

Wetland Hydrology Indicators:

Primary Indicators (minimum of one required; check all that apply)

___ Surface Water (A1)
___ High Water Table (A2)
___ Saturation (A3)
___ Water Marks (B1)
___ Sediment Deposits (B2)
___ Drift Deposits (B3)
___ Algal Mat or Crust (B4)
___ Iron Deposits (B5)
___ Surface Soil Cracks (B6)
___ Inundation Visible on Aerial Imagery (B7)
___ Sparsely Vegetated Concave Surface (B8)
___ Water-Stained Leaves (B9) (**except MLRA 1, 2, 4A, and 4B**)
___ Salt Crust (B11)
___ Aquatic Invertebrates (B13)
___ Hydrogen Sulfide Odor (C1)
___ Oxidized Rhizospheres along Living Roots (C3)
___ Presence of Reduced Iron (C4)
___ Recent Iron Reduction in Tilled Soils (C6)
___ Stunted or Stressed Plants (D1) (**LRR A**)
___ Other (Explain in Remarks)

Secondary Indicators (2 or more required)

___ Water-Stained Leaves (B9) (**MLRA 1, 2, 4A, and 4B**)
___ Drainage Patterns (B10)
___ Dry-Season Water Table (C2)
___ Saturation Visible on Aerial Imagery (C9)
___ Geomorphic Position (D2)
___ Shallow Aquitard (D3)
X FAC-Neutral Test (D5)
___ Raised Ant Mounds (D6) (**LRR A**)
___ Frost-Heave Hummocks (D7)

Field Observations:

Surface Water Present?	Yes ___	No X	Depth (inches):	
Water Table Present?	Yes ___	No X	Depth (inches):	
Saturation Present? (includes capillary fringe)	Yes ___	No X	Depth (inches):	

Wetland Hydrology Present? Yes ___ No X

Describe Recorded Data (stream gauge, monitoring well, aerial photos, previous inspections), if available:

Remarks: Soil profile dry throughout.

WETLAND DETERMINATION DATA FORM – Western Mountains, Valleys, and Coast Region

Project/Site: Pacific Marine Energy Center City/County: Lincoln County Sampling Date: 06/02/2016
Applicant/Owner: Oregon State University State: OR Sampling Point: SP G - 2
Investigator(s): Z. Halstead, B. Sahatjian Section, Township, Range: T13S R11W S7
Landform (hillslope, terrace, etc.): Toeslope Local relief (concave, convex, none): Concave Slope (%): 1%
Subregion (LRR): A Lat: 44.46112 Long: -124.07648 Datum: NAD83
Soil Map Unit Name: Yaquina fine sand, 0 – 3% slopes NWI classification: PFO1B
Are climatic / hydrologic conditions on the site typical for this time of year? Yes ___ No X (If no, explain in Remarks.)
Are Vegetation N , Soil N , or Hydrology N significantly disturbed? Are "Normal Circumstances" present? Yes X No ___
Are Vegetation N , Soil N , or Hydrology N naturally problematic? (If needed, explain any answers in Remarks.)

SUMMARY OF FINDINGS – Attach site map showing sampling point locations, transects, important features, etc.

Hydrophytic Vegetation Present? Yes X No ___	Is the Sampled Area within a Wetland?	Yes X No ___
Hydric Soil Present? Yes X No ___		
Wetland Hydrology Present? Yes X No ___		

Remarks: Drier than normal antecedent precipitation.

VEGETATION – Use scientific names of plants.

	Absolute % Cover	Dominant Species?	Indicator Status
Tree Stratum (Plot size: ___)			
1. Alnus rubra	60	Y	FAC
2.			
3.			
4.			
	60	= Total Cover	
Sapling/Shrub Stratum (Plot size: 10')			
1. Gaultheria shallon	15	Y	FACU
2. Lonicera involucrata	15	Y	FAC
3. Rubus spectabilis	5	N	FAC
4. Alnus rubra	5	N	FAC
5. Spiraea douglasii	5	N	FACW
6. Holodiscus discolor	2	N	FACU
	47	= Total Cover	
Herb Stratum (Plot size: 10')			
1. Carex obnupta	50	Y	OBL
2.			
3.			
4.			
5.			
6.			
7.			
8.			
9.			
10.			
11.			
	50	= Total Cover	
Woody Vine Stratum (Plot size: 10')			
1. Rubus armeniacus	5	Y	FAC
2.			
	5	= Total Cover	

% Bare Ground in Herb Stratum ___

Dominance Test worksheet:

Number of Dominant Species That Are OBL, FACW, or FAC: 4 (A)
Total Number of Dominant Species Across All Strata: 5 (B)
Percent of Dominant Species That Are OBL, FACW, or FAC: 80 (A/B)

Prevalence Index worksheet:

Total % Cover of:		Multiply by:	
OBL species		x 1 =	
FACW species		x 2 =	
FAC species		x 3 =	
FACU species		x 4 =	
UPL species		x 5 =	
Column Totals:	(A)		(B)

Prevalence Index = B/A = ___

Hydrophytic Vegetation Indicators:

- ___ 1 - Rapid Test for Hydrophytic Vegetation
- X 2 - Dominance Test is >50%
- ___ 3 - Prevalence Index is ≤3.0[1]
- ___ 4 - Morphological Adaptations[1] (Provide supporting data in Remarks or on a separate sheet)
- ___ 5 - Wetland Non-Vascular Plants[1]
- ___ Problematic Hydrophytic Vegetation[1] (Explain)

[1]Indicators of hydric soil and wetland hydrology must be present, unless disturbed or problematic.

Hydrophytic Vegetation Present? Yes X No ___

Remarks: Plot size 10'X20' for tree stratum.

SOIL

Sampling Point: SP G - 2

Profile Description: (Describe to the depth needed to document the indicator or confirm the absence of indicators.)

Depth (inches)	Matrix Color (moist)	Matrix %	Redox Color (moist)	Redox %	Type[1]	Loc[2]	Texture	Remarks
0 - 5	7.5YR 2.5/1	90					SALO	10% angular rock fill
5 - 11	10YR 4/2	80	7.5YR 3/4	20	C	M	SALO	aa+
11 - 20	G1 4/N	85	7.5YR 3/3	15	C	M, RC	FSALO	aa+

[1]Type: C=Concentration, D=Depletion, RM=Reduced Matrix, CS=Covered or Coated Sand Grains. [2]Location: PL=Pore Lining, M=Matrix.

Hydric Soil Indicators: (Applicable to all LRRs, unless otherwise noted.)

- ___ Histosol (A1)
- ___ Histic Epipedon (A2)
- ___ Black Histic (A3)
- ___ Hydrogen Sulfide (A4)
- ___ Depleted Below Dark Surface (A11)
- ___ Thick Dark Surface (A12)
- ___ Sandy Mucky Mineral (S1)
- ___ Sandy Gleyed Matrix (S4)
- ___ Sandy Redox (S5)
- ___ Stripped Matrix (S6)
- ___ Loamy Mucky Mineral (F1) (**except MLRA 1**)
- X Loamy Gleyed Matrix (F2)
- X Depleted Matrix (F3)
- ___ Redox Dark Surface (F6)
- ___ Depleted Dark Surface (F7)
- ___ Redox Depressions (F8)

Indicators for Problematic Hydric Soils[3]:

- ___ 2 cm Muck (A10)
- ___ Red Parent Material (TF2)
- ___ Very Shallow Dark Surface (TF12)
- ___ Other (Explain in Remarks)

[3]Indicators of hydrophytic vegetation and wetland hydrology must be present, unless disturbed or problematic

Restrictive Layer (if present):

Type: None

Depth (inches):

Hydric Soil Present? **Yes** X **No** ___

Remarks:

HYDROLOGY

Wetland Hydrology Indicators:

Primary Indicators (minimum of one required; check all that apply)

- ___ Surface Water (A1)
- X High Water Table (A2)
- X Saturation (A3)
- ___ Water Marks (B1)
- ___ Sediment Deposits (B2)
- ___ Drift Deposits (B3)
- ___ Algal Mat or Crust (B4)
- ___ Iron Deposits (B5)
- ___ Surface Soil Cracks (B6)
- ___ Inundation Visible on Aerial Imagery (B7)
- ___ Sparsely Vegetated Concave Surface (B8)
- ___ Water-Stained Leaves (B9) (**except MLRA 1, 2, 4A, and 4B**)
- ___ Salt Crust (B11)
- ___ Aquatic Invertebrates (B13)
- ___ Hydrogen Sulfide Odor (C1)
- X Oxidized Rhizospheres along Living Roots (C3)
- X Presence of Reduced Iron (C4)
- ___ Recent Iron Reduction in Tilled Soils (C6)
- ___ Stunted or Stressed Plants (D1) (**LRR A**)
- ___ Other (Explain in Remarks)

Secondary Indicators (2 or more required)

- ___ Water-Stained Leaves (B9) (**MLRA 1, 2, 4A, and 4B**)
- ___ Drainage Patterns (B10)
- ___ Dry-Season Water Table (C2)
- ___ Saturation Visible on Aerial Imagery (C9)
- X Geomorphic Position (D2)
- ___ Shallow Aquitard (D3)
- ___ FAC-Neutral Test (D5)
- ___ Raised Ant Mounds (D6) (**LRR A**)
- ___ Frost-Heave Hummocks (D7)

Field Observations:

Surface Water Present?	Yes ___	No X	Depth (inches):		
Water Table Present?	Yes X	No ___	Depth (inches):	12	
Saturation Present? (includes capillary fringe)	Yes X	No ___	Depth (inches):	10	

Wetland Hydrology Present? **Yes** X **No** ___

Describe Recorded Data (stream gauge, monitoring well, aerial photos, previous inspections), if available:

Remarks: Plot located in concave area at toeslope.

WETLAND DETERMINATION DATA FORM – Western Mountains, Valleys, and Coast Region

Project/Site: Pacific Marine Energy Center City/County: Lincoln County Sampling Date: 06/21/2017
Applicant/Owner: Oregon State University State: OR Sampling Point: SP H – 1
Investigator(s): L. Cleveland, B. Sahatjian Section, Township, Range: T13S R11W Sec 7
Landform (hillslope, terrace, etc.): Marine Terrace Local relief (concave, convex, none): Convex Slope (%): 4%
Subregion (LRR): A Lat: 44.459807 Long: -124.072128 Datum: NAD83
Soil Map Unit Name: Bandon fine sandy loam, 3-12% slopes NWI classification: Upland
Are climatic / hydrologic conditions on the site typical for this time of year? Yes X No ___ (If no, explain in Remarks.)
Are Vegetation N , Soil N , or Hydrology N significantly disturbed? Are "Normal Circumstances" present? Yes X No ___
Are Vegetation N , Soil N , or Hydrology N naturally problematic? (If needed, explain any answers in Remarks.)

SUMMARY OF FINDINGS – Attach site map showing sampling point locations, transects, important features, etc.

Hydrophytic Vegetation Present?	Yes ___	No X
Hydric Soil Present?	Yes ___	No X
Wetland Hydrology Present?	Yes ___	No X

Is the Sampled Area within a Wetland? Yes ___ No X

Remarks:

VEGETATION – Use scientific names of plants.

Stratum / Species	Absolute % Cover	Dominant Species?	Indicator Status
Tree Stratum (Plot size: 20')			
1. Pinus contorta	30	Y	FAC
2.			
3.			
4.			
= Total Cover	30		
Sapling/Shrub Stratum (Plot size: 10')			
1. Gaultheria shallon	35	Y	FACU
2. Vaccinium ovatum	35	Y	FACU
3.			
4.			
5.			
= Total Cover	70		
Herb Stratum (Plot size: 10')			
1. Anthoxanthum odoratum	20	Y	FACU
2. Equisetum arvense	5	N	FAC
3. Hypochaeris radicata	5	N	FACU
4. Plantago lanceolata	10	Y	FACU
5. Panicum capillare	5	N	FAC
6.			
7.			
8.			
9.			
10.			
11.			
= Total Cover	45		
Woody Vine Stratum (Plot size: 10')			
1. Rubususrsinus	45	Y	FACU
2.			
= Total Cover	45		

% Bare Ground in Herb Stratum 55

Dominance Test worksheet:

Number of Dominant Species That Are OBL, FACW, or FAC: 1 (A)
Total Number of Dominant Species Across All Strata: 6 (B)
Percent of Dominant Species That Are OBL, FACW, or FAC: 17 (A/B)

Prevalence Index worksheet:

Total % Cover of:		Multiply by:	
OBL species	0	x 1 =	0
FACW species	0	x 2 =	0
FAC species	40	x 3 =	120
FACU species	150	x 4 =	600
UPL species	0	x 5 =	0
Column Totals:	230 (A)		720 (B)

Prevalence Index = B/A = 3.13

Hydrophytic Vegetation Indicators:

- ___ 1 - Rapid Test for Hydrophytic Vegetation
- ___ 2 - Dominance Test is >50%
- ___ 3 - Prevalence Index is ≤3.0[1]
- ___ 4 - Morphological Adaptations[1] (Provide supporting data in Remarks or on a separate sheet)
- ___ 5 - Wetland Non-Vascular Plants[1]
- ___ Problematic Hydrophytic Vegetation[1] (Explain)

[1]Indicators of hydric soil and wetland hydrology must be present, unless disturbed or problematic.

Hydrophytic Vegetation Present? Yes ___ No X

Remarks:

SOIL

Sampling Point: SP H – 1

Profile Description: (Describe to the depth needed to document the indicator or confirm the absence of indicators.)

Depth (inches)	Matrix Color (moist)	Matrix %	Redox Features Color (moist)	Redox Features %	Type[1]	Loc[2]	Texture	Remarks
0 – 5	10YR 2.5/1	100					L	
5 – 15	10YR 2.5/1	90	7.5YR 4/6	10	C	M	L	

[1]Type: C=Concentration, D=Depletion, RM=Reduced Matrix, CS=Covered or Coated Sand Grains. [2]Location: PL=Pore Lining, M=Matrix.

Hydric Soil Indicators: (Applicable to all LRRs, unless otherwise noted.)

___ Histosol (A1)
___ Histic Epipedon (A2)
___ Black Histic (A3)
___ Hydrogen Sulfide (A4)
___ Depleted Below Dark Surface (A11)
___ Thick Dark Surface (A12)
___ Sandy Mucky Mineral (S1)
___ Sandy Gleyed Matrix (S4)
___ Sandy Redox (S5)
___ Stripped Matrix (S6)
___ Loamy Mucky Mineral (F1) (**except MLRA 1**)
___ Loamy Gleyed Matrix (F2)
___ Depleted Matrix (F3)
_X_ Redox Dark Surface (F6)
___ Depleted Dark Surface (F7)
___ Redox Depressions (F8)

Indicators for Problematic Hydric Soils[3]:

___ 2 cm Muck (A10)
___ Red Parent Material (TF2)
___ Very Shallow Dark Surface (TF12)
___ Other (Explain in Remarks)

[3]Indicators of hydrophytic vegetation and wetland hydrology must be present, unless disturbed or problematic

Restrictive Layer (if present):
Type: None
Depth (inches): ______

Hydric Soil Present? **Yes** X **No** ___

Remarks:

HYDROLOGY

Wetland Hydrology Indicators:

Primary Indicators (minimum of one required; check all that apply)

___ Surface Water (A1)
___ High Water Table (A2)
___ Saturation (A3)
___ Water Marks (B1)
___ Sediment Deposits (B2)
___ Drift Deposits (B3)
___ Algal Mat or Crust (B4)
___ Iron Deposits (B5)
___ Surface Soil Cracks (B6)
___ Inundation Visible on Aerial Imagery (B7)
___ Sparsely Vegetated Concave Surface (B8)
___ Water-Stained Leaves (B9) (**except MLRA 1, 2, 4A, and 4B**)
___ Salt Crust (B11)
___ Aquatic Invertebrates (B13)
___ Hydrogen Sulfide Odor (C1)
___ Oxidized Rhizospheres along Living Roots (C3)
___ Presence of Reduced Iron (C4)
___ Recent Iron Reduction in Tilled Soils (C6)
___ Stunted or Stressed Plants (D1) (**LRR A**)
___ Other (Explain in Remarks)

Secondary Indicators (2 or more required)

___ Water-Stained Leaves (B9) (**MLRA 1, 2, 4A, and 4B**)
___ Drainage Patterns (B10)
___ Dry-Season Water Table (C2)
___ Saturation Visible on Aerial Imagery (C9)
___ Geomorphic Position (D2)
___ Shallow Aquitard (D3)
___ FAC-Neutral Test (D5)
___ Raised Ant Mounds (D6) (**LRR A**)
___ Frost-Heave Hummocks (D7)

Field Observations:

	Yes	No	Depth (inches)
Surface Water Present?		X	
Water Table Present?		X	
Saturation Present? (includes capillary fringe)		X	

Wetland Hydrology Present? **Yes** ___ **No** X

Describe Recorded Data (stream gauge, monitoring well, aerial photos, previous inspections), if available:

Remarks:

WETLAND DETERMINATION DATA FORM – Western Mountains, Valleys, and Coast Region

Project/Site: Pacific Marine Energy Center City/County: Lincoln County Sampling Date: 06/21/2017
Applicant/Owner: Oregon State University State: OR Sampling Point: SP H – 2
Investigator(s): L. Cleveland, B. Sahatjian Section, Township, Range: T13S R11W Sec 7
Landform (hillslope, terrace, etc.): Marine Terrace Local relief (concave, convex, none): Convex Slope (%): 2%
Subregion (LRR): A Lat: 44.459779 Long: -124.072148 Datum: NAD83
Soil Map Unit Name: Bandon fine sandy loam, 3-12% slopes NWI classification: Upland
Are climatic / hydrologic conditions on the site typical for this time of year? Yes X No ___ (If no, explain in Remarks.)
Are Vegetation N , Soil N , or Hydrology N significantly disturbed? Are "Normal Circumstances" present? Yes X No ___
Are Vegetation N , Soil N , or Hydrology N naturally problematic? (If needed, explain any answers in Remarks.)

SUMMARY OF FINDINGS – Attach site map showing sampling point locations, transects, important features, etc.

Hydrophytic Vegetation Present?	Yes X No ___	Is the Sampled Area within a Wetland? Yes X No ___
Hydric Soil Present?	Yes X No ___	
Wetland Hydrology Present?	Yes X No ___	

Remarks:

VEGETATION – Use scientific names of plants.

Tree Stratum (Plot size: 20')	Absolute % Cover	Dominant Species?	Indicator Status
1.			
2.			
3.			
4.			
= Total Cover			
Sapling/Shrub Stratum (Plot size: 10')			
1.			
2.			
3.			
4.			
5.			
= Total Cover			
Herb Stratum (Plot size: 10')			
1. Anthoxanthum odoratum	25	Y	FACU
2. Equisetum arvense	10	N	FAC
3. Hypochaeris radicata	20	N	FACU
4. Juncus effuses	15	N	FACW
5. Ranunculus repens	25	Y	FAC
6. Festuca rubra	10	N	FAC
7. Blechnum spicant	5	N	FAC
8.			
9.			
10.			
11.			
= Total Cover	110		
Woody Vine Stratum (Plot size: 10')			
1. Rubus armeniacus	10	Y	FAC
2.			
= Total Cover	10		

% Bare Ground in Herb Stratum 0

Dominance Test worksheet:

Number of Dominant Species That Are OBL, FACW, or FAC: 2 (A)
Total Number of Dominant Species Across All Strata: 3 (B)
Percent of Dominant Species That Are OBL, FACW, or FAC: 66 (A/B)

Prevalence Index worksheet:

Total % Cover of:		Multiply by:	
OBL species		x 1 =	
FACW species		x 2 =	
FAC species		x 3 =	
FACU species		x 4 =	
UPL species		x 5 =	
Column Totals:	(A)		(B)

Prevalence Index = B/A =

Hydrophytic Vegetation Indicators:

- ___ 1 - Rapid Test for Hydrophytic Vegetation
- X 2 - Dominance Test is >50%
- ___ 3 - Prevalence Index is ≤3.0[1]
- ___ 4 - Morphological Adaptations[1] (Provide supporting data in Remarks or on a separate sheet)
- ___ 5 - Wetland Non-Vascular Plants[1]
- ___ Problematic Hydrophytic Vegetation[1] (Explain)

[1]Indicators of hydric soil and wetland hydrology must be present, unless disturbed or problematic.

Hydrophytic Vegetation Present? Yes X No ___

Remarks: Plot for percent cover estimate is limited to the depressional area.

SOIL

Sampling Point: SP H – 2

Profile Description: (Describe to the depth needed to document the indicator or confirm the absence of indicators.)

Depth (inches)	Matrix Color (moist)	Matrix %	Redox Features Color (moist)	Redox Features %	Type[1]	Loc[2]	Texture	Remarks
0 – 3	10YR 2.5/1	98	7.5YR 4/6	2	C	M	L	
3 – 16	10YR 2.5/1	90	7.5YR 4/6	10	C	M	L	

[1]Type: C=Concentration, D=Depletion, RM=Reduced Matrix, CS=Covered or Coated Sand Grains. [2]Location: PL=Pore Lining, M=Matrix.

Hydric Soil Indicators: (Applicable to all LRRs, unless otherwise noted.)

___ Histosol (A1)
___ Histic Epipedon (A2)
___ Black Histic (A3)
___ Hydrogen Sulfide (A4)
___ Depleted Below Dark Surface (A11)
___ Thick Dark Surface (A12)
___ Sandy Mucky Mineral (S1)
___ Sandy Gleyed Matrix (S4)
___ Sandy Redox (S5)
___ Stripped Matrix (S6)
___ Loamy Mucky Mineral (F1) (**except MLRA 1**)
___ Loamy Gleyed Matrix (F2)
___ Depleted Matrix (F3)
X Redox Dark Surface (F6)
___ Depleted Dark Surface (F7)
___ Redox Depressions (F8)

Indicators for Problematic Hydric Soils[3]:

___ 2 cm Muck (A10)
___ Red Parent Material (TF2)
___ Very Shallow Dark Surface (TF12)
___ Other (Explain in Remarks)

[3]Indicators of hydrophytic vegetation and wetland hydrology must be present, unless disturbed or problematic

Restrictive Layer (if present):

Type: None
Depth (inches): ___

Hydric Soil Present? **Yes** X **No** ___

Remarks:

HYDROLOGY

Wetland Hydrology Indicators:

Primary Indicators (minimum of one required; check all that apply)

___ Surface Water (A1)
___ High Water Table (A2)
X Saturation (A3)
___ Water Marks (B1)
___ Sediment Deposits (B2)
___ Drift Deposits (B3)
___ Algal Mat or Crust (B4)
___ Iron Deposits (B5)
___ Surface Soil Cracks (B6)
___ Inundation Visible on Aerial Imagery (B7)
___ Sparsely Vegetated Concave Surface (B8)
___ Water-Stained Leaves (B9) (**except MLRA 1, 2, 4A, and 4B**)
___ Salt Crust (B11)
___ Aquatic Invertebrates (B13)
___ Hydrogen Sulfide Odor (C1)
___ Oxidized Rhizospheres along Living Roots (C3)
___ Presence of Reduced Iron (C4)
___ Recent Iron Reduction in Tilled Soils (C6)
___ Stunted or Stressed Plants (D1) (**LRR A**)
___ Other (Explain in Remarks)

Secondary Indicators (2 or more required)

___ Water-Stained Leaves (B9) (**MLRA 1, 2, 4A, and 4B**)
___ Drainage Patterns (B10)
___ Dry-Season Water Table (C2)
___ Saturation Visible on Aerial Imagery (C9)
___ Geomorphic Position (D2)
___ Shallow Aquitard (D3)
___ FAC-Neutral Test (D5)
___ Raised Ant Mounds (D6) (**LRR A**)
___ Frost-Heave Hummocks (D7)

Field Observations:

	Yes	No	Depth (inches)
Surface Water Present?		X	
Water Table Present?		X	
Saturation Present? (includes capillary fringe)	X		10

Wetland Hydrology Present? **Yes** X **No** ___

Describe Recorded Data (stream gauge, monitoring well, aerial photos, previous inspections), if available:

Remarks:

WETLAND DETERMINATION DATA FORM – Western Mountains, Valleys, and Coast Region

Project/Site: Pacific Marine Energy Center City/County: Lincoln County Sampling Date: 06/21/2017
Applicant/Owner: Oregon State University State: OR Sampling Point: SP H – 3
Investigator(s): L. Cleveland, B. Sahatjian Section, Township, Range: T13S R11W Sec 7
Landform (hillslope, terrace, etc.): Marine Terrace Local relief (concave, convex, none): Convex Slope (%): 1%
Subregion (LRR): A Lat: 44.459856 Long: -124.073302 Datum: NAD83
Soil Map Unit Name: Bandon fine sandy loam, 3-12% slopes NWI classification: Upland
Are climatic / hydrologic conditions on the site typical for this time of year? Yes X No ___ (If no, explain in Remarks.)
Are Vegetation N , Soil N , or Hydrology N significantly disturbed? Are "Normal Circumstances" present? Yes X No ___
Are Vegetation N , Soil N , or Hydrology N naturally problematic? (If needed, explain any answers in Remarks.)

SUMMARY OF FINDINGS – Attach site map showing sampling point locations, transects, important features, etc.

Hydrophytic Vegetation Present?	Yes X No ___	Is the Sampled Area within a Wetland? Yes X No ___
Hydric Soil Present?	Yes X No ___	
Wetland Hydrology Present?	Yes X No ___	

Remarks:

VEGETATION – Use scientific names of plants.

	Absolute % Cover	Dominant Species?	Indicator Status
Tree Stratum (Plot size: 20')			
1.			
2.			
3.			
4.			
= Total Cover			
Sapling/Shrub Stratum (Plot size: 10')			
1. Alnus rubra	10	Y	FAC
2.			
3.			
4.			
5.			
= Total Cover	10		
Herb Stratum (Plot size: 10')			
1. Blechnum spicant	10	N	FAC
2. Juncus effuses	85	Y	FACW
3. Juncus articulates	15	N	OBL
4.			
5.			
6.			
7.			
8.			
9.			
10.			
11.			
= Total Cover	110		
Woody Vine Stratum (Plot size: 10')			
1. Rubus armeniacus	10	Y	FAC
2.			
= Total Cover	10		
% Bare Ground in Herb Stratum 0			

Dominance Test worksheet:

Number of Dominant Species That Are OBL, FACW, or FAC: 3 (A)
Total Number of Dominant Species Across All Strata: 3 (B)
Percent of Dominant Species That Are OBL, FACW, or FAC: 100 (A/B)

Prevalence Index worksheet:

Total % Cover of:		Multiply by:
OBL species		x 1 =
FACW species		x 2 =
FAC species		x 3 =
FACU species		x 4 =
UPL species		x 5 =
Column Totals:	(A)	(B)

Prevalence Index = B/A =

Hydrophytic Vegetation Indicators:

- [ ] 1 - Rapid Test for Hydrophytic Vegetation
- [X] 2 - Dominance Test is >50%
- [ ] 3 - Prevalence Index is ≤3.0[1]
- [ ] 4 - Morphological Adaptations[1] (Provide supporting data in Remarks or on a separate sheet)
- [ ] 5 - Wetland Non-Vascular Plants[1]
- [ ] Problematic Hydrophytic Vegetation[1] (Explain)

[1]Indicators of hydric soil and wetland hydrology must be present, unless disturbed or problematic.

Hydrophytic Vegetation Present? Yes X No ___

Remarks: Plot for percent cover estimate is limited to the depressional area.

SOIL

Sampling Point: SP H – 3

Profile Description: (Describe to the depth needed to document the indicator or confirm the absence of indicators.)

Depth (inches)	Matrix Color (moist)	Matrix %	Redox Features Color (moist)	Redox Features %	Type[1]	Loc[2]	Texture	Remarks
0 – 6	10YR 2.5/1	100					L	
6 – 14	10YR 2.5/1	95	7.5YR 4/3	5	C	M	L	

[1]Type: C=Concentration, D=Depletion, RM=Reduced Matrix, CS=Covered or Coated Sand Grains. [2]Location: PL=Pore Lining, M=Matrix.

Hydric Soil Indicators: (Applicable to all LRRs, unless otherwise noted.)

- ___ Histosol (A1)
- ___ Histic Epipedon (A2)
- ___ Black Histic (A3)
- X Hydrogen Sulfide (A4)
- ___ Depleted Below Dark Surface (A11)
- ___ Thick Dark Surface (A12)
- ___ Sandy Mucky Mineral (S1)
- ___ Sandy Gleyed Matrix (S4)
- ___ Sandy Redox (S5)
- ___ Stripped Matrix (S6)
- ___ Loamy Mucky Mineral (F1) (**except MLRA 1**)
- ___ Loamy Gleyed Matrix (F2)
- ___ Depleted Matrix (F3)
- X Redox Dark Surface (F6)
- ___ Depleted Dark Surface (F7)
- ___ Redox Depressions (F8)

Indicators for Problematic Hydric Soils[3]:

- ___ 2 cm Muck (A10)
- ___ Red Parent Material (TF2)
- ___ Very Shallow Dark Surface (TF12)
- ___ Other (Explain in Remarks)

[3]Indicators of hydrophytic vegetation and wetland hydrology must be present, unless disturbed or problematic

Restrictive Layer (if present):
Type: None
Depth (inches):

Hydric Soil Present? **Yes** X **No**

Remarks:

HYDROLOGY

Wetland Hydrology Indicators:

Primary Indicators (minimum of one required; check all that apply)

- X Surface Water (A1)
- X High Water Table (A2)
- X Saturation (A3)
- ___ Water Marks (B1)
- ___ Sediment Deposits (B2)
- ___ Drift Deposits (B3)
- ___ Algal Mat or Crust (B4)
- ___ Iron Deposits (B5)
- ___ Surface Soil Cracks (B6)
- ___ Inundation Visible on Aerial Imagery (B7)
- ___ Sparsely Vegetated Concave Surface (B8)
- ___ Water-Stained Leaves (B9) (**except MLRA 1, 2, 4A, and 4B**)
- ___ Salt Crust (B11)
- ___ Aquatic Invertebrates (B13)
- X Hydrogen Sulfide Odor (C1)
- ___ Oxidized Rhizospheres along Living Roots (C3)
- ___ Presence of Reduced Iron (C4)
- ___ Recent Iron Reduction in Tilled Soils (C6)
- ___ Stunted or Stressed Plants (D1) (**LRR A**)
- ___ Other (Explain in Remarks)

Secondary Indicators (2 or more required)

- ___ Water-Stained Leaves (B9) (**MLRA 1, 2, 4A, and 4B**)
- ___ Drainage Patterns (B10)
- ___ Dry-Season Water Table (C2)
- ___ Saturation Visible on Aerial Imagery (C9)
- ___ Geomorphic Position (D2)
- ___ Shallow Aquitard (D3)
- X FAC-Neutral Test (D5)
- ___ Raised Ant Mounds (D6) (**LRR A**)
- ___ Frost-Heave Hummocks (D7)

Field Observations:

Surface Water Present?	Yes	X	No		Depth (inches): 2
Water Table Present?	Yes	X	No		Depth (inches): 0
Saturation Present? (includes capillary fringe)	Yes	X	No		Depth (inches): 0

Wetland Hydrology Present? **Yes** X **No**

Describe Recorded Data (stream gauge, monitoring well, aerial photos, previous inspections), if available:

Remarks:

WETLAND DETERMINATION DATA FORM – Western Mountains, Valleys, and Coast Region

Project/Site: Pacific Marine Energy Center City/County: Lincoln County Sampling Date: 06/21/2017
Applicant/Owner: Oregon State University State: OR Sampling Point: SP H – 4
Investigator(s): L. Cleveland, B. Sahatjian Section, Township, Range: T13S R11W Sec 7
Landform (hillslope, terrace, etc.): Marine Terrace Local relief (concave, convex, none): Convex Slope (%): 2%
Subregion (LRR): A Lat: 44.459823 Long: -124.073313 Datum: NAD83
Soil Map Unit Name: Bandon fine sandy loam, 3-12% slopes NWI classification: Upland
Are climatic / hydrologic conditions on the site typical for this time of year? Yes X No ___ (If no, explain in Remarks.)
Are Vegetation N, Soil N, or Hydrology N significantly disturbed? Are “Normal Circumstances” present? Yes X No ___
Are Vegetation N, Soil N, or Hydrology N naturally problematic? (If needed, explain any answers in Remarks.)

SUMMARY OF FINDINGS – Attach site map showing sampling point locations, transects, important features, etc.

Hydrophytic Vegetation Present?	Yes ___ No X	Is the Sampled Area within a Wetland? Yes ___ No X
Hydric Soil Present?	Yes ___ No X	
Wetland Hydrology Present?	Yes ___ No X	

Remarks:

VEGETATION – Use scientific names of plants.

Tree Stratum (Plot size: 20’)	Absolute % Cover	Dominant Species?	Indicator Status
1. Picea sitchensis	20	Y	FAC
2.			
3.			
4.			
	20	= Total Cover	
Sapling/Shrub Stratum (Plot size: 10’)			
1. Alnus rubra	5	N	FAC
2. Gaultheria shallon	15	Y	FACU
3. Vaccinium ovatum	10	Y	FACU
4.			
5.			
	30	= Total Cover	
Herb Stratum (Plot size: 10’)			
1. Anthoxanthum odoratum	25	Y	FACU
2. Hypochaeris radicata	15	Y	FACU
3.			
4.			
5.			
6.			
7.			
8.			
9.			
10.			
11.			
	40	= Total Cover	
Woody Vine Stratum (Plot size: 10’)			
1. Rubus ursinus	10	Y	FACU
2.			
	10	= Total Cover	

% Bare Ground in Herb Stratum 60

Dominance Test worksheet:

Number of Dominant Species That Are OBL, FACW, or FAC: 1 (A)
Total Number of Dominant Species Across All Strata: 6 (B)
Percent of Dominant Species That Are OBL, FACW, or FAC: 17 (A/B)

Prevalence Index worksheet:

Total % Cover of:		Multiply by:	
OBL species	0	x 1 =	0
FACW species	0	x 2 =	0
FAC species	25	x 3 =	75
FACU species	75	x 4 =	300
UPL species	0	x 5 =	0
Column Totals:	100 (A)		375 (B)

Prevalence Index = B/A = 3.75

Hydrophytic Vegetation Indicators:

- ___ 1 - Rapid Test for Hydrophytic Vegetation
- ___ 2 - Dominance Test is >50%
- ___ 3 - Prevalence Index is ≤3.0[1]
- ___ 4 - Morphological Adaptations[1] (Provide supporting data in Remarks or on a separate sheet)
- ___ 5 - Wetland Non-Vascular Plants[1]
- ___ Problematic Hydrophytic Vegetation[1] (Explain)

[1]Indicators of hydric soil and wetland hydrology must be present, unless disturbed or problematic.

Hydrophytic Vegetation Present? Yes ___ No X

Remarks:

SOIL

Sampling Point: SP H – 4

Profile Description: (Describe to the depth needed to document the indicator or confirm the absence of indicators.)

Depth (inches)	Matrix Color (moist)	Matrix %	Redox Features Color (moist)	Redox %	Type[1]	Loc[2]	Texture	Remarks
0 – 3	10YR 3/3	100					L	
3 – 16	10YR 3/3	98	10YR 4/6	2	C	M	L	

[1]Type: C=Concentration, D=Depletion, RM=Reduced Matrix, CS=Covered or Coated Sand Grains. [2]Location: PL=Pore Lining, M=Matrix.

Hydric Soil Indicators: (Applicable to all LRRs, unless otherwise noted.)

___ Histosol (A1)
___ Histic Epipedon (A2)
___ Black Histic (A3)
___ Hydrogen Sulfide (A4)
___ Depleted Below Dark Surface (A11)
___ Thick Dark Surface (A12)
___ Sandy Mucky Mineral (S1)
___ Sandy Gleyed Matrix (S4)
___ Sandy Redox (S5)
___ Stripped Matrix (S6)
___ Loamy Mucky Mineral (F1) (**except MLRA 1**)
___ Loamy Gleyed Matrix (F2)
___ Depleted Matrix (F3)
___ Redox Dark Surface (F6)
___ Depleted Dark Surface (F7)
___ Redox Depressions (F8)

Indicators for Problematic Hydric Soils[3]:

___ 2 cm Muck (A10)
___ Red Parent Material (TF2)
___ Very Shallow Dark Surface (TF12)
___ Other (Explain in Remarks)

[3]Indicators of hydrophytic vegetation and wetland hydrology must be present, unless disturbed or problematic

Restrictive Layer (if present):
Type: None
Depth (inches): ______

Hydric Soil Present? **Yes** ___ **No** **X**

Remarks:

HYDROLOGY

Wetland Hydrology Indicators:

Primary Indicators (minimum of one required; check all that apply)

___ Surface Water (A1)
___ High Water Table (A2)
___ Saturation (A3)
___ Water Marks (B1)
___ Sediment Deposits (B2)
___ Drift Deposits (B3)
___ Algal Mat or Crust (B4)
___ Iron Deposits (B5)
___ Surface Soil Cracks (B6)
___ Inundation Visible on Aerial Imagery (B7)
___ Sparsely Vegetated Concave Surface (B8)
___ Water-Stained Leaves (B9) (**except MLRA 1, 2, 4A, and 4B**)
___ Salt Crust (B11)
___ Aquatic Invertebrates (B13)
___ Hydrogen Sulfide Odor (C1)
___ Oxidized Rhizospheres along Living Roots (C3)
___ Presence of Reduced Iron (C4)
___ Recent Iron Reduction in Tilled Soils (C6)
___ Stunted or Stressed Plants (D1) (**LRR A**)
___ Other (Explain in Remarks)

Secondary Indicators (2 or more required)

___ Water-Stained Leaves (B9) (**MLRA 1, 2, 4A, and 4B**)
___ Drainage Patterns (B10)
___ Dry-Season Water Table (C2)
___ Saturation Visible on Aerial Imagery (C9)
___ Geomorphic Position (D2)
___ Shallow Aquitard (D3)
___ FAC-Neutral Test (D5)
___ Raised Ant Mounds (D6) (**LRR A**)
___ Frost-Heave Hummocks (D7)

Field Observations:

Surface Water Present?	Yes		No	X	Depth (inches):
Water Table Present?	Yes		No	X	Depth (inches):
Saturation Present? (includes capillary fringe)	Yes		No	X	Depth (inches):

Wetland Hydrology Present? **Yes** ___ **No** **X**

Describe Recorded Data (stream gauge, monitoring well, aerial photos, previous inspections), if available:

Remarks:

WETLAND DETERMINATION DATA FORM – Western Mountains, Valleys, and Coast Region

Project/Site: Pacific Marine Energy Center City/County: Lincoln County Sampling Date: 06/21/2017
Applicant/Owner: Oregon State University State: OR Sampling Point: SP H – 5
Investigator(s): L. Cleveland, B. Sahatjian Section, Township, Range: T13S R11W Sec 7
Landform (hillslope, terrace, etc.): Marine Terrace Local relief (concave, convex, none): Convex Slope (%): 1%
Subregion (LRR): A Lat: 44.459927 Long: -124.073393 Datum: NAD83
Soil Map Unit Name: Bandon fine sandy loam, 3-12% slopes NWI classification: Upland
Are climatic / hydrologic conditions on the site typical for this time of year? Yes X No ___ (If no, explain in Remarks.)
Are Vegetation N , Soil N , or Hydrology N significantly disturbed? Are "Normal Circumstances" present? Yes X No ___
Are Vegetation N , Soil N , or Hydrology N naturally problematic? (If needed, explain any answers in Remarks.)

SUMMARY OF FINDINGS – Attach site map showing sampling point locations, transects, important features, etc.

Hydrophytic Vegetation Present?	Yes X	No	Is the Sampled Area within a Wetland?	Yes X No ___
Hydric Soil Present?	Yes X	No		
Wetland Hydrology Present?	Yes X	No		

Remarks: Sample plot located on an access road that is infrequently used.

VEGETATION – Use scientific names of plants.

	Absolute % Cover	Dominant Species?	Indicator Status
Tree Stratum (Plot size: 20')			
1.			
2.			
3.			
4.			
= Total Cover			
Sapling/Shrub Stratum (Plot size: 10')			
1.			
2.			
3.			
4.			
5.			
= Total Cover			
Herb Stratum (Plot size: 10')			
1. Juncus effuses	15	Y	FACW
2.			
3.			
4.			
5.			
6.			
7.			
8.			
9.			
10.			
11.			
= Total Cover	15		
Woody Vine Stratum (Plot size: 10')			
1. Rubus armeniacus	90	Y	FAC
2.			
= Total Cover	90		
% Bare Ground in Herb Stratum 85			

Dominance Test worksheet:

Number of Dominant Species That Are OBL, FACW, or FAC: 2 (A)
Total Number of Dominant Species Across All Strata: 2 (B)
Percent of Dominant Species That Are OBL, FACW, or FAC: 100 (A/B)

Prevalence Index worksheet:

Total % Cover of:		Multiply by:
OBL species		x 1 =
FACW species		x 2 =
FAC species		x 3 =
FACU species		x 4 =
UPL species		x 5 =
Column Totals:	(A)	(B)

Prevalence Index = B/A =

Hydrophytic Vegetation Indicators:

- [ ] 1 - Rapid Test for Hydrophytic Vegetation
- [X] 2 - Dominance Test is >50%
- [ ] 3 - Prevalence Index is ≤3.0[1]
- [ ] 4 - Morphological Adaptations[1] (Provide supporting data in Remarks or on a separate sheet)
- [ ] 5 - Wetland Non-Vascular Plants[1]
- [ ] Problematic Hydrophytic Vegetation[1] (Explain)

[1]Indicators of hydric soil and wetland hydrology must be present, unless disturbed or problematic.

Hydrophytic Vegetation Present? Yes X No ___

Remarks: Plot for percent cover estimate is limited to the depressional area.

SOIL

Sampling Point: SP H – 5

Profile Description: (Describe to the depth needed to document the indicator or confirm the absence of indicators.)

Depth (inches)	Matrix Color (moist)	Matrix %	Redox Features Color (moist)	Redox Features %	Type[1]	Loc[2]	Texture	Remarks
0 – 6	10YR 2.5/1	100					L	
6 – 16	10YR 2.5/1	95	7.5YR 4/3	5	C	M	L	

[1]Type: C=Concentration, D=Depletion, RM=Reduced Matrix, CS=Covered or Coated Sand Grains. [2]Location: PL=Pore Lining, M=Matrix.

Hydric Soil Indicators: (Applicable to all LRRs, unless otherwise noted.)

___ Histosol (A1)
___ Histic Epipedon (A2)
___ Black Histic (A3)
___ Hydrogen Sulfide (A4)
___ Depleted Below Dark Surface (A11)
___ Thick Dark Surface (A12)
___ Sandy Mucky Mineral (S1)
___ Sandy Gleyed Matrix (S4)
___ Sandy Redox (S5)
___ Stripped Matrix (S6)
___ Loamy Mucky Mineral (F1) (**except MLRA 1**)
___ Loamy Gleyed Matrix (F2)
___ Depleted Matrix (F3)
_X_ Redox Dark Surface (F6)
___ Depleted Dark Surface (F7)
___ Redox Depressions (F8)

Indicators for Problematic Hydric Soils[3]:

___ 2 cm Muck (A10)
___ Red Parent Material (TF2)
___ Very Shallow Dark Surface (TF12)
___ Other (Explain in Remarks)

[3]Indicators of hydrophytic vegetation and wetland hydrology must be present, unless disturbed or problematic

Restrictive Layer (if present):

Type: None
Depth (inches): ______

Hydric Soil Present? **Yes** X **No** ___

Remarks:

HYDROLOGY

Wetland Hydrology Indicators:

Primary Indicators (minimum of one required; check all that apply)

___ Surface Water (A1)
_X_ High Water Table (A2)
_X_ Saturation (A3)
___ Water Marks (B1)
___ Sediment Deposits (B2)
___ Drift Deposits (B3)
___ Algal Mat or Crust (B4)
___ Iron Deposits (B5)
___ Surface Soil Cracks (B6)
___ Inundation Visible on Aerial Imagery (B7)
___ Sparsely Vegetated Concave Surface (B8)
___ Water-Stained Leaves (B9) (**except MLRA 1, 2, 4A, and 4B**)
___ Salt Crust (B11)
___ Aquatic Invertebrates (B13)
___ Hydrogen Sulfide Odor (C1)
___ Oxidized Rhizospheres along Living Roots (C3)
___ Presence of Reduced Iron (C4)
___ Recent Iron Reduction in Tilled Soils (C6)
___ Stunted or Stressed Plants (D1) (**LRR A**)
___ Other (Explain in Remarks)

Secondary Indicators (2 or more required)

___ Water-Stained Leaves (B9) (**MLRA 1, 2, 4A, and 4B**)
___ Drainage Patterns (B10)
___ Dry-Season Water Table (C2)
___ Saturation Visible on Aerial Imagery (C9)
___ Geomorphic Position (D2)
___ Shallow Aquitard (D3)
_X_ FAC-Neutral Test (D5)
___ Raised Ant Mounds (D6) (**LRR A**)
___ Frost-Heave Hummocks (D7)

Field Observations:

	Yes		No		Depth (inches)
Surface Water Present?	Yes		No	X	
Water Table Present?	Yes	X	No		8
Saturation Present? (includes capillary fringe)	Yes	X	No		3

Wetland Hydrology Present? **Yes** X **No** ___

Describe Recorded Data (stream gauge, monitoring well, aerial photos, previous inspections), if available:

Remarks:

WETLAND DETERMINATION DATA FORM – Western Mountains, Valleys, and Coast Region

Project/Site: Pacific Marine Energy Center | City/County: Lincoln County | Sampling Date: 06/21/2017
Applicant/Owner: Oregon State University | State: OR | Sampling Point: SP H – 6
Investigator(s): L. Cleveland, B. Sahatjian | Section, Township, Range: T13S R11W Sec 7
Landform (hillslope, terrace, etc.): Marine Terrace | Local relief (concave, convex, none): Convex | Slope (%): 3%
Subregion (LRR): A | Lat: 44.459920 | Long: -124.073424 | Datum: NAD83
Soil Map Unit Name: Bandon fine sandy loam, 3-12% slopes | NWI classification: Upland
Are climatic / hydrologic conditions on the site typical for this time of year? Yes X No ___ (If no, explain in Remarks.)
Are Vegetation N , Soil N , or Hydrology N significantly disturbed? Are "Normal Circumstances" present? Yes X No ___
Are Vegetation N , Soil N , or Hydrology N naturally problematic? (If needed, explain any answers in Remarks.)

SUMMARY OF FINDINGS – Attach site map showing sampling point locations, transects, important features, etc.

Hydrophytic Vegetation Present?	Yes ___	No X	Is the Sampled Area within a Wetland?	Yes ___ No X
Hydric Soil Present?	Yes ___	No X		
Wetland Hydrology Present?	Yes ___	No X		

Remarks: Sample plot located on an access road that is infrequently used.

VEGETATION – Use scientific names of plants.

Tree Stratum (Plot size: 20')	Absolute % Cover	Dominant Species?	Indicator Status
1. Picea sitchensis	20	Y	FAC
2. Pinus contorta	15	Y	FAC
3.			
4.			
	35	= Total Cover	
Sapling/Shrub Stratum (Plot size: 10')			
1. Alnus rubra	10	N	FAC
2. Gaultheria shallon	15	Y	FACU
3. Vaccinium ovatum	15	Y	FACU
4.			
5.			
	40	= Total Cover	
Herb Stratum (Plot size: 10')			
1. Anthoxanthum odoratum	15	Y	FACU
2. Hypochaeris radicata	15	Y	FACU
3.			
4.			
5.			
6.			
7.			
8.			
9.			
10.			
11.			
	30	= Total Cover	
Woody Vine Stratum (Plot size: 10')			
1. Rubus ursinus	40	Y	FACU
2.			
	10	= Total Cover	

% Bare Ground in Herb Stratum 70

Dominance Test worksheet:

Number of Dominant Species That Are OBL, FACW, or FAC: 2 (A)
Total Number of Dominant Species Across All Strata: 7 (B)
Percent of Dominant Species That Are OBL, FACW, or FAC: 28 (A/B)

Prevalence Index worksheet:

Total % Cover of:		Multiply by:	
OBL species	0	x 1 =	0
FACW species	0	x 2 =	0
FAC species	45	x 3 =	135
FACU species	100	x 4 =	400
UPL species	0	x 5 =	0
Column Totals:	145 (A)		535 (B)

Prevalence Index = B/A = 3.69

Hydrophytic Vegetation Indicators:

- ___ 1 - Rapid Test for Hydrophytic Vegetation
- ___ 2 - Dominance Test is >50%
- ___ 3 - Prevalence Index is ≤3.0[1]
- ___ 4 - Morphological Adaptations[1] (Provide supporting data in Remarks or on a separate sheet)
- ___ 5 - Wetland Non-Vascular Plants[1]
- ___ Problematic Hydrophytic Vegetation[1] (Explain)

[1]Indicators of hydric soil and wetland hydrology must be present, unless disturbed or problematic.

Hydrophytic Vegetation Present? Yes ___ No X

Remarks: Plot for percent cover estimate is partial to road prism.

SOIL

Sampling Point: SP H – 6

Profile Description: (Describe to the depth needed to document the indicator or confirm the absence of indicators.)

Depth	Matrix		Redox Features					
(inches)	Color (moist)	%	Color (moist)	%	Type[1]	Loc[2]	Texture	Remarks
0 – 5	10YR 3/3	100					L	
5 – 15	10YR 3/3	98	10YR 4/6	2	C	M	L	

[1]Type: C=Concentration, D=Depletion, RM=Reduced Matrix, CS=Covered or Coated Sand Grains. [2]Location: PL=Pore Lining, M=Matrix.

Hydric Soil Indicators: (Applicable to all LRRs, unless otherwise noted.)

___ Histosol (A1)
___ Histic Epipedon (A2)
___ Black Histic (A3)
___ Hydrogen Sulfide (A4)
___ Depleted Below Dark Surface (A11)
___ Thick Dark Surface (A12)
___ Sandy Mucky Mineral (S1)
___ Sandy Gleyed Matrix (S4)
___ Sandy Redox (S5)
___ Stripped Matrix (S6)
___ Loamy Mucky Mineral (F1) (**except MLRA 1**)
___ Loamy Gleyed Matrix (F2)
___ Depleted Matrix (F3)
___ Redox Dark Surface (F6)
___ Depleted Dark Surface (F7)
___ Redox Depressions (F8)

Indicators for Problematic Hydric Soils[3]:

___ 2 cm Muck (A10)
___ Red Parent Material (TF2)
___ Very Shallow Dark Surface (TF12)
___ Other (Explain in Remarks)

[3]Indicators of hydrophytic vegetation and wetland hydrology must be present, unless disturbed or problematic

Restrictive Layer (if present):
Type: None
Depth (inches):

Hydric Soil Present? **Yes** ___ **No** X

Remarks:

HYDROLOGY

Wetland Hydrology Indicators:

Primary Indicators (minimum of one required; check all that apply)

___ Surface Water (A1)
___ High Water Table (A2)
___ Saturation (A3)
___ Water Marks (B1)
___ Sediment Deposits (B2)
___ Drift Deposits (B3)
___ Algal Mat or Crust (B4)
___ Iron Deposits (B5)
___ Surface Soil Cracks (B6)
___ Inundation Visible on Aerial Imagery (B7)
___ Sparsely Vegetated Concave Surface (B8)
___ Water-Stained Leaves (B9) (**except MLRA 1, 2, 4A, and 4B**)
___ Salt Crust (B11)
___ Aquatic Invertebrates (B13)
___ Hydrogen Sulfide Odor (C1)
___ Oxidized Rhizospheres along Living Roots (C3)
___ Presence of Reduced Iron (C4)
___ Recent Iron Reduction in Tilled Soils (C6)
___ Stunted or Stressed Plants (D1) (**LRR A**)
___ Other (Explain in Remarks)

Secondary Indicators (2 or more required)

___ Water-Stained Leaves (B9) (**MLRA 1, 2, 4A, and 4B**)
___ Drainage Patterns (B10)
___ Dry-Season Water Table (C2)
___ Saturation Visible on Aerial Imagery (C9)
___ Geomorphic Position (D2)
___ Shallow Aquitard (D3)
___ FAC-Neutral Test (D5)
___ Raised Ant Mounds (D6) (**LRR A**)
___ Frost-Heave Hummocks (D7)

Field Observations:

Surface Water Present?	Yes		No	X	Depth (inches):
Water Table Present?	Yes		No	X	Depth (inches):
Saturation Present? (includes capillary fringe)	Yes		No	X	Depth (inches):

Wetland Hydrology Present? **Yes** ___ **No** X

Describe Recorded Data (stream gauge, monitoring well, aerial photos, previous inspections), if available:

Remarks:

WETLAND DETERMINATION DATA FORM – Western Mountains, Valleys, and Coast Region

Project/Site: Pacific Marine Energy Center City/County: Lincoln County Sampling Date: 06/22/2017
Applicant/Owner: Oregon State University State: OR Sampling Point: SP I – 1
Investigator(s): L. Cleveland, B. Sahatjian Section, Township, Range: T13S R11W Sec 7
Landform (hillslope, terrace, etc.): Marine Terrace Local relief (concave, convex, none): Convex Slope (%): <1%
Subregion (LRR): A Lat: 44.459603 Long: -124.074684 Datum: NAD83
Soil Map Unit Name: Bandon fine sandy loam, 3-12% slopes NWI classification: Upland
Are climatic / hydrologic conditions on the site typical for this time of year? Yes X No ___ (If no, explain in Remarks.)
Are Vegetation N , Soil N , or Hydrology N significantly disturbed? Are "Normal Circumstances" present? Yes X No ___
Are Vegetation N , Soil N , or Hydrology N naturally problematic? (If needed, explain any answers in Remarks.)

SUMMARY OF FINDINGS – Attach site map showing sampling point locations, transects, important features, etc.

Hydrophytic Vegetation Present?	Yes X No ___	**Is the Sampled Area within a Wetland? Yes X No ___**
Hydric Soil Present?	Yes X No ___	
Wetland Hydrology Present?	Yes X No ___	

Remarks:

VEGETATION – Use scientific names of plants.

	Absolute % Cover	Dominant Species?	Indicator Status
Tree Stratum (Plot size: 20')			
1.			
2.			
3.			
4.			
= Total Cover			
Sapling/Shrub Stratum (Plot size: 10')			
1.			
2.			
3.			
4.			
5.			
= Total Cover			
Herb Stratum (Plot size: 10')			
1. Anthoxanthum odoratum	10	N	FACU
2. Juncus patens	80	Y	FACW
3. Lotus corniculatus	5	N	FAC
4. Juncus effuses	10	N	FACW
5. Holcus lanatus	5	N	FAC
6. Juncus ensifolius	5	N	FACW
7.			
8.			
9.			
10.			
11.			
= Total Cover	115		
Woody Vine Stratum (Plot size: 10')			
1.			
2.			
= Total Cover			

% Bare Ground in Herb Stratum 0

Dominance Test worksheet:

Number of Dominant Species That Are OBL, FACW, or FAC: 1 (A)
Total Number of Dominant Species Across All Strata: 1 (B)
Percent of Dominant Species That Are OBL, FACW, or FAC: 100 (A/B)

Prevalence Index worksheet:

Total % Cover of:		Multiply by:	
OBL species		x 1 =	
FACW species		x 2 =	
FAC species		x 3 =	
FACU species		x 4 =	
UPL species		x 5 =	
Column Totals:	(A)		(B)

Prevalence Index = B/A =

Hydrophytic Vegetation Indicators:

- ___ 1 - Rapid Test for Hydrophytic Vegetation
- X 2 - Dominance Test is >50%
- ___ 3 - Prevalence Index is ≤3.0[1]
- ___ 4 - Morphological Adaptations[1] (Provide supporting data in Remarks or on a separate sheet)
- ___ 5 - Wetland Non-Vascular Plants[1]
- ___ Problematic Hydrophytic Vegetation[1] (Explain)

[1]Indicators of hydric soil and wetland hydrology must be present, unless disturbed or problematic.

Hydrophytic Vegetation Present? Yes X No ___

Remarks: Plot for percent cover estimate is limited to the depressional area.

SOIL

Sampling Point: SP I – 1

Profile Description: (Describe to the depth needed to document the indicator or confirm the absence of indicators.)

Depth (inches)	Matrix Color (moist)	Matrix %	Redox Color (moist)	Redox %	Type[1]	Loc[2]	Texture	Remarks
0 – 6	10YR 2.5/2	98	5YR 3/4	2	C	M	L	
6 – 16	10YR 2.5/2	90	5YR 3/4	5	C	M	GrL	
			7.5YR 4/4	5	C	M		

[1]Type: C=Concentration, D=Depletion, RM=Reduced Matrix, CS=Covered or Coated Sand Grains. [2]Location: PL=Pore Lining, M=Matrix.

Hydric Soil Indicators: (Applicable to all LRRs, unless otherwise noted.)

- ___ Histosol (A1)
- ___ Histic Epipedon (A2)
- ___ Black Histic (A3)
- ___ Hydrogen Sulfide (A4)
- ___ Depleted Below Dark Surface (A11)
- ___ Thick Dark Surface (A12)
- ___ Sandy Mucky Mineral (S1)
- ___ Sandy Gleyed Matrix (S4)
- ___ Sandy Redox (S5)
- ___ Stripped Matrix (S6)
- ___ Loamy Mucky Mineral (F1) (**except MLRA 1**)
- ___ Loamy Gleyed Matrix (F2)
- ___ Depleted Matrix (F3)
- X Redox Dark Surface (F6)
- ___ Depleted Dark Surface (F7)
- ___ Redox Depressions (F8)

Indicators for Problematic Hydric Soils[3]:

- ___ 2 cm Muck (A10)
- ___ Red Parent Material (TF2)
- ___ Very Shallow Dark Surface (TF12)
- ___ Other (Explain in Remarks)

[3]Indicators of hydrophytic vegetation and wetland hydrology must be present, unless disturbed or problematic

Restrictive Layer (if present):

Type: None

Depth (inches):

Hydric Soil Present? Yes X No

Remarks:

HYDROLOGY

Wetland Hydrology Indicators:

Primary Indicators (minimum of one required; check all that apply)

- ___ Surface Water (A1)
- ___ High Water Table (A2)
- ___ Saturation (A3)
- ___ Water Marks (B1)
- ___ Sediment Deposits (B2)
- ___ Drift Deposits (B3)
- ___ Algal Mat or Crust (B4)
- ___ Iron Deposits (B5)
- ___ Surface Soil Cracks (B6)
- ___ Inundation Visible on Aerial Imagery (B7)
- ___ Sparsely Vegetated Concave Surface (B8)
- ___ Water-Stained Leaves (B9) (**except MLRA 1, 2, 4A, and 4B**)
- ___ Salt Crust (B11)
- ___ Aquatic Invertebrates (B13)
- ___ Hydrogen Sulfide Odor (C1)
- ___ Oxidized Rhizospheres along Living Roots (C3)
- ___ Presence of Reduced Iron (C4)
- ___ Recent Iron Reduction in Tilled Soils (C6)
- ___ Stunted or Stressed Plants (D1) (**LRR A**)
- ___ Other (Explain in Remarks)

Secondary Indicators (2 or more required)

- ___ Water-Stained Leaves (B9) (**MLRA 1, 2, 4A, and 4B**)
- ___ Drainage Patterns (B10)
- X Dry-Season Water Table (C2)
- ___ Saturation Visible on Aerial Imagery (C9)
- ___ Geomorphic Position (D2)
- ___ Shallow Aquitard (D3)
- X FAC-Neutral Test (D5)
- ___ Raised Ant Mounds (D6) (**LRR A**)
- ___ Frost-Heave Hummocks (D7)

Field Observations:

Surface Water Present?	Yes		No	X	Depth (inches):
Water Table Present?	Yes		No	X	Depth (inches):
Saturation Present? (includes capillary fringe)	Yes		No	X	Depth (inches):

Wetland Hydrology Present? Yes X No

Describe Recorded Data (stream gauge, monitoring well, aerial photos, previous inspections), if available:

Remarks: Dry season water table observed at 23 inches

WETLAND DETERMINATION DATA FORM – Western Mountains, Valleys, and Coast Region

Project/Site: Pacific Marine Energy Center City/County: Lincoln County Sampling Date: 06/22/2017
Applicant/Owner: Oregon State University State: OR Sampling Point: SP I – 2
Investigator(s): L. Cleveland, B. Sahatjian Section, Township, Range: T13S R11W Sec 7
Landform (hillslope, terrace, etc.): Marine Terrace Local relief (concave, convex, none): Convex Slope (%): <1%
Subregion (LRR): A Lat: 44.459558 Long: -124.074629 Datum: NAD83
Soil Map Unit Name: Bandon fine sandy loam, 3-12% slopes NWI classification: Upland
Are climatic / hydrologic conditions on the site typical for this time of year? Yes X No ___ (If no, explain in Remarks.)
Are Vegetation N , Soil N , or Hydrology N significantly disturbed? Are "Normal Circumstances" present? Yes X No ___
Are Vegetation N , Soil N , or Hydrology N naturally problematic? (If needed, explain any answers in Remarks.)

SUMMARY OF FINDINGS – Attach site map showing sampling point locations, transects, important features, etc.

Hydrophytic Vegetation Present?	Yes X No ___	Is the Sampled Area within a Wetland? Yes ___ No X
Hydric Soil Present?	Yes ___ No X	
Wetland Hydrology Present?	Yes ___ No X	

Remarks:

VEGETATION – Use scientific names of plants.

	Absolute % Cover	Dominant Species?	Indicator Status
Tree Stratum (Plot size: 20')			
1.			
2.			
3.			
4.			
		= Total Cover	
Sapling/Shrub Stratum (Plot size: 10')			
1.			
2.			
3.			
4.			
5.			
		= Total Cover	
Herb Stratum (Plot size: 10')			
1. Anthoxanthum odoratum	20	Y	FACU
2. Juncus patens	45	Y	FACW
3. Lotus corniculatus	25	Y	FAC
4. Juncus effuses	5	N	FACW
5. Holcus lanatus	10	N	FAC
6. Sisyrinchium californicum	T	N	FACW
7.			
8.			
9.			
10.			
11.			
	100	= Total Cover	
Woody Vine Stratum (Plot size: 10')			
1. Rubus armeniacus	5	Y	FAC
2.			
	5	= Total Cover	
% Bare Ground in Herb Stratum 0			

Dominance Test worksheet:

Number of Dominant Species That Are OBL, FACW, or FAC: 3 (A)
Total Number of Dominant Species Across All Strata: 4 (B)
Percent of Dominant Species That Are OBL, FACW, or FAC: 75 (A/B)

Prevalence Index worksheet:

Total % Cover of:		Multiply by:
OBL species		x 1 =
FACW species		x 2 =
FAC species		x 3 =
FACU species		x 4 =
UPL species		x 5 =
Column Totals:	(A)	(B)

Prevalence Index = B/A =

Hydrophytic Vegetation Indicators:

- [ ] 1 - Rapid Test for Hydrophytic Vegetation
- [X] 2 - Dominance Test is >50%
- [ ] 3 - Prevalence Index is ≤3.0[1]
- [ ] 4 - Morphological Adaptations[1] (Provide supporting data in Remarks or on a separate sheet)
- [ ] 5 - Wetland Non-Vascular Plants[1]
- [ ] Problematic Hydrophytic Vegetation[1] (Explain)

[1]Indicators of hydric soil and wetland hydrology must be present, unless disturbed or problematic.

Hydrophytic Vegetation Present? Yes X No ___

Remarks:

SOIL

Sampling Point: SP I – 2

Profile Description: (Describe to the depth needed to document the indicator or confirm the absence of indicators.)

Depth (inches)	Matrix Color (moist)	Matrix %	Redox Color (moist)	Redox %	Type[1]	Loc[2]	Texture	Remarks
0 – 11	10YR 2.5/2	98	5YR 3/4	2	C	M	L	
11 – 16	10YR 2.5/2	75	7.5YR 3/4	5	C	M	L	
			5YR 3/4	20	C	M		

[1]Type: C=Concentration, D=Depletion, RM=Reduced Matrix, CS=Covered or Coated Sand Grains. [2]Location: PL=Pore Lining, M=Matrix.

Hydric Soil Indicators: (Applicable to all LRRs, unless otherwise noted.)

___ Histosol (A1)
___ Histic Epipedon (A2)
___ Black Histic (A3)
___ Hydrogen Sulfide (A4)
___ Depleted Below Dark Surface (A11)
___ Thick Dark Surface (A12)
___ Sandy Mucky Mineral (S1)
___ Sandy Gleyed Matrix (S4)
___ Sandy Redox (S5)
___ Stripped Matrix (S6)
___ Loamy Mucky Mineral (F1) (**except MLRA 1**)
___ Loamy Gleyed Matrix (F2)
___ Depleted Matrix (F3)
___ Redox Dark Surface (F6)
___ Depleted Dark Surface (F7)
___ Redox Depressions (F8)

Indicators for Problematic Hydric Soils[3]:

___ 2 cm Muck (A10)
___ Red Parent Material (TF2)
___ Very Shallow Dark Surface (TF12)
___ Other (Explain in Remarks)

[3]Indicators of hydrophytic vegetation and wetland hydrology must be present, unless disturbed or problematic

Restrictive Layer (if present):
Type: None
Depth (inches): ____

Hydric Soil Present? **Yes** ____ **No** **X**

Remarks:

HYDROLOGY

Wetland Hydrology Indicators:

Primary Indicators (minimum of one required; check all that apply)

___ Surface Water (A1)
___ High Water Table (A2)
___ Saturation (A3)
___ Water Marks (B1)
___ Sediment Deposits (B2)
___ Drift Deposits (B3)
___ Algal Mat or Crust (B4)
___ Iron Deposits (B5)
___ Surface Soil Cracks (B6)
___ Inundation Visible on Aerial Imagery (B7)
___ Sparsely Vegetated Concave Surface (B8)
___ Water-Stained Leaves (B9) (**except MLRA 1, 2, 4A, and 4B**)
___ Salt Crust (B11)
___ Aquatic Invertebrates (B13)
___ Hydrogen Sulfide Odor (C1)
___ Oxidized Rhizospheres along Living Roots (C3)
___ Presence of Reduced Iron (C4)
___ Recent Iron Reduction in Tilled Soils (C6)
___ Stunted or Stressed Plants (D1) (**LRR A**)
___ Other (Explain in Remarks)

Secondary Indicators (2 or more required)

___ Water-Stained Leaves (B9) (**MLRA 1, 2, 4A, and 4B**)
___ Drainage Patterns (B10)
___ Dry-Season Water Table (C2)
___ Saturation Visible on Aerial Imagery (C9)
___ Geomorphic Position (D2)
___ Shallow Aquitard (D3)
X FAC-Neutral Test (D5)
___ Raised Ant Mounds (D6) (**LRR A**)
___ Frost-Heave Hummocks (D7)

Field Observations:

Surface Water Present? Yes ___ No X Depth (inches): ____
Water Table Present? Yes ___ No X Depth (inches): ____
Saturation Present? (includes capillary fringe) Yes ___ No X Depth (inches): ____

Wetland Hydrology Present? **Yes** ___ **No** **X**

Describe Recorded Data (stream gauge, monitoring well, aerial photos, previous inspections), if available:

Remarks:

WETLAND DETERMINATION DATA FORM – Western Mountains, Valleys, and Coast Region

Project/Site: Pacific Marine Energy Center City/County: Lincoln County Sampling Date: 06/22/2017
Applicant/Owner: Oregon State University State: OR Sampling Point: SP I – 3
Investigator(s): L. Cleveland, B. Sahatjian Section, Township, Range: T13S R11W Sec 7
Landform (hillslope, terrace, etc.): Marine Terrace Local relief (concave, convex, none): Convex Slope (%): <1%
Subregion (LRR): A Lat: 44.459858 Long: -124.074563 Datum: NAD83
Soil Map Unit Name: Bandon fine sandy loam, 3-12% slopes NWI classification: Upland
Are climatic / hydrologic conditions on the site typical for this time of year? Yes X No ___ (If no, explain in Remarks.)
Are Vegetation N , Soil N , or Hydrology N significantly disturbed? Are "Normal Circumstances" present? Yes X No ___
Are Vegetation N , Soil N , or Hydrology Y naturally problematic? (If needed, explain any answers in Remarks.)

SUMMARY OF FINDINGS – Attach site map showing sampling point locations, transects, important features, etc.

Hydrophytic Vegetation Present?	Yes X	No ___	Is the Sampled Area within a Wetland?	Yes X No ___
Hydric Soil Present?	Yes X	No ___		
Wetland Hydrology Present?	Yes ___	No X		

Remarks: Although hydrologic indicators were not present, the sample plot is located in a depression with primary indicators for hydric soils as well as a robust hydrophytic plant community. As I-1 contained water at a depth of 23 inches and also included similar soils and vegetation, this location is assumed to have water earlier in the growing season and was deemed to be a wetland based on the problematic procedures for hydrology in the manual.

VEGETATION – Use scientific names of plants.

	Absolute % Cover	Dominant Species?	Indicator Status
Tree Stratum (Plot size: 20')			
1.			
2.			
3.			
4.			
= Total Cover			
Sapling/Shrub Stratum (Plot size: 10')			
1.			
2.			
3.			
4.			
5.			
= Total Cover			
Herb Stratum (Plot size: 10')			
1. Anthoxanthum odoratum	5	N	FACU
2. Juncus patens	50	Y	FACW
3. Lotus corniculatus	20	Y	FAC
4. Juncus effuses	5	N	FACW
5. Holcus lanatus	10	N	FAC
6. Carex obnupta	10	N	OBL
7. Ranunculus repens	5	N	FAC
8.			
9.			
10.			
11.			
= Total Cover	105		
Woody Vine Stratum (Plot size: 10')			
1. Rubus armeniacus	10	Y	FAC
2.			
= Total Cover	10		
% Bare Ground in Herb Stratum	0		

Dominance Test worksheet:

Number of Dominant Species That Are OBL, FACW, or FAC: 3 (A)
Total Number of Dominant Species Across All Strata: 3 (B)
Percent of Dominant Species That Are OBL, FACW, or FAC: 100 (A/B)

Prevalence Index worksheet:

Total % Cover of:		Multiply by:	
OBL species		x 1 =	
FACW species		x 2 =	
FAC species		x 3 =	
FACU species		x 4 =	
UPL species		x 5 =	
Column Totals:		(A)	(B)

Prevalence Index = B/A =

Hydrophytic Vegetation Indicators:

- ___ 1 - Rapid Test for Hydrophytic Vegetation
- X 2 - Dominance Test is >50%
- ___ 3 - Prevalence Index is ≤3.0[1]
- ___ 4 - Morphological Adaptations[1] (Provide supporting data in Remarks or on a separate sheet)
- ___ 5 - Wetland Non-Vascular Plants[1]
- ___ Problematic Hydrophytic Vegetation[1] (Explain)

[1]Indicators of hydric soil and wetland hydrology must be present, unless disturbed or problematic.

Hydrophytic Vegetation Present? **Yes** X **No** ___

Remarks: Plot for percent cover estimate is confined to the depressional area.

SOIL

Sampling Point: SP I – 3

Profile Description: (Describe to the depth needed to document the indicator or confirm the absence of indicators.)

Depth (inches)	Matrix Color (moist)	Matrix %	Redox Features Color (moist)	Redox Features %	Type[1]	Loc[2]	Texture	Remarks
0 – 7	10YR 2.5/2	99	7.5YR 3/4	1	C	M	L	
7 – 15	10YR 2.5/2	95	7.5YR 3/4	5	C	M	L	

[1]Type: C=Concentration, D=Depletion, RM=Reduced Matrix, CS=Covered or Coated Sand Grains. [2]Location: PL=Pore Lining, M=Matrix.

Hydric Soil Indicators: (Applicable to all LRRs, unless otherwise noted.)

___ Histosol (A1)
___ Histic Epipedon (A2)
___ Black Histic (A3)
___ Hydrogen Sulfide (A4)
___ Depleted Below Dark Surface (A11)
___ Thick Dark Surface (A12)
___ Sandy Mucky Mineral (S1)
___ Sandy Gleyed Matrix (S4)
___ Sandy Redox (S5)
___ Stripped Matrix (S6)
___ Loamy Mucky Mineral (F1) (**except MLRA 1**)
___ Loamy Gleyed Matrix (F2)
___ Depleted Matrix (F3)
X Redox Dark Surface (F6)
___ Depleted Dark Surface (F7)
___ Redox Depressions (F8)

Indicators for Problematic Hydric Soils[3]:

___ 2 cm Muck (A10)
___ Red Parent Material (TF2)
___ Very Shallow Dark Surface (TF12)
___ Other (Explain in Remarks)

[3]Indicators of hydrophytic vegetation and wetland hydrology must be present, unless disturbed or problematic

Restrictive Layer (if present):
Type: None
Depth (inches): ___

Hydric Soil Present? **Yes** X **No** ___

Remarks:

HYDROLOGY

Wetland Hydrology Indicators:

Primary Indicators (minimum of one required; check all that apply)

___ Surface Water (A1)
___ High Water Table (A2)
___ Saturation (A3)
___ Water Marks (B1)
___ Sediment Deposits (B2)
___ Drift Deposits (B3)
___ Algal Mat or Crust (B4)
___ Iron Deposits (B5)
___ Surface Soil Cracks (B6)
___ Inundation Visible on Aerial Imagery (B7)
___ Sparsely Vegetated Concave Surface (B8)
___ Water-Stained Leaves (B9) (**except MLRA 1, 2, 4A, and 4B**)
___ Salt Crust (B11)
___ Aquatic Invertebrates (B13)
___ Hydrogen Sulfide Odor (C1)
___ Oxidized Rhizospheres along Living Roots (C3)
___ Presence of Reduced Iron (C4)
___ Recent Iron Reduction in Tilled Soils (C6)
___ Stunted or Stressed Plants (D1) (**LRR A**)
___ Other (Explain in Remarks)

Secondary Indicators (2 or more required)

___ Water-Stained Leaves (B9) (**MLRA 1, 2, 4A, and 4B**)
___ Drainage Patterns (B10)
___ Dry-Season Water Table (C2)
___ Saturation Visible on Aerial Imagery (C9)
___ Geomorphic Position (D2)
___ Shallow Aquitard (D3)
X FAC-Neutral Test (D5)
___ Raised Ant Mounds (D6) (**LRR A**)
___ Frost-Heave Hummocks (D7)

Field Observations:

	Yes		No		Depth (inches):
Surface Water Present?	Yes		No	X	Depth (inches): ___
Water Table Present?	Yes		No	X	Depth (inches): ___
Saturation Present? (includes capillary fringe)	Yes		No	X	Depth (inches): ___

Wetland Hydrology Present? **Yes** ___ **No** X

Describe Recorded Data (stream gauge, monitoring well, aerial photos, previous inspections), if available:

Remarks: Augured to a depth of 36 inches and did not encounter dry season water table.

WETLAND DETERMINATION DATA FORM – Western Mountains, Valleys, and Coast Region

Project/Site: Pacific Marine Energy Center City/County: Lincoln County Sampling Date: 06/22/2017
Applicant/Owner: Oregon State University State: OR Sampling Point: SP I – 4
Investigator(s): L. Cleveland, B. Sahatjian Section, Township, Range: T13S R11W Sec 7
Landform (hillslope, terrace, etc.): Marine Terrace Local relief (concave, convex, none): Convex Slope (%): 2
Subregion (LRR): A Lat: 44.459541 Long: -124.074571 Datum: NAD83
Soil Map Unit Name: Bandon fine sandy loam, 3-12% slopes NWI classification: Upland
Are climatic / hydrologic conditions on the site typical for this time of year? Yes X No ___ (If no, explain in Remarks.)
Are Vegetation N , Soil N , or Hydrology N significantly disturbed? Are "Normal Circumstances" present? Yes X No ___
Are Vegetation N , Soil N , or Hydrology N naturally problematic? (If needed, explain any answers in Remarks.)

SUMMARY OF FINDINGS – Attach site map showing sampling point locations, transects, important features, etc.

Hydrophytic Vegetation Present?	Yes ___	No X
Hydric Soil Present?	Yes ___	No X
Wetland Hydrology Present?	Yes ___	No X

Is the Sampled Area within a Wetland? Yes ___ No X

Remarks:

VEGETATION – Use scientific names of plants.

Stratum / Species	Absolute % Cover	Dominant Species?	Indicator Status
Tree Stratum (Plot size: 20')			
1.			
2.			
3.			
4.			
= Total Cover			
Sapling/Shrub Stratum (Plot size: 10')			
1. Vaccinium ovatum	5	Y	FACU
2.			
3.			
4.			
5.			
= Total Cover	5		
Herb Stratum (Plot size: 10')			
1. Anthoxanthum odoratum	25	Y	FACU
2. Juncus patens	15	N	FACW
3. Lotus corniculatus	20	Y	FAC
4. Plantago lanceolata	15	N	FACU
5. Holcus lanatus	15	N	FAC
6.			
7.			
8.			
9.			
10.			
11.			
= Total Cover	90		
Woody Vine Stratum (Plot size: 10')			
1. Rubus armeniacus	15	Y	FAC
2.			
= Total Cover	15		

% Bare Ground in Herb Stratum 10

Dominance Test worksheet:

Number of Dominant Species That Are OBL, FACW, or FAC: 2 (A)
Total Number of Dominant Species Across All Strata: 4 (B)
Percent of Dominant Species That Are OBL, FACW, or FAC: 50 (A/B)

Prevalence Index worksheet:

Total % Cover of:		Multiply by:
OBL species	0	x 1 = 0
FACW species	15	x 2 = 30
FAC species	50	x 3 = 150
FACU species	45	x 4 = 180
UPL species	0	x 5 = 0
Column Totals:	110 (A)	360 (B)

Prevalence Index = B/A = 3.27

Hydrophytic Vegetation Indicators:

- ___ 1 - Rapid Test for Hydrophytic Vegetation
- ___ 2 - Dominance Test is >50%
- ___ 3 - Prevalence Index is ≤3.0[1]
- ___ 4 - Morphological Adaptations[1] (Provide supporting data in Remarks or on a separate sheet)
- ___ 5 - Wetland Non-Vascular Plants[1]
- ___ Problematic Hydrophytic Vegetation[1] (Explain)

[1]Indicators of hydric soil and wetland hydrology must be present, unless disturbed or problematic.

Hydrophytic Vegetation Present? Yes ___ No X

Remarks:

SOIL

Sampling Point: SP I – 4

Profile Description: (Describe to the depth needed to document the indicator or confirm the absence of indicators.)

Depth (inches)	Matrix Color (moist)	Matrix %	Redox Features Color (moist)	Redox %	Type[1]	Loc[2]	Texture	Remarks
0 – 8	10YR 2.5/2	100					L	
8 – 15	10YR 2.5/2	99	7.5YR 3/4	1	C	M	L	

[1]Type: C=Concentration, D=Depletion, RM=Reduced Matrix, CS=Covered or Coated Sand Grains. [2]Location: PL=Pore Lining, M=Matrix.

Hydric Soil Indicators: (Applicable to all LRRs, unless otherwise noted.)

___ Histosol (A1)
___ Histic Epipedon (A2)
___ Black Histic (A3)
___ Hydrogen Sulfide (A4)
___ Depleted Below Dark Surface (A11)
___ Thick Dark Surface (A12)
___ Sandy Mucky Mineral (S1)
___ Sandy Gleyed Matrix (S4)
___ Sandy Redox (S5)
___ Stripped Matrix (S6)
___ Loamy Mucky Mineral (F1) (**except MLRA 1**)
___ Loamy Gleyed Matrix (F2)
___ Depleted Matrix (F3)
___ Redox Dark Surface (F6)
___ Depleted Dark Surface (F7)
___ Redox Depressions (F8)

Indicators for Problematic Hydric Soils[3]:

___ 2 cm Muck (A10)
___ Red Parent Material (TF2)
___ Very Shallow Dark Surface (TF12)
___ Other (Explain in Remarks)

[3]Indicators of hydrophytic vegetation and wetland hydrology must be present, unless disturbed or problematic

Restrictive Layer (if present):
Type: None
Depth (inches):

Hydric Soil Present? **Yes** ___ **No** X

Remarks:

HYDROLOGY

Wetland Hydrology Indicators:

Primary Indicators (minimum of one required; check all that apply)

___ Surface Water (A1)
___ High Water Table (A2)
___ Saturation (A3)
___ Water Marks (B1)
___ Sediment Deposits (B2)
___ Drift Deposits (B3)
___ Algal Mat or Crust (B4)
___ Iron Deposits (B5)
___ Surface Soil Cracks (B6)
___ Inundation Visible on Aerial Imagery (B7)
___ Sparsely Vegetated Concave Surface (B8)
___ Water-Stained Leaves (B9) (**except MLRA 1, 2, 4A, and 4B**)
___ Salt Crust (B11)
___ Aquatic Invertebrates (B13)
___ Hydrogen Sulfide Odor (C1)
___ Oxidized Rhizospheres along Living Roots (C3)
___ Presence of Reduced Iron (C4)
___ Recent Iron Reduction in Tilled Soils (C6)
___ Stunted or Stressed Plants (D1) (**LRR A**)
___ Other (Explain in Remarks)

Secondary Indicators (2 or more required)

___ Water-Stained Leaves (B9) (**MLRA 1, 2, 4A, and 4B**)
___ Drainage Patterns (B10)
___ Dry-Season Water Table (C2)
___ Saturation Visible on Aerial Imagery (C9)
___ Geomorphic Position (D2)
___ Shallow Aquitard (D3)
___ FAC-Neutral Test (D5)
___ Raised Ant Mounds (D6) (**LRR A**)
___ Frost-Heave Hummocks (D7)

Field Observations:

	Yes		No		Depth (inches):
Surface Water Present?	Yes		No	X	Depth (inches):
Water Table Present?	Yes		No	X	Depth (inches):
Saturation Present? (includes capillary fringe)	Yes		No	X	Depth (inches):

Wetland Hydrology Present? **Yes** ___ **No** X

Describe Recorded Data (stream gauge, monitoring well, aerial photos, previous inspections), if available:

Remarks:

WETLAND DETERMINATION DATA FORM – Western Mountains, Valleys, and Coast Region

Project/Site: Pacific Marine Energy Center City/County: Lincoln County Sampling Date: 06/22/2017
Applicant/Owner: Oregon State University State: OR Sampling Point: SP I – 5
Investigator(s): L. Cleveland, B. Sahatjian Section, Township, Range: T13S R11W Sec 7
Landform (hillslope, terrace, etc.): Marine Terrace Local relief (concave, convex, none): Convex Slope (%): 1
Subregion (LRR): A Lat: 44.459836 Long: -124.074529 Datum: NAD83
Soil Map Unit Name: Bandon fine sandy loam, 3-12% slopes NWI classification: Upland
Are climatic / hydrologic conditions on the site typical for this time of year? Yes X No ___ (If no, explain in Remarks.)
Are Vegetation N , Soil N , or Hydrology N significantly disturbed? Are "Normal Circumstances" present? Yes X No ___
Are Vegetation N , Soil N , or Hydrology N naturally problematic? (If needed, explain any answers in Remarks.)

SUMMARY OF FINDINGS – Attach site map showing sampling point locations, transects, important features, etc.

Hydrophytic Vegetation Present?	Yes ___ No X	Is the Sampled Area within a Wetland? Yes ___ No X
Hydric Soil Present?	Yes ___ No X	
Wetland Hydrology Present?	Yes ___ No X	

Remarks:

VEGETATION – Use scientific names of plants.

Tree Stratum (Plot size: 20')	Absolute % Cover	Dominant Species?	Indicator Status
1. Malus fusca	15	Y	FACW
2.			
3.			
4.			
	15	= Total Cover	
Sapling/Shrub Stratum (Plot size: 10')			
1. Vaccinium ovatum	5	N	FACU
2. Gaultheria shallon	40	Y	FACU
3. Vaccinnium parvifolium	5	N	FACU
4.			
5.			
	50	= Total Cover	
Herb Stratum (Plot size: 10')			
1. Anthoxanthum odoratum	30	Y	FACU
2. Holcus lanatus	5	N	FAC
3. Lotus corniculatus	35	Y	FAC
4. Plantago lanceolata	30	Y	FACU
5.			
6.			
7.			
8.			
9.			
10.			
11.			
	100	= Total Cover	
Woody Vine Stratum (Plot size: 10')			
1. Rubus armeniacus	10	Y	FAC
2.			
	10	= Total Cover	

% Bare Ground in Herb Stratum 0

Dominance Test worksheet:

Number of Dominant Species That Are OBL, FACW, or FAC: 3 (A)
Total Number of Dominant Species Across All Strata: 6 (B)
Percent of Dominant Species That Are OBL, FACW, or FAC: 50 (A/B)

Prevalence Index worksheet:

Total % Cover of:		Multiply by:	
OBL species	0	x 1 =	0
FACW species	15	x 2 =	30
FAC species	50	x 3 =	150
FACU species	110	x 4 =	440
UPL species	0	x 5 =	0
Column Totals:	175 (A)		620 (B)

Prevalence Index = B/A = 3.54

Hydrophytic Vegetation Indicators:

- ___ 1 - Rapid Test for Hydrophytic Vegetation
- ___ 2 - Dominance Test is >50%
- ___ 3 - Prevalence Index is ≤3.0[1]
- ___ 4 - Morphological Adaptations[1] (Provide supporting data in Remarks or on a separate sheet)
- ___ 5 - Wetland Non-Vascular Plants[1]
- ___ Problematic Hydrophytic Vegetation[1] (Explain)

[1]Indicators of hydric soil and wetland hydrology must be present, unless disturbed or problematic.

Hydrophytic Vegetation Present? Yes ___ No X

Remarks:

SOIL

Sampling Point: SP I – 5

Profile Description: (Describe to the depth needed to document the indicator or confirm the absence of indicators.)

Depth (inches)	Matrix Color (moist)	Matrix %	Redox Features Color (moist)	Redox Features %	Type[1]	Loc[2]	Texture	Remarks
0 – 5	10YR 2.5/2	100					L	
5 – 15	10YR 2.5/2	98	7.5YR 3/4	2	C	M	L	

[1]Type: C=Concentration, D=Depletion, RM=Reduced Matrix, CS=Covered or Coated Sand Grains. [2]Location: PL=Pore Lining, M=Matrix.

Hydric Soil Indicators: (Applicable to all LRRs, unless otherwise noted.)

___ Histosol (A1)
___ Histic Epipedon (A2)
___ Black Histic (A3)
___ Hydrogen Sulfide (A4)
___ Depleted Below Dark Surface (A11)
___ Thick Dark Surface (A12)
___ Sandy Mucky Mineral (S1)
___ Sandy Gleyed Matrix (S4)
___ Sandy Redox (S5)
___ Stripped Matrix (S6)
___ Loamy Mucky Mineral (F1) (**except MLRA 1**)
___ Loamy Gleyed Matrix (F2)
___ Depleted Matrix (F3)
___ Redox Dark Surface (F6)
___ Depleted Dark Surface (F7)
___ Redox Depressions (F8)

Indicators for Problematic Hydric Soils[3]:

___ 2 cm Muck (A10)
___ Red Parent Material (TF2)
___ Very Shallow Dark Surface (TF12)
___ Other (Explain in Remarks)

[3]Indicators of hydrophytic vegetation and wetland hydrology must be present, unless disturbed or problematic

Restrictive Layer (if present):
Type: None
Depth (inches):

Hydric Soil Present? **Yes** ___ **No** **X**

Remarks:

HYDROLOGY

Wetland Hydrology Indicators:

Primary Indicators (minimum of one required; check all that apply)

___ Surface Water (A1)
___ High Water Table (A2)
___ Saturation (A3)
___ Water Marks (B1)
___ Sediment Deposits (B2)
___ Drift Deposits (B3)
___ Algal Mat or Crust (B4)
___ Iron Deposits (B5)
___ Surface Soil Cracks (B6)
___ Inundation Visible on Aerial Imagery (B7)
___ Sparsely Vegetated Concave Surface (B8)
___ Water-Stained Leaves (B9) (**except MLRA 1, 2, 4A, and 4B**)
___ Salt Crust (B11)
___ Aquatic Invertebrates (B13)
___ Hydrogen Sulfide Odor (C1)
___ Oxidized Rhizospheres along Living Roots (C3)
___ Presence of Reduced Iron (C4)
___ Recent Iron Reduction in Tilled Soils (C6)
___ Stunted or Stressed Plants (D1) (**LRR A**)
___ Other (Explain in Remarks)

Secondary Indicators (2 or more required)

___ Water-Stained Leaves (B9) (**MLRA 1, 2, 4A, and 4B**)
___ Drainage Patterns (B10)
___ Dry-Season Water Table (C2)
___ Saturation Visible on Aerial Imagery (C9)
___ Geomorphic Position (D2)
___ Shallow Aquitard (D3)
___ FAC-Neutral Test (D5)
___ Raised Ant Mounds (D6) (**LRR A**)
___ Frost-Heave Hummocks (D7)

Field Observations:

Surface Water Present?	Yes		No	X	Depth (inches):
Water Table Present?	Yes		No	X	Depth (inches):
Saturation Present? (includes capillary fringe)	Yes		No	X	Depth (inches):

Wetland Hydrology Present? **Yes** ___ **No** **X**

Describe Recorded Data (stream gauge, monitoring well, aerial photos, previous inspections), if available:

Remarks:

WETLAND DETERMINATION DATA FORM – Western Mountains, Valleys, and Coast Region

Project/Site: Pacific Marine Energy Center City/County: Lincoln County Sampling Date: 06/22/2017
Applicant/Owner: Oregon State University State: OR Sampling Point: SP I – 6
Investigator(s): L. Cleveland, B. Sahatjian Section, Township, Range: T13S R11W Sec 7
Landform (hillslope, terrace, etc.): Marine Terrace Local relief (concave, convex, none): Convex Slope (%): <1%
Subregion (LRR): A Lat: 44.459921 Long: -124.074598 Datum: NAD83
Soil Map Unit Name: Bandon fine sandy loam, 3-12% slopes NWI classification: Upland
Are climatic / hydrologic conditions on the site typical for this time of year? Yes X No ___ (If no, explain in Remarks.)
Are Vegetation N , Soil N , or Hydrology N significantly disturbed? Are "Normal Circumstances" present? Yes X No ___
Are Vegetation N , Soil N , or Hydrology Y naturally problematic? (If needed, explain any answers in Remarks.)

SUMMARY OF FINDINGS – Attach site map showing sampling point locations, transects, important features, etc.

Hydrophytic Vegetation Present?	Yes X No ___	Is the Sampled Area within a Wetland? Yes X No ___
Hydric Soil Present?	Yes X No ___	
Wetland Hydrology Present?	Yes ___ No X	

Remarks: Although hydrologic indicators were not present, the sample plot is located in a depression with primary indicators for hydric soils as well as a robust hydrophytic plant community. Other areas within the wetland exhibited water at a depth of 23 inches and also included similar soils and vegetation. Therefore, this location is assumed to have water earlier in the growing season and was deemed to be a wetland based on the problematic procedures for hydrology in the manual.

VEGETATION – Use scientific names of plants.

	Absolute % Cover	Dominant Species?	Indicator Status
Tree Stratum (Plot size: 20')			
1.			
2.			
3.			
4.			
		= Total Cover	
Sapling/Shrub Stratum (Plot size: 10')			
1. Alnus rubra	20	Y	FAC
2.			
3.			
4.			
5.			
	20	= Total Cover	
Herb Stratum (Plot size: 10')			
1. Anthoxanthum odoratum	15	Y	FACU
2. Juncus patens	20	Y	FACW
3. Lotus corniculatus	15	Y	FAC
4. Juncus effuses	25	Y	FACW
5. Holcus lanatus	10	N	FAC
6. Carex obnupta	10	N	OBL
7.			
8.			
9.			
10.			
11.			
	95	= Total Cover	
Woody Vine Stratum (Plot size: 10')			
1. Rubus armeniacus	15	Y	FAC
2.			
	15	= Total Cover	

% Bare Ground in Herb Stratum 5

Dominance Test worksheet:

Number of Dominant Species That Are OBL, FACW, or FAC: 5 (A)
Total Number of Dominant Species Across All Strata: 6 (B)
Percent of Dominant Species That Are OBL, FACW, or FAC: 83 (A/B)

Prevalence Index worksheet:

Total % Cover of:		Multiply by:
OBL species	___	x 1 = ___
FACW species	___	x 2 = ___
FAC species	___	x 3 = ___
FACU species	___	x 4 = ___
UPL species	___	x 5 = ___
Column Totals:	___ (A)	___ (B)

Prevalence Index = B/A = ___

Hydrophytic Vegetation Indicators:

- ___ 1 - Rapid Test for Hydrophytic Vegetation
- X 2 - Dominance Test is >50%
- ___ 3 - Prevalence Index is ≤3.0[1]
- ___ 4 - Morphological Adaptations[1] (Provide supporting data in Remarks or on a separate sheet)
- ___ 5 - Wetland Non-Vascular Plants[1]
- ___ Problematic Hydrophytic Vegetation[1] (Explain)

[1]Indicators of hydric soil and wetland hydrology must be present, unless disturbed or problematic.

Hydrophytic Vegetation Present? Yes X No ___

Remarks: Plot for percent cover estimate is confined to the depressional area.

SOIL

Sampling Point: SP I – 6

Profile Description: (Describe to the depth needed to document the indicator or confirm the absence of indicators.)

Depth (inches)	Matrix Color (moist)	Matrix %	Redox Features Color (moist)	Redox Features %	Type[1]	Loc[2]	Texture	Remarks
0 – 5	10YR 2.5/2	98	7.5YR 3/4	2	C	M	L	
5 – 15	10YR 2.5/2	95	7.5YR 3/4	5	C	M	L	

[1]Type: C=Concentration, D=Depletion, RM=Reduced Matrix, CS=Covered or Coated Sand Grains. [2]Location: PL=Pore Lining, M=Matrix.

Hydric Soil Indicators: (Applicable to all LRRs, unless otherwise noted.)

- ___ Histosol (A1)
- ___ Histic Epipedon (A2)
- ___ Black Histic (A3)
- ___ Hydrogen Sulfide (A4)
- ___ Depleted Below Dark Surface (A11)
- ___ Thick Dark Surface (A12)
- ___ Sandy Mucky Mineral (S1)
- ___ Sandy Gleyed Matrix (S4)
- ___ Sandy Redox (S5)
- ___ Stripped Matrix (S6)
- ___ Loamy Mucky Mineral (F1) (**except MLRA 1**)
- ___ Loamy Gleyed Matrix (F2)
- ___ Depleted Matrix (F3)
- X Redox Dark Surface (F6)
- ___ Depleted Dark Surface (F7)
- ___ Redox Depressions (F8)

Indicators for Problematic Hydric Soils[3]:

- ___ 2 cm Muck (A10)
- ___ Red Parent Material (TF2)
- ___ Very Shallow Dark Surface (TF12)
- ___ Other (Explain in Remarks)

[3]Indicators of hydrophytic vegetation and wetland hydrology must be present, unless disturbed or problematic

Restrictive Layer (if present):

Type: None

Depth (inches):

Hydric Soil Present? **Yes** X **No**

Remarks:

HYDROLOGY

Wetland Hydrology Indicators:

Primary Indicators (minimum of one required; check all that apply)

- ___ Surface Water (A1)
- ___ High Water Table (A2)
- ___ Saturation (A3)
- ___ Water Marks (B1)
- ___ Sediment Deposits (B2)
- ___ Drift Deposits (B3)
- ___ Algal Mat or Crust (B4)
- ___ Iron Deposits (B5)
- ___ Surface Soil Cracks (B6)
- ___ Inundation Visible on Aerial Imagery (B7)
- ___ Sparsely Vegetated Concave Surface (B8)
- ___ Water-Stained Leaves (B9) (**except MLRA 1, 2, 4A, and 4B**)
- ___ Salt Crust (B11)
- ___ Aquatic Invertebrates (B13)
- ___ Hydrogen Sulfide Odor (C1)
- ___ Oxidized Rhizospheres along Living Roots (C3)
- ___ Presence of Reduced Iron (C4)
- ___ Recent Iron Reduction in Tilled Soils (C6)
- ___ Stunted or Stressed Plants (D1) (**LRR A**)
- ___ Other (Explain in Remarks)

Secondary Indicators (2 or more required)

- ___ Water-Stained Leaves (B9) (**MLRA 1, 2, 4A, and 4B**)
- ___ Drainage Patterns (B10)
- ___ Dry-Season Water Table (C2)
- ___ Saturation Visible on Aerial Imagery (C9)
- ___ Geomorphic Position (D2)
- ___ Shallow Aquitard (D3)
- X FAC-Neutral Test (D5)
- ___ Raised Ant Mounds (D6) (**LRR A**)
- ___ Frost-Heave Hummocks (D7)

Field Observations:

	Yes	No	Depth (inches)
Surface Water Present?		X	
Water Table Present?		X	
Saturation Present? (includes capillary fringe)		X	

Wetland Hydrology Present? **Yes** **No** X

Describe Recorded Data (stream gauge, monitoring well, aerial photos, previous inspections), if available:

Remarks: Augured to a depth of 30 inches and did not encounter dry season water table.

WETLAND DETERMINATION DATA FORM – Western Mountains, Valleys, and Coast Region

Project/Site: Pacific Marine Energy Center City/County: Lincoln County Sampling Date: 06/22/2017
Applicant/Owner: Oregon State University State: OR Sampling Point: SP I – 7
Investigator(s): L. Cleveland, B. Sahatjian Section, Township, Range: T13S R11W Sec 7
Landform (hillslope, terrace, etc.): Marine Terrace Local relief (concave, convex, none): Convex Slope (%): 2
Subregion (LRR): A Lat: 44.459927 Long: -124.074639 Datum: NAD83
Soil Map Unit Name: Bandon fine sandy loam, 3-12% slopes NWI classification: Upland
Are climatic / hydrologic conditions on the site typical for this time of year? Yes X No ___ (If no, explain in Remarks.)
Are Vegetation N , Soil N , or Hydrology N significantly disturbed? Are "Normal Circumstances" present? Yes X No ___
Are Vegetation N , Soil N , or Hydrology N naturally problematic? (If needed, explain any answers in Remarks.)

SUMMARY OF FINDINGS – Attach site map showing sampling point locations, transects, important features, etc.

	Yes	No
Hydrophytic Vegetation Present?		X
Hydric Soil Present?		X
Wetland Hydrology Present?		X

Is the Sampled Area within a Wetland? Yes ___ No X

Remarks:

VEGETATION – Use scientific names of plants.

Tree Stratum (Plot size: 20')	Absolute % Cover	Dominant Species?	Indicator Status
1. Picea sitchensis	30	Y	FAC
2.			
3.			
4.			
	30	= Total Cover	
Sapling/Shrub Stratum (Plot size: 10')			
1. Vaccinium ovatum	15	Y	FACU
2. Gaultheria shallon	10	Y	FACU
3. Alnus rubra	5	N	FAC
4.			
5.			
	30	= Total Cover	
Herb Stratum (Plot size: 10')			
1. Anthoxanthum odoratum	30	Y	FACU
2. Holcus lanatus	5	N	FAC
3. Lotus corniculatus	35	Y	FAC
4. Plantago lanceolata	30	Y	FACU
5.			
6.			
7.			
8.			
9.			
10.			
11.			
	100	= Total Cover	
Woody Vine Stratum (Plot size: 10')			
1. Rubus armeniacus	10	Y	FAC
2.			
	10	= Total Cover	

% Bare Ground in Herb Stratum 0

Dominance Test worksheet:

Number of Dominant Species That Are OBL, FACW, or FAC: 3 (A)
Total Number of Dominant Species Across All Strata: 7 (B)
Percent of Dominant Species That Are OBL, FACW, or FAC: 43 (A/B)

Prevalence Index worksheet:

Total % Cover of:		Multiply by:	
OBL species	0	x 1 =	0
FACW species	0	x 2 =	0
FAC species	85	x 3 =	255
FACU species	85	x 4 =	340
UPL species	0	x 5 =	0
Column Totals:	170 (A)		595 (B)

Prevalence Index = B/A = 3.50

Hydrophytic Vegetation Indicators:

- ___ 1 - Rapid Test for Hydrophytic Vegetation
- ___ 2 - Dominance Test is >50%
- ___ 3 - Prevalence Index is ≤3.0[1]
- ___ 4 - Morphological Adaptations[1] (Provide supporting data in Remarks or on a separate sheet)
- ___ 5 - Wetland Non-Vascular Plants[1]
- ___ Problematic Hydrophytic Vegetation[1] (Explain)

[1]Indicators of hydric soil and wetland hydrology must be present, unless disturbed or problematic.

Hydrophytic Vegetation Present? Yes ___ No X

Remarks:

SOIL

Sampling Point: SP I – 7

Profile Description: (Describe to the depth needed to document the indicator or confirm the absence of indicators.)

Depth (inches)	Matrix Color (moist)	Matrix %	Redox Features Color (moist)	Redox Features %	Type[1]	Loc[2]	Texture	Remarks
0 – 6	10YR 2.5/2	100					L	
6 – 15	10YR 2.5/2	99	7.5YR 3/4	1	C	M	L	

[1]Type: C=Concentration, D=Depletion, RM=Reduced Matrix, CS=Covered or Coated Sand Grains. [2]Location: PL=Pore Lining, M=Matrix.

Hydric Soil Indicators: (Applicable to all LRRs, unless otherwise noted.)

___ Histosol (A1)
___ Histic Epipedon (A2)
___ Black Histic (A3)
___ Hydrogen Sulfide (A4)
___ Depleted Below Dark Surface (A11)
___ Thick Dark Surface (A12)
___ Sandy Mucky Mineral (S1)
___ Sandy Gleyed Matrix (S4)
___ Sandy Redox (S5)
___ Stripped Matrix (S6)
___ Loamy Mucky Mineral (F1) (**except MLRA 1**)
___ Loamy Gleyed Matrix (F2)
___ Depleted Matrix (F3)
___ Redox Dark Surface (F6)
___ Depleted Dark Surface (F7)
___ Redox Depressions (F8)

Indicators for Problematic Hydric Soils[3]:

___ 2 cm Muck (A10)
___ Red Parent Material (TF2)
___ Very Shallow Dark Surface (TF12)
___ Other (Explain in Remarks)

[3]Indicators of hydrophytic vegetation and wetland hydrology must be present, unless disturbed or problematic

Restrictive Layer (if present):
Type: None
Depth (inches): ______

Hydric Soil Present? **Yes** ______ **No** X

Remarks:

HYDROLOGY

Wetland Hydrology Indicators:

Primary Indicators (minimum of one required; check all that apply)

___ Surface Water (A1)
___ High Water Table (A2)
___ Saturation (A3)
___ Water Marks (B1)
___ Sediment Deposits (B2)
___ Drift Deposits (B3)
___ Algal Mat or Crust (B4)
___ Iron Deposits (B5)
___ Surface Soil Cracks (B6)
___ Inundation Visible on Aerial Imagery (B7)
___ Sparsely Vegetated Concave Surface (B8)
___ Water-Stained Leaves (B9) (**except MLRA 1, 2, 4A, and 4B**)
___ Salt Crust (B11)
___ Aquatic Invertebrates (B13)
___ Hydrogen Sulfide Odor (C1)
___ Oxidized Rhizospheres along Living Roots (C3)
___ Presence of Reduced Iron (C4)
___ Recent Iron Reduction in Tilled Soils (C6)
___ Stunted or Stressed Plants (D1) (**LRR A**)
___ Other (Explain in Remarks)

Secondary Indicators (2 or more required)

___ Water-Stained Leaves (B9) (**MLRA 1, 2, 4A, and 4B**)
___ Drainage Patterns (B10)
___ Dry-Season Water Table (C2)
___ Saturation Visible on Aerial Imagery (C9)
___ Geomorphic Position (D2)
___ Shallow Aquitard (D3)
___ FAC-Neutral Test (D5)
___ Raised Ant Mounds (D6) (**LRR A**)
___ Frost-Heave Hummocks (D7)

Field Observations:

	Yes		No		Depth (inches):
Surface Water Present?	Yes		No	X	
Water Table Present?	Yes		No	X	
Saturation Present? (includes capillary fringe)	Yes		No	X	

Wetland Hydrology Present? **Yes** ______ **No** **X**

Describe Recorded Data (stream gauge, monitoring well, aerial photos, previous inspections), if available:

Remarks:

Streamflow Duration Field Assessment Form

Project # / Name	Pacific Marine Energy Center	Assessor	Halstead
Address		Date	06-01-16
Waterway Name	Friday Creek	Coordinates at downstream end (ddd.mm.ss)	Lat. 44° 28'2.972" N Long. 124° 4'39.900" W
Reach Boundaries			

Precipitation w/in 48 hours (cm) none	Channel Width (m) 2.5	☐ Disturbed Site / Difficult Situation (Describe in "Notes")

Observed Hydrology

% of reach w/observed surface flow 100

% of reach w/any flow (surface or hyporheic) 100

# of pools observed 0

Observations

Observed Wetland Plants (and indicator status):

None. No plants present in channel.

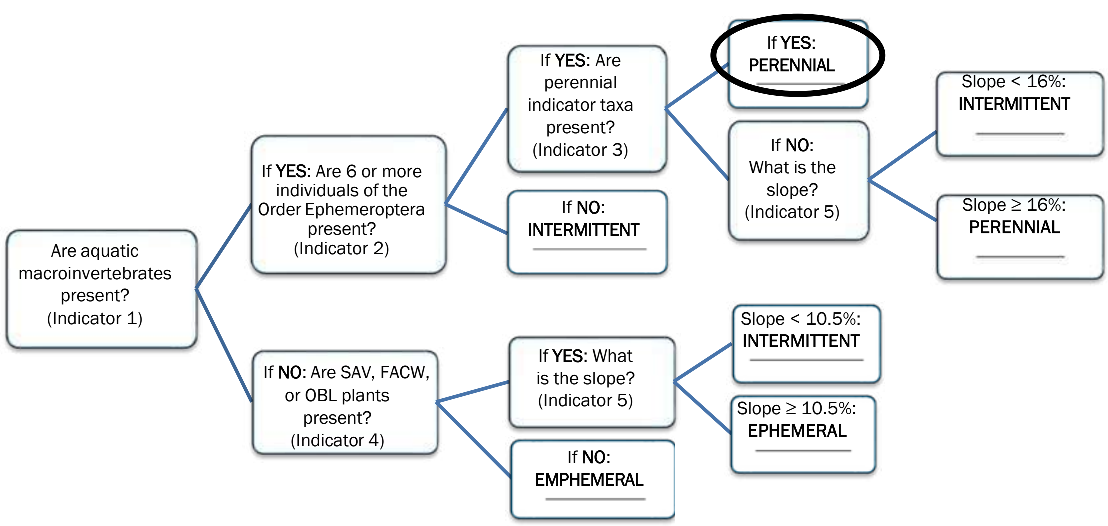
Observed Macroinvertebrates:

Taxon	Indicator Status	Ephemeroptera?	# of Individuals
Fish are present - did not review stream for macroinvertebrates			

Indicators

1. Are aquatic macroinvertebrates present?	☐ Yes	☒ No
2. Are 6 or more individuals of the Order Ephemeroptera present?	☐ Yes	☒ No
3. Are perennial indicator taxa present? (refer to Table 1)	☒ Yes	☒ No
4. Are FACW, OBL, or SAV plants present? (Within ½ channel width)	☐ Yes	☒ No
5. What is the slope? (In percent, measured for the valley, not the stream)	2 %	

Conclusions



Single Indicators:
☒ Fish
☐ Amphibians

Finding:
☐ Ephemeral
☐ Intermittent
☒ Perennial

Notes: (explanation of any single indicator co nclusions, description of disturbances or modifications that may interfere with indicators, etc.)

Difficult Situation:

- ☐ Prolonged Abnormal Rainfall / Snowpack
  - ☐ Below Average
  - ☐ Above Average
- ☐ Natural or Anthropogenic Disturbance
- ☐ Other: ____________________________

Describe situation. For disturbed streams, note extent, type, and history of disturbance.

Additional Notes: (sketch of site, description of photos, comments on hydrological observations, etc.) Attach additional sheets as necessary.

Defined bed and bank present.

Ancillary Information:

- ☐ Riparian Corridor
- ☐ Erosion and Deposition
- ☐ Floodplain Connectivity

Observed Amphibians, Snake, and Fish:

Taxa	Life History Stage	Location Observed	Number of Individuals Observed

Streamflow Duration Field Assessment Form

Project # / Name: **Pacific Marine Energy Center**	Assessor: **Halstead**
Address	Date: 06-01-16
Waterway Name: **Twombly Creek**	Coordinates at downstream end (ddd.mm.ss): Lat. 44°27'37.881" N; Long. 124°4'34.497" W
Reach Boundaries	

Precipitation w/in 48 hours (cm) none	Channel Width (m) 3	☐ Disturbed Site / Difficult Situation (Describe in "Notes")

Observed Hydrology

% of reach w/observed surface flow 50

% of reach w/any flow (surface or hyporheic) 50

# of pools observed 0

Observations

Observed Wetland Plants (and indicator status):

None. No plants present in channel.

Observed Macroinvertebrates:

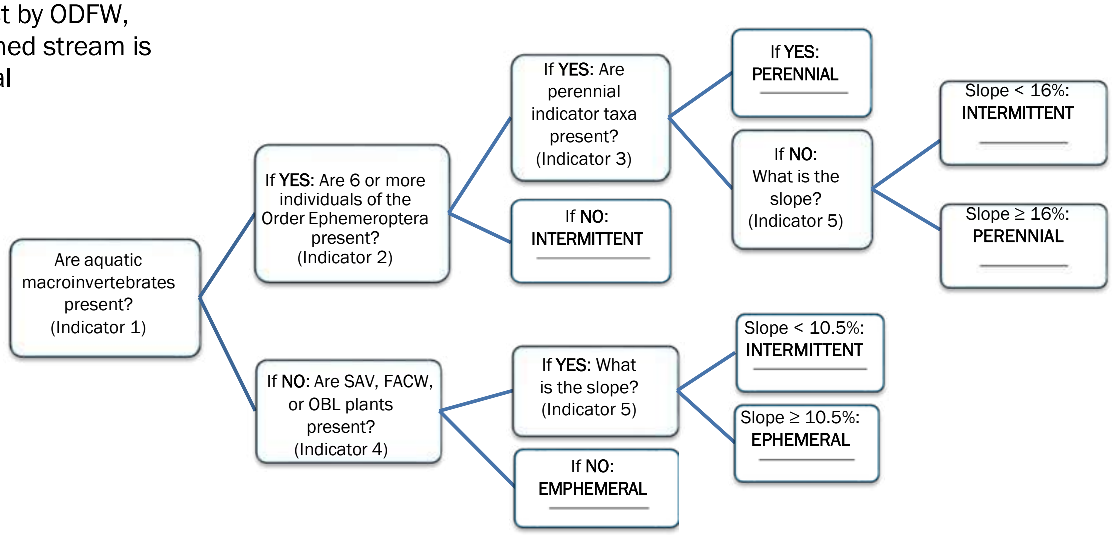
Taxon	Indicator Status	Ephemeroptera?	# of Individuals
did not review stream for macroinvertebrates			

Indicators

1. Are aquatic macroinvertebrates present?	☐ Yes	☒ No
2. Are 6 or more individuals of the Order Ephemeroptera present?	☐ Yes	☒ No
3. Are perennial indicator taxa present? (refer to Table 1)	☒ Yes	☒ No
4. Are FACW, OBL, or SAV plants present? (Within ½ channel width)	☐ Yes	☒ No
5. What is the slope? (In percent, measured for the valley, not the stream)	2 %	

Conclusions

Based on observed flow in August by ODFW, determined stream is perennial



Single Indicators:
- ☐ Fish
- ☐ Amphibians

Finding:
- ☐ Ephemeral
- ☐ Intermittent
- ☒ Perennial

Notes: (explanation of any single indicator co nclusions, description of disturbances or modifications that may interfere with indicators, etc.)

Difficult Situation:

Describe situation. For disturbed streams, note extent, type, and history of disturbance.

- ☐ Prolonged Abnormal Rainfall / Snowpack
  - ☐ Below Average
  - ☐ Above Average
- ☐ Natural or Anthropogenic Disturbance
- ☐ Other: ____________________________

Additional Notes: (sketch of site, description of photos, comments on hydrological observations, etc.) Attach additional sheets as necessary.

Defined bed and bank present.

Ancillary Information:

- ☐ Riparian Corridor
- ☐ Erosion and Deposition
- ☐ Floodplain Connectivity

Observed Amphibians, Snake, and Fish:

Taxa	Life History Stage	Location Observed	Number of Individuals Observed

Streamflow Duration Field Assessment Form

Project # / Name	Pacific Marine Energy Center	Assessor	Halstead
Address		Date	06-01-16
Waterway Name	Stream 3	Coordinates at downstream end (ddd.mm.ss)	Lat. 44°27'40.176" N Long. 124°4'35.667" W
Reach Boundaries			

Precipitation w/in 48 hours (cm) none	Channel Width (m) <1	☐ Disturbed Site / Difficult Situation (Describe in "Notes")

Observed Hydrology

% of reach w/observed surface flow 100

% of reach w/any flow (surface or hyporheic) 100

# of pools observed 0

Observations

Observed Wetland Plants (and indicator status):

None. No plants present in channel.

Observed Macroinvertebrates:

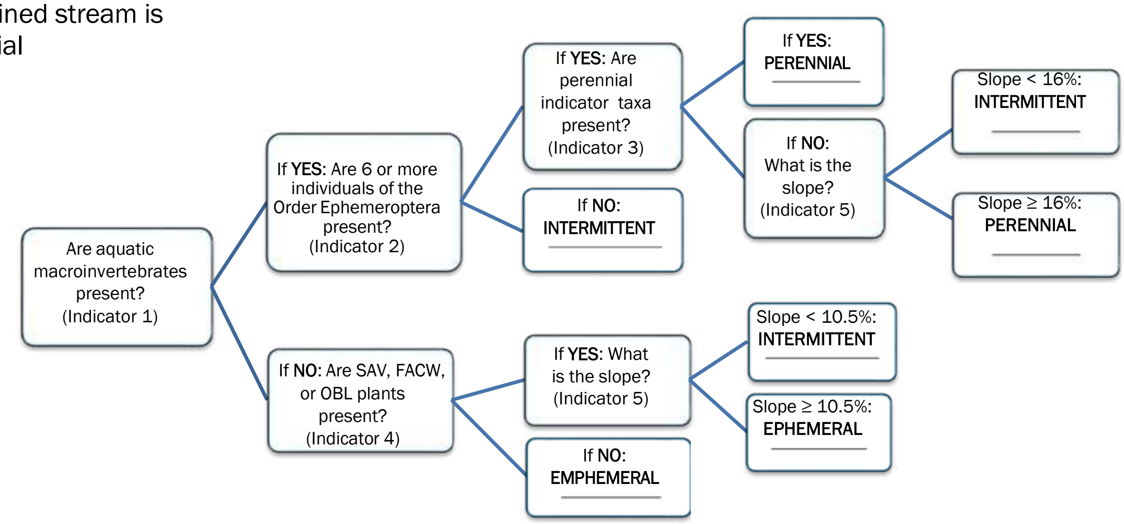
Taxon	Indicator Status	Ephemeroptera?	# of Individuals
did not review stream for macroinvertebrates			

Indicators

1. Are aquatic macroinvertebrates present?	☒ Yes	☐ No
2. Are 6 or more individuals of the Order Ephemeroptera present?	☐ Yes	☒ No
3. Are perennial indicator taxa present? (refer to Table 1)	☐ Yes	☒ No
4. Are FACW, OBL, or SAV plants present? (Within ½ channel width)	☐ Yes	☒ No
5. What is the slope? (In percent, measured for the valley, not the stream)	2 %	

Conclusions

Based on observed flow in August by ODFW, determined stream is perennial



Single Indicators:

☐ Fish

☐ Amphibians

Finding:

☐ Ephemeral

☒ Intermittent

☐ Perennial

Notes: (explanation of any single indicator co nclusions, description of disturbances or modifications that may interfere with indicators, etc.)

Difficult Situation:

Describe situation. For disturbed streams, note extent, type, and history of disturbance.

☐ Prolonged Abnormal Rainfall / Snowpack

☐ Below Average

☐ Above Average

☐ Natural or Anthropogenic Disturbance

☐ Other: ____________________________

Additional Notes: (sketch of site, description of photos, comments on hydrological observations, etc.) Attach additional sheets as necessary.

Defined bed and bank present and signs of erosion.

Ancillary Information:

☐ Riparian Corridor

☐ Erosion and Deposition

☐ Floodplain Connectivity

Observed Amphibians, Snake, and Fish:

Taxa	Life History Stage	Location Observed	Number of Individuals Observed

Streamflow Duration Field Assessment Form

Project # / Name: **Pacific Marine Energy Center**	Assessor: **Halstead**
Address	Date: **06-01-16**
Waterway Name: **Stream 4**	Coordinates at downstream end (ddd.mm.ss): Lat. 44°27'50.146" N; Long. 124°4'39.145" W
Reach Boundaries	

Precipitation w/in 48 hours (cm) none	Channel Width (m) 1.25	☐ Disturbed Site / Difficult Situation (Describe in "Notes")

Observed Hydrology

% of reach w/observed surface flow 100

% of reach w/any flow (surface or hyporheic) 100

# of pools observed 0

Observations

Observed Wetland Plants (and indicator status):

Some areas of channel included yellow water flag (*Iris pseudacorus*-OBL), yellow skunk cabbage (*Lysichiton americanus*-OBL), and yellow pond lily (*Nuphar polysepala*-OBL).

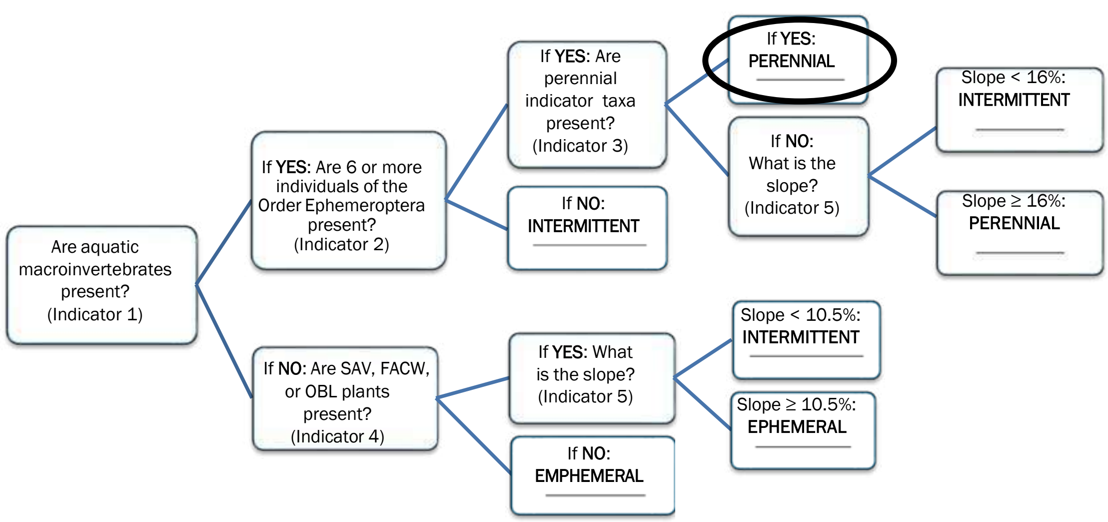
Observed Macroinvertebrates:

Taxon	Indicator Status	Ephemeroptera?	# of Individuals
did not review stream for macroinvertebrates			

Indicators

1. Are aquatic macroinvertebrates present?	☒ Yes	☐ No
2. Are 6 or more individuals of the Order Ephemeroptera present?	☐ Yes	☒ No
3. Are perennial indicator taxa present? (refer to Table 1)	☒ Yes	☐ No
4. Are FACW, OBL, or SAV plants present? (Within ½ channel width)	☒ Yes	☐ No
5. What is the slope? (In percent, measured for the valley, not the stream)	2 %	

Conclusions



Single Indicators:

☒ Fish

☒ Amphibians

Finding:

☐ Ephemeral

☐ Intermittent

☒ Perennial

Notes: (explanation of any single indicator co nclusions, description of disturbances or modifications that may interfere with indicators, etc.)

Difficult Situation:

Describe situation. For disturbed streams, note extent, type, and history of disturbance.

- ☐ Prolonged Abnormal Rainfall / Snowpack
  - ☐ Below Average
  - ☐ Above Average
- ☐ Natural or Anthropogenic Disturbance
- ☐ Other: ____________________________

Additional Notes: (sketch of site, description of photos, comments on hydrological observations, etc.) Attach additional sheets as necessary.

Defined bed and bank present and signs of erosion.

Adult rough skinned newts (*Taricha granulosa*), Northwest salamander (*Ambystoma gracile*) egg masses, and small fish were observed.

Ancillary Information:

- ☐ Riparian Corridor
- ☐ Erosion and Deposition
- ☐ Floodplain Connectivity

Observed Amphibians, Snake, and Fish:

Taxa	Life History Stage	Location Observed	Number of Individuals Observed

Appendix C. Ground Level Photographs

Photo 1. Wetland A looking east from SE wetland boundary from Photo Point 1.

Source: HDR, June 2016

Photo 2. Twombly Creek (not flowing), looking west downstream near SP A-3.

Source: HDR, June 2016

Photo 3. Looking north at roadside ditch with connection to Twombly Creek from Photo Point 2.

Source: HDR, June 2016

Photo 4. Looking west at Wetland B from upland plot SP B-2.

Source: HDR, June 2016

Photo 5. Looking northwest from wetland plot SP C-1 toward wetland boundary.

Source: HDR, June 2016

Photo 6. Looking west from wetland plot SP D-1 toward wetland boundary.

Source: HDR, June 2016

Photo 7. Wetland E facing north near SP E-1 at Photo Point 4.

Source: HDR, June 2016

Photo 8. Looking south near upland plot SP E-2 at Photo Point 5.

Source: HDR, June 2016

Photo 9. Looking east at point where Stream 4 discharges into roadside ditch at Photo Point 8.

Source: HDR, June 2016

Photo 10. Looking north from Photo Point 8.

Source: HDR, June 2016

Photo 11. Looking south from Photo Point 8.

Source: HDR, June 2016

Photo 12. Looking northeast from highway road prism at Wetland G from Photo Point 9. Stream 3 flows east to west to culvert entrance at center-left of photo.

Source: HDR, June 2016

Photo 13. Looking down at Stream 3 as it enters culvert under the highway from Photo Point 10.

Source: HDR, June 2016

Photo 14. Wetland H west end facing northeast from Photo Point 14.

Source: HDR, June 2017

Photo 15. Wetland H east end facing northeast Photo Point 15.

Source: HDR, June 2017

Photo 16. Wetland I facing southwest Photo Point 16.

Source: HDR, June 2017

Appendix D. WETS Table

WETS Table

WETS Station: NEWPORT MUNI AP, OR								
Requested years: 1971 - 2000								
Month	Avg Max Temp	Avg Min Temp	Avg Mean Temp	Avg Precip	30% chance precip less than	30% chance precip more than	Avg number days precip 0.10 or more	Avg Snowfall
Jan	51.0	38.6	44.8	10.22	6.71	12.27	16	0.3
Feb	53.0	39.2	46.1	8.69	6.04	10.33	15	0.2
Mar	54.1	39.8	47.0	7.74	5.54	9.15	15	0.0
Apr	56.1	41.0	48.5	4.95	3.49	5.88	12	0.0
May	59.1	44.8	52.0	3.68	2.44	4.41	9	0.0
Jun	62.0	48.5	55.2	2.72	1.70	3.29	7	0.0
Jul	64.8	50.7	57.8	1.04	0.54	1.27	2	0.0
Aug	65.7	50.9	58.3	1.02	0.45	1.24	3	0.0
Sep	65.4	49.0	57.2	2.39	0.83	2.88	5	0.0
Oct	61.3	45.0	53.1	5.12	2.78	6.25	9	0.0
Nov	54.8	41.8	48.3	10.67	7.29	12.72	17	0.0
Dec	51.1	38.9	45.0	11.51	7.99	13.69	16	0.6
Annual:					61.69	77.39		
Average	58.2	44.0	51.1	-	-	-	-	-
Total	-	-	-	69.76			126	1.0

GROWING SEASON DATES			
Years with missing data:	24 deg = 2	28 deg = 1	32 deg = 1
Years with no occurrence:	24 deg = 19	28 deg = 10	32 deg = 0
Data years used:	24 deg = 28	28 deg = 29	32 deg = 29
Probability	24 F or higher	28 F or higher	32 F or higher
50 percent *	No occurrence	2/6 to 12/29: 326 days	3/19 to 11/28: 254 days
70 percent *	No occurrence	No occurrence	3/3 to 12/15: 287 days
* Percent chance of the growing season occurring between the Beginning and Ending dates.			

STATS TABLE - total precipitation (inches)													
Yr	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annl
1951								0.28	4.82	9.21	M8.30	10.15	32.76
1952	15.20	9.14	12.46	2.37	0.75	1.27	0.07	0.74	0.67	1.26	3.82	12.23	59.98
1953	24.24	7.97	M8.96	4.60	M5.25	3.09	0.54	2.91	2.48	5.84	14.22	13.45	93.55
1954	15.01	9.98	7.47	5.54	1.40	3.65	1.05	2.93	2.44	6.42	6.98	12.75	75.62
1955	5.97	6.62	7.91	10.17	1.56	1.55	1.98	0.08	3.20	11.72	M9.35	16.90	77.01
1956	20.64	9.53	M12.03	1.49	1.84	2.46	0.24	0.66	2.17	10.86	M1.87	9.76	73.55
1957	5.71	7.48	13.60	3.90	4.09	1.63	0.36	1.37	1.15	M6.79	M3.93	M13.12	63.13
1958	11.85	13.76	5.78	8.77	1.78	1.99	0.13	0.74	3.55	3.89	15.55	8.49	76.28

1959	15.51	10.11	8.83	2.76	3.68	4.86	1.18	0.68	5.78	5.95	4.86	6.73	70.93
1960	9.52	11.54	8.68	5.71	7.13	1.18	0.20	2.52	0.50	7.46	15.72	4.73	74.89
1961	9.22	16.64	14.47	5.08	5.77	1.04	0.27	1.21	1.12	7.61	10.10	10.20	82.73
1962	3.94	7.19	7.03	4.78	3.92	1.04	0.39	2.33	3.22	5.16	16.20	5.52	60.72
1963	5.29	8.39	7.61	9.55	4.34	2.22	1.27	0.61	2.84	6.65	11.52	7.24	67.53
1964	M11.98	M3.12	M7.44	2.97	M1.39	M2.55	1.87	M2.03	M1.15		14.17	18.89	67.56
1965	21.24	3.83	1.35	6.63	2.80	1.25	0.25	M0.53	0.46	M2.87	10.36	13.64	65.21
1966	10.97	3.24	12.57	2.14	0.94	1.65	1.16	0.78	3.17	6.03	11.52	M7.04	61.21
1967	M5.28	5.16	9.83	6.98	2.21	1.25	0.00	0.05	1.55	9.37	7.86	12.86	62.40
1968	11.41	12.70	11.36	3.01	5.07	6.78	0.84	7.60	3.24	9.22	17.12	22.68	111.03
1969	14.66	7.15	4.09	5.91	3.96	5.68	0.56	0.36	4.45	5.65	5.24	15.34	73.05
1970	19.20	8.25	3.26	6.90	2.50	1.00	0.36	0.37	4.41	5.36	8.83	14.03	74.47
1971	15.43	7.15	8.97	7.55	2.02	3.75	1.13	1.51	6.32	6.19	10.45	20.00	90.47
1972	13.99	7.26	11.42	6.83	2.13	1.73	0.53	0.41	3.22	1.32	6.40	14.72	69.96
1973	8.72	2.69	8.40	1.61	2.80	4.86	0.13	1.17	5.69	6.33	22.13	17.96	82.49
1974	13.77	11.04	13.60	4.48	2.92	2.48	3.30	0.47	0.66	1.98	12.70	13.35	80.75
1975	13.93	10.26	9.14	5.98	3.47	1.94	1.12	2.43	0.03	11.39	13.15	13.83	86.67
1976	12.02	11.30	6.79	4.20	2.53	1.06	1.53	1.88	1.47	2.34	2.06	2.88	50.06
1977	2.31	7.09	8.82	1.20	6.21	1.15	0.25	3.07	5.38	4.18	11.94	15.55	67.15
1978	9.65	5.55	2.55	8.06	5.83	2.67	0.97	3.19	4.53	1.01	7.12	7.39	58.52
1979	5.02	12.42	6.67	4.96	4.22	1.84	0.77	1.00	3.09	8.84	8.18	15.70	72.71
1980	10.02	M5.37	6.68	4.76	2.71	2.95	0.35	0.45	1.60	3.27	9.47	15.90	63.53
1981	2.80	6.86	7.03	5.29	4.68	5.54	0.71	0.44	3.74	10.58	11.51	13.39	72.57
1982	M13.39	10.33	8.95	6.62	0.66	1.92	1.12	0.58	2.95	6.44	7.42	14.73	75.11
1983	16.54	14.79	13.84	3.32	3.00	3.20	3.24	1.31	0.52	2.36	17.66	11.10	90.88
1984	5.38	9.35	6.19	6.40	7.04	5.75	0.46	0.23	1.64	8.70	18.81	8.52	78.47
1985	0.68	5.67	8.33	2.21	2.05	5.86	0.72	0.40	4.50	7.14	8.80	3.87	50.23
1986	8.29	11.73	5.04	4.33	M3.31	1.10	2.51	0.14	3.63	4.39	9.44	M4.08	57.99
1987	11.94	7.12	11.00	M2.52	M2.75	0.63	M2.41	0.55	0.66	0.13	4.47		44.18
1988	13.50	M2.37	M6.82	4.01	7.21	2.23	1.12	0.36	1.61	1.42	17.03	M7.10	64.78
1989	9.32	6.90	13.08	1.85	2.94	2.66	0.82	1.04	0.52	4.52	5.57	4.99	54.21
1990	14.31	9.63	4.03	5.13	3.38	2.87	0.88	0.85	1.25	6.98	8.83	4.41	62.55
1991	4.35	7.21	6.57	7.27	3.81	0.61	0.36	2.22	0.05	2.90	10.06	8.38	53.79
1992	8.11	6.20	1.22	7.94	0.34	0.41	0.24	0.74	1.93	4.73	7.20	11.35	50.41

1993	6.65	1.56	M6.43	8.16	6.05	3.70	1.52	0.20	0.05	1.22	2.17	8.54	46.25
1994	6.57	9.26	3.58	3.31	2.47	3.11	0.20	0.20	0.91	9.03	12.15	12.21	63.00
1995	14.93	7.68	8.16	5.75	1.96	4.04	0.39	0.94	4.09	5.25	13.83	11.81	78.83
1996	11.21	16.28	4.13	8.41	5.03	1.06	1.27	0.38	2.56	8.02	13.65	22.44	94.44
1997	13.15	3.54	12.75	6.55	4.62	4.12	1.39	2.78	6.26	9.00	8.80	7.61	80.57
1998	15.23	13.18	9.34	2.09	5.07	2.60	0.41	0.07	1.05	6.18	17.96	17.60	90.78
1999	12.71	16.81	8.93	2.54	5.80	2.61	0.91	1.42	0.17	3.41	16.91	14.61	86.83
2000	12.80	10.71	3.86	2.88	3.36	3.18	0.38	0.16	1.74	4.46	4.10	5.32	52.95
2001	4.09	4.05	5.30	5.19	1.94	3.37	0.27	1.54	0.71	4.14	10.99	12.41	54.00
2002	14.85	M6.16	M7.40	M5.05	M2.20	2.36	0.10	0.23	M1.05	M1.04	M4.95	M15.04	60.43
2003	M10.15	M5.08	M11.95	M8.07	1.33	0.77	M0.20	0.08	2.04	3.41	8.97	15.48	67.53
2004	M13.46	6.40	M3.96	3.77	2.67	1.08	0.02	3.22	3.08	7.39	3.93	7.00	55.98
2005	M4.96	M1.06	M5.57	M4.42	M1.13	M5.02	M0.32	M0.04	M1.93	M2.65	M5.94	M10.88	43.92
2006	M12.48	3.40	M6.48	M3.16	M1.32	M0.92	0.37	MT	M1.17	M0.79	M17.15	M5.98	53.22
2007	M4.08	M7.20	7.29	M2.56	M1.14	M1.68	M0.73	M0.60	M1.37	M5.70	M4.55	M7.00	43.90
2008	M4.33	M1.82	M3.82	M2.08	M0.24	M0.37	MT	M0.00	0.26	3.57	11.09	10.85	38.43
2009	M2.47	M1.76	M1.72	M2.46	M2.03	M1.19	M0.29	M0.99	M1.82	M0.31	M6.62	M2.82	24.48
2010	M5.59	M5.99	M4.10	M4.61	M2.26	M4.97	0.51	M0.04	M1.96	M0.77	M8.49	M8.40	47.69
2011	M8.69	M5.03	M10.52	M7.25	M3.18	MT	M0.59	M0.00	M0.07	M2.97	6.65	M0.23	45.18
2012	M0.57	M2.31	M8.71	M4.75	2.51	2.63	0.46	M0.17	0.10	8.88	8.52	M11.00	50.61
2013	4.92	2.92	2.36	2.61	M3.68	2.51	T	M1.62	5.71	1.52	M3.27	2.38	33.50
2014	3.15	M6.77	5.74	3.43	2.41	M1.33	0.63	0.39	1.66	7.69	5.82	9.74	48.76
2015	3.52	6.45	4.64	3.54	1.36	0.22	0.03	M0.92	0.61	M3.07	M6.63	M16.13	47.12
2016	M8.43	4.85	8.35	M2.16	0.65	M1.25	0.99	0.06	M1.01	M9.79	12.53	6.10	56.17
2017	5.28	M14.18	10.32	M5.65	2.46	2.04	M0.03						39.96
Notes: Data missing in any month have an "M" flag. A "T" indicates a trace of precipitation.													
Data missing for all days in a month or year is blank.													
Creation date: 2016-07-22													

Appendix E. References

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APPENDIX D

PacWave Site Characterization Report

SITE CHARACTERIZATION REPORT – BENTHIC

CONTACT: DAN HELLIN, OPERATIONS & LOGISTICS MANAGER, PACWAVE, OSU
541-737-5452 DAN.HELLIN@OREGONSTATE.EDU

Principle Investigator: SARAH HENKEL, ASSISTANT PROFESSOR, HATFIELD MARINE SCIENCE CENTER
DIRECTOR OF ENVIRONMENTAL RESEARCH, OSU
541-867-0316, SARAH.HENKEL@OREGONSTATE.EDU

1. INTRODUCTION/OVERVIEW

Benthic invertebrates inhabiting the nearshore marine environment provide important secondary production in marine food webs and are integral to the breakdown and recycling of organic material in the marine ecosystem. They also provide a key food source for important commercial and recreational fish and macroinvertebrate species like Dungeness crab, as well as for other protected or managed fish species. The presence of Project structures, such as anchors and subsea cables, may alter benthic habitat conditions, subsequently affecting macrofaunal invertebrate species. In addition to direct effects to the benthic community, the Project could result in indirect effects such as changes to marine community composition and predator/prey interactions. In order to evaluate these types of potential effects, it is important to characterize the benthic community in and around the Project area.

1.1. Resource(s) of Interest

Based on data collected at Ocean Dredged Material Disposal Sites off the coast of Newport, local sediments near the PacWave South (formerly known as Pacific Marine Energy Center South Energy Test Site [PMEC-SETS]) are likely to be consistent with those found on much of the Oregon shelf. This area is expected to consist predominantly of medium-grained sand with some shell debris and a minor amount (less than 2 percent) of silt and smaller material (USACE and EPA 2011), the low amount of fines presumably a result of winnowing by wave energy. Benthic sampling at PacWave North (formerly known as Pacific Marine Energy Center North Energy Test Site [PMEC-NETS]) since 2010 found that fines (silt and clay; grain sizes smaller than 62.5 um) usually were only present at sampling stations less than 40 m deep; in general, larger grain sizes were found with greater depths to 80 m (the extent of sampling depth conducted by Henkel in this region). This habitat encompasses to two main community types: infaunal (living in the sediment) and epifaunal (living on top of the sediment), collectively referred to as macrofaunal in this document. These macrofaunal invertebrates modify the sediment, structure the habitat, promote nutrient cycling, and serve as prey for higher tropic levels, making them key species despite their individual small sizes.

The spatial distribution patterns of benthic invertebrates found on or in seafloor sediments result from interactions with a host of environmental variables. Multiple studies have found significant associations between macrofaunal composition and sediment characteristics (percent silt-clay, organic carbon, grain size) (Weston 1988, Van Hoey *et al.* 2004, Jayaraj *et al.* 2008, Labrune *et al.*

2008), particular water temperatures and/or dissolved oxygen levels (Cerame-Vivas and Gray 1966, Cimberg *et al.* 1993, Carroll and Ambrose 2012), or most related to differences in depth (Hyland *et al.* 1991, Oug 1998, Bergen *et al.* 2001). Based on a series of macrofaunal invertebrate surveys in southern California, depth was considered to be the primary variable structuring species distributions, with other factors such dissolved oxygen, grain size, and total organic carbon secondary (SAIC 1986, Lissner 1989, Hyland *et al.* 1991, Allen *et al.* 2007).

1.2. Potential Effects/Issue Summary

The installation and presence of the subsea cables, subsea connectors, and anchors would result in both temporary and long-term alterations of benthic habitat in the Project area.

The subsea cables, extending from the subsea connectors to the HDD conduits near shore, would be installed in trenches 1 to 2 m below the seafloor using jet plowing or other trenching methods. This would cause temporary displacement of unconsolidated sediments as the cable is buried. Benthic and infaunal organisms (e.g., amphipods, bivalves, and polychaetes) within the pathway of the plow would be removed, displaced, or killed during the trenching process. Additionally, as the plow moves along the seafloor, slow-moving infaunal or surface dwelling organisms located in the path of the plow's skids or wheels that span the trench likely would be killed. Mobile invertebrates (e.g., crabs), fish species that feed on or near the bottom, and species that shelter on the bottom at times would likely move away from the immediate vicinity of the anchors and cable and move to nearby areas during deployment and removal activities.

There would be long-term loss of unconsolidated sand habitat within the footprint of the subsea connectors (4 subsea connectors each having a footprint of about 30 square feet) and WEC anchors. Suction caisson and plate anchors are placed into and under the seabed, and therefore would have minimal footprint on the seabed other than the mooring hardware and line extending from the anchor under the seabed up to the WEC. As indicated in the effects analysis, the footprint of the anchors would range from 0 to 19,068 square feet (0.4 acres) for the initial development and 0 to 90,800 square feet (2 acres) for the full build out. A single anchor would be used by adjoining devices when practicable, thus reducing the footprint on the seabed from this maximum case estimate. In the areas where the anchors, subsea connectors, and cables are sitting on the seabed, the soft bottom habitat would be replaced with hard structures that, in the case of the anchors and subsea connectors, would extend vertically above the seafloor (the cables would likely be buried by natural sedimentation processes). Sessile or highly mobile organisms (e.g., sponges, hydroids, crustaceans) would colonize Project components resting on the seabed, replacing (in these small areas) the benthic community typically associated with soft sediments (infaunal organisms). These habitat modifications would be permanent for the subsea connectors (about 120 square feet total for the four subsea connectors) and long-term for WEC anchors (up to 5 years or longer). Installation of drag embedment anchors requires dragging the anchor a lateral distance across the seafloor to set them at a sufficient penetration (sediment depth). It is anticipated that most of this disturbance would be below the seabed surface. The extent of permanent habitat modification would vary depending on anchor type and number of anchors, considering some anchor types would be buried and not rest on the seabed. As anchors are removed, the disturbed areas are expected to recover by natural sediment transport processes.

The placement of anchors or other project components on the seabed could result in localized areas of scour or deposition; however, the particle size range found at PacWave South is likely less susceptible to movement than areas having finer grained sediment. Based on reviews of bottom changes resulting from deployment of artificial reefs and offshore oil platforms (Henkel *et al.* 2013), sedimentary changes could be expected to occur at least 20 m away from an anchor installation. Based on surveys at PacWave North, changes to the benthos (particularly shell hash accumulation) may be expected to occur up to 250 m away from an anchor installation; however, this accumulation may not have a measureable effect on the composition of the macrofaunal community (Henkel and Hellin 2016). Anchors may also reduce available benthic foraging habitat, although the total area lost by anchors is expected be small, as quantified above.

1.3. Study Objective

The primary objectives of this study were to: (1) quantify the sediment characteristics in and around the PacWave South Project area; and (2) quantify the macrofaunal species present in and around the PacWave South Project area. Additionally, we sought to determine if there were seasonal variations in the sediment characteristics or macrofaunal species present in the Project area.

2. Data Collection

All sampling trips were conducted on the R/V *Elakha*. See Table 1 in Section 2.2 for full list of sampling trips. Organisms were collected under ODFW Scientific Taking Permit numbers 18022 (2013), 18655 (2014), and 19435 (2015).

2.1. Methods & Equipment

For Site Characterization of benthic conditions and macrofaunal invertebrates around the PacWave South area, sampling stations were spaced broadly throughout the area to survey the range of species present within and surrounding the Project Site in order to develop a full list of possible organisms that could be encountered at PacWave South. Initially, 14 sampling stations were established to mirror the stations around PacWave North, with transects every 2 minutes of latitude and stations at approximately 30, 40, 50, and 60 m along each transect (Figure 1). South of Yaquina Bay, the reef extends a little deeper, so box core stations could not be reliably sampled at 30 m, and for the middle two transects (RS and SB) could not be sampled at all. While median grain size generally increases moving offshore Newport, mapping data conducted by Chris Goldfinger in 2014 indicated fine sand found beyond 60 m at PacWave South. This was unexpected because mapping conducted in 2010 and box core collections 2010 - 2013 at 70 m and deeper at PacWave North did not indicate this shift to finer sediment. Additionally, over the timeframe of the Site Characterization sampling, the site was refined and the deeper end of the box was selected. Thus, for the 2015 surveys (April and June), we added samples at 70 m along the four transects and sampled at 70 m in June of 2015 at PacWave North.

Box core sampling was conducted using the same methods as have been used at PacWave North since 2010. Sediment samples were collected with a modified Gray-O'Hare 0.1 m^2 box core. One grab sample was taken at each station. Subsamples of sediment from the undisturbed surface layer were collected and later used to determine percent silt-clay of sediment and median grain size (MGS). Samples then were sieved onboard through a 1.0 mm screen, and all collected macrofaunal organisms (both infauna living in the sediment and small epifauna which may have been on the surface) were preserved in a mixture of 10 % buffered formalin and seawater. At each station, vertical water-column profiles of conductivity, temperature, depth, dissolved oxygen, and turbidity, and pH were obtained with a Sea-Bird Electronics CTD unit.

Upon return to the laboratory, organisms were transferred to 70% ethanol then sorted into major taxonomic groups by Oregon State University (OSU) staff. Crustaceans, polychaetes, and other worm-like creatures were sent to contracted taxonomic experts. These taxonomic experts were the same individuals we have used for all the Henkel lab studies to date; thus we are confident in the consistency of identification between all datasets. OSU laboratory staff identified molluscs, echinoderms, and remaining taxa.

Grain sizes were analyzed using a Beckman Coulter Laser Diffraction Particle Size Analyzer (LD-PSA) to determine median grain size and percent silt/clay (portion less than 62.5 µm; Wentworth 1922). In most cases, the percent sand (62.5 µm to 2 mm) was the balance of the sample. If grain sizes larger than 2 mm (maximum size for the LD-PSA) were encountered, these samples would be fractioned and the percent gravel (that fraction greater than 2 mm) determined by weight and the balance of the fraction would be analyzed by the LD-PSA to determine % sand and silt/clay (also called mud). However, no sediment samples collected from PacWave South contained gravel.

2.2. Schedule & Frequency

Eight (nearly) paired (NETS and SETS) surveys were conducted across spring, summer, and fall (Table 1). We were unable to complete the August NETS survey in 2014, so that was carried out in mid-September. Because we were committed to Site Characterization of PacWave South and were only obligated to get samples from PacWave North in June of 2014 and 2015, when weather conditions were challenging, we prioritized obtaining the full set of samples from SETS. Thus, the number of samples collected from NETS is much more variable.

Table 1. Box core surveys at PacWave. The number in each cell indicates how many 'regular' stations were sampled in each month. The number in parentheses indicates additional anchor grabs at PacWave North.

	2013		2014					2015	
	Aug	Oct	Apr	June	Aug	Sept	Oct	April	June
PacWave North Box Cores	16	15 (3)	16 (8)	11 (8)		16 (8)	4 (4)	11 (8)	19 (8)
PacWave South Box Cores	14	14	14	14	14		14	16	17

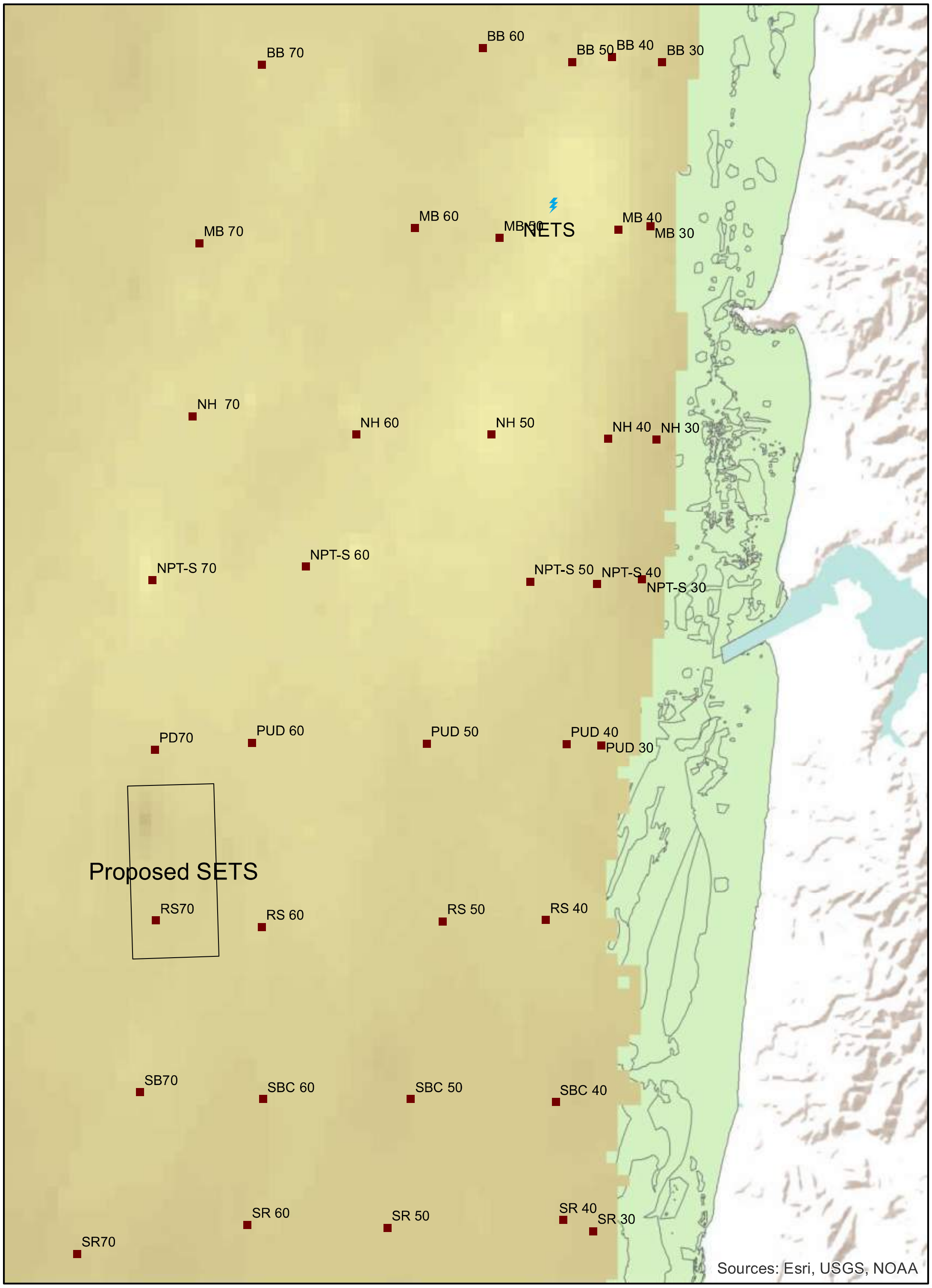

Figure 1. The 38 'regular' stations sampled using the box corer at PacWave North and PacWave South. Not all stations were sampled in all months. This map does not show the 8 grabs around the anchors collected from NETS.

2.3. Constraints & Limitations

The 2014 ocean conditions were unusually challenging for obtaining box core grabs. Typically we are able to collect all the box core stations from a site (NETS or SETS) in a single day. In June, we went out on the 23rd and got successful grabs at 30, 40, and 50 at NETS. After attempting up to 5 grabs per station to continue sampling at NETS, we decided to move south to see if we could get anything accomplished below Yaquina Bay. We were able to successfully get cores from 3 of the SETS stations before conditions got too rough to stay out. The following day (June 24, 2014) we were able to finish the 11 remaining SETS stations and then moved north to try to finish NETS. We were able to take the grabs around the Ocean Sentinel anchors but could not finish sampling to obtain cores from the 60 m stations. Later summer and fall also were challenging. We had to cancel the August 2014 NETS cruise, although when we rescheduled for September we were able to samples all NETS stations. In October 2014, we successfully sampled SETS but only got grabs around the Ocean Sentinel anchors and at the 40 m reference stations at NETS. In April of 2015, we were able to add the 70 m stations at SETS but not at NETS. Finally in June 2015 we were able to sample at the 70 m stations at both NETS and SETS (but were unable to grab one of the 30 m stations from each site).

2.4. Analysis

The data collected at PacWave South are analyzed independently and then along with the data from PacWave North during the time period to describe the overall spatial and temporal variability of sediment characteristics and macrofaunal diversity and abundances in the region. This is important to give context to future pre- and post-installation monitoring studies to understand if potential observed changes at PacWave South are within the range of 'normal' for the mid and inner shelf of the central Oregon coast or if they are outside the bounds of what has been observed for this region.

Two-way ANOVAs were used to test for differences in sediment characteristics (median grain size and percent silt clay) at PacWave South across depth and over time (from August 2013 to June 2015). Tukey's HSD post hoc tests then were used to identify specific differences among depths or over time. For assemblage analyses, Shannon–Weaver diversity (H') and species richness (S) were calculated for each sample. These indices were compared using three-way ANOVAs with the factors site (NETS/SETS), depth, and month; Tukey's HSD post hoc tests then were used to identify specific differences in diversity or richness among depths or over time.

Species count data were square root transformed for multivariate analyses. Cluster analysis was conducted on the transformed density datasets (SETS only and then NETS and SETS combined) in order to produce groups of similar stations based on the species abundances. The SIMPROF routine in Primer 6 (Clarke 1993) determines if clusters in the dendrogram have statistically significant structure. Multidimensional Scaling (MDS) was used to display the transformed density data in order to examine species composition across stations. ANOSIM (a multivariate ANOVA) was used to test for differences in the assemblages among depths, transects, and over time at PacWave South. ANOSIM R-values range from 0 (tested groups similar) to 1 (tested groups different), with values near 0.5 indicating that differences with groups are approximately equal to differences between tested groups.

3. RESULTS

Sediment

On the mid to inner shelf off Newport, Oregon, median grain size varied significantly by depth ($p < 0.001$). Median grain size generally increased with depth from 30 to 60 m, then at 70 m switched to smaller grain size sediment at the northern and southern ends of the study region but not in the middle (Figure 2). Between sites, the median grain size was significantly larger at SETS than NETS ($p = 0.003$) and was consistent across time ($p = 0.877$) (Table 2). Median grain size did not vary across sampling months.

Generally very small percentages of silt/clay (fines) were present, mostly just in samples from 30 m, which was statistically significant ($p = 0.047$). At PacWave North percent fines ranged from 0 to 12.9%; at PacWave South the maximum percentage was 4.2%. This difference is likely due to the fact that fewer shallow stations are sampled at PacWave South. However, no statistically significant differences in the amount of fine sediment were detected between the sites ($p = 0.168$). The amount of fine sediment present in samples did vary over time ($p = 0.002$) with August/September 2014 having more fines than other most other collections (Table 2). The next highest percent fines was August 2013.

Table 2. Sediment and organism indicators at NETS and SETS. *In April (SETS) and June (both) 2015, 70 m sampling stations were added. ⁺In October 2014, only 40 m stations were sampled at NETS; the larger average median grain size for that survey relative to previous collections is likely due to the lack of shallower, smaller grain-sized stations included

		Average Median GS	Average Percent Fines	Average # of Species	Average Diversity (H')
August 2013	NETS	262.2	0.67	23.8	2.03
	SETS	329.1	0.98	23.4	1.89
October 2013	NETS	270.4	0.20	25.3	2.00
	SETS	347.5	0.15	25.7	1.85
April 2014	NETS	268.7	0.28	20.5	2.32
	SETS	301.0	0.12	22.3	2.39
June 2014	NETS	287.1	0.38	23.9	2.30
	SETS	334.1	0.17	22.6	2.37
August/Sept 2014	NETS	294.0	1.33	38.3	2.39
	SETS	341.3	0.59	29.4	2.35
October 2014	NETS⁺	353.6	0.25	25.8	2.31
	SETS	324.0	0.22	25.4	2.16
April 2015*	NETS	284.6	0.32	23.0	2.32
	SETS	301.7	0.19	22.1	2.32
June 2015*	NETS	305.7	0.23	22.2	2.57
	SETS	340.7	0.18	22.4	2.62

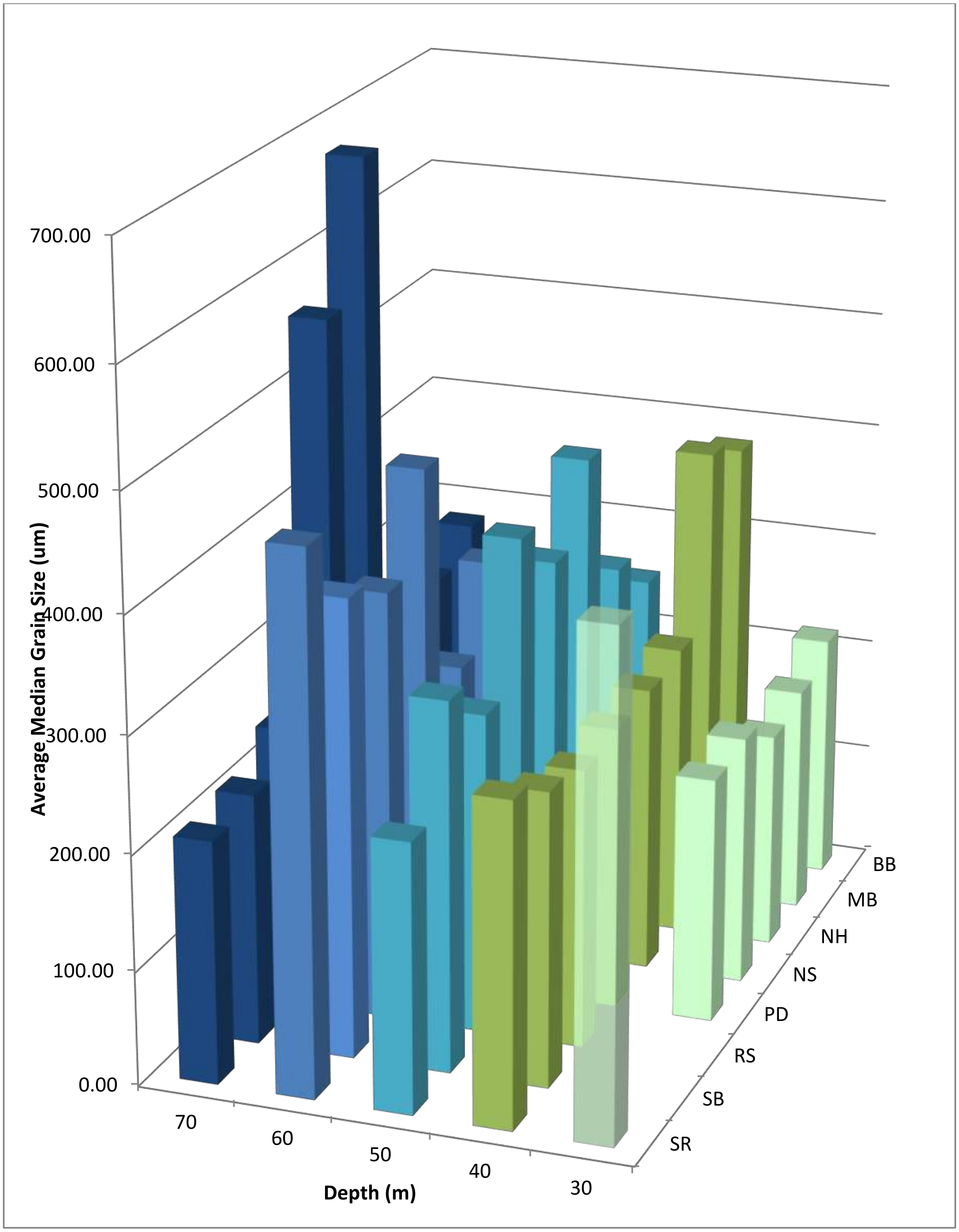

Figure 2. Average median grain size at thirty-eight sampled stations across PacWave North and PacWave South.

Macrofauna

Within the PacWave South sampling area, the sampling stations clustered into three major groups with one station (SR30) being unique (Figure 3). The 30 m station with large and variable median grain size (Seal Rock 30 m; grey cross) was unique from all other stations and showed high within-station variability in organisms collected among collection dates, likely due to its close proximity to the reef. The other 30 and 40 m stations clustered together (green triangles) but with the 2013 assemblages statistically significantly different from to the 2014 and 2015 collections (Appendix Table 4). The two 50 m stations with slightly smaller median grain size (RS and SR; red diamonds) had similar species assemblages that were often (but not always) statistically distinct from the larger grain size 50 m stations. All the 60 m stations (blue squares) and the two 50 m stations (purple squares) with larger median grain size (SBC and PUD) shared a similar assemblage of macrofaunal organisms. At these stations, collections from 2013 and 2014 were more similar to each other and 2015 collections were more unique, although there was a lot of variably in 2014 (Appendix Table 4). The 70 m station at the PD line shared assemblages with the PD60 station, and the other three 70 m stations (blue pentagons) shared assemblages with the SB60 and SR60 stations.

The analysis of similarity (ANOSIM) of transects and depths (all years combined) at PacWave Southindicated that there were no differences in macrofaunal assemblages among transects with a significant global R of 0.225 and that there were significant differences among depths with a significant global R of 0.653. Since no differences were detected among transects, an ANOSIM of depths and years was conducted. Again more differences were detected among depth bins than similarities. Among depth bins 30 m and 40 m were similar (R = 0.303), and 50 m, 60 m, and 70 m were similar (R = 0.234 to 0.351). R-values for pairwise comparisons of depths we considered different ranged from 0.664 to 0.835. The global R for differences between year groups was low at 0.303, but the pairwise comparisons indicated that 2013 was different from 2015 (R = 0.692) while 2014 was similar to both 2013 (R = 0.149) and 2015 (R = 0.281). Unfortunately, the multivariate ANOSIM cannot calculate an interaction effect the way that the univariate ANOVA does, which would be useful since the differences between years depended on depth (Appendix Table 4). To investigate this using univariate techniques, we conducted two way ANOVAs using depth vs. year (Table 3). Richness varied significantly by depth but not by year, indicating there were no more or less species collected across years. Year and depth both were significant for abundance (number of organisms per core) with the number of organisms per core actually declining over the three years. Year was significant for diversity (H') with the diversity increasing across the three years. As in the cluster analysis, Tukey post-hoc analysis indicated that samples collected from 30 m and 40 m were different in 2013 (lower diversity) than in 2014 and 2015. At 50 m and 60 m, diversity was significantly lower in 2013 as compared to 2015, while 2014 was not different from either (as in the ANOSIM analysis). For the diversity to increase without the number of species increasing, that means that there must be greater evenness in the species collected. This was the case as both year and depth were significant factors for evenness (Table 3). Because overall abundances declined over the course of the study, greater diversity and evenness required that the numerically dominant species must have declined. SIMPER analysis confirmed this.

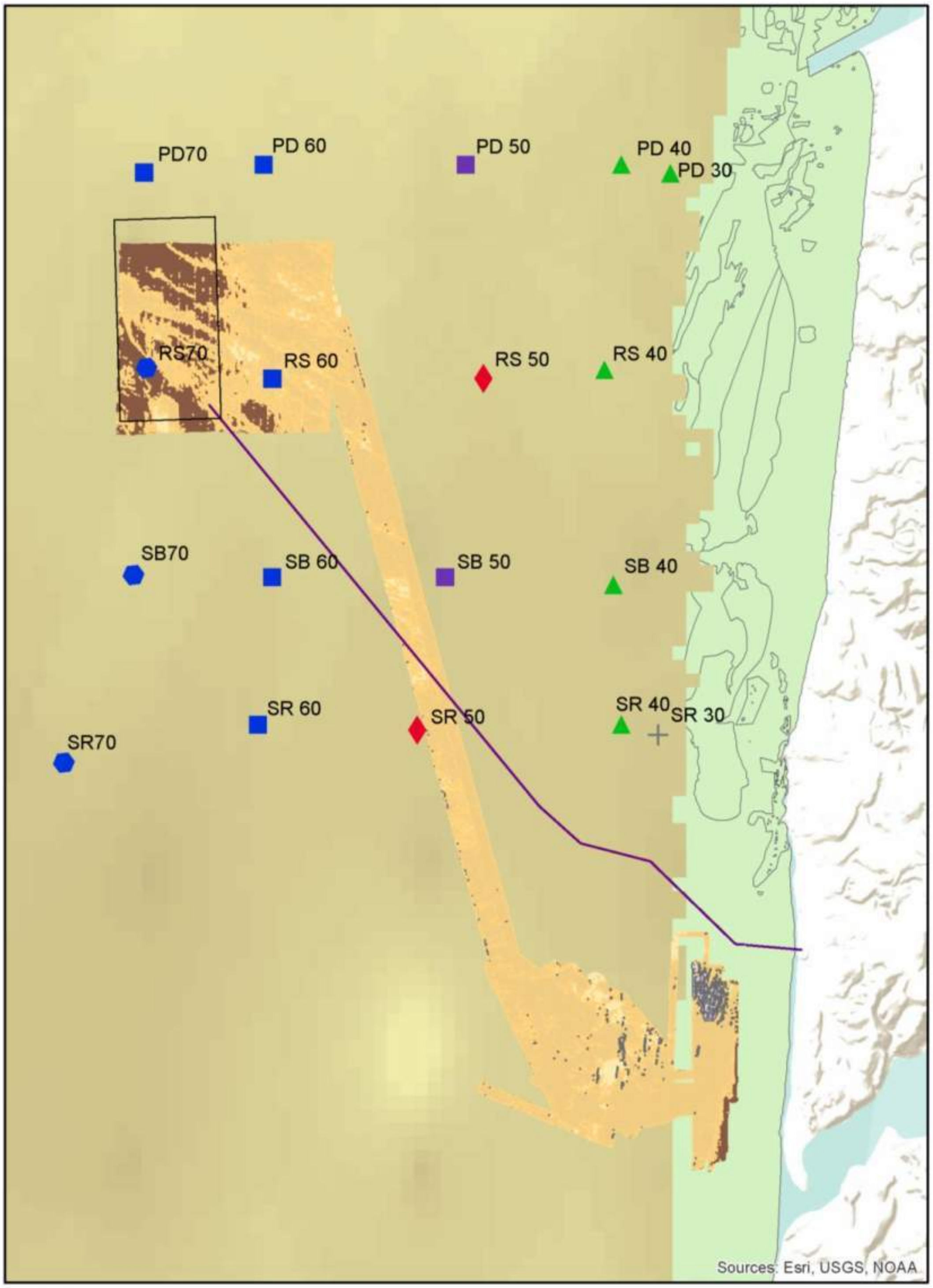

Figure 3. PacWave South Survey area. Symbols for the sampling stations represent the statistical clusters of macrofaunal species assemblages collected from August 2013 to June 2015. Sediment type layer is based on backscatter results from multibeam mapping (not box core grabs). Potential cable routes are shown in purple. Stations with the same color and/or same shape are statistically similar. For example, SB50 and SB60 are statistically similar and SB60 and SB70 are statistically similar, but SB50 is not similar to SB70.

Table 3. ANOVA results of factors year and depth on SETS macrofaunal metrics.

Metric	Factor	Df	Sum Sq	Mean Sq	F-value	P value
Richness (S)	Year	2	158.5	79.257	1.895	0.156
	Depth	4	1253.9	313.467	7.494	<0.001
	Year:Depth	6	242.3	40.384	0.965	0.453
	Residuals	104	4350.5	41.831		
Abundance (N)	Year	2	355134	177567	17.343	<0.001
	Depth	4	470386	117596	11.485	<0.001
	Year:Depth	6	153918	25653	2.506	0.026
	Residuals	104	1064838	10239		
Diversity (H')	Year	2	5.975	2.988	17.829	<0.001
	Depth	4	0.325	0.082	0.485	0.747
	Year:Depth	6	1.416	0.236	1.408	0.218
	Residuals	104	17.428	0.168		
Evenness (J')	Year	2	0.654	0.327	25.755	<0.001
	Depth	4	0.192	0.048	3.784	<0.001
	Year:Depth	6	0.166	0.027	2.147	0.054
	Residuals	104	1.321	0.013		

Comparisons between NETS and SETS

The macrofaunal species assemblages identified at SETS are consistent with those collected at NETS over the same time period. Figure 4 shows all the samples collected from both sites from August 2013 to June 2015. There is complete overlap of the NETS (green triangles) and SETS (blue triangles) stations. The grabs taken around the Ocean Sentinel anchors at NETS (aqua squares, not otherwise discussed in this report) also are fully within the cloud of NETS and SETS stations. The dominant pattern on the MDS plot appears to be related to depth; most of the 30 m and 40 m stations cluster together on the right, and the deeper stations are more spread out on the left side of the plot. However, as grain size varies with depth, it cannot be determined with this analysis which of these factors (grain size or depth) may be driving species distributions.

Between NETS and SETS there were no site differences in either the number of species collected ($p = 0.442$) or H' diversity ($p = 0.116$). Depth was a significant factor ($p < 0.001$) in the number of species due to a higher species count at the 50 m stations than 30 m and 40 m. Significant differences in the number of species per grab also were seen among months with August/September having higher richness than April. This is likely due to the extremely rich collection at NETS in September 2014. For H' diversity, both depth ($p = 0.007$) and month ($p < 0.001$) were again significant factors with differences between June (highest diversity) and October (lowest). Multivariate ANOSIM testing the entire macrofaunal assemblage against depth nested within site resulted in a significant R value of 0.488 for depth, indicating that variability among depths was similar to variability within depth, and a significant R value of -0.133 for site, indicating that differences within sites (likely due to depth) were greater than differences between sites.

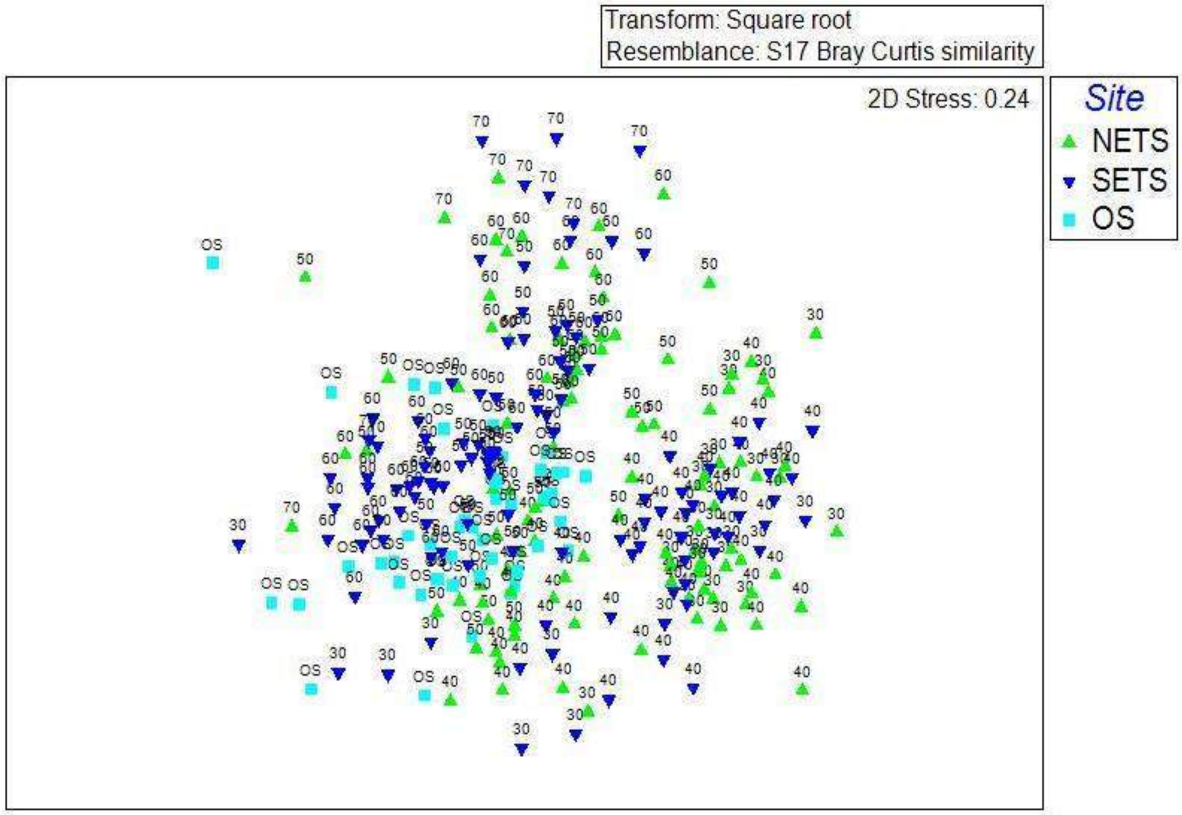

Figure 4. Multidimensional scaling plot of all macrofaunal abundances from NETS (green triangles), SETS (inverted blue triangles), and around the Ocean Sentinel anchors at NETS (aqua squares) collected August 2013 to June 2015. Labels on the points indicate the depth contour of the sampling station.

4. Discussion

The data obtained through this sampling, as well as existing data, successfully characterized spatial and temporal variability in sediment conditions at SETS and further characterized the range of variability in species composition and abundance in the region. Sediment in this region is almost entirely medium sand; the specific grain size varies with depth with a small amount of fine material (silt/clay) increasing at shallower stations by the end of the more quiescent summer but without an effect on the overall median grain size. As noted in the benthic study plan, sediments with a silty fraction have much greater potential for changes related to scour (as fine grains are more easily moved) than coarser (larger grain size) sediments. The large grain size with little silt fraction in the sampled stations suggests that there is less capacity for changes in sediment characteristics (and thus the organisms living in the sediment) due to scour than might be expected in regions with more fine grained sediments.

The macrofaunal assemblages we collected have been consistent across PacWave North and PacWave South, varying in response to depth and median grain size. Two major “assemblages” of macroinvertebrates can be described in the vicinity of PacWave South: a deeper, larger grain size-associated assemblage, and a smaller grain size-associated assemblage. At 50 m, two different assemblages were detected; however the stations with larger median grain size (PUD and SBC) had similar invertebrates to the 60 m stations. This suggests that, at these depths, differences in species assemblage are more strongly related to the sediment characteristics than the specific depth. Similarly, at the shallower stations where we saw seasonal fluctuations in the amount of fine sediment (silt/clay) present, we also saw seasonal variability in the macroinvertebrates, suggesting a response to these seasonally-variable sediment conditions. While only one 70 m station was sampled (two times) in the SETS Project Site itself, because the collections there were similar to the collections at the two 70 m stations to the south (and the grain sizes are similar), we are confident we have adequately characterized the SETS Project Site. If there is greater variability within the site than we have captured here, that will be apparent in the pre-installation surveys that are berth-specific, as described in the Benthic Monitoring Plan for PacWave South.

Interestingly, we detected differences in how assemblages changed differently across years at different depths. At the shallower stations (30 – 40 m), diversity was significantly greater in both 2014 and 2015 as compared to 2013, while at the deeper stations (50 – 60 m) the increase in diversity was more gradual from 2013 to 2015. Normally when starting a new sampling regime, observations of increased diversity over time might be attributed to increasing ability of staff to detect different species. However, since we have been using the same contracted taxonomic experts since 2010 (and they were previously used by the Newport EPA branch), observer ‘training’ seems like an unlikely cause of this increased diversity. A possible explanation may be the presence of the ‘Warm Blob’; these warm SST anomalies began in winter 2013-14 and spread into the nearshore waters of the PNW in September 2014 (Bond *et al.* 2015). This may have resulted in shifts among the dominant species the Oregon central coast during the latter half of our sampling (although not the introduction of ‘warm’ species as has been observed in other assemblages). It is estimated that this warm feature persisted through the end of 2015 (NOAA Fisheries 2015); thus pre-installation surveys in “normal” conditions definitely should be conducted to assess if diversity has decreased back to 2013 levels before assessing whether there are impacts of cable/device deployment.

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Appendix Table 4. Significant SIMPER groupings of stations based on macrofaunal composition. Values in the cells are years that each station clustered into each group. Each of the stations 30 – 60 m were sampled 8 times from 2013 to 2015, and the 70 m stations were each sampled two times in 2015 only.

	PD 30	SR 30	PD 40	RS 40	SB 40	SR 40	PD 50	RS 50	SB 50	SR 50	PD 60	RS 60	SB 60	SR 60	PD 70	RS 70	SB 70	SR 70
A		14																
B																15		
C								15					15	15	15	15	15	15
D													14	14				
E								14	14									
F								15										
G											14							
H										14								
I								13 14		13 14 15								
J		13 15									13			15				
K		14																
L							13 14		13 14		13 14	13 14	13 14	13 14				
M											15			14	15			
N							14	14	14			14						
O							15		15			15	15					
P		13 14				15												
Q						15						15						
R			14	14														
S	13 14		13	13	13	13 14												
T	13 14 15		14 15	14 15	14 15	14 15												

SITE CHARACTERIZATION REPORT - CRABS

CONTACT: DAN HELLIN, OPERATIONS & LOGISTICS MANAGER, OSU
541-737-5452 DAN.HELLIN@OREGONSTATE.EDU

Principle Investigator: SARAH HENKEL, ASSISTANT PROFESSOR, HATFIELD MARINE SCIENCE CENTER
DIRECTOR OF ENVIRONMENTAL RESEARCH, OSU
541-867-0316, SARAH.HENKEL@OREGONSTATE.EDU

1. INTRODUCTION/OVERVIEW

1.1. Resource of Interest

Dungeness crab is a strategy species under the Oregon Nearshore Strategy (ODFW 2006), and their distribution is of particular interest due to their high commercial and recreational value. Other species of interest include red and Pacific/brown rock crabs, which prefer harder substrates.

1.2. Potential Effects/Issue Summary

The installation and presence of the subsea cables, subsea connectors, and anchors would result in both temporary and long-term alterations of benthic habitat in the Project area. Alterations to habitat, marine community composition, and predator/prey interactions could result in changes in the distribution and abundance of crabs within the Project area. The Project could cause behavioral responses (e.g., attraction or avoidance) in crabs. These potential effects are discussed in Section 3.3.3 of the Preliminary Draft Environmental Assessment.

1.3. Study Objective

The objective of this study was to quantify CPUE (catch per unit effort) in the Project area as compared to reference areas in order to investigate spatial distributions of crabs in the region.

2. DATA COLLECTION

All sampling trips were conducted on the R/V *Elakha*. See Table 1 in Section 2.2 for full list of sampling trips. Organisms were collected under ODFW Scientific Taking Permit numbers 18022 (2013), 18655 (2014), and 19435 (2015).

2.1. Methods & Equipment

We deployed 30” crab pots (escape ring closed to retain smaller crabs) south of the Project area (South Beaver Creek), near the Project area (PUD line), and north of the Project area (Newport Hydrographic line) to characterize both along-shelf and depth distributions of crabs. PUD 60 was in the PacWave South (formerly known as Pacific Marine Energy Center South Energy Test Site [PMEC-SETS]) Study Area as designated at the start of the project. The down-selected Project Location ended up in the SW corner of the Study Area; thus, no crab collection location was in the current Project Location. Three crab pots were dropped at 60 meters (m) and 40 m depths near the Project and references to the north and south (for a total of 18 pots across six stations; Figure 1). The pots were left to soak for 24-48 hours; all collected crabs were sized, sexed, and released.

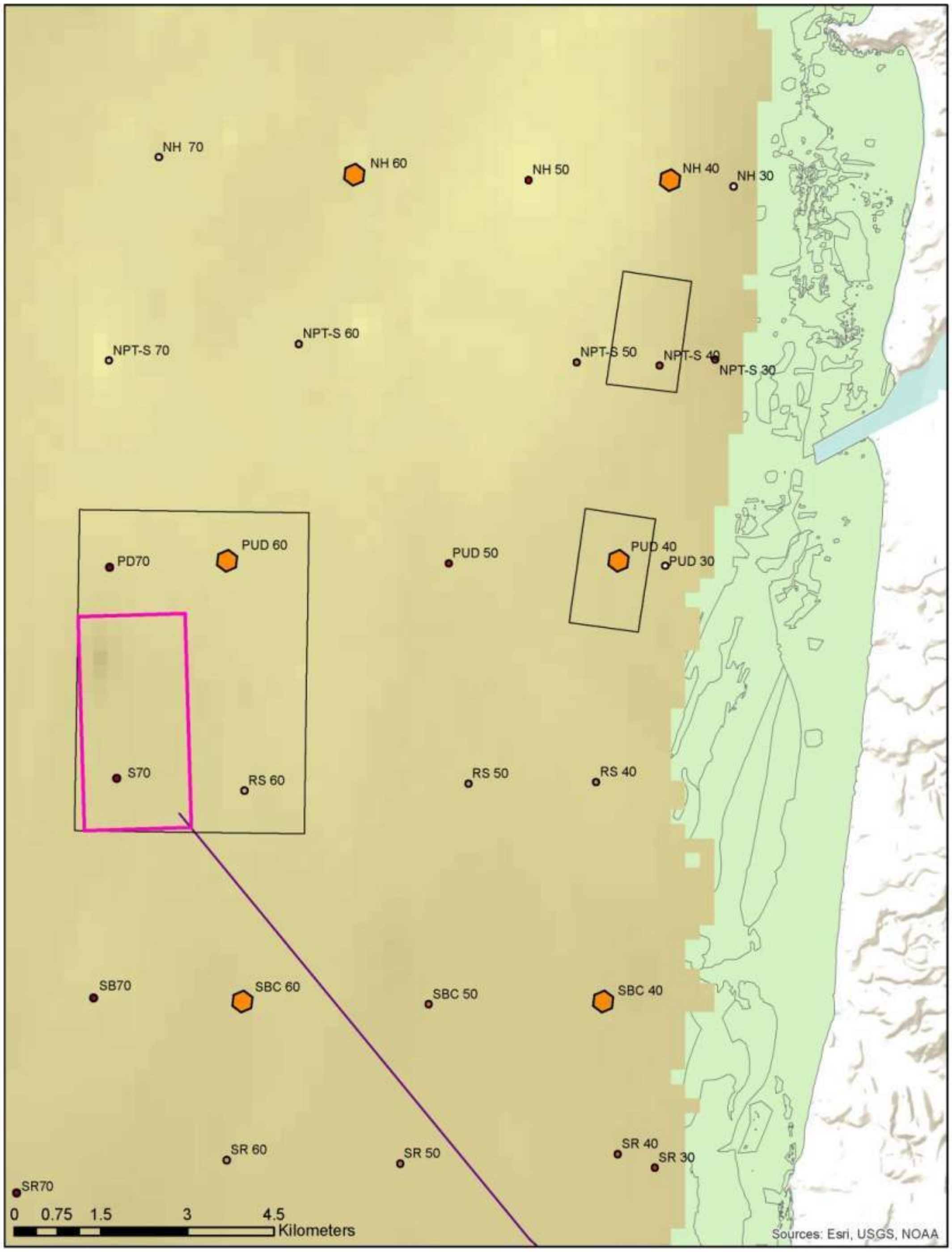

Figure 1. The 6 crab pot stations (large orange hexagons) along with nearby box core stations at PacWave North (formerly known as Pacific Marine Energy Center North Energy Test Site [PMEC-NETS]) and PacWave South.

The larger black box was the PacWave South Study Area. The pink box is the down-selected Project Location. The shallower boxes are US-ACE dredged material disposal areas. Underlying map is interpreted median grain size (provided by C. Goldfinger), showing very slight variability across the survey area.

2.2. Schedule & Frequency

Two full years of surveys (8 collections) across all seasons were conducted (Table 1).

Table 1. Schedule of crab surveys.

	2013		2014			2015		
	Sept	Dec	Apr	June	Sept	Jan	April/ May	June
Crab collections	✔	✔	✔	✔	✔	✔	✔	✔

2.3. Constraints & Limitations

We planned to do only 24 hour soaks for each survey. However, a snowstorm in December 2013 resulted in a 48 hour soak. This did not seem to affect the results, as December 2013 abundances were not statistically different from other surveys. In April 2014 we used a different method of baiting the crab pots. This affected the overall abundances, as April 2014 was statistically different from any other survey. However, the spatial pattern was the same in April 2014 as in all other months. Due to both weather and boat repairs, we were not able to sample in December 2014 before the opening of crab season as we did in 2013; instead we sampled in January 2015. However, no differences were detected between December 2013 and January 2015 ($p = 0.88$). Of the pots deployed on April 30, 2015 only the 40 m pots were retrieved on May 1 due to weather. At that time, no floats for the 60 m pots were seen (presumed pulled underwater during the rough conditions). The 60 m pots were retrieved on May 4, but no data were taken since the pots had been soaking for so long.

2.4. Analysis

Analyses is of Dungeness crab only since of the 1,392 total crabs caught, only two crabs were red rock and no other species have been collected. We did not calculate CPUE on a per hour or per day basis as no differences were observed between the December 2013 surveys when pots were left out for 48 h as compared to other collections with a 24 h soak.

Crab abundances (CPUE per pot) were analyzed using three-way ANOVA with the factors transect, depth, and month to determine if there were significantly different abundances among locations or across seasons. Due to the collection issues in April 2014 and May 2015, these sampling dates were removed from the dataset and ANOVAs were re-run on the abundance data only using the remaining six collections. The sex ratios of crabs were analyzed using three-way ANOVA with the factors transect, depth, and month (all months) to determine if there were significant differences in the ratio of males to females among locations or across seasons.

The sizes (carapace widths) of crabs were analyzed using three-way ANOVA with the factors sex, depth, and month to assess differences between the sexes and to determine if there were significant differences in crab sizes between the two depths or across seasons. Histograms of male and female crab sizes were separately developed to describe the differences in size distributions between collected male and female crabs.

3. Results

We captured a total of 1390 Dungeness crabs across the 8 sampling trips. There were statistically significant differences between depths ($p << 0.001$) with more crabs landed per pot at 40 m than 60 m (Table 2). There were no statistically significant differences among the three transects (i.e. between the Project area (PUD) and stations to the north or south; $p = 0.139$). There was a statistically significant difference among months ($p < 0.001$), with April 2014 and May 2015 being different than other months. However, as previously noted, the spatial pattern in April was the same as all other collections, and we attribute the lower number of crabs to the different baiting method rather than other season-related factors. Overall differences in May 2015 are due to having no data at 60 m; counts in the 40 m pots were not different from other months. When the data were re-analyzed with April 2014 and May 2015 removed, the depth differences were still highly significant ($p << 0.001$), still no differences were detected among the lines ($p = 0.095$), and month was no longer significant ($p = 0.066$).

Table 2. Average number of crabs collected per pot.

		NH	PUD	SBC	Total Average per Pot per Month
September 2013	40 m	16.3	10.3	14.0	**12.7**
	60 m	14.7	7.7	13.0	
December 2013	40 m	11.7	12.7	8.3	**11.9**
	60 m	13.0	11.7	14.3	
April 2014	40 m	7.0	7.7	8.7	**5.4**
	60 m	3.7	2.0	3.3	
June 2014	40 m	16.7	11.5	14.3	**12.3**
	60 m	6.3	6.0	13.0	
September 2014	40 m	6.0	12.0	15.7	**9.4**
	60 m	11.0	7.3	4.7	
January 2015	40 m	12.7	11.3	12.0	**9.3**
	60 m	9.7	3.0	7.0	
April/May 2015	40 m	15.7	16.7	12.5	**15.3**
	60 m	-	-	-	(high b/c no 60 m)
June 2015	40 m	9.3	15.7	16.7	**11.9**
	60 m	11.0	9.0	9.7	
Total Average per Pot per Line		**10.73**	**8.6**	**10.69**	

The sex ratio of crabs did not vary significantly with depth (p = 0.068) or by transect (p = 0.165). The sex ratio did vary significantly by the month of collection (p << 0.001), although a specific seasonal pattern could not be discerned (Figure 2). Summers (June 2014 and June 2015) had the most equal sex ratios, but the spring and fall collections did not show similar consistencies. April 2014 was skewed to more females while May 2015 were skewed to more males (although there were issues with both of those collections). Likewise, there were many more males in September 2013 and many more females in September 2014. In December 2014 (just before the start of commercial crab season), the numbers of male crabs was highest and female crabs the lowest, and the opposite ratio was observed in January of 2015 (just after the start of commercial crab season).

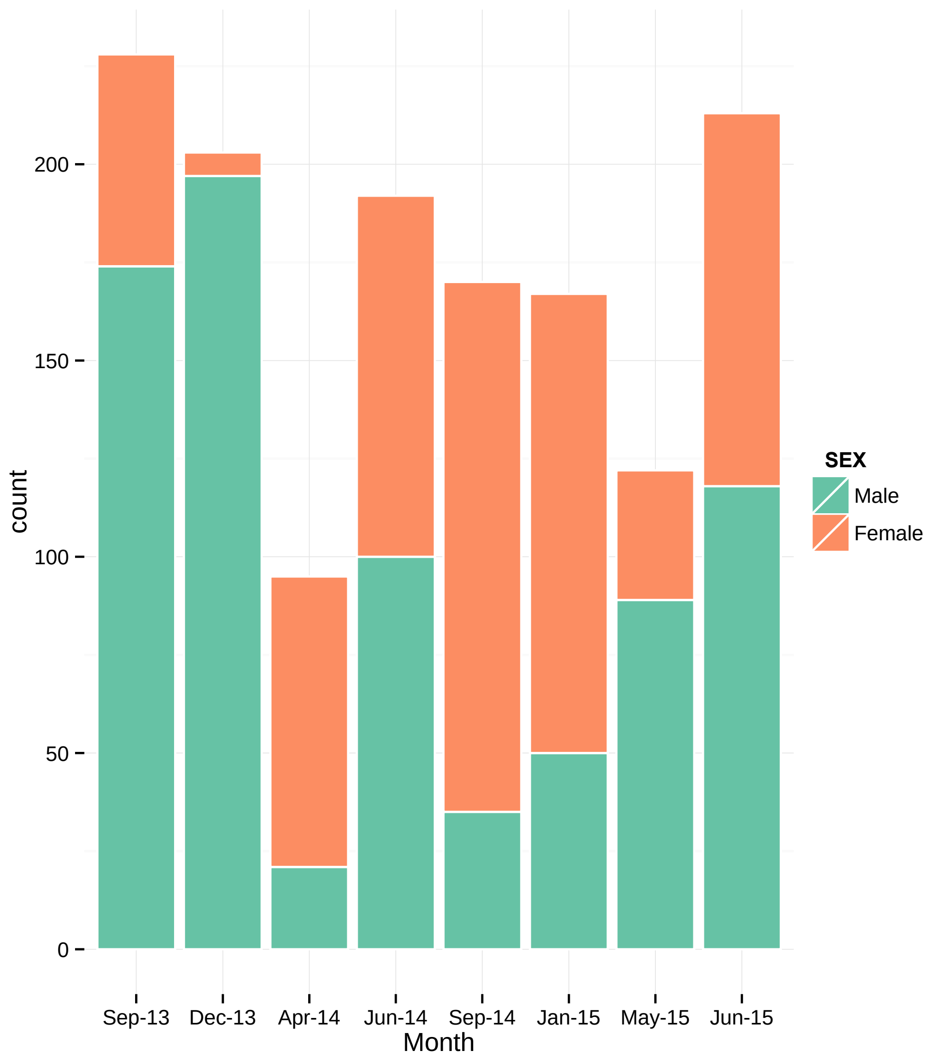

Figure 2. The total numbers of male and female crabs caught in all pots on each sampling trip.

Collected crabs ranged from 112 mm to 215 mm carapace width. Both males and females were collected in the smallest size bin (107 – 120 mm); however, no females were collected greater than

195 mm (Figure 3). Most collected male crabs were 'legal' by both recreational and commercial limits (Figure 3, left panel).

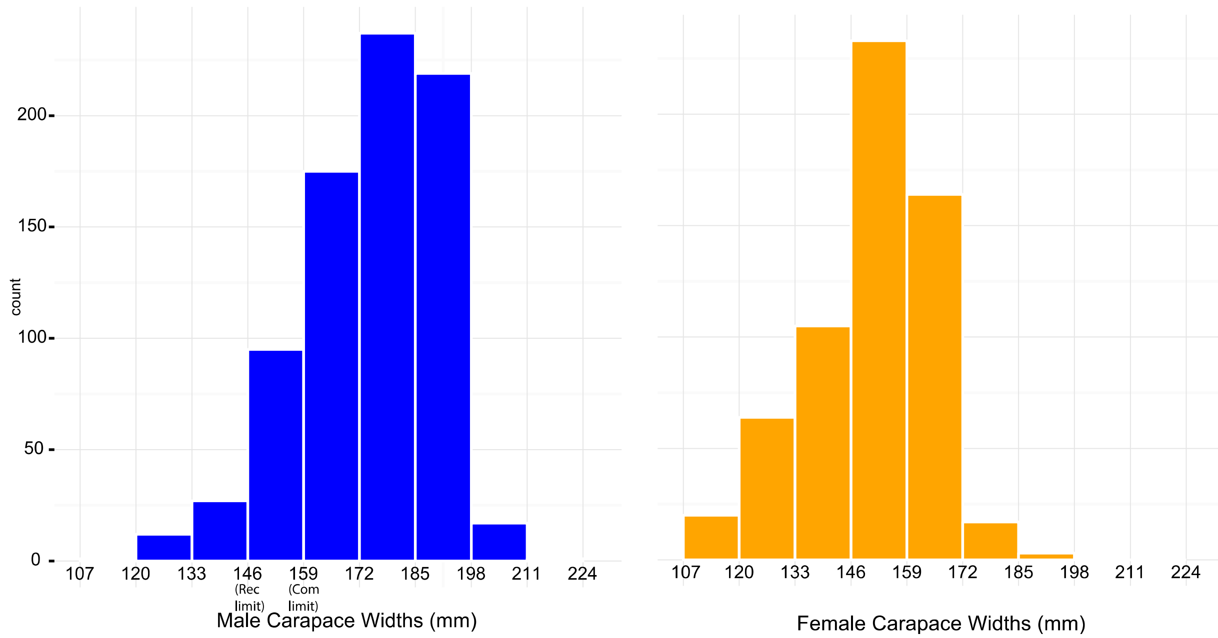

Figure 3. Crab size distributions for collected male (blue) and female (orange) Dungeness crabs.

Sex (p << 0.001), depth (p = 0.003), and month (p << 0.001) all were significant factors in variation in carapace widths. On average, collected males were larger than collected females, and slightly larger males were collected at 60 m than at 40 m while depth differences in size were not observed for females (Figure 4).

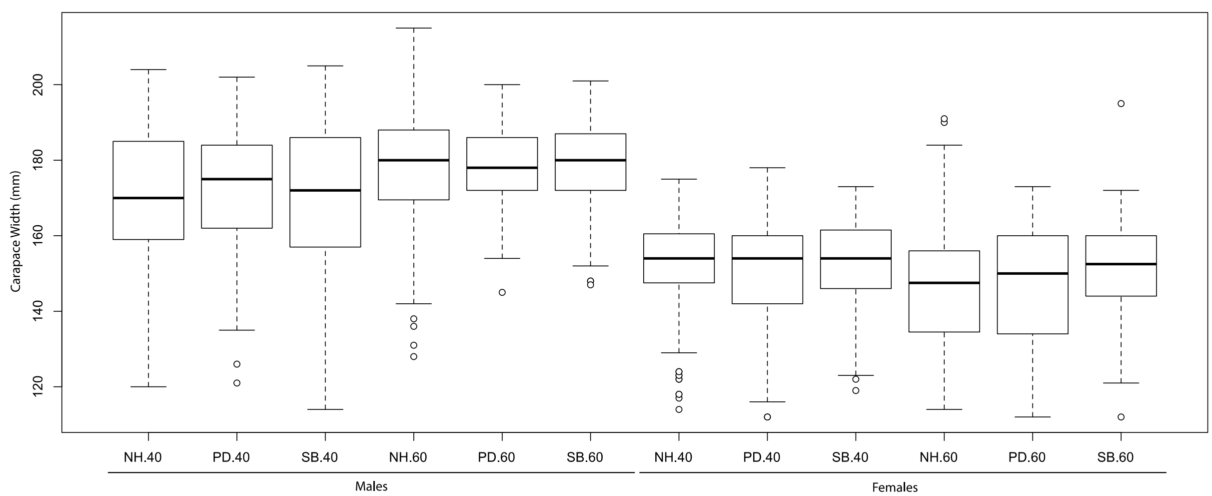

Figure 4. Mean carapace widths of male (left) and female (right) crabs at the six sampling stations.

Although month of collection was a significant factor in the analysis of carapace widths, again there was no discernable seasonal pattern. The largest males were found in the fall and winter trips in

2013 with variable sized (mostly smaller) males collected since; female crab sizes were consistent throughout most of the study with smaller crabs collected in the final two surveys (Figure 5).

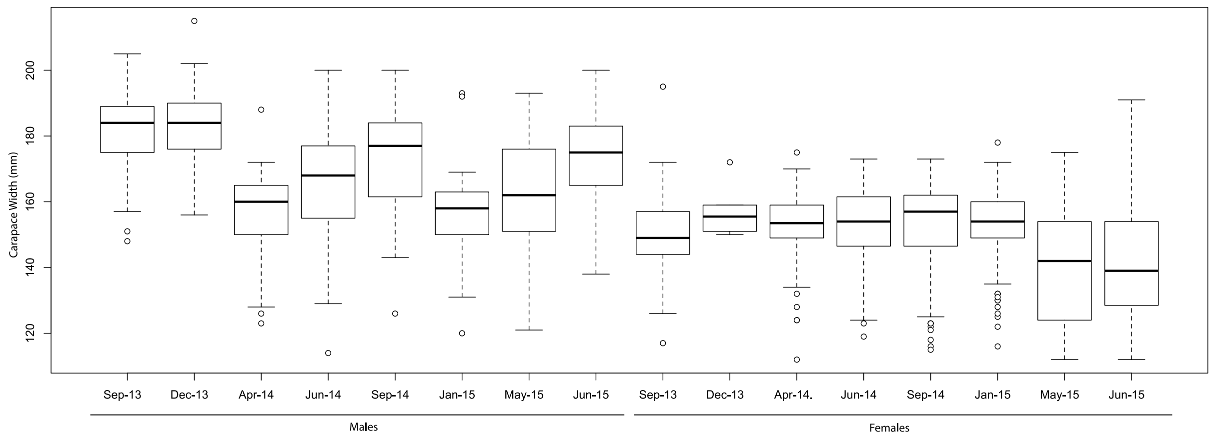

Figure 5. Mean carapace widths of male (left) and female (right) crabs across the sampling trips.

4. Discussion

Spatial variability

The primary objective of this project was to investigate spatial distributions of crabs locally. Overall, we observed spatial differences in crab CPUE and crab size related to depth, but few along-shelf differences were observed. This spatial pattern was consistent over time. While the transect closest to PacWave South (the PUD line) consistently had the fewest crabs per pot; this difference was not statistically significant. Thus, the project area does not appear to be very unique in crab densities although it does seem to be a preferred fishing area as we observed many more other crab floats in the area relative to our sampling areas to the north and the south. Our vessel captain hypothesizes that this is likely due to proximity to the harbor. While we did not end up with a crab sampling station in the final, down selected Project Site, we believe our findings are still relevant to the Project Site since no differences were detected in the numbers of crabs between any of the sampling sites within the deeper contour.

More crabs were collected from the 40 m stations than the 60 m stations across all sampling months and transects except for two occasions when more crabs were collected from the deeper station on the NH line only. Thus, it is possible that a smaller proportion of crabs would be affected by the project located in ~70 meters of water than if a project were sited shallower.

Temporal variability

While the primary objective of this project was to investigate spatial distributions, we sampled over two years to assess whether spatial patterns were temporally consistent. We did find the spatial patterns in crab distributions to be consistent over time, and we also were able to investigate other questions regarding how sizes or sex ratios might vary over time. Although month was a significant factor in the number of crabs collected, the ratio of males to females, and the sizes of collected crabs, no consistent seasonal pattern was apparent.

The temporal variability in the total number of crabs collected was likely due to the baiting and pot retrieval issues in April 2014 and May 2015, respectively. These were the only two months that were significantly different in the total number of crabs collected. All other months were statistically similar. Thus, we conclude that there likely is no seasonal variability in Dungeness CPUE using our methods in this region.

The greater proportion of female crabs in January 2015 could be attributed to many males being harvested starting in December 2014. However, there also were more females relative to males in the previous collection (September 2014), so it may not be related to harvest. Fall-winter 2014-2015 showed the opposite pattern from fall-winter 2013-2014 when more males were collected than females in both September and December 2013. These differences suggest inter-annual variability in sex ratios rather than seasonal responses; however, this would require more years of data to determine.

Significant differences among months in crab sizes were driven by differences at the beginning of the project when larger males were collected and at the end of the project when smaller females were collected.

5. References

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SITE CHARACTERIZATION REPORT - MARINE MAMMALS

CONTACT: DAN HELLIN, OPERATIONS & LOGISTICS MANAGER, PACWAVE
541-737-5452 DAN.HELLIN@OREGONSTATE.EDU

Principle Investigator: DR. SARAH HENKEL WITH SUPPORT FROM DR. LEIGH TORRES AND GRADUATE STUDENT AMANDA HOLDMAN, HATFIELD MARINE SCIENCE CENTER. OREGON STATE UNIVERSITY

1. INTRODUCTION/OVERVIEW

1.1 Resource(s) of Interest

The eastern North Pacific is an area rich in marine mammal species. Of the 30 marine mammal species known to occur in the area, 9 are listed as either endangered or threatened by the National Marine Fisheries Service (NMFS). The most common marine mammals in near-shore Oregon Territorial Sea (within 3 nautical miles of shore) are the grey whale, harbor porpoise, California sea lion, Steller sea lion, harbor seal, and northern elephant seal. Minke, humpback, blue, fin and killer whales and Dall's porpoise are also found, but at lesser frequency than the more common species. The other marine mammal species are found over the outer continental shelf or even farther from shore. Marine mammal presence in Oregon waters may be year-round or seasonal and within a species it may also vary in terms of distance from shore. It has been suggested that harbor porpoise occupy deeper offshore water in late winter (Dohl et al. 1983). The Eastern North Pacific stock of gray whales spend their summers feeding in the Bering Sea and migrate south in the winter to calving lagoons in Baja California, Mexico (Ortega-Ortiz and Mate 2008). During summer and autumn gray whales feed off Oregon in shallow water typically <1km from shore, although, during winter and spring, migrating gray whales are farther offshore (Ortega-Ortiz and Mate 2008). Consequently, the proposed PacWave-South project is located in the migratory path of these whales.

The harbor porpoise is of elevated concern because of its high sensitivity to anthropogenic noise (Herr et al. 2005, Tougaard et al. 2012) and the potential for considerable overlap with potential wave energy converters (WEC). Harbor porpoises are typically distributed in near-shore waters less than 200m deep (Balcomb and Minasian 1984), which are prime deployment locations for WECs. In the U.S., regulators have separate noise exposure criterion for harbor porpoise than other cetaceans: regulators predict that any noise exposure above a comparatively low level of 120 dB SPL (sound pressure level) will disturb porpoises (Southhall et al. 2008).

1.2 Potential Effects/Issue Summary

The potential impacts of wave energy development on marine mammals in Oregon shelf waters may depend on the time of year because of the seasonal distribution of many species. Impacts may be direct or indirect, negative or positive. They will also depend on the type of technology, location, and development phase along with the behavioral state of the animals. The uncertainties about impacts on marine mammals from future wave energy installations are due in part to the lack of data on marine mammal seasonal occurrence and migrations. Sound and vessel activity associated with site assessment, construction, operations and decommissioning can disturb marine mammals and may interfere with important activities, including foraging, resting, socializing, and migrating. In addition, support vessel activities pose the risk of collisions between ships and whales and also some risk of spills of fuel oil or other materials. Sound generated from renewable operations generally would be continuous, of low intensity and at low frequencies (below a few kHz) (Tougard et al. 2009). Playback experiments involving harbor porpoise and harbor seals prompted a distinct reaction by both species to wind turbine sounds (Koschinski et al. 2003). It is unknown if these results are comparable for wave energy. It should also be stated that wave energy converters have the potential for positive environmental effects as well. While the mooring lines are a concern for collision and entanglement of large marine mammals, they could potentially provide artificial reef habitat, attracting fish and providing foraging sites for cetaceans and pinnipeds (Cada et al. 2007). However, colonization by marine organisms may also have negative consequences in terms of maintenance and operation (Cada et al. 2007).

1.3 Study Objective

The seasonal abundance and distribution of marine mammals in Oregon’s near shore waters is not well understood. With the exception of two Global Ocean Ecosystem Dynamics (GLOBEC) surveys conducted late spring and early summer (Tynan et al. 2005) periodic marine mammal surveys off the Pacific Northwest have been restricted to late-summer and fall months (Carretta et al. 2009), with survey efforts in Oregon waters typically lasting only a few weeks. Coverage of the winter and early spring months is lacking, as are year-round observations needed to establish seasonal distributions and migration patterns. The objective of this study is to use ship-based line transect surveys to obtain adequate information on species utilization of the areas around the NETS (PacWave North), and SETS (PacWave South) Project areas across multiple seasons.

2. Data Collection

2.1 Visual Methods & Equipment

Vessel based visual monitoring for marine mammals incorporated standard-line transect marine mammal survey protocol (Buckland et al. 2001). All visual line transect surveys took place on “small boats of opportunity”, such as the R/V Elakha to cost effectively survey marine mammals off Oregon. A transect was defined as continuous boat movement between 8 and 12 knots. At least one trained marine mammal observer was on board all cruises and used 7X50 binoculars to sight, identify and estimate group size of all cetaceans and pinnipeds encountered during daylight transits along the NH, NETS (PacWave North), and SETS (PacWave South) transect survey lines (See Figure A1 in Appendix). A second volunteer (extra bird or mammal observer) was responsible for the data entry onto a laptop. Additionally, basic oceanographic data was recorded such as conductivity, salinity, temperature, depth, and florescence. Opportunistic photographs were taken when practical to assist in species identification. Information on all cetacean sightings was logged systematically using the program WinCruz, including species, group size, reticle of animal position relative to the horizon, angle, latitude, longitude, and ship’s heading, behavior, environmental data and comments. Survey effort was limited to sea state Beaufort 5 or lower, and when visibility was at least 1km. The vessel did not alter course for species identification or group size estimates. An excel data sheet was generated for future use, but only harbor porpoise encounters will be used for further spatio-temporal variability.

General survey

Observers conducted a visual watch for marine mammals during daylight hours - following visibility criteria described by Buckland et al. 2003. Observers rotated through 2 or 3 watch positions dependent on number of observers on board: port binocular, data recorder, and either starboard binocular or photo ID, typically shifting positions every hour or every transect whichever was more convenient.

Survey data was collected in one of two modes: 1) on-effort searching, and 2) off-effort to opportunistically collect observations, or for “non-observers” to mark identified species. During on-effort searching, the observers on watch actively scanned the 90° from the bow to the port midline of the ship for new sightings. Only sightings made during the on-effort mode were used in the line-transect estimates of abundance.

On-effort Searching Mode

Sighting data are collected only by the observers on watch in the designated watch positions during searching mode. Other personnel are allowed on the flying bridge/bow, but no information from these personnel or from the auxiliary binocular positions about actual or potential sightings forward of 90° abeam is relayed to the primary team during searching. Any configuration other than the on-watch observers actively scanning for marine mammals was classified as off-effort. The on-effort observers were allowed to be informed of missed sightings by other personnel once the animals were past 90° abeam, at which time they are entered as off-effort sightings.

Each observer with binoculars scanned out to the horizon from 90° abeam of his/her side of the ship to 10° to the opposite side of the bow (100° in all). This provided coverage of the 20° along the ship’s track line by when two observers are present while lateral regions are each covered by one observer. Observers were instructed to scan their entire area of responsibility in a consistent manner and not focus on particular regions. The details of scan rates and patterns (begin scanning at the track line or the beam, etc.) were left to individual observer preference.

There was no “back wall” at which mammal observers stop scanning. Visual observations extended to the horizon if possible. If/when weather precludes observations to the greatest extent it was noted in the environmental data. If visibility was good within closer range of the vessel, but poor beyond 300 m then only, off-effort sightings could be recorded.

Sightings

A sighting was entered into WinCruz (see below) when the presence of a marine mammal at 0.1 reticles or closer had been confirmed by an observer. Sightings were assigned a unique identification number at this time. The distance to a sighting at the horizon could not be estimated and was not entered as a sighting-events until the mammal came closer to the vessel. Sightings at the horizon, however, were allowed to be described as off-effort sightings, particularly if they were unlikely to be within 0.1 reticles from the vessel.

At the time of the sighting, the data recorder entered sighting, weather, navigation, searching effort, observer position and other data into the laptop computer.

The initial angle from the track line (read from compass binoculars), port or starboard, and a reticle reading were recorded for each sighting, along with the sighting cue and related information. Occasionally, the initial angle and distance to sightings made by the recorder was estimated by unaided eye. The initial bearing and distance to a school were based on the location of the first mammal seen. For many schools, few or no additional mammals were observable until several minutes after the school is first sighted, so no early estimate of the “center” of the school was made. Information, such as the size and extent of the school at a distant sighting is often limited. Early judgments were changed in light of subsequent information as the sighting was approached, and was edited in the WinCruz comments to reflect the best possible data available.

Data Entry

Data was entered using the SWFSC software program WinCruz 3. The computer was linked to the ship's global positioning system to record time and position for every event entered, such as a sighting or effort change, as well as automatically at a set interval, usually 10 minutes, if no other event was entered.

WinCruz was used to monitor different types of survey events (i.e., species, behavior, group composition, count, etc.). Each new event was represented by a new record in a text file database. Keyboard function keys were used to record new events. Data was entered via a dialog box for each event containing the fields for that type of event.

2.2 Schedule & Frequency

Table 1: Number of cruises by site from October 2013 to September 2015

Location	Cruises
NETS (PacWave North)	13
SETS (PacWave South)	11
NH line	13
Total:	**37**

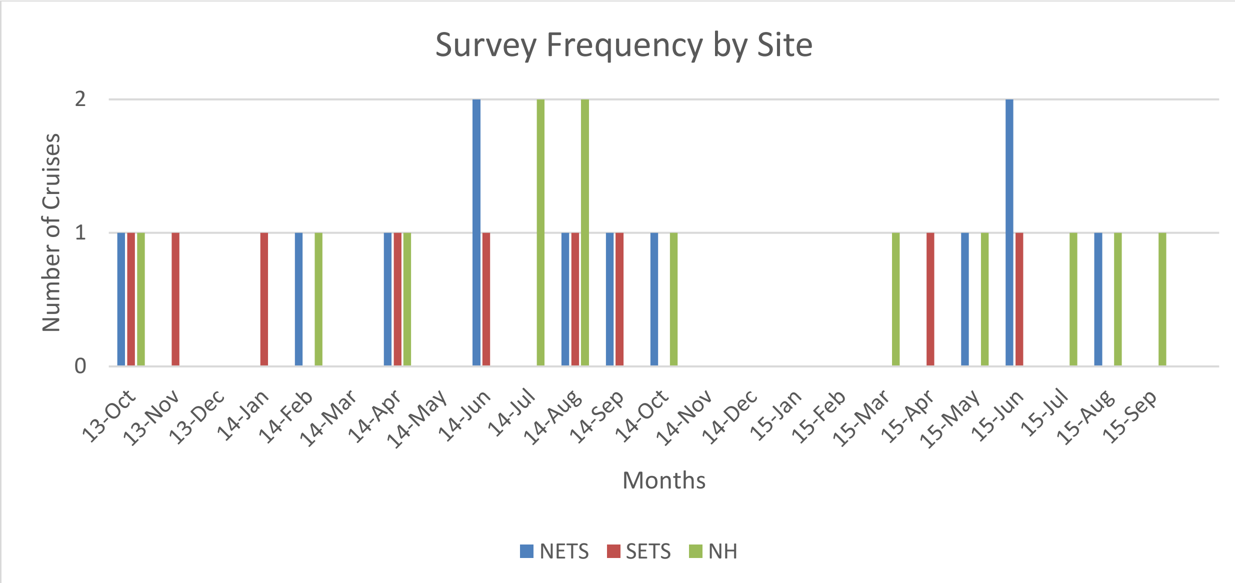

Figure 1: Survey frequency each month.

2.3 Acoustic Observations

The Acoustics Site Characterization Report includes results from seasonal deployments of autonomous drifting underwater hydrophone (ADUH) recordings at the project site, a lander deployed inshore of SETS (PacWave South) May through July of 2014, and a lander deployed at the Project site June through November of 2015. Mooring “self-noise” contamination begins to emerge within the record near August 6, 2015 affecting and became increasingly louder and more frequent as the weather conditions degraded later in the fall season. On both the 2014 nearshore and 2015 Project site hydrophone landers, the vocal presence of low (baleen whales) and high frequency (orcas) marine mammals were characterized.

Additionally, DMONS were deployed at two sites multiple times over the 6-month period from 13 May to 14 October 2014. Owing to the high sample rate (320 kHz) required for capturing harbor porpoise vocalizations, the recorders were programmed to record on a 10% duty cycle (first minute of every 10 min period) to conserve both battery power and memory storage space. The system features a noise floor 32 dB re µPa/√Hz and a system sensitivity of −203 dB re V/µPa (Baumgartner et al. 2013). The DMON was mounted with positively buoyant housing to avoid interference and suspended ~5 m above the seafloor along a mooring line attached to a surface buoy. The two instruments were operated on the 30 m isobath in close proximity (<50 m) to a rocky reef and offshore on the 60 m isobath in the Project Area in an open sandy environment. Individual deployments were approximately two weeks in duration, limited by DMON battery and data storage capacity. Ten total deployments were made over the 6 month deployment period: five at each site at a variable rate of one to two deployments per month. Moored DMONs collected approximately 43 days of acoustic data at the reef site and 60 days at the Project site. This effort included 35 days of deployment overlap allowing for site comparison.

2.4 Constraints & Limitations

The biggest constraint in visual data collection was weather. During the months of November to March in all years, only four cruises were attempted, some of which had to return due to heavy fog. Occasionally, equipment malfunctions with GPS tracking and oceanographic flow-through devices occurred, resulting in an inability to determine sighting location and oceanographic conditions during those sightings. The cruises on October 24th, October 25th, and November 22nd of 2013 in the PacWave sites had no available flow-through data. Additionally, the April 8th 2014 cruise on NH had no GPS data, and the July 22nd NH cruise had neither GPS nor flow-through data. There were no equipment failures in 2015. During the preliminary stage of data collection in winter of 2013, observer nausea and fatigue occurred (PacWave South cruises on October 25th, and November 22nd of 2013), possibly the cause of no marine mammal observations.

2.5 Analysis

Due to the low numbers of visual observations, we were not able to conduct statistical analyses to investigate variability across time or among sites. The visual observations are summarized in tables and graphs below. On the DMONs, a harbor porpoise encounter was defined as any recording minute that contained at least five visually confirmed clicks, and termed a porpoise positive minute (PPM). In addition to presence patterns, individual harbor porpoise click trains were analyzed for feeding behavior through assessment of the Interclick Interval (ICI), which was used to differentiate between feeding buzz trains and all other trains. The high numbers of detections of harbor porpoise on the DMONs are analyzed as described in Holdman et al. (2019), and a summary of those findings are presented below. For more detail on methods and results, see the paper.

3. Results

3.1. Visual Observations

A total of 37 opportunistic boat-based visual surveys were carried out in the three areas near Newport, Oregon, between October 2013 and September 2015 (Table 1). A total of 209 "on-effort" sightings were made from October 2013 to September 2015, and 10 different species of marine mammals were seen (Table 2). Harbor porpoise was the most abundant species with 81 individuals sighted. Gray and humpback whales were the most common large whale with 24 and 20 individuals sighted respectively. Three large unidentified baleen whales were also observed, and one fin whale was identified.

There is a correlation between the number of sightings and survey effort; months with more cruises had more sightings. Large baleen whales were seen in all seasons except the first fall (when observers were impaired) with more sightings in the first half of the calendar year than late summer and fall in 2014 (Figure 2). Killer whales were seen from our boat-based surveys on just one occasion (June 2014). A seasonal pattern of harbor porpoise sightings off Newport was observed, with most visual detections in the summer months (Figure 3).

While the number of trips was relatively consistent among sites, more harbor porpoises were sighted in the SETS (PacWave South) Project area than the NETS (PacWave North) and NH survey sites (Table 3). This may still be due to survey effort as the total distance covered by cruises to the SETS Project area is much larger than the distance covered by the NETS cruises. The distance covered by the NH cruises varied each time.

Table 2: Total sightings by species

Species	Individuals observed
Harbor porpoise	81
Gray whale	24
Humpback whale	20
Fin whale	1
Steller sea lion	20
California sea lion	14
Unidentified whale	3
Dall's porpoise	7
Pacific white sided dolphin	22
Unidentified cetacean	1
Unidentified porpoise	3
Unidentified sea lion	7
Killer whale	4
Harbor seal	2
Total:	**209**

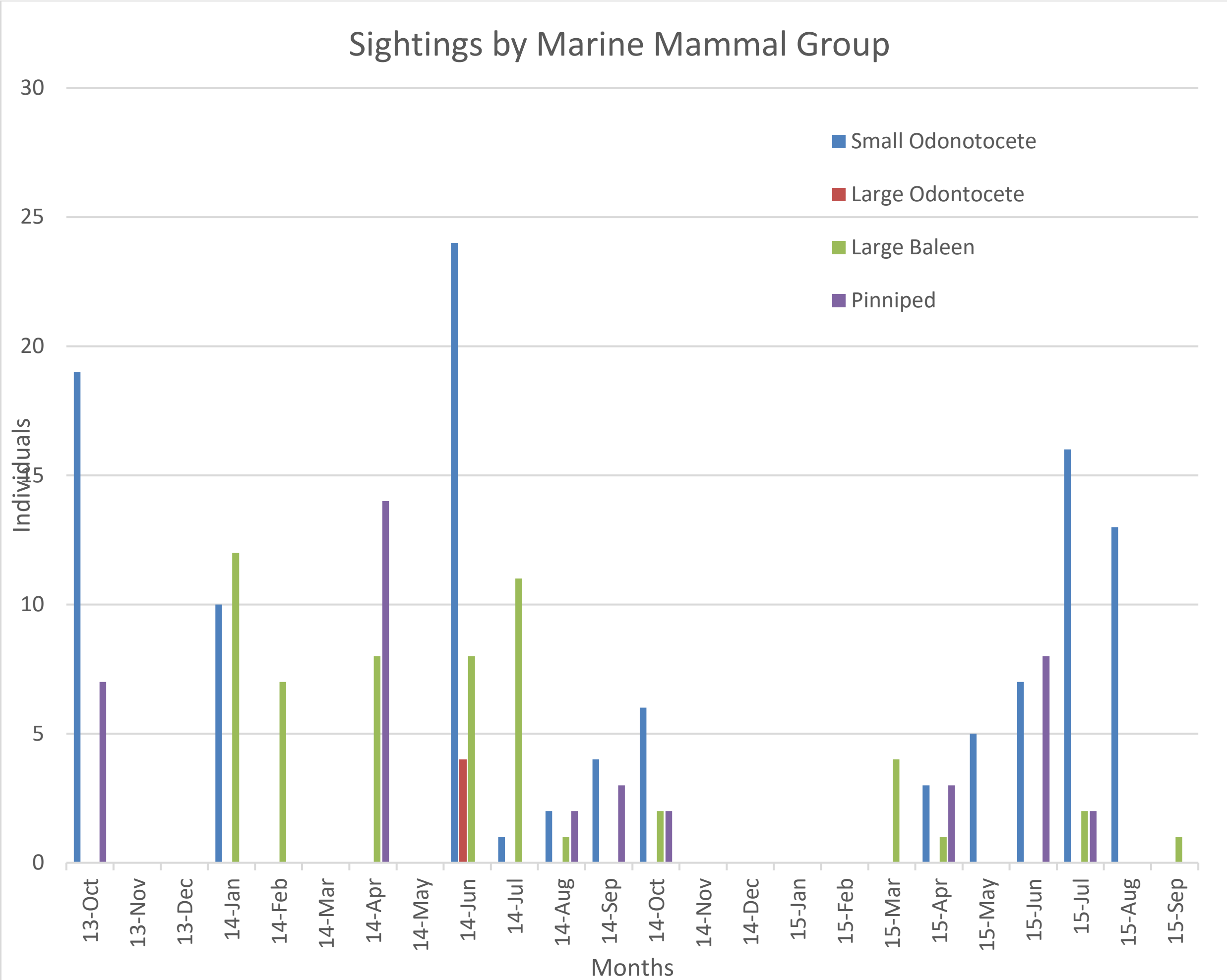

Figure 2: Sightings by marine mammal group: small odontocetes (harbor porpoise, Dall's porpoise, and Pacific white-sided dolphin); large odontocetes (killer whales only); large baleen (gray and humpback whales); and pinnipeds (California sea lion, Steller Sea lion, and harbor seals).

Table 3: Harbor porpoise sightings by site October 2013 to September 2015

Location	Total Individuals observed	Individuals per cruise
SETS	41	3.42
NETS	13	1.08
NH	27	2.70
Total:	**81**	**Average: 2.31**

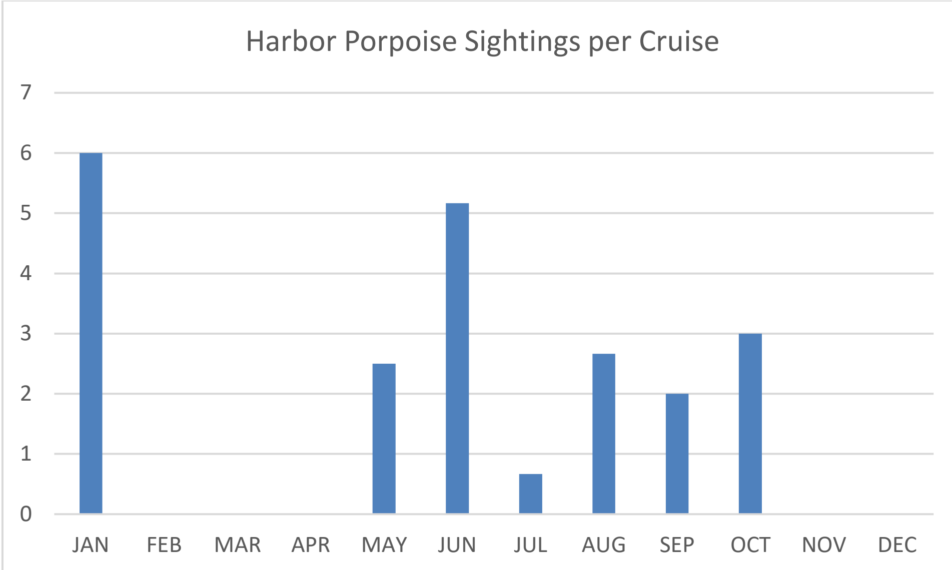

Figure 3: Harbor porpoise per cruise pooled by month 2013-2015. No cruises were conducted in December in any year. January data are from a single cruise on which all 6 porpoises were sighted.

3.2 DMON Detections of Harbor Porpoise

From the DMONS deployed May – October 2014 (at 30 m and 60 m), harbor porpoise were acoustically detected on 96% and 93% of the total monitored days at the reef and Project site respectively. Peak harbor porpoise detections occurred in June and July with a gradual decreasing trend in monthly presence through the fall, with the lowest PPMs in October. However, the largest single daily peak occurred in September with almost 70% PPM detection on the offshore station.

Click train detection rates were higher at the reef site (38% of total detections) compared to offshore at the Project site (18% of total detections). Relative foraging activity was a little higher, although not statistically significant, at the reef site where 30% of click trains were classified as buzzes (611 of 2,057) compared to 25% offshore (353 of 1,420).

When DMONS were deployed at both sites during the same period, during 78% of the co-monitored minutes, PPM occurred at either the offshore or the reef site, compared to 22% when PPMs were detected at both sites simultaneously.

3.3 Hydrophone Detections

From the inshore ("reef") lander deployed in 2014, both humpback whale (*Megaptera novaeangliae*) and killer whale (*Orcinus orca*) vocalizations were identified within the four-month period. Visual spectral recognition analysis for killer whale signals identified calls on 7 days (April 8th, 9th, 19th, 20th, May 16th & 26th, and June 10th) within the acoustic data set spanning April 1st – July 26th, 2014.

On the lander deployed within the Project Area in 2015, humpback whale vocalizations were observed with increasing regularity from early September through the end of recording on November 10th, 2015. Killer whale sounds look a lot like the chain noise experienced late in the deployment, so spectrograms again were "hand browsed" rather than using an automated detection algorithm. Visual spectral recognition analysis for killer whale signals in the 2015 SETS acoustic mooring data identified 3 days (July 16th, July 28th, and August 11th) where killer whales were vocally active in the vicinity of the hydrophone between the recording period June 24th – November 10th, 2015.

4. Discussion

Baleen whales

Gray whales were seen January to July on the boat-based surveys, which is consistent with their northward migratory path through Oregon in the spring.

Humpback whales detected on the hydrophone landers both in the earlier (April to July) deployment in 2014 and in the later (July to November) deployment in 2015. They were occasionally sighted from the boat August through October, which is consistent with the period of increasing vocalizations on the 2015 lander in the fall. Generally, humpback whales are most abundant off the U.S. West Coast from spring through fall, with most migrating to low-latitude areas located primarily off Mexico and Central America in winter (Calambokidis et al. 2000); however, sightings and passive acoustic detections by other researchers off the U.S. West Coast in winter and spring indicate a portion of the population can be in northern waters even in winter (Forney & Barlow 1998). Calambokidis et al. (2015) report the primary occurrence of humpbacks from Stonewall and Heceta Bank to be May – November, which is consistent with our detections.

Killer whales

Over the 257 days for which we had hydrophone coverage, which spanned from early April to mid-November, we identified killer whale calls on just 10 days in the spring and summer (April to August). Killer whales were spotted on just one of the 35 cruises, in June 2014, which is consistent with the timing of the detections on the hydrophone. Consistent with these observations, killer whales often are spotted in Yaquina Bay and close to shore from the Whale Watch Center in Depoe Bay from April to June.

Harbor porpoise

Digital monitoring device (DMON) results indicate a regular use of coastal waters off Newport by harbor porpoises with almost daily presence both within the Project area and the inshore "reef" location. Harbor porpoises were spotted on 16 of the 35 cruises offshore Newport and four of the twelve cruises to the Project area (although they may have been observed on the transit to/from the Project area, not necessarily within). Overall, echolocation activity indicative of presence and foraging at the reef site was higher and influenced by tidal phase. Harbor porpoise foraging activity was also prevalent at the Project site where harbor porpoise displayed increased feeding from sundown to sunrise. This is concurrent with other PAM studies that reported porpoises appear to shift their distribution to different depths and/or habitats at night, perhaps to take advantage of changing prey availability (Carlström 2005, Todd et al. 2009, Mikkelsen et al. 2013). Furthermore, water depth has a significant impact on porpoise diel rhythms, with more nocturnal porpoise echolocation activity occurring in deeper waters (Brandt et al. 2014, Wisniewska et al. 2016).

The gradual increase of harbor porpoise detections on the DMONs from May to July, and peak detections in late summer, along with visual observations almost exclusively from May through October, is consistent with the hypothesis that harbor porpoises move nearshore in relation to large scale temperature changes, which may increase prey availability and mating and calving opportunities (Dohl et al. 1983, Green et al. 1992). Our results correspond to previous reports documenting the largest concentrations of harbor porpoises along the west coast of the United States occur in summer and early fall, specifically September (Calambokidis and Barlow 1987, Barlow et al. 1988). While we only had DMON coverage during the expected high concentration periods, across the nine cruises we had November through April during the two-year study period, we had a single cruise (January) on which we saw 6 harbor porpoises, confirming the idea that they are unlikely to occupy this part of the coast during winter.

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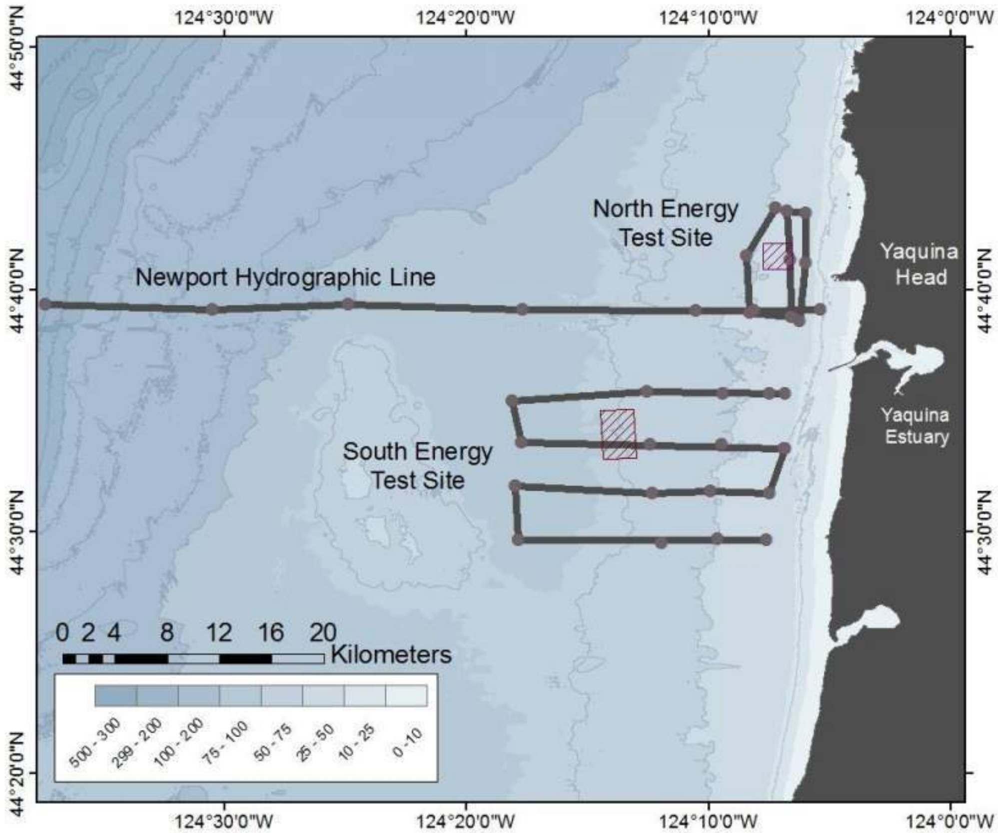

Figure A1. Ship tracks of 3 survey sites. The Newport Hydrographic line extends west from shore 40 km, while SETS extends 16 km. Grey nodes indicate sampling stations/breaks in continuous surveying effort and the boxes indicate PacWave-North (North Energy Test Site) and the proposed PacWave-South (South Energy Test Site) are denoted by hatched boxes.

SITE CHARACTERIZATION REPORT - SEABIRDS

CONTACT: DAN HELLIN, OPERATIONS & LOGISTICS MANAGER, PACWAVE
P: 541-737-5452 DAN.HELLIN@OREGONSTATE.EDU

Principle Investigators: ROBERT SURYAN, ASSOCIATE PROFESSOR – SENIOR RESEARCH, DEPARTMENT OF FISHERIES AND WILDLIFE, OREGON STATE UNIVERSITY, HATFIELD MARINE SCIENCE CENTER, NEWPORT, OREGON.

JESSICA PORQUEZ, M.S. STUDENT, MARINE RESOURCE MANAGEMENT PROGRAM, COLLEGE OF EARTH, OCEAN, AND ATMOSPHERIC SCIENCES, OREGON STATE UNIVERSITY, CORVALLIS, OREGON

1. INTRODUCTION/OVERVIEW

1.1. Resource(s) of Interest

A collective shift away from reliance on fossil fuel energy has increased the focus on alternative energy resources, including marine renewable energy. Off the U.S. west coast in the California Current System (CCS), there is increased interest in offshore wind and wave energy development. Within the California Current there are areas of marine renewable wind and wave energy research, with pilot studies aimed at understanding potential ecosystem effects in addition to testing marine renewable energy converters for broad-scale commercial production (Boehlert et al. 2012).

Located within the northern California Current System (nCCS), the north-central Oregon coast possesses favorable environmental conditions for the development of wind and wave renewable energy. Subsequently, nearshore waters in Newport, Oregon, were selected for the PacWave North (formerly known as Pacific Marine Energy Center North Energy Test Site [PMEC-NETS]) and PacWave South (formerly known as Pacific Marine Energy Center South Energy Test Site [PMEC-SETS]). An increasing diversity of human use of marine waters, such as renewable energy facilities, increases the potential for anthropogenic interactions with marine organisms in the nCCS, particularly with highly mobile species such as seabirds.

The Oregon coast supports approximately 1.3 million nesting seabirds per year (Naughton *et al.* 2007). The most abundant breeding seabirds include common murres (*Uria aalge*), concentrated in colonies in both northern and southern Oregon, and Leach's storm-petrels (*Oceanodroma leucorhoa*), with colonies concentrated in southern Oregon (Naughton et al. 2007, Suryan et al. 2012). The north-central Oregon coast, where the Project is located, is dominated by extensive sandy beaches and hosts relatively few nesting seabirds; it is home to about six percent of the Oregon seabird breeding population. Eleven species of breeding seabirds are known to nest in this region; the majority nest at Yaquina Head located about 15 km to the northeast of the PacWave South, although a few cormorants (*Phalocrocoracidae* spp.), gulls (*Laridae*), pigeon guillemots (*Cepphus columba*), and black oystercatchers nest along the shores south of Newport, potentially in the general vicinity of the shore cable landing. With the exception of black oystercatchers (*Haematopus bachmani*), which are restricted to shore, any of the other seabird species that nest in the area could occur in and forage in waters around the PacWave South.

Oregon coastal waters provide important foraging habitat for seabirds throughout the year, particularly in the fall when millions of marine birds that breed elsewhere (e.g., auklets, albatrosses, shearwaters, loons, grebes, sea ducks, and gulls) are known to migrate to Oregon's productive coastal waters to feed (Briggs et al. 1992, Phillips et al. 2011). Aerial surveys conducted in 2011-2012 documented the highest marine bird densities along the entire nearshore (<100 m depth) Oregon coast during fall (49.4 ± 5.0 7birds/km^2), with lower densities in winter and summer (37.4 ± 4.6 birds/km2 and 37.5 ± 6.4 birds/km2, respectively; Adams et al. 2014). Common murres and sooty shearwaters (*Puffinus griseus*) were the most abundant species in the PacWave South Project area in spring and summer, based on surveys conducted in the inner shelf waters (<100 m depth) around Newport in March-August 2003-2009 (Suryan et al. 2012) and in 2011-2012 (Adams et al. 2014). These two species are also the most abundant seabirds along the entire Oregon coast in spring and summer (Strong 2009, Suryan et al. 2012, Zamon et al. 2014). Surveys in 2011-2012 in the inner shelf waters (<100 m depth) around Newport also showed an influx of seabirds such as shearwaters, northern fulmars, Cassin's auklets, rhinoceros auklets, and brown pelicans in the fall (Adams et al. 2014). Thus, seabirds occur and forage in the Project area throughout the year with abundance likely highest in the fall and species composition changing throughout the year.

Prior research has documented high use of Oregon nearshore regions by alcids, cormorants, storm-petrels, shearwaters, gulls, brown pelicans, murrelets and phalaropes during the breeding season (although those are primarily post-breeding dispersers, migrants or nonbreeding "summering" individuals), however, the broad scale of these past studies (Suryan et al. 2012, Adams et al. 2014, Zamon et al. 2014) results in inadequate coverage of the PacWave area. In the non-breeding season, the nCCS is a high-use migration path that sustains millions of seabirds (Briggs et al. 1987; 1992, Adams et al. 2014). From 2011-2012, results from aerial surveys depicted higher densities of marine birds in the nearshore region (<100m depth). Adams et al. (2014) documented the densest aggregations in the fall (49.4 ± 5.0 7birds/km^2), with lower densities in winter and summer (37.4 ± 4.6 birds/km^2 and 37.5 ± 6.4 birds/km^2, respectively). These studies provide strong evidence that seabirds occur in highest densities nearshore, and therefore within the Project area, with species composition changing from near- to offshore and seasonally. The PacWave North and PacWave South are located entirely within the continental shelf, therefore we included an additional cross-shelf transect extending 40 km offshore from the PacWave sites to capture seasonal fluctuations and cross-shelf variation in community composition throughout the year (Figure 1; Hickey & Banas 2003)**.** Prior to our study, our understanding of seabird variation off the central Oregon coast was at a relatively coarse spatial and temporal resolution, with limited applicability to a small area like the PacWave sites.

1.2. Potential Effects/Issue Summary

The primary potential effects on marine birds are the attraction to WECs for artificial perching, nesting, and foraging habitat, above surface collision with flying birds, below surface collision or entanglement with diving birds, and light attraction of nocturnal birds.

Artificial Perching and Foraging Habitat – Seabirds commonly use artificial structures including navigational buoys to roost and nest on or forage around. Likewise, seabirds such as gulls and cormorants could be attracted to WECs at PacWave South. WECs can also act as fish aggregating devices or otherwise provide enhance foraging opportunities for seabirds (Boehlert et al. 2008, Langton et al. 2011). With the rather low density of artificial structures at PacWave South, however, the greatest risk of collision would generally only be during poor visibility or poor flying conditions for above water impacts and entanglement with sub-surface debris (such as nets) that may accumulate on below water structures. Examples from wind farms show avoidance rates of entire farms or individual structures by many species of seabirds at greater than 98% (Cook et al. 2012).

Effects of Artificial Lighting – A number of species of seabirds feed both diurnally and nocturnally and several feed almost exclusively at night. Seabirds such as shearwaters, storm-petrels, auklets, and murrelets that forage nocturnally are attracted to artificial lighting at night and therefore could be attracted to navigational lighting on the WECs or to lighting on servicing and support vessels associated with installation or maintenance of the WECs, and they could collide with, or land on, the WEC or vessel structures or become exhausted by continual circling around the lights (Montevecchi 2006). Nocturnally foraging seabirds have been shown to be highly attracted to artificial light in the marine environment; typical sources of light include boats, lighthouses, oil and gas platforms, coastal resorts, and commercial fishery operations. Continuous high-intensity white lighting has a higher likelihood of attracting nocturnal seabirds than lower-intensity, colored lights and those that flash at intervals. Nocturnally active seabirds are most susceptible to light attraction in cloudy, foggy, hazy conditions, in light rain, and when the moon is absent or obscured, and immature and nonbreeding nocturnal seabirds tend to be more attracted to light than breeding adults (Montevecchi 2006; Miles et al. 2010).

Collision and Seabirds – Seabirds are unlikely to collide with above-surface structures of WECs at PacWave South during periods of high visibility and low winds. The avoidance rate estimates are based on surveys conducted when sea conditions and visibility are good (Camphuysen et al. 2004). However, seabirds may be more susceptible to collisions with above-surface structures of WECs during periods of high winds or poor visibility (e.g., storm conditions, fog, and darkness; Boehlert et al. 2008; Suryan et al. 2012; Henkel et al. 2014). Seabird species in the PacWave South area that are most likely to collide with WECs include those known to fly at altitudes of less than 30 m at least some of the time, including alcids (common murres, auklets, puffins), cormorants, storm-petrels, shearwaters, gulls, brown pelicans, and phalaropes (Geo-Marine 2011, Suryan et al. 2012, Henkel et al. 2014). Of these species, alcids, gulls, phalaropes, storm-petrels and cormorants may be most likely to collide with above-surface structures of WECs during high winds because they tend to fly at lower altitudes (<10 m) during high winds, while fulmars, shearwaters, and albatrosses fly at higher altitudes when wind speeds increase (Ainley et al. 2015). Artificial lighting may increase the likelihood of collisions with WECs or service vessels for some light-attracted nocturnal seabirds (e.g., shearwaters, petrels, auklets, and murrelets) (Montevecchi 2006, Miles et al. 2010).

1.3. Study Objective

The objective of this study is to quantify the seasonal abundance, species composition, and distribution of seabirds and identify their associations with oceanographic habitats within and adjacent to the PacWave South site. Seabird distribution and bio-physical data from PacWave South will be compared with similar data collected in adjacent areas, including repeated cross-continental shelf surveys. These site comparisons will provide a better understanding of how seabird assemblages and habitat use within PacWave South compares to the surrounding area.

2. DATA COLLECTION

2.1 Methods & Equipment

We conducted vessel-based, strip transect surveys at three study areas in neritic waters off the central Oregon coast (Figure 2) from May 2013 to October 2015 on a total of 44 cruises. Additionally for one site, the Newport Hydrographic Line, we included data from 13 surveys conducted December 2006 to July 2009. Table 1 shows all cruises to each of the three sites, binned by month.

Sighting data - All surveys were conducted aboard the R/V *Elakha* (16.5 m) using the strip transect method (Tasker et al. 1984). We had one dedicated observer sight birds and one dedicated data entry person record the sightings and pertinent information. The observation bridge is 1.9 m above the water, with an average observer eye height of 3.5 m from the sea surface. Observers surveyed from the port side of the vessel out to 300 m in a 90-degree arc from bow to beam. Sightings were recorded during continuous transit between oceanographic sampling stations when the vessel speed was between 15-22 km/hour.

Observations were recorded using the SeeBird (2006-2013) or SeeBird WinCruz version 3.5+ (2014; Holland 2008) data acquisition software and are geo- and time-referenced with a direct input from the vessel's global positioning satellite receiver (GPS). For every cruise, a designated observer and data recorder alternated duties to avoid fatigue. Environmental sighting conditions included Beaufort sea state, visibility, cloud cover and rain/fog. For analytical purposes we only included data that had a Beaufort Sea state rating < 4. While previous studies used a Beaufort Sea state cutoff of 5 (Ronconi & Burger 2009, Adams et al. 2014) or 6 (Sigler et al. 2012), our observation platform was lower and we used a cutoff of 4 to avoid compromising the detection of small alcids on the water. Above this sea state (4) detectability of birds on the water from the R/V Elakha became significantly compromised. For each seabird sighting, observers noted the bird species, number of individuals, distance from ship (<100 m and 100 - 300 m), and multi-species associations.

We calculated seabird density (birds km^{-2}) in 3 km sections along transects using a custom program written in R v.3.1.1 (R core team 2014). Sections of continuous transit shorter than 1.5 km were not used for subsequent analysis. We selected 3 km sections in order to account for spatial autocorrelation in the data (Schneider 1991, Yen et al. 2004).

Environmental/effort data - Environmental and effort data were entered at the start of the cruise and updated as conditions changed. Environmental data included observation conditions/visibility, Beaufort sea state, cloud cover, rain/fog, and observer/recorder identification. Effort data included date, cruise identification number, Greenwich Mean and local time, vessel position (latitude/longitude), and ship course (speed).

Surveys were conducted on "ships of opportunity" with other labs on their cruises to the PacWave sites (PacWave South and PacWave North) and NH line. Along with prohibitive weather, this posed challenges to scheduling and cruise frequency (Figure 1).

Bio-physical and habitat data - While underway we collected *in-situ* surface water conductivity (salinity), temperature and fluorescence measurements using a SeaCat21 thermosalinograph (hereafter referred to as "flow-through") on 37 of 48 cruises from 2013-2015. Flow-through measurements were recorded every 3 seconds using SBE Seasave V7 software. These data were then converted and processed using the SBE Data Processing program, and binned into 300 m sections in R v.3.1.1 (R core team 2014), providing surface water characterization of the sites. These data were temporally matched to the binned observational data using a custom program written in Matlab (vR2013a). See *Appendix a* for a breakdown of flow-through and GPS data availability by cruise.

We obtained benthic habitat data for our study area from the Oregon Department of Fish and Wildlife Nearshore Ecological Data Atlas (NEDA), a spatial planning grid of nearshore benthic terrain. Surficial geologic habitat for NEDA was classified by the Active Tectonics Lab at Oregon State University into six sediment types: fine, medium and coarse sand, gravel mix and rock outcrop (Goldfinger 2010; 2014). The data also included classifications of general bathymetry classifications: shelf, slope, ridge, basin, nearshore, and channel.

Site descriptions – PacWave South (Figure 1) is south of the Yaquina River and transects through this site extended from 1-10 nm/1.5-16 km west of the coastline and 6-nm/9.5 km south of the river mouth. The South site was broken up into 4 major transit lines (each 10 nm) with 4 E-W transects and 4 station stops at each transit line on the 30, 40, 50 and 60-meter isobaths. There is also a 2-nm N-S transect between each major transit line. Cruises at this site departed at sunrise and returned late afternoon/ early evening.

PacWave North (Figure 1) is north of the Yaquina River, within 3 nm of shore and less than 1 nm from Yaquina Head, which is home to a large breeding colony of up to 80,000 common murres at peak breeding season. Transects run in E-W and N-S directions, with 4 sampling stations each along the 30, 40, 50 and 60-meter isobaths. Cruises to this site departed at sunrise and returned in the early afternoon.

The NH line (Figure 1) is a cross-shelf oceanographic sampling line that extends 25 nm/40 km west from Yaquina Head, Oregon. The NH line is a straight continuous line with sampling stations at 1, 3, 5, 10, 15, 20, and 25-nm from shore. The transect line at this site runs E to W. Sampling on station takes 20 to 60 minutes, during which time seabird data are not being collected. These cruises began 4 hours before sunset, and observers surveyed to the end of the line (station NH25) or until it was too dark to reliably identify birds. Over the course of our study, we conducted one night study along the NH Line, with the use of night-vision binoculars.

Equipment

- **Data entry computer**: Equipped with SeeBird WinCruz version 3.5+ and connected to the vessel's Global Positioning System (GPS) via serial cable.
- **Flow-through computer**: Equipped with SBE Seasoft V2 suite which includes Seasave 7, Seaterm (a terminal program for setup, calibration, data retrieval and diagnostics), and SBE Data Processing.
- **Thermosalinograph**: SBE SeaCat21 which measures surface conductivity (salinity), temperature and fluorescence every 3 seconds.
- **Range finders**: A wooden stick with angles from the horizon marked that denote 100 and 300 meters from the ship. Observers hold their fully extended arm in a 90^{O} angle from the body and align the top of the stick with the horizon to determine distances.
- **Binoculars**: Binoculars (7-10X power) were used as needed to aid in identifying birds out to 300 m, although the majority of birds are easily identified by the unaided eye.

2.2 Schedule & Frequency

Table 1. Seasonal cruise frequency by site and month. White boxes indicate = no cruise, light grey = 1-2 cruises, dark grey => 3 cruises in a given month (numbers represent sample sizes). Surveys at the PacWave North (15 total) and PacWave South (13 total) all occurred 2013-2015. NH Line surveys include a data set from 2006-2009 (18 cruises) and 2013-2015 (11 cruises).

	Month											
	Jan	Feb	March	April	May	June	July	Aug	Sept	Oct	Nov	Dec
PacWave South	1			2		4		3	1	1	1	
PacWave North		1		1	1	6		2	1	3		
NH		1	2	2	4	3	6	4	2	4		1

2.3 Constraints & Limitations

The primary constraints to data collection were the use of ships of opportunity and inclement weather cancelling cruises or affecting siting conditions. From November to January we were only able to conduct 1 cruise per month and longer study duration could provide a larger sample size during these winter months.

2.4 Analysis

Seasonal/temporal distributions - We used PC-ORD v. 6.0 (McCune and Medford 2011) to analyze seasonal shifts in the seabird community. Seasons were defined by Gregorian calendar dates (DJF, MAM, JJA, SON). We used non-metric multidimensional scaling (NMS; Kruskal 1964) to develop community ordinations that reduced the dimensionality of species relationships over space and time, resulting in n-dimensional visual representations of the community across the study area. NMS ordination was conducted on focal species that were selected using a recommended threshold of 5% of total observations and on foraging niches ecologically important to the area (table 2.3; McCune and Grace 2002). We calculated density km^{-2} for all birds observed and conducted community analysis on the selected 7 focal species and the 5 defined foraging niches. The data sets for the ordinations contained a mean nearshore ($\leq 18.5\ km$) and offshore ($> 18.5\ km$) species or group density value for each cruise, derived from the binned observational data. The near- and offshore classifications were selected because of observations that biological indicators and hydrography changed westward of sampling station NH10 and this also corresponded with the westward extent of the PacWave transects, allowing us to compare seabird community composition and abundance at PacWave sites relative to offshore waters. Fewer offshore surveys were conducted, resulting in an uneven number of near- and offshore data points. Final data matrices for ordination include 74 density values of focal species and 69 foraging group densities from 2007-2015. For all ordinations we employed Sorensen's distance measure, with a random starting configuration, Monte Carlo test, and 100 runs with real data. Ordinations were evaluated and selected with the use of scree plots, final instability and final stress values (McCune & Grace 2002).

Since the PacWave South area boundary is proposed but the installation sites remain undetermined, we graphically represented seasonal species densities and overlap with PacWave sites using inverse distance weighted maps for common murres and sooty shearwaters.

We had a low observation rate of brown pelicans (*Pelicanus occidentalis*), marbled murrelets (*Brachyramphus marmoratus*) and black-footed albatrosses (*Phoebastria nigripes*), however we included maps of their distributions around the PacWave because of their significance as federally listed endangered species or species of interest. We used black-footed albatross sightings as a proxy for interpreting potential short-tailed albatross (*P. albatrus*) distributions because they use similar habitat within the CCS (Guy et al. 2013) .

Spatial distributions - To assess the relationship between spatial variables and the seabird community, we developed non-linear generalized additive mixed-effects models (GAMMs) using the "mgcv" package in R v. 3.2.2 (Aarts et al. 2008; Wood 2006, 2011; R Core Team 2015) for focal species only. GAMMs allow us to examine non-parametric species' response to environmental variables and were generated for all 7 focal species (Gusian 2002, Elith 2009). For these models we used 3 km transect bins where birds were present and paired the observed densities with environmental/habitat measurements. We define species presence as any observation that yields a mean density/km^2 > 0, therefore when the observed density of a given species = 0, the true mean density is unknown. There are numerous intrinsic and extrinsic factors that affect the year-round presence of seabirds in an area, many of which we did not measure, such as prey abundance, wind speed, variable migration timing, etc. (see Millspaugh & Martzluff 2001). Therefore, our models address the question of when present in an area, which of our measured variables contributes to increased species density and diversity. We used Spearman's rank correlation to test for correlations among covariates and highly correlated covariates (> 0.7) were not included together in the same model. The bird density data were log transformed and fit using a Gaussian distribution for presence only observations, and the best model was selected based on Akaike's Information Criteria (AIC; Akaike 1973) and generalized cross validation (GCV) scores (Wood 2006, Zuur 2009). Best overall fit was acquired with stepwise methods, AIC and GCV scores for each species and foraging niche. The AIC and GCV values were compared for model selection between the full and null models. We plotted the autocorrelation factor of the models and detected no spatial autocorrelation among the residuals, therefore we did not apply a correlation factor to any model.

Our explanatory habitat variables; surface salinity, surface temperature, surface fluorescence, and substrate were selected a priori due to anticipated effects on seabird distribution from previous studies (Santora et al. 2011, Yen et al. 2004) and available instrumentation on the vessel. Additionally, we included season, water depth, year and distance to shore as environmental parameters. To control for individual effects over the 3 study areas, site was included in the model as a random effect. A mathematical equation to describe species or foraging niche density in response to given environmental variables is:

$$Y_i \sim (\lambda_i, \vartheta)$$

where Y_i is the observed species or group density km^{-2} given a set of environmental conditions, λ_i is the unobserved true mean density km^{-2} of the species, given a set of environmental conditions, and θ is the dispersion parameter (Gaussian). Our parameters include:

$$\log(\lambda_i) = \alpha + f_1(\text{fluores}_i) + f_2(\text{salinity}_i) + f_3(\text{temp}_i) + f_4(\text{depth}_i) + f_5(\text{distance}_i) + \beta_1(\text{season}_i) + \beta_2(\text{substrate}_i) + \beta_3(\text{year}_i) + p_k + \varepsilon_i$$

$$\text{where } \varepsilon_i \sim N(0, \sigma^2) \text{ and } p_k \sim N(0, \sigma_p^2) \text{ and } \text{Cov}(p_k, p_{k'}) = 0$$

In the model, λ_i represents the unobserved true mean density/km^2 of the modeled species, given the observed density $Y_i > 0$. The functions f_i represent smoothing splines applied to explanatory variables *fluorescence (fluores)*, *salinity, temperature (temp), depth, and distance to shore* (distance). The smooth term varied depending on model fit, but for single parameters we applied either a thin plate or cubic regression smooth spline (Wood 2004; 2006, Zuur et al. 2009). The functions β_i represent coefficients for categorical variables, where a smooth is not applicable, and p_k is the random effect *site*.

3. Results

We surveyed 3,533 km^2 during 391 hours of observation and recorded 30,997 birds. Of the 50 species documented through our surveys, common murres were the numerically dominant species, representing 70% of total sightings, while the sooty shearwater was the major component (78%) of the migratory species group. Six additional observed species represented at least 5% of total sightings, and were subsequently included in analyses (Table 2).

Seasonal distributions - A two dimensional NMS ordination (Figure 2) with orthogonal axes explained 86% of total variance in the species distribution and had an acceptable final stress of 13.3. Axis 1 (r^2=0.51) represented a nearshore/offshore gradient, while axis 2 (r^2=0.32) captured the effect of resident versus non-resident or migrating species. We detected spring and summer clusters with low distinction between the near and offshore community, although spring appears more nearshore community driven, while summer appears to be more influenced by offshore species presence. Common murres, the dominant species, were densely aggregated nearshore in the spring and summer, dispersing further across the shelf in the fall (Figure 4). The greatest overlap between common murres and the PacWave North and PacWave South occurred in the spring, with a density highest within the PacWave North (2500-5000 murres/km^{-2}, Figure 4). Within the PacWave South during spring there were between 800-1100 common murres/km^{-2}, with some higher densities within 2 km of the site. During the summer and fall there was a marked decrease in common murre densities within both sites. The ordinated fall community differs distinctly from the rest of the year, with the offshore community comprising species found nearshore during the spring and summer while species present offshore during the spring and summer appeared nearshore during the fall. The nearshore fall community was primarily dominated by sooty shearwaters, which were found dispersed further offshore in the spring and summer (Figure 5). Shearwaters were detected at high densities between the PacWave North and PacWave South (100-220 birds/km^{-2}) during the fall, although density within either site was relatively low throughout the year (Figure 5).

We used a two dimensional NMS ordination to assess community assemblages on a foraging group level (Figure 3). The ordination described 78% of variance within foraging group distributions, with orthogonal axes and a final stress of 15.02. Axis 1 (r^2=0.37) represented a seasonal gradient, reiterating a distinctly different community structure in the fall months, while Axis 2 (r^2=.42) indicated a near/offshore gradient, which can be interpreted in terms of foraging strategies, as diving species occur nearshore and surface feeders offshore.

We quantitatively addressed the spatial distributions of federally listed (endangered/threatened) species as well as unlisted species of interest in the area by generating maps of species observations. Brown pelicans were primarily observed within <50 meter depths, and occurred individually and in flocks along the coastal extent of the PacWave study area (Figure 6). While pelicans were more concentrated at the mouth of the Yaquina River Estuary and at the PacWave North, they appear to use the PacWave South as well. We recorded a total of 91 brown pelicans over the course of our study. All marbled murrelets were detected within about 17 km of shore with the highest occurrence very near to shore (< 50 m depth, Figure 7). We recorded a total of 35 marbled murrelets sightings, primarily concentrated in the eastern portion of PacWave South and adjacent nearshore waters near the mouth of the Yaquina River Estuary. We did not observe any murrelets in the PacWave North. Nearly all of our black-footed albatross sightings were beyond 20 km from shore along the NH Line, except for one sighting near the PacWave South, about 16 km from shore (Figure 8). We recorded a total of 41 black-footed albatrosses throughout our study. While present in the surrounding area, none of the species of interest occurred within the explicit PacWave South boundary.

Night survey - Our single nighttime survey was conducted on July 7, 2014 along the NH Line from 12:00 am to 1:30 am. During this time, 17 birds were recorded: 6 unidentified albatrosses (most likely black-footed), 6 fork-tailed storm petrels and 5 common murres. All birds detected were sitting on the water. The limited duration of the study makes it difficult to extrapolate patterns, however, we did not observe any species that were different than those observed during daylight hours. The frequency of albatross sightings was relatively high (4.5/hour), and most were recorded between stations NH 5 (8 km offshore) and NH10 (18 km offshore).

Seabird and habitat spatial models - Common murre densities were highest in the spring, followed by the summer, and comparable decline in the fall and winter (Table 5). Common murre density/km^2 was negatively correlated with depth, with diminished density over deeper water, although there appears to be a peak in higher densities around a depth of 30-40 meters (Figure 9a). There was a multimodal response to fluorescence, with peaks in densities around 1.1, 1.5 and 4.5 volts (Figure 9b). Common murre density was negatively correlated with temperatures exceeding 12^{o}C (Figure 9c) and negatively correlated to salinity (Figure 9d). Site was significantly correlated with the response, reflecting dense aggregations of murres around Yaquina Head during the breeding season.

Sooty shearwater density was highest in the fall, lower in the spring and summer, and lowest in the winter (Table 5). Depth and distance to shore were both excluded from the final model, as they likely confounded by the seasonal shoreward shift of sooty shearwaters illustrated by the NMS ordination described in the previous section. Sooty shearwater density was negatively correlated with salinity, indicating higher densities at lower salinities, although Figure 10 shows that there is high variability in the response to higher salinities.

Brandt's cormorant density was correlated with depth, fluorescence, salinity, and temperature. There was a bimodal response to depth, with peaks in density at 40m and 60m depths (Figure 11a). There was a positive correlation with fluorescence (Figure 11b) and salinity (Figure 11c). Brandt's cormorant density had a negative response to temperature (Figure 11d).

Pelagic cormorant density was highest in the fall and lowest in the winter (Table 5), with significantly higher densities over sandy substrate versus mud or rock. The relationship between density and depth was linearly negative (Figure 12a), with all sightings <70 meters depth. Although there were several larger group densities at deeper depths, there were overall more regular observations over shallower water. The response to temperature was negative (Figure 12b). Site also had an effect on pelagic cormorants, with higher overall densities at the PacWave North.

Cassin's auklets were seasonally driven, with the highest densities in summer, with lower densities in the fall (Table 5). Fluorescence was significant, and the response was variable, with a peak around 1.5 volts, and a positive response to fluorescence exceeding 2 volts (Figure 13a). Density was positive relative to increasing depth (Figure13b).

Western gulls were present throughout the study area, with no significant effect of season, and the highest densities occurred closer to shore (within 10 km; Figure 14a). There was a negative response to both salinity (Figure 14b) and temperature (Figure 14c), although there was overall higher sighting frequency at higher salinity values.

Red-necked phalarope densities were highest in the summer and fall (Table 5). The response to temperature was unimodal, illustrating increased density response until an optimal temperature of about 14^0C, at which point warmer temperatures were associated with lower red-necked phalarope concentrations (Figure15a). Although red-necked phalaropes are distributed throughout the study area, denser aggregations were associated with lower (<33.5 ppt) salinity (Figure 15b).

4. Discussion

Fluctuations in seabird community - In general, diving piscivores were the most abundant of all foraging groups. While this group was found at all 3 survey areas, the most observations were recorded on PacWave South cruises. It is important to note that the diving planktivore group only contains one species (Cassin's auklet), thereby contributing to their low overall abundance relative to other groups. Winter surveys had the lowest abundance for all foraging groups, after correcting for the different number of cruises seasonally. Overall we tended to see diving piscivores mostly concentrated further inshore (primarily driven by common murres and their proximity to the Yaquina Head nesting colony), and the other 3 groups appear evenly distributed. Common murres make up 58-97% of the diving piscivore group seasonally and as a result, distributional inferences of this foraging group often reflect common murre phenology. Diving piscivores also constituted the largest number of observed individuals in a single sighting event. When looking at the seasonal flux of foraging group distribution, diving piscivores appear to comprise the majority of the seabird composition at the three sites during the winter and spring. Again, diving piscivore dominance in the spring might be explained by the start of the breeding season and the common murre colony at Yaquina Head. Summer distributions of diving piscivores appear in higher concentrations at PacWave North, which might be explained by nesting common murre adults coming and going from the colony to forage for chicks. Summer and fall appear to have higher species richness and larger group sightings of various foraging groups (beyond diving piscivores), which might reflect migration corridors, and shifting of prey availability.

The NMS results indicated that the spring community appeared primarily driven by nearshore species/foraging niches while the summer community comprised both near and offshore species/niches. Both the spring and summer nearshore communities were driven by resident species, including common murres, Brandt's and pelagic cormorants. This contradicts Adams et al. (2014), which found the highest densities of common murres and cormorant species during the fall. This could be an effect of limited common murre and cormorants foraging trips from Yaquina Head during the breeding season, when the species, which share similar foraging strategies, are constrained by foraging and chick rearing activities (Orians & Pearson 1979, Cairns et al. 1987). Common murres regularly form rafts in waters around Yaquina Head in response to disturbance and predation at the colony (Horton 2014), contributing to dense aggregations around the PacWave North and greater nearshore region in the spring and summer. Evidence that bottom-up forcing heavily regulates murres could explain spatial dispersal following chick fledging (fall and winter) as murres' foraging range expanded (Davoren et al. 2003a, Parrish & Zador 2003). Some pursuit divers (e.g. alcids), however, appear to be nearshore specialists, which may reflect benthic foraging by some (e.g. cormorants) more than others (e.g. Cassin's auklets). This was especially true with respect to both cormorant species, which rarely occurred beyond 16 km from shore. Prior research has found a negative correlation between cormorants and temperature, suggesting sensitivity to upper temperature limits

(Cairns et al. 2008). The spatial and foraging overlap of the two species suggests a similar response to environmental parameters, but while we detected a significant relationship between temperature and pelagic cormorants, this parameter was insignificant in our Brandt's cormorant model. Ainley et al. (1981) documented overlap between Brandt's and pelagic cormorant foraging ranges, but distinct habitat preferences and prey consumption between the two species. Ainley et al. (1981) described a correlation between rocky substrate and pelagic cormorants based on stomach samples and identified prey distributions, which we did not detect in our study. Instead, we observed an association between pelagic cormorants and sandy or flat substrate, which could indicate a shift in foraging or prey availability or interactions between flight range and available foraging habitat.

In contrast, migratory species, dominated primarily by sooty shearwaters, remained offshore during the spring and summer. The fall community was composed of both resident and migratory species, capturing the southward migration of sooty shearwaters and northern fulmars during these months. Adams et al. (2014) also detected a trend of higher sooty shearwater density in the nearshore (0-100m depth) region during the summer (June 2012) and fall (September 2012), although they did not identify a shift to or from the offshore region during the spring or winter. The occurrence of coastal upwelling may facilitate greater prey abundance on the continental shelf during the boreal summer and fall, prompting the spring and summer offshore community (primarily sooty shearwaters and Cassin's auklets) to shift nearer to shore during the upwelling season. There is strong evidence that sooty shearwaters and Cassin's auklets are positively correlated with upwelling indicators and high euphausiid density (temperature and chlorophyll-a, respectively; Oedekoven 2001, Yen et al. 2006, Adams et al. 2012), which corresponds to upwelling conditions on the Oregon coast. Other studies have found sooty shearwaters associated with warmer temperatures (Shaffer et al. 2009, Hedd et al. 2012), although we found that the effect of temperature is dependent on salinity, with the highest aggregations correlated with high temperature and high salinity, and variable responses to varying temperatures.

Spatiotemporal overlap with the PacWave sites - Common murres and sooty shearwaters were the most abundant species over our study area, consistent with earlier studies for the entire Oregon coast (Strong 2009, Suryan et al. 2012, and Zamon et al. 2014). However, we observed the highest abundance of shearwaters in late summer and fall, (consistent with Adams et al. 2014) rather than spring and summer (Suryan et al. 2012, Zamon et al. 2014), indicating a later peak in shearwater density at the PacWave sites from 2013-2015. Our divergence from these findings could perhaps be attributed to anomalous oceanographic conditions in 2013-2015.

Although they might easily avoid mooring lines, diving birds are at a higher risk of underwater entanglements with marine debris that may accrue on with WEC moorings (Furness et al. 2012), which could be a concern for the dense aggregations of common murres and cormorants observed in our study area. However, other than the high densities of common murres staged around Yaquina Head during the breeding season, the highest concentrations of common murres and sooty shearwaters, along with other species, were concentrated outside of the PacWave sites throughout our study period.

We also observed use of the PacWave area by brown pelicans (PacWave North) and marbled murrelets (PacWave South), and further assessment of these species in the area could provide insight into larger conservation issues. Black-footed albatrosses are seldom observed within 16 km of shore, as our study confirmed, and therefore we infer that short-tailed albatross use of the PacWave area is likely quite low as well. Nonetheless, occasionally conditions exist that draw outer continental shelf and slope species into relatively nearshore regions.

Our study confirmed an influx of shearwaters, northern fulmars, Cassin's auklets, rhinoceros auklets, and brown pelicans to inner shelf waters (<100 m depth) in the fall, consistent with previous findings that did not note the seasonal near/offshore shift, but documented higher overall nearshore densities in the fall (Adams et al. 2014). With the PacWave North and PacWave South data we were able to capture a broader nearshore community than results from only surveying the NH Line, with greater application to the PacWave and future monitoring of the community. Assuming the persistence or regularity of significant environmental conditions, we might expect these species to have higher rates of exposure to effects of WECs at the PacWave South and the Ocean Sentinel/anchored platform at PacWave North.

Habitat preferences - Common murres were negatively correlated with salinity and temperature, with the highest densities detected at low salinities and low temperatures. This possibly indicated a common murre preference for specific cold, low salinity water masses. Palacios et al. (2013) modeled relationships between temperature, salinity and nitrate, and determined that water masses with low saline and temperature properties were typically coupled with high levels of nitrate, indicating a fresh water or estuarine component of the water mass. The correlation between these habitat conditions and common murres could reflect a preference or greater foraging success in estuarine water from the Yaquina River, or from the southern-most extent of the Columbia River plume.

Upwelled water is characterized by low temperatures and high salinities, a signal of nutrient rich waters that support euphausiid production and subsequent organisms up the food web. Our model for Brandt's cormorants detected correlations to typical upwelling indicators; cold, highly saline, nutrient rich water, possibly reflecting greater foraging or foraging potential in upwelled waters. However, during anomalous years, (e.g. presence of the "Blob" 2013-2015) upwelled water may be warmer (higher overall variability in temperatures), with high salinities and poor nutrient content. In our study, we found a correlation between sooty shearwaters and high salinity, but no significant relationship to temperature. This could indicate a correlation between sooty shearwaters and upwelled water masses, which may have warmed as a result of anomalous oceanographic conditions. Therefore, while both species appear to be responding to upwelled water, sooty shearwaters appeared to be less sensitive to variable temperatures in their foraging grounds, while Brandt's cormorants displayed a clearer bias for cold temperatures.

Development of the PacWave and future seabird interactions - Although the use of the PacWave area by focal species is highly seasonal, the year-round presence of WECs makes our data valuable in providing insight for ongoing monitoring of seabirds at the PacWave sites. The newness of renewable wave energy development leaves seabird/WEC interactions largely unexamined, but our study provides baseline information on the distributions of breeding and non-breeding species, as well as use of the area by species of concern.

5. Conclusions

Our study confirms our initial hypothesis that the density and distribution of seabirds at the PacWave north and south test sites and adjacent study areas are correlated with both spatial and seasonal variables, however, there was variable significance and response among species. Previous surveys off Newport have omitted the entire PacWave South area (Adams et al. 2014, Zamon et al. 2014), and instead sampled the NH Line, which provides cross shelf variation in the seabird community in the surrounding PacWave area, but has limited application to the PacWave without the PacWave South surveys. Our observations include multiple transects through and around both PacWave North and PacWave South. While other studies contained transects off Newport, they were not continuous (Ainley at al 2009, Zamon et al. 2014), or were at a much broader scale and lesser frequency (Adams et al. 2014), making our surveys particularly suited to informing the implementation of the PacWave. Continued survey effort could address questions about interannual variability and species' response to long term shifts in habitat conditions at the PacWave sites.

Table 2. Dominant species selected using a cutoff of a single species representing at least 5% of the total observations. Common murres (*Uria aalge*) were excluded from the cutoff calculation because total sightings were a degree of magnitude larger than the next largest single species sightings. Foraging niches are differentiated by whether a species' diet is comprised primarily of fish (piscivorous) or plankton (planktivorous) and whether they are diving or surface feeder. Observed species with a mixed diet were excluded from foraging niches.

Species and groups	
Dominant species	
common murre	*Uria aalge*
sooty shearwaters	*Puffinus griseus*
Cassin's auklet	*Ptychoramphus aleuticus*
western gull	*Larus occidentalis*
Brandt's cormorant	*Phalacrocorax penicillatus*
pelagic cormorant	*Phalacrocorax pelagicus*
red-necked phalarope	*Phalaropus lobatus*
Foraging niches	
surface piscivores	tern spp., gull spp., kittiwake spp.
diving planktivores	Cassin's auklet (*Ptychoramphus aleuticus)*
surface planktivores	phalarope spp., storm petrel spp.
diving piscivores	common murres *(Uria aalge),* cormorant spp., pigeon guillemot (*C. columba),* murrelet spp., rhinoceros auklet (*C. monocerata*), puffins
migratory species	sooty shearwaters (*Puffinus griseus*) and northern fulmars (*Fulmaris glacialis*)

Table 3. Three best fit models for each species, with selected model highlighted in grey. X's indicate coefficients used in the model, larger, bold X's indicate parameters that were statistically significant.

Model	Coefficients																
	Spring	Summer	Fall/mud	Winter	Rock	Sand	Salinity	Fluores	Temp	Depth	Dist	2014	2015	Site	AIC	Adj r^2	GCV score
BRCO							**X**	**X**	**X**	**X**				x	314	0.18	0.86
BRCO.2								**X**	x	**X**				x	318	0.17	0.9
BRCO.3	**X**	x	**X**	x			**X**	**X**	x	**X**				x	322	0.16	0.94
CAAU	**X**	**X**	**X**	x			x	**X**		**X**				x	141	0.5	0.9
CAAU.2	**X**	**X**	**X**	x			x	x		**X**		x	x	x	141	0.51	1.1
CAAU.3	x	**X**	**X**	X				**X**		**X**				x	148	0.39	1.1
COMU	**X**	**X**	**X**	**X**			**X**	**X**	**X**	**X**		x	**X**	**X**	1472	0.31	1.2
COMU.2	**X**	**X**	x	x	x	x	x	**X**	**X**	**X**				**X**	1472	0.3	1.28
COMU.3	**X**	**X**	**X**	**X**			**X**	X		**X**				**X**	1480	0.27	1.32
PECO	x	**X**	**X**	x		**X**			**X**	**X**				**X**	224	0.26	0.6
PECO.2	x	**X**	**X**	**X**		**X**		X	**X**	**X**				**X**	226	0.25	0.62
PECO.3	x	**X**	**X**	**X**		**X**	x		**X**	**X**				**X**	226	0.25	0.62
RNPH	**X**	**X**	**X**				**X**		**X**		**X**			**X**	55	0.81	0.6
RNPH.2							**X**		**X**		x			**X**	65	0.76	0.61
RNPH.3	x	x	**X**				x		**X**					**X**	81	0.61	0.74
SOSH	x	**X**	**X**	x			**X**		x			x	**X**	x	576	0.26	1.2
SOSH.2	x	**X**	**X**	x			**X**	x	x			x	**X**	x	577	0.26	1.3
SOSH.3	x	**X**	**X**	x			**X**		x	x		x	**X**	x	576	0.26	1.3
WEGU			**X**				**X**		**X**		**X**			x	530	0.11	0.55
WEGU.2			**X**		**X**	x	x		x		**X**			x	531	0.12	0.55
WEGU.3			**X**						**X**		**X**			x	532	0.10	0.55

Table 5. Seasonal mean densities by species, with 95% confidence intervals and standard error. Values in bold indicate statistically significant parameters in GAMMs.

Species	Season	Lower 95% CI	Mean	Upper 95% CI	SE
common murres	**spring**	**102.4**	**214.7**	**327.2**	**56.8**
	summer	**51.4**	**61.6**	**71.8**	**5.2**
	fall	**22.6**	**40.1**	**57.5**	**8.8**
	winter	**19.8**	**107.6**	**195.3**	**42.1**
sooty shearwaters	**spring**	**-1.1**	**27.3**	**55.7**	**13.9**
	summer	**8.5**	**14.7**	**20.8**	**3.1**
	fall	**28.3**	**95.8**	**163.5**	**33.9**
	winter	**3.4**	**16.9**	**30.4**	**6.1**
Brandt's cormorants	spring	7.2	18.1	28.9	5.3
	summer	13.9	20.0	26.0	2.9
	fall	7.0	17.9	28.9	5.2
	winter	NA	3.9	NA	NA
pelagic cormorants	spring	11.9	16.9	22.0	2.5
	summer	**7.7**	**12.0**	**16.2**	**2.1**
	fall	**-8.2**	**19.4**	**46.9**	**11.7**
	winter	**3.1**	**6.9**	**10.7**	**1.5**
Cassin's auklets	spring	NA	3.7	NA	NA
	summer	**3.1**	**25.6**	**48.1**	**10.5**
	fall	**-39.7**	**67.8**	**175.3**	**52.2**
	winter	**-6.6**	**23.1**	**52.9**	**12.9**
western gulls	spring	7.0	11.1	15.1	2.0
	summer	8.1	11.5	14.9	1.7
	fall	5.4	6.8	8.3	0.7
	winter	7.5	12.5	17.6	2.4
red-necked phalaropes	spring	-77.0	22.3	121.5	7.8
	summer	5.1	30.1	55.2	10.9
	fall	**20.4**	**37.7**	**54.9**	**8.3**
	winter	------------------	no data	---------------	--------

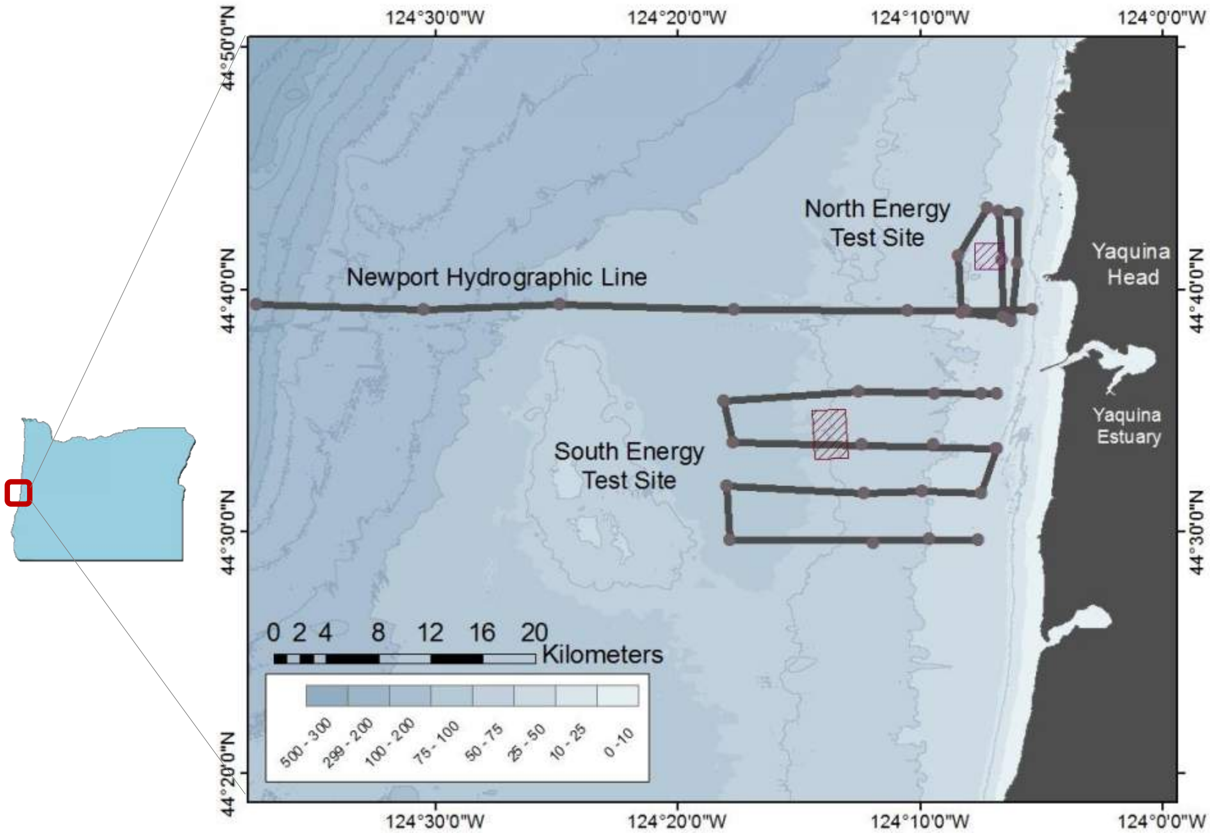

Figure 1. Ship tracks of 3 survey sites. The Newport Hydrographic line extends west from shore 40km, while PacWave South extends 16km. Grey nodes indicate sampling stations/breaks in continuous surveying effort and the boxes indicate the PacWave North and the proposed PacWave South are denoted by hatched boxes.

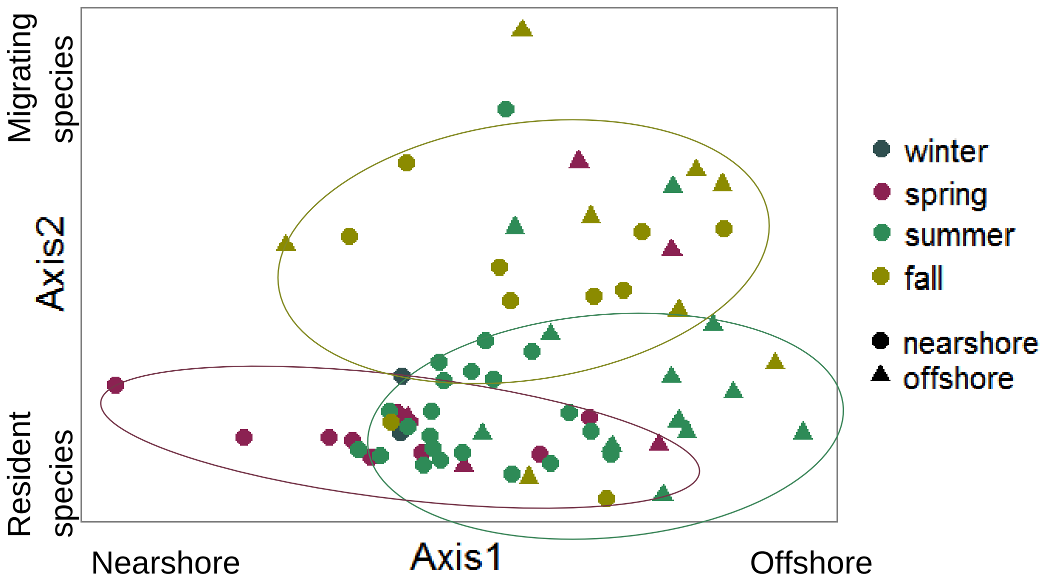

Figure 2. 2-dimensional NMS ordination of focal species, colored by season, with shapes indicating near- or offshore classification. Groupings indicate seasonal and distance to shore gradients.

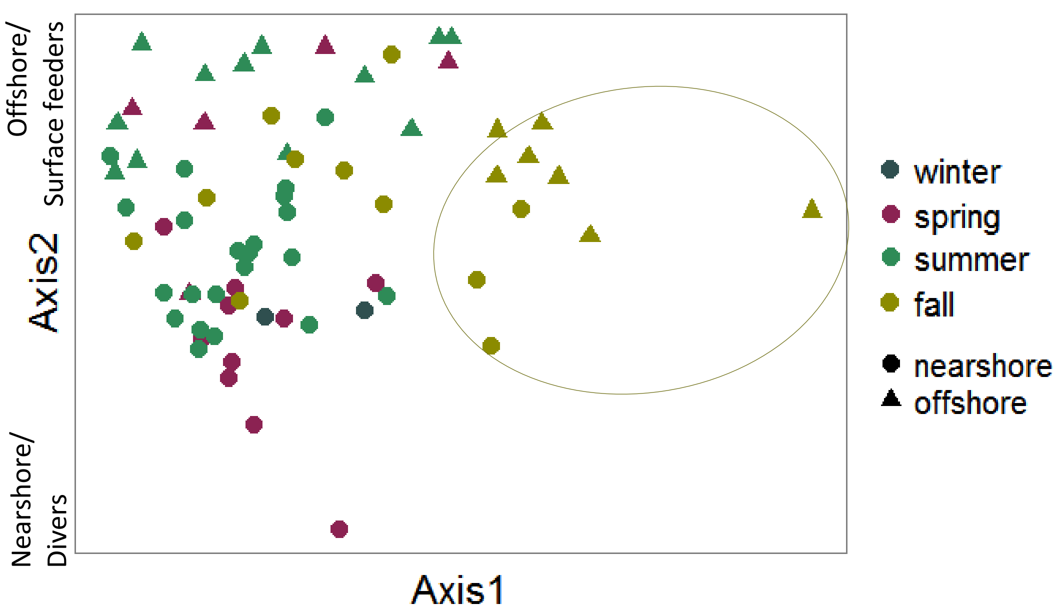

Figure 3. 2-dimensional NMS ordination of foraging groups, colored by season, with shapes indicating near- or offshore classification.

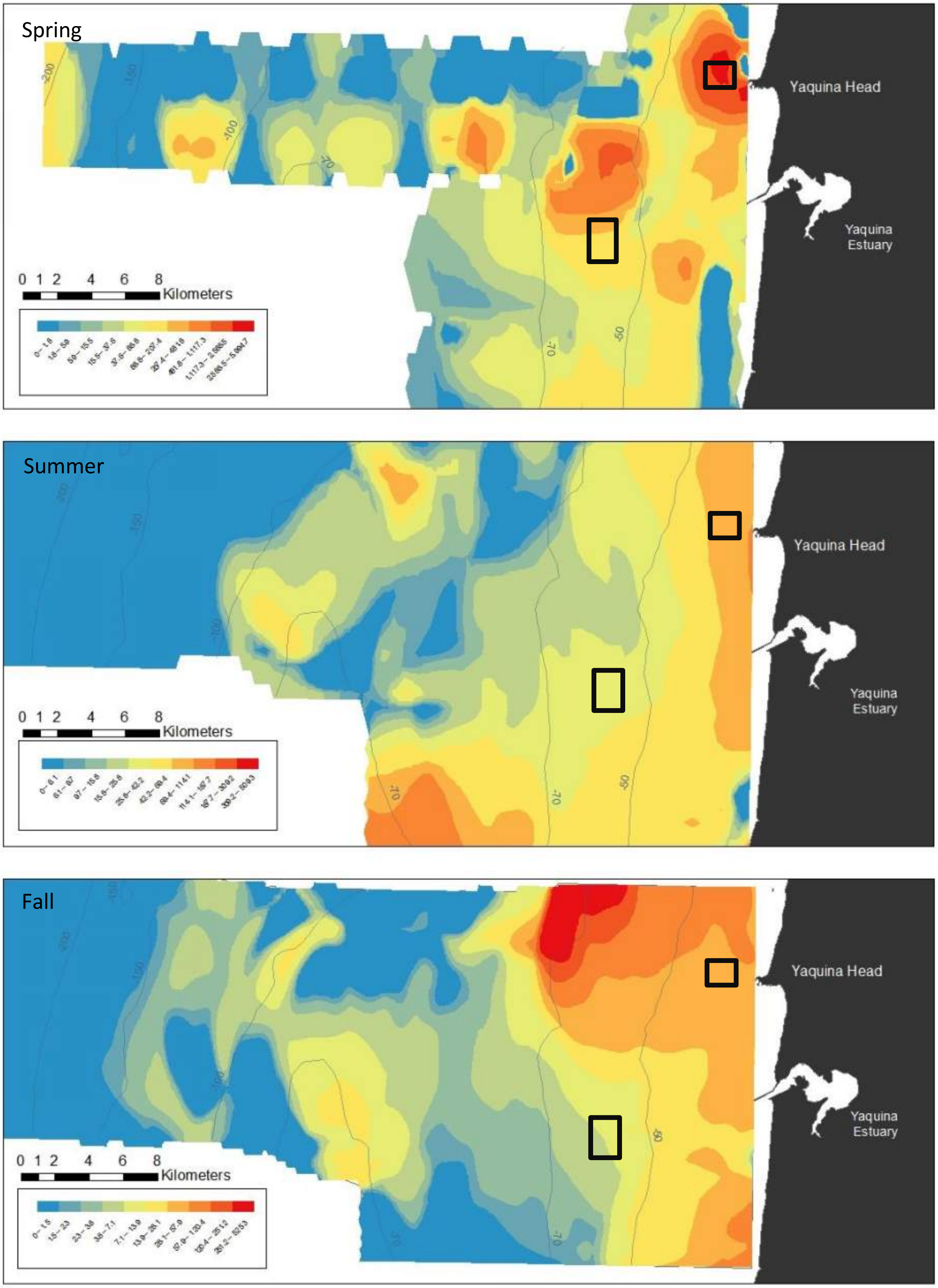

Figure 4. Seasonal common murre density across the three study sites. Kernel density estimates produced in ArcMap 10.2 with constant kernel function and prediction output. A power of 1 and ridge of 50 was applied to all 3 maps. The black boxes identify the PacWave North and PacWave South. Note that the maximum spring density predictions are an order of magnitude greater than summer

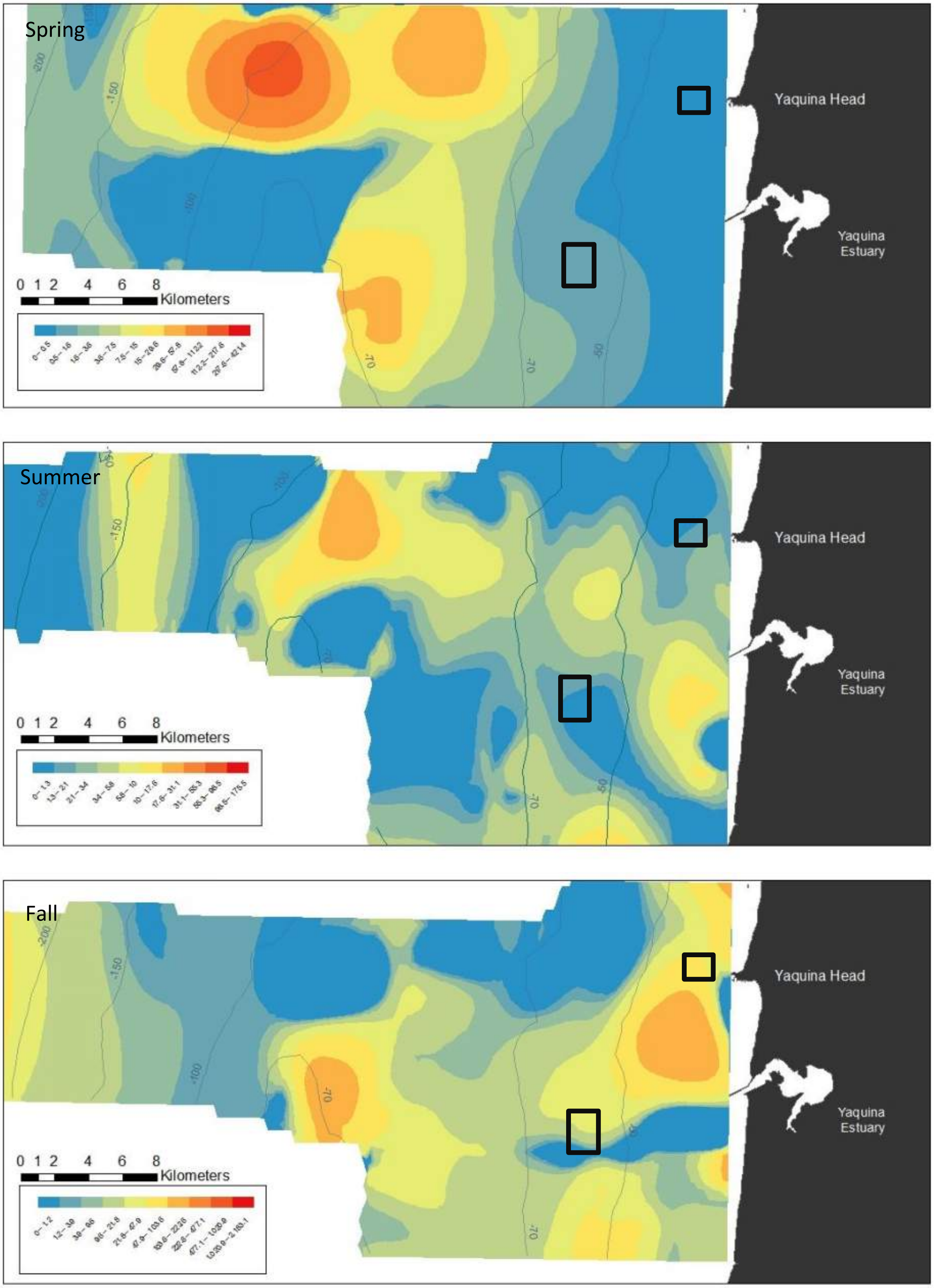

Figure 5. Seasonal sooty shearwater density across the three study sites. Kernel density estimates produced in ArcMap 10.2 with constant kernel function and prediction output. A power of 1 and ridge of 50 was applied to all 3 maps. The black boxes denote the PacWave North and PacWave South. Note that the maximum fall density predictions are an order of magnitude greater than spring and summer.

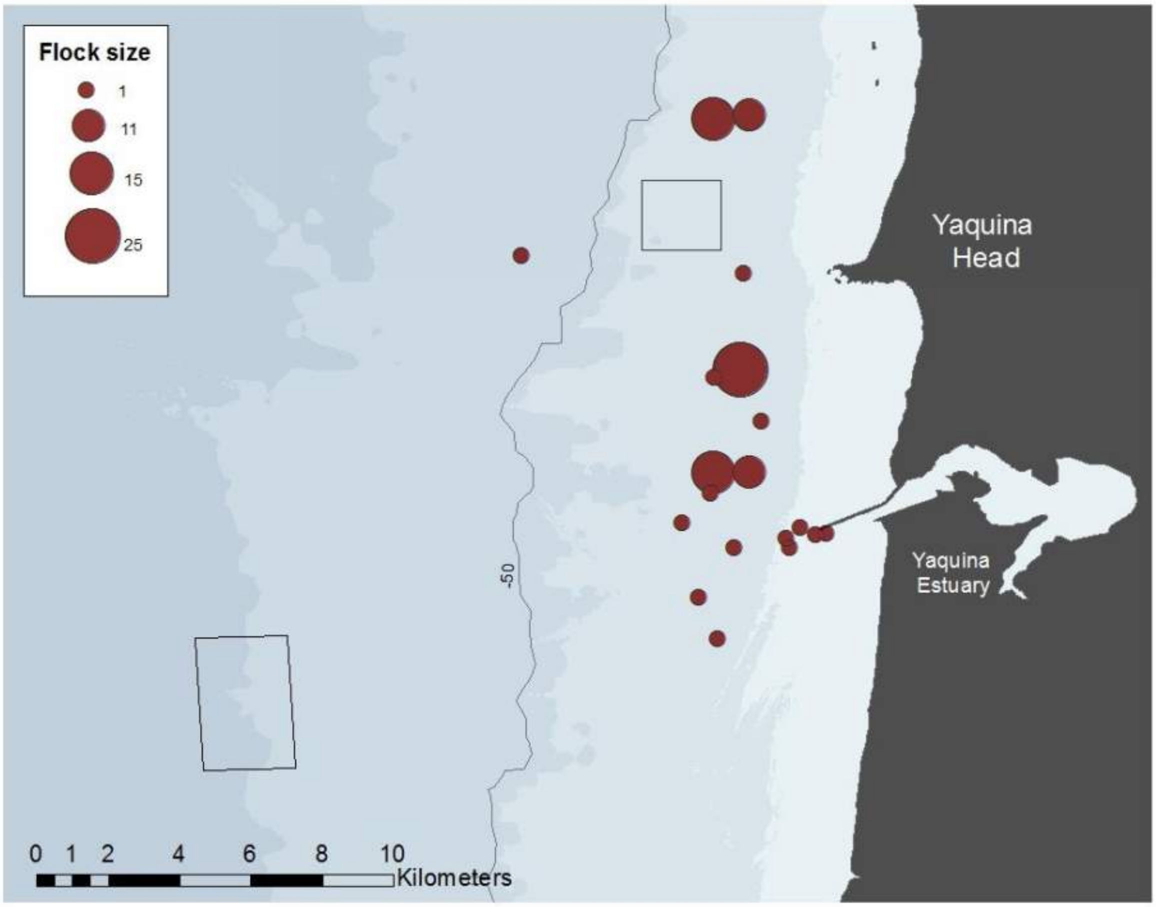

Figure 6. Map of brown pelican observations, with point size varying with flock size (from 1-25). We observed a total of 91 total brown pelicans over the course of the study.

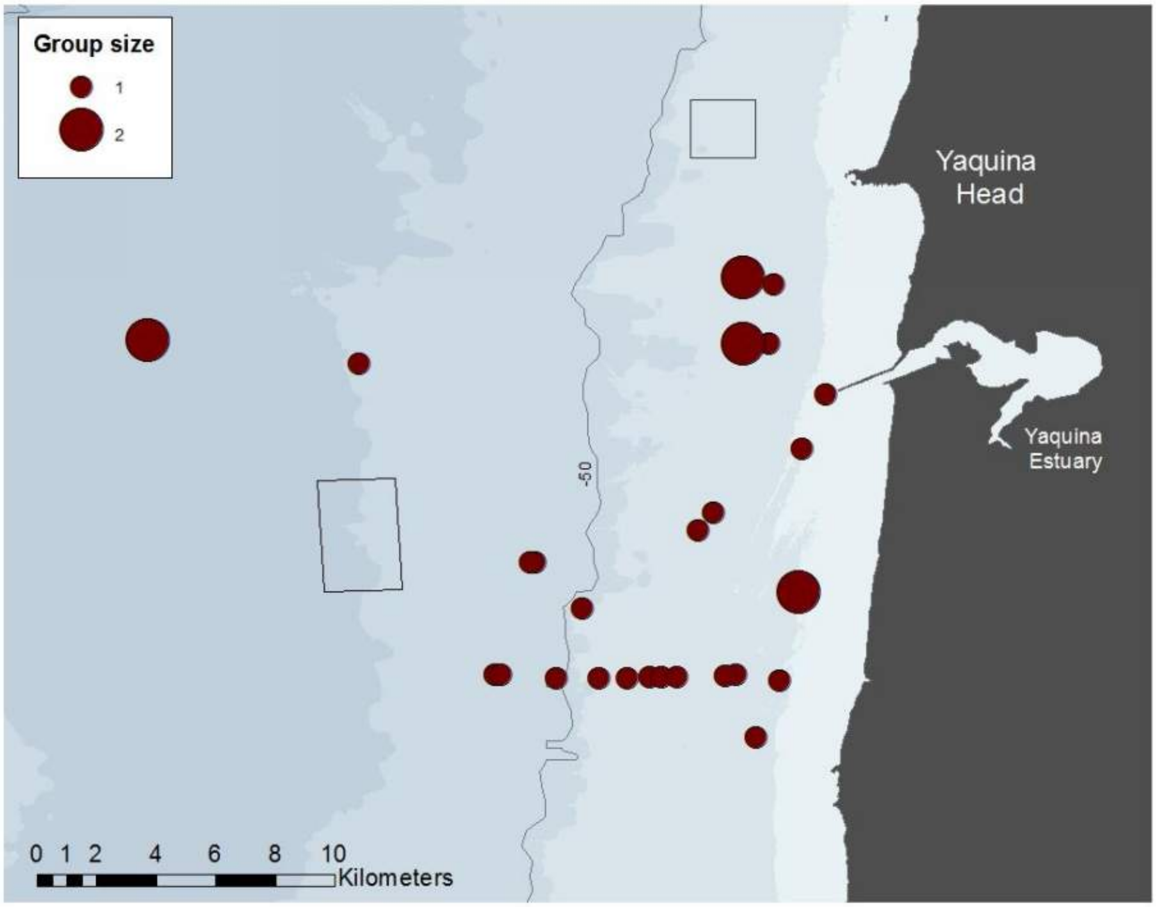

Figure 7. Map of observed marbled murrelets, with point size varying with observed group number (1-2). We observed a total of 35 marbled murrelets over the course of this study.

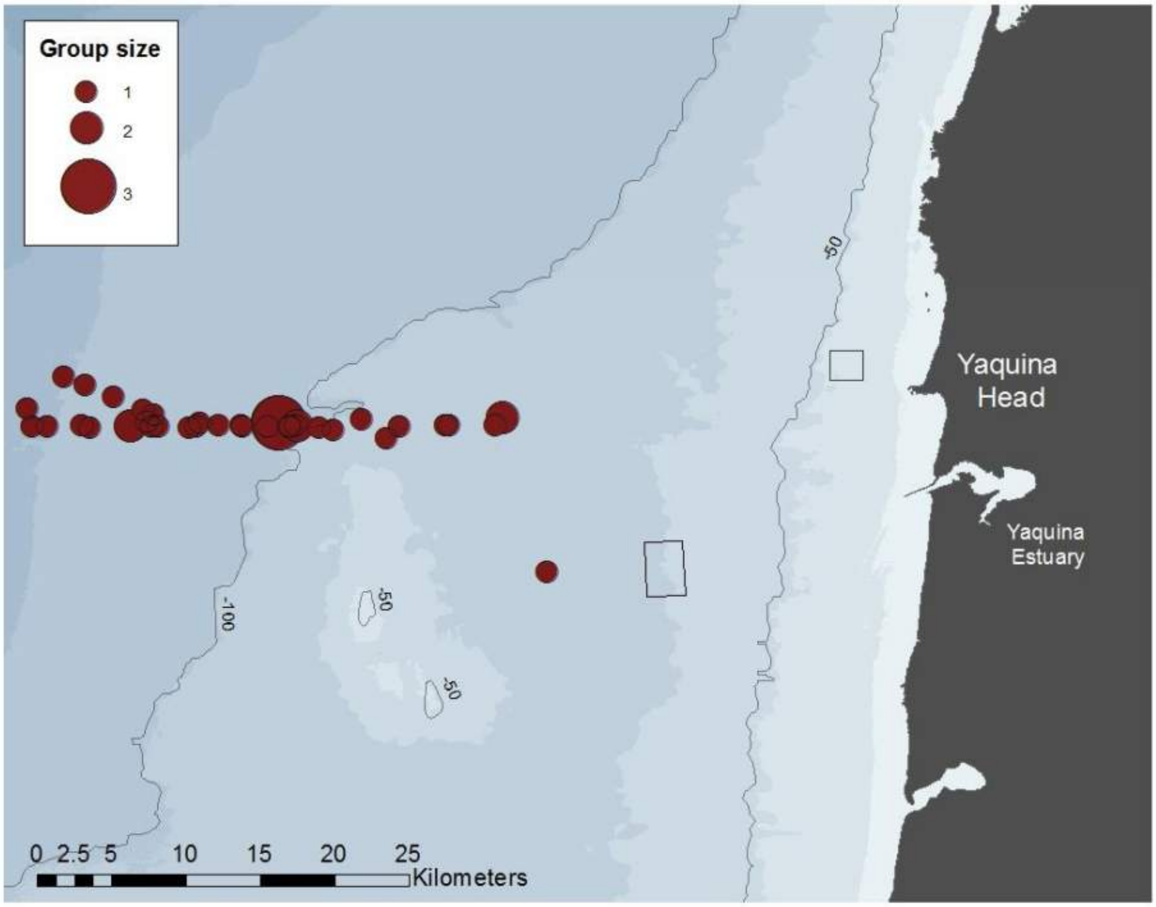

Figure 8. Map of black footed albatross observations. Icon varies by size of group sighting (from one to three individuals). We observed a total of 41 black-footed albatrosses sighted the study.

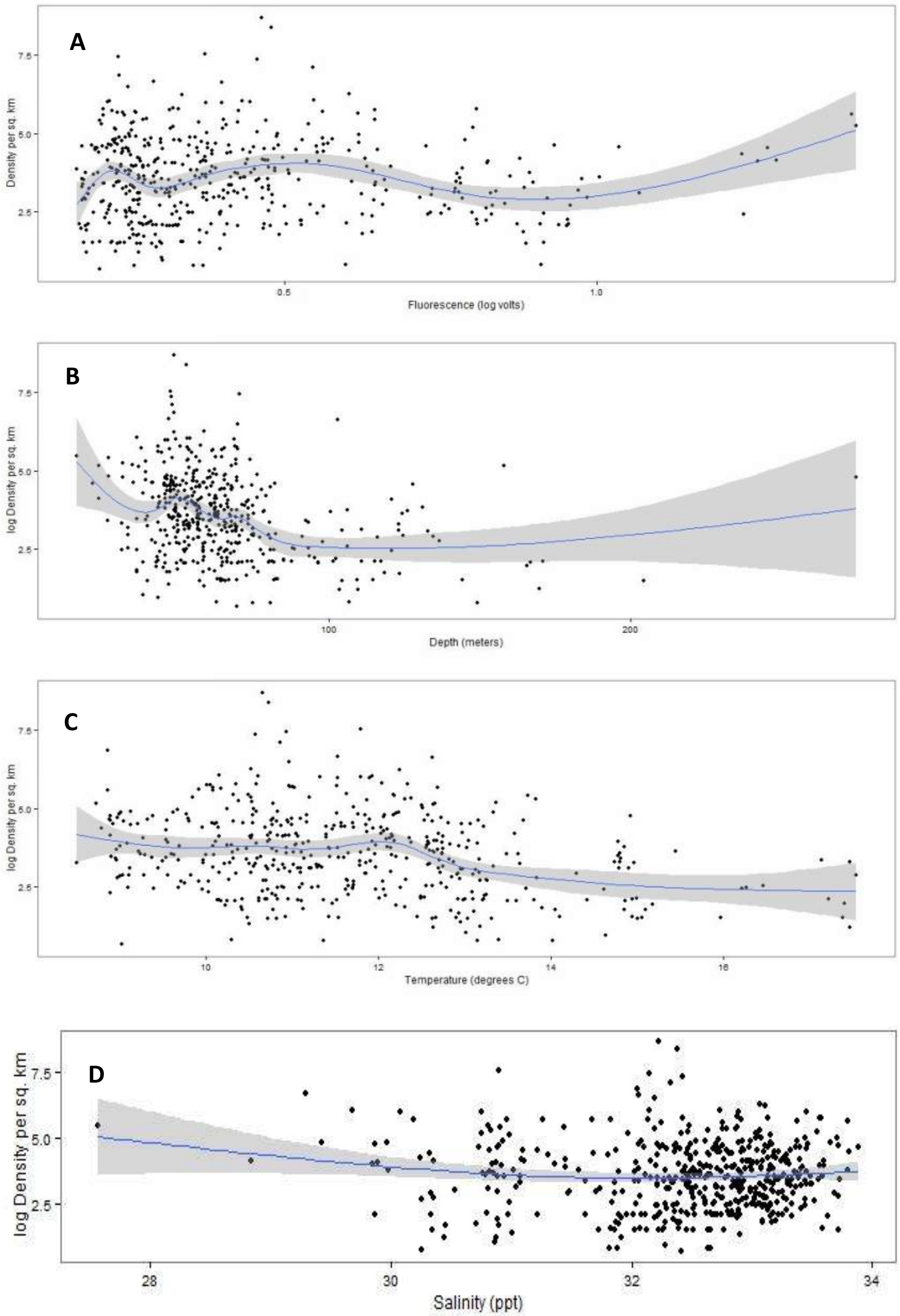

Figure 9. Modeled response of significant factors (A. fluorescence, B. depth, C. temperature, D. salinity) impacting common murre density. Smoothed line indicates trend, with 95% confidence intervals in grey. A thin plate smoothing spline was applied to all three parameters; depth ($p<0.001$, on 3.9 edf, fluorescence ($p=0.002$ on 8 edf), temperature ($p=0.03$ on 5 edf and salinity ($p=0.09$ on 1 edf).

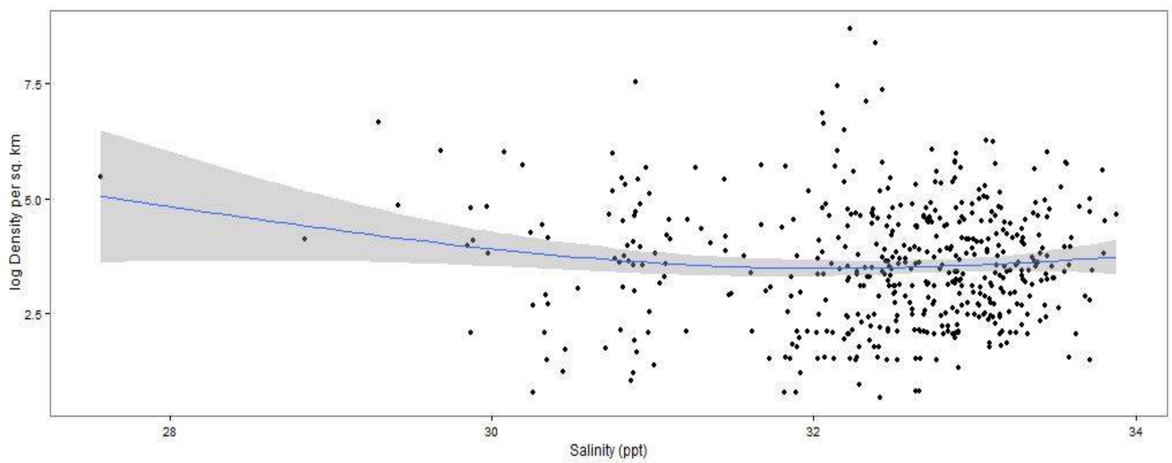

Figure 10. Modeled response of the impact of the one significant factor (salinity) on sooty shearwater density. A thin plate smooth term was applied to the model (p=0.02 on 10 edf).

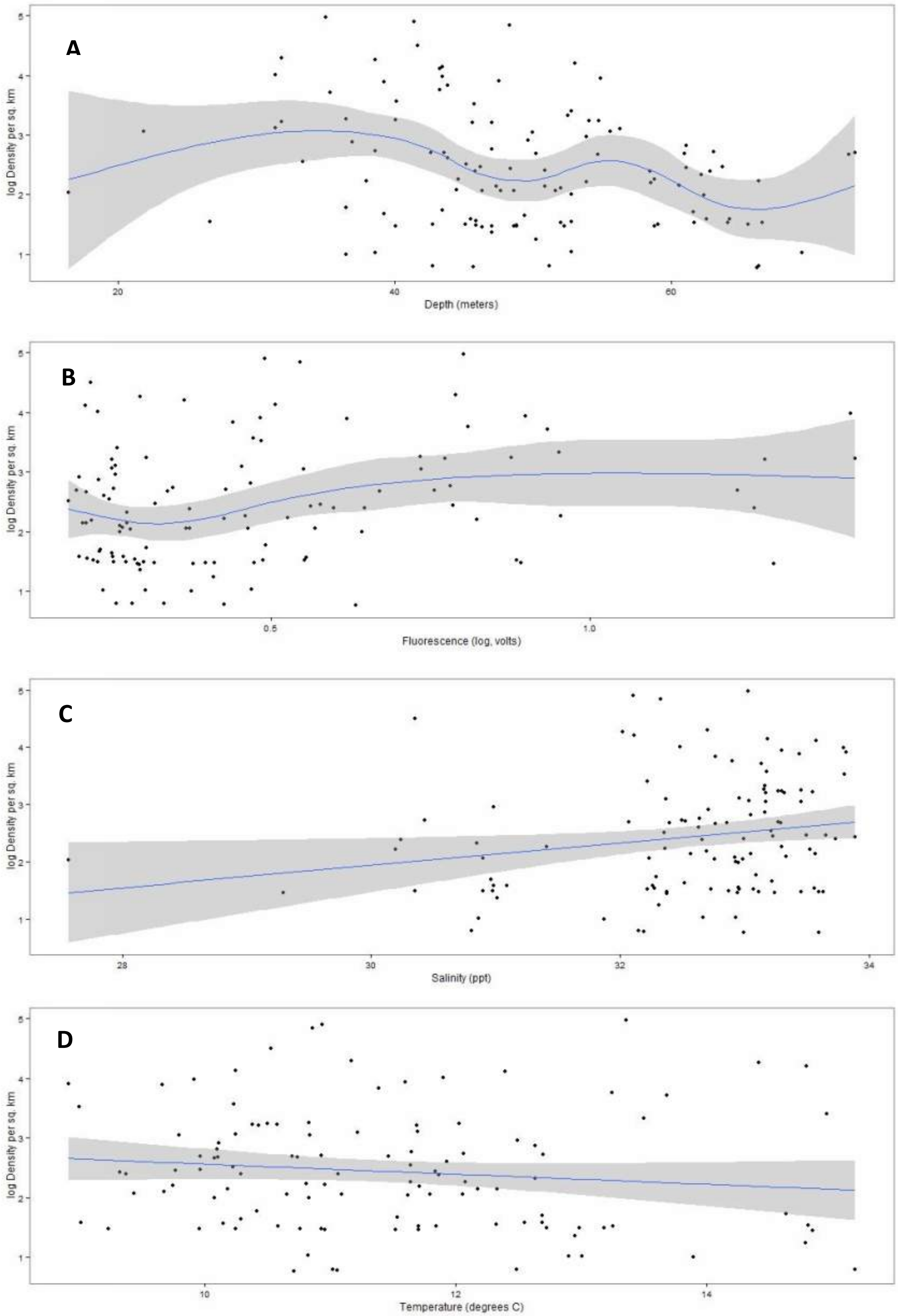

Figure 11. Modeled response of significant factors (A. depth, B. fluorescence, C. salinity D. temperature) impacting Brandt's cormorant density. Smoothed line indicates trend, with 95% confidence intervals in grey. A thin plate smoothing spline was applied to all parameters; A: p=0.001 on 0.1 edf, B: p=0.004 on 0.2 edf, C. p=0.001 on 0.1 edf, D: p=0.01 on 0.6 edf).

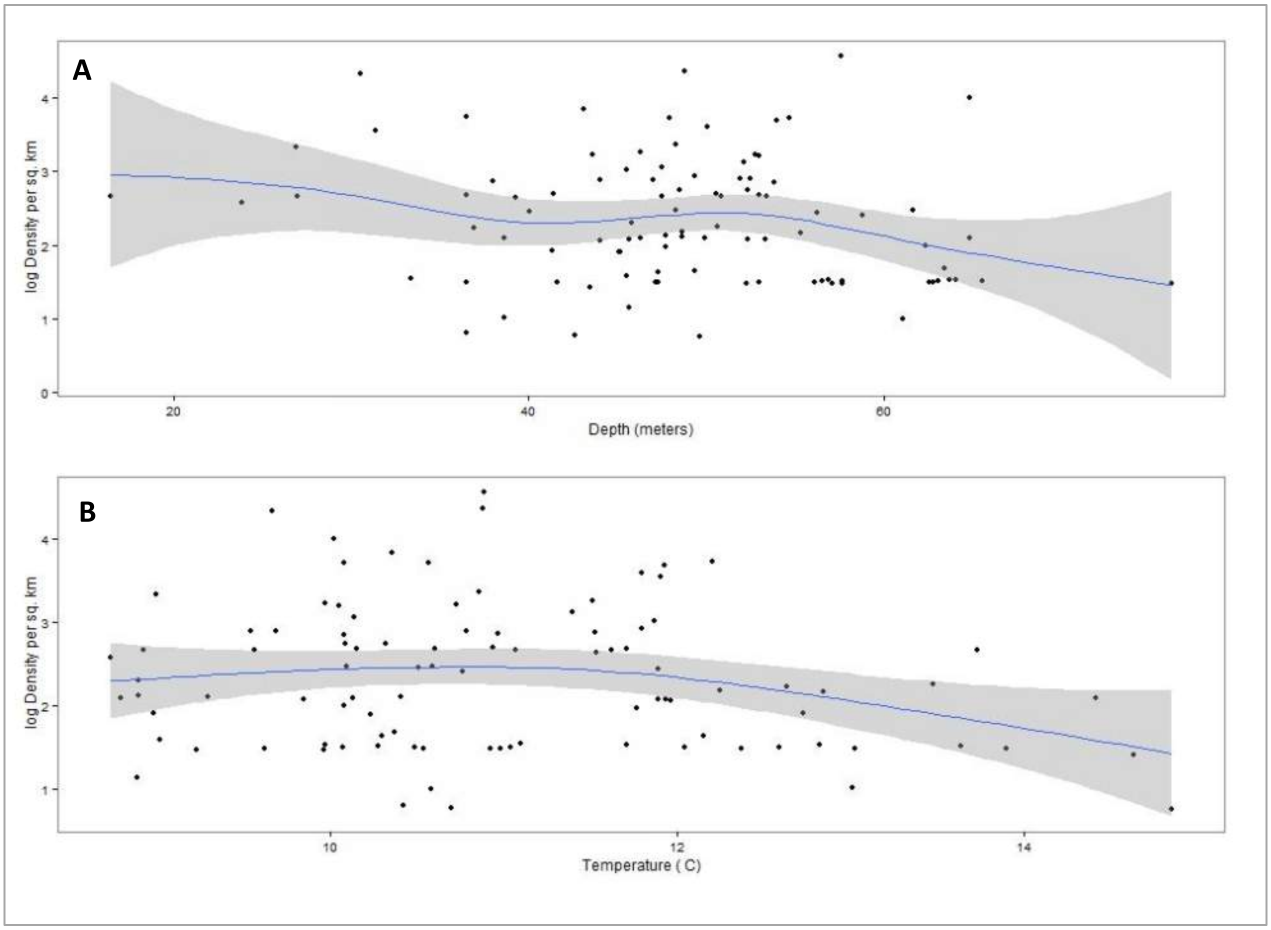

Figure 12. Modeled response of the impact of significant factors (A. depth, B. temperature) on pelagic cormorant density. Smoothed line indicates trend, with 95% confidence intervals in grey. A cubic regression smoothing spline was applied to depth (p=0.004 on 2 edf) and temperature (p=0.01 on 1.5 edf).

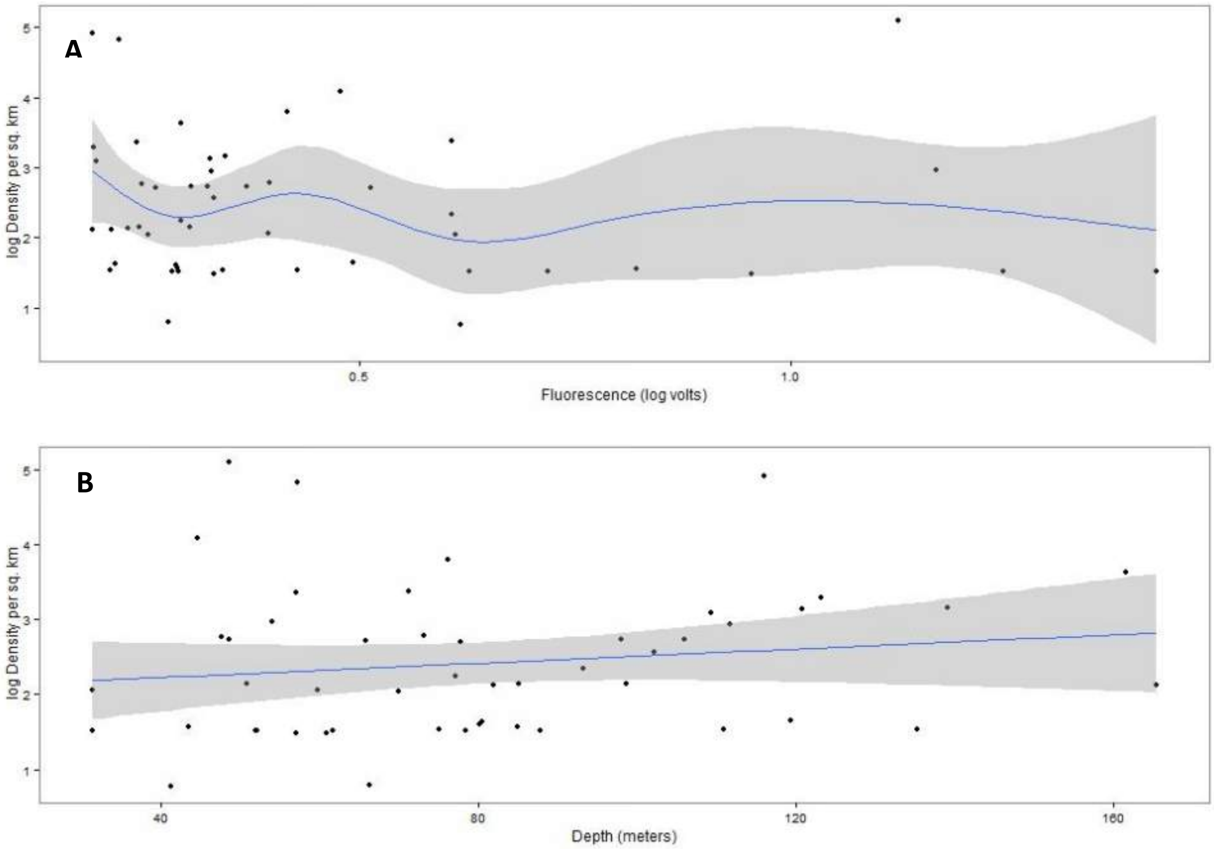

Figure 13. Modeled response of significant factors (A. fluorescence, B. depth) impacting Cassin's auklet density. Smoothed line indicates trend, with 95% confidence intervals in grey. A thin plate smoothing spline was applied to fluorescence (P= 0.03 on 0.9 edf) and depth (P=0.02 on 4.7 edf).

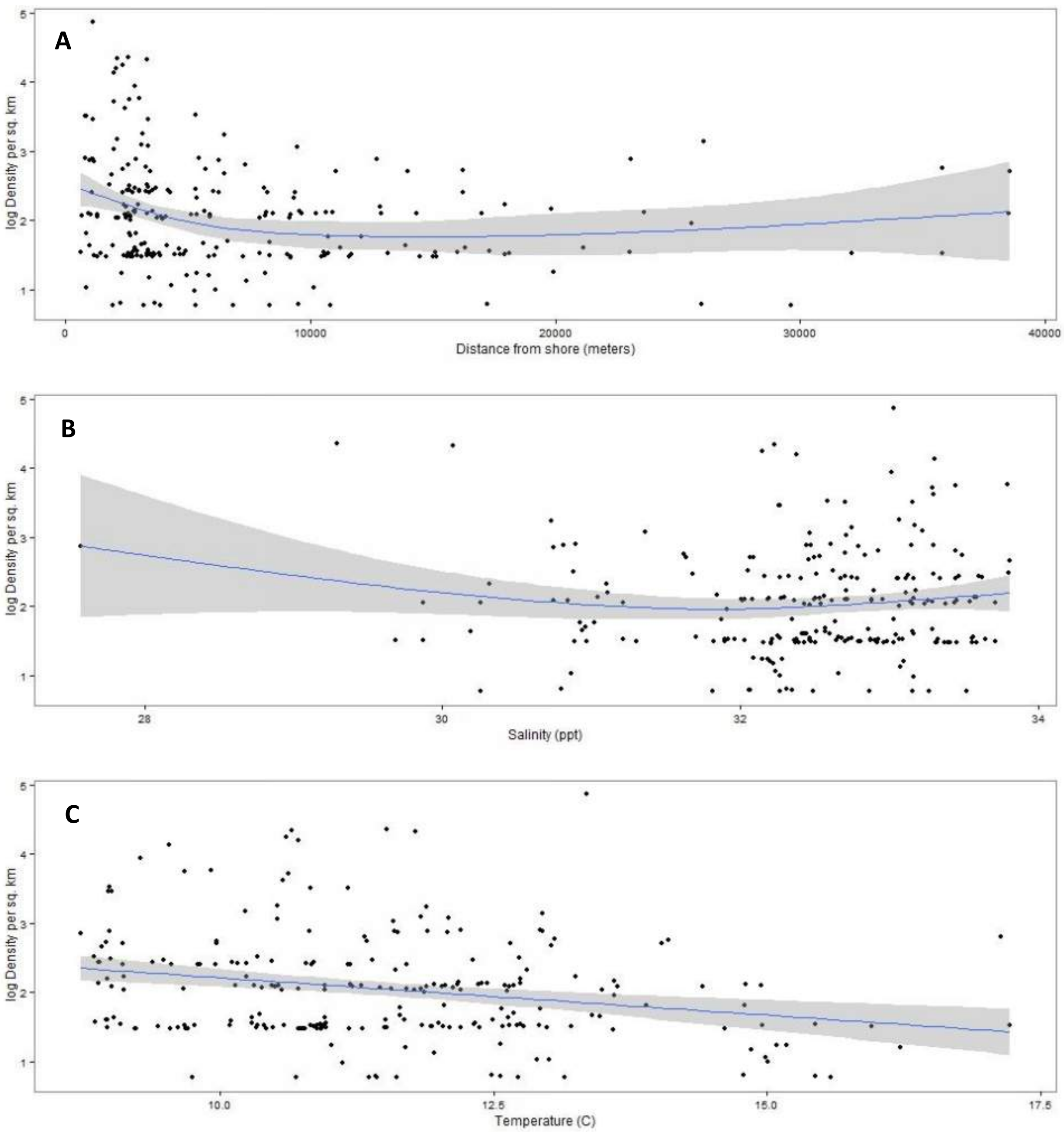

Figure 14. Modeled response of the impact of significant factors (A. distance from shore, B. salinity, C. temperature) on western gull density. Smoothed line indicates trend, with 95% confidence intervals in grey. A cubic regression smoothing spline was applied to all parameters A: p= 0.001 on 2.7 edf,, B: p=0.03 on 0.8 edf, C: p<0.001 on 0.9 edf).

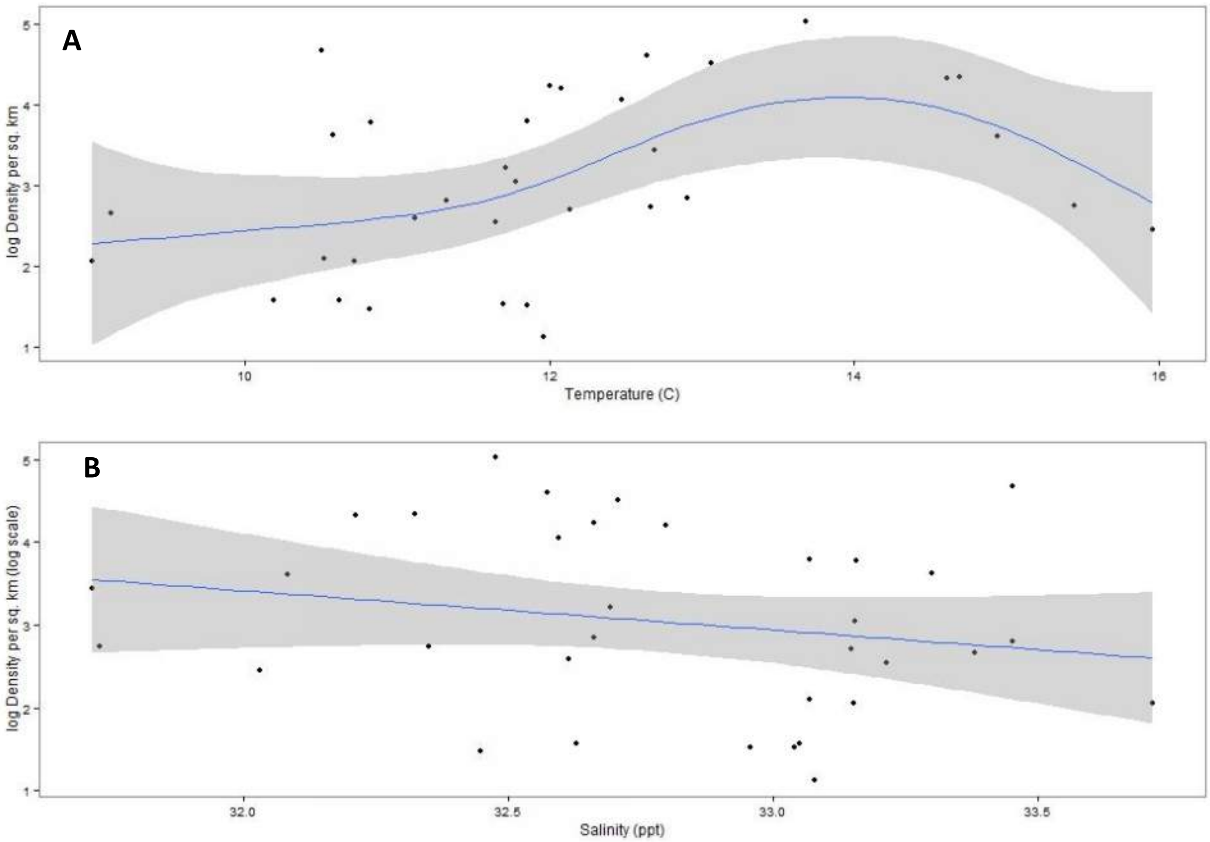

Figure 15. Modeled response of the impact of significant factors (A. temperature, B. salinity) on red-necked phalarope density. Smoothed line indicates trend, with 95% confidence intervals in grey. A cubic regression smoothing spline was applied to temperature (P= 0.002, on 7.5 edf) and salinity (P=0.01on 5.4 edf).

Appendices

Appendix a. Complete species list and total sightings

Species (common name)	Species (Latin name)	Sightings
Common murre	*Uria aalge*	18,782
Sooty shearwater	*Puffinus griseus*	2556
Dark shearwater	*Puffinus spp*	2024
Western gull	*Larus occidentalis*	1309
Cassin's auklet	*Ptychoramphus aleuticus*	1038
Brandt's cormorant	*Phalacrocorax penicillatus*	826
Unidentified gull	*Larus spp*	658
Pelagic cormorant	*Phalacrocorax pelagicus*	487
Immature gull	*Larus spp*	471
Red-necked phalarope	*Phalaropus lobatus*	423
Pink-footed shearwater	*Puffinus creatopus*	341
Northern fulmar	*Fulmaris glacialis*	232
California gull	*Larus californicus*	224
Rhinoceros auklet	*Cerorhinca monocerata*	150
Unidentified bird		143
Short-tailed shearwater	*Puffinus tenuirostris*	131
Unidentified phalarope	*Phalaropus spp*	101
Brown pelican	*Pelicanus occidentalis*	91
Pigeon guillemot	*Cepphus columba*	86
Unidentified cormorant	*Phalacrocorax spp*	82
Surf scoter	*Melanitta perspicillata*	80
Fork-tailed storm petrel	*Oceanodroma furcata*	78
Leach's storm petrel	*Oceanodroma leucorhoa*	67
Unidentified shorebird		56
Flesh-footed shearwater	*Puffinus carneipes*	54
Unidentified loon	*Gavia spp*	43
Black-footed albatross	*Phoebastria nigripes*	41
Unidentified albatross	*Phoebatria spp*	37
Marbled murrelet	*Brachyramphus marmoratus*	35
Glaucous-winged gull	*Larus glaucescens*	30
Common loon	*Gavia immer*	29
White-winged scoter	*Melanitta deglandi*	27
Red phalarope	*Phalaropus fulicarius*	20
Parasitic jaeger	*Stercorarius parasiticus*	16
Pacific loon	*Gavia pacifica*	16
Caspian tern	*Hydroprogne caspia*	14
Bonaparte's gull	*Chroicocephalus philadelphia*	13
Unidentified scoter	*Melanitta spp*	10

Species (common name)	Species (Latin name)	Sightings
Black-legged kittiwake	*Rissa tridactyla*	8
Buller's shearwater	*Puffinus bulleri*	8
Heerman's gull	*Larus heermanni*	8
Unidentified auklet	*Alcidae spp*	7
Glaucous-winged western gull	*Larus glaucescens x occidentalis (hybrid)*	7
Ring-billed gull	*Larus delawarensis*	7
Double-crested cormorant	*Phalacrocorax auritus*	6
Western grebe	*Aechmophorus occidentalis*	4
Mew gull	*Larus canus*	4
Unidentified storm petrel	*Oceanodroma spp*	3
Unidentified jaeger	*Stercorarius spp*	3
Tufted puffin	*Fraternicula cirrhata*	2
Ancient murrelet	*Synthliboramphus antiquus*	1
Unidentified grebe	*Aechmophorus spp*	1
Western-glaucous gull	*Larus occidentalis x hyperboreus (hybrid)*	1

Appendix b. Flow through and GPS data collection/availability by cruise

Cruise date	Site	Flow-through	GPS	Stations
12/5/06	NH Line	No	No	NH1-NH25
3/14/07	NH Line	No	No	NH1-NH20
4/19/07	NH Line	No	No	NH1-NH10-NH5
5/15/07	NH Line	No	Yes	NH1-NH25
6/12/07	NH Line	No	Yes	NH1-NH20+
7/14/07	NH Line	No	Yes	NH1-NH20
8/15/07	NH Line	No	Yes	NH1-NH25
9/12/07	NH Line	Yes	Yes	NH1-NH20+
10/12/07	NH Line	No	Yes	NH1-NH20
5/1/08	NH Line	No	No	NH5-NH15+
6/24/08	NH Line	No	Yes	NH1-NH20
10/27/08	NH Line	No	Yes	NH1-NH25
7/28/09	NH Line	No	Yes	NH1-NH20+
5/30/13	NH Line	No	Yes	NH1-NH25
6/19/13	NH Line	No	Yes	NH1-NH15
7/29/13	NH Line	No	Yes	NH1-NH20
8/30/13	PacWave South	No	Yes	all
9/11/13	NH Line	Yes	Yes	NH1-NH15
9/12/13	PacWave South	Yes	Yes	all
10/22/13	NH Line	Yes	Yes	NH1-NH25
10/24/13	PacWave North	Yes	Yes	all
10/25/13	PacWave South	No	Yes	all
10/30/13	PacWave North	No	Yes	all
11/22/13	PacWave South	No	Yes	all
1/18/14	PacWave South	Yes	Yes	CTD SBC 40, 50, 60; PUD 30, 60
2/4/14	NH Line	Yes	Yes	NH1-NH25
2/25/14	PacWave North	Yes	Yes	all
4/7/14	PacWave North	Yes	Yes	all
4/8/14	NH Line	Yes	No	NH1-NH25
4/16/14	PacWave South	Yes	Yes	all
4/17/14	PacWave North	Yes	Partial	all
5/6/14	NH Line	Yes	Yes	NH1-NH25
6/18/14	PacWave North	Yes	Yes	all
6/23/14	PacWave North	Yes	Yes	all except buoy cores
6/24/14	PacWave South/ PacWave North	Yes	Yes	all
7/7/14	NH Line	Yes	Yes	NH1-NH25
7/22/14	NH Line	No	No	NH1-NH25
8/6/14	NH Line	Yes	Yes	NH1-15

8/18/14	PacWave North	Yes	Yes	all
8/20/14	NH Line	Yes	Yes	NH1-25
8/26/14	PacWave South	Yes	Yes	Turned around <1 hr
8/27/14	PacWave South	Yes	Yes	all
9/12/14	PacWave North	Yes	Yes	all
9/16/14	PacWave South	Yes	Yes	all - southernmost transect
10/8/14	NH Line	Yes	Yes	NH1-23(about)
10/10/14	PacWave North	Yes	Yes	all
3/26/2015	NH Line	Yes	Yes	all
4/9/2015	PacWave North/PacWave South	Yes	Yes	All PacWave North, All PacWave South
5/19/2015	NH Line	Yes	Yes	all
5/22/2015	PacWave North	Yes	Yes	Very limited survey
6/18/2015	PacWave North /PacWave South	Yes	Yes	All PacWave South, half PacWave North
6/19/2015	PacWave North	Yes	Yes	Half of PacWave North
6/25/2015	PacWave North	Yes	Yes	All
7/15/2015	NH Line	Yes	Yes	All- day trip
8/10/2015	NH Line	Yes	Yes	NH 1-15 day trip
8/25/2015	PacWave North	Yes	Yes	all

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SITE CHARACTERIZATION REPORT - ACOUSTICS

CONTACT: DAN HELLIN, OPERATIONS & LOGISTICS MANAGER, PACWAVE
541-737-5452 DAN.HELLIN@OREGONSTATE.EDU

Principle Investigator: JOSEPH HAXEL, HATFIELD MARINE SCIENCE CENTER, OREGON STATE UNIVERSITY

1. INTRODUCTION/OVERVIEW

1.1. Resource(s) of Interest

Ambient sound in the marine environment originates from both natural and anthropogenic sources, such as commercial and recreational vessel traffic, wave action, marine life, atmospheric sound, and others. Sound in the ocean may affect marine species in a variety of ways, ranging from no effect to acute lethal effects. Responses to sound can be variable depending on the acoustic characteristics of the sound (e.g., frequency, amplitude, and duration), non-acoustic characteristics of the sound source (e.g., stationary or moving), environmental factors that affect sound transmission, the sensitivity of an animal's hearing, the behavioral or motivational state at the time of exposure, and past exposure to the sound which may have caused habituation or sensitization (NRC 2003). A key component for assessing effects from sound exposure is rooted in determining whether animals can detect and are sensitive to sound generated above ambient levels. Further complications arise as marine animals may detect sounds above and below existing regulatory guidance threshold levels that fail to elicit a response, behavioral or physiological.

The PacWave South (previously PMEC SETS) area and surrounding region experience considerable vessel traffic related noise from the Port of Newport, which is home to the west coast's largest commercial fishing fleet, as well as a seasonably active sport fishing community. Energetic weather conditions (surf, wind, rain) and acoustically active marine mammals also make significant contributions to ambient noise levels. In 2010, Haxel *et al.* (2013) collected passive acoustic data to characterize low frequency ambient conditions up to 840 Hz at PacWave North (previously PMEC NETS), which is located approximately 7 nm north of the PacWave South area. The close proximity suggests ambient sound levels in the PacWave South Project area should also be influenced by the three types of dominant acoustic sources experienced at PacWave North: environmental processes, anthropogenic activity, and marine mammal vocalizations. However, NMFS sound characterization guidance limits the range for site investigations to far less than the 7 nm separation between PacWave South and PacWave North, and therefore PacWave North acoustic characterization data cannot be used as a proxy to describe noise levels at PacWave South. Nevertheless, the PacWave North data provides a valuable starting point for the types of sounds and range of low frequency noise levels to expect at PacWave South.

The low frequency recordings (< 840 Hz) from the PacWave North study show a strong seasonal migratory presence of acoustically active baleen whales throughout the region during the months of September – January. In addition to the seasonal presence low frequency cetaceans, several mid-

(killer whales) and high- (harbor porpoise) frequency odontocetes are also likely to be vocally active within the Project area during specific times of the year, emphasizing the need to monitor the broad range of frequencies (20Hz – 20 kHz) suggested in NMFS guidance.

1.2. Potential Effects/Issue Summary

Noise and/or vibrations generated by project structures and activities could affect acoustically sensitive species of resident and migratory fish, sea turtles, and marine mammals. Chronic and episodically generated noise associated with project activities may cause significant behavioral disturbances (e.g. masking, Clark *et al.*, 2009) in both resident and transient marine species. The temporal and spatial scales of the acoustic disturbance depend on factors such as the amplitude, spectral characteristics and duration of the noises generated during project activities.

1.3. Study Objective

This study aims to provide baseline ambient noise level measurements across a range of environmental conditions and anthropogenic activities to: 1) provide a robust temporal and spectral characterization of the dominant natural and man-made sound sources currently contributing to noise levels in the PacWave South Project area; and 2) to detect the vocal presence of low (baleen whales) and high frequency (orcas and harbor porpoise) marine mammals.

2. Data Collection

2.1. Methods & Equipment

To capture variability in ambient noise levels across a range of environmental conditions, in 2014 OSU deployed two seafloor lander hydrophones (similar to the one used at PacWave North) to record ocean ambient noise levels in frequencies dominated by wind, rain, breaking waves, vessel traffic, marine mammal vocalizations and fish. The “offshore” lander at PacWave South was placed at a depth of 62 m in order to locate it near the center of the Project area, while the “nearshore” lander (REEF) was placed at 30 m depth, east of the Project area (Figure 1) to characterize physical and biological sound sources related to the nearby rocky reef structure. The lander hydrophones record ambient ocean noise levels in frequencies dominated by wind, rainfall, surf generated noise, vessel traffic, as well as a range of frequencies common for marine mammal and fish vocalizations in the area.

The lander hydrophones were set to record continuously at both PacWave South (62 m) and in the adjacent nearshore area REEF (30 m) for a period of four months, from April through July 2014. Both lander moorings were equipped with a new generation of autonomous underwater hydrophone (AUH) capable of providing frequency content up to 13 kHz. Despite this high sampling rate, the hydrophones were set to record continuously, resulting in a combined data volume of more than 1 TB over the 4 month recording period. This sampling strategy provides significantly more data recording than is required for noise measurements in an effort to address the study objective (2) of detecting more transient biological signals of scientific interest.

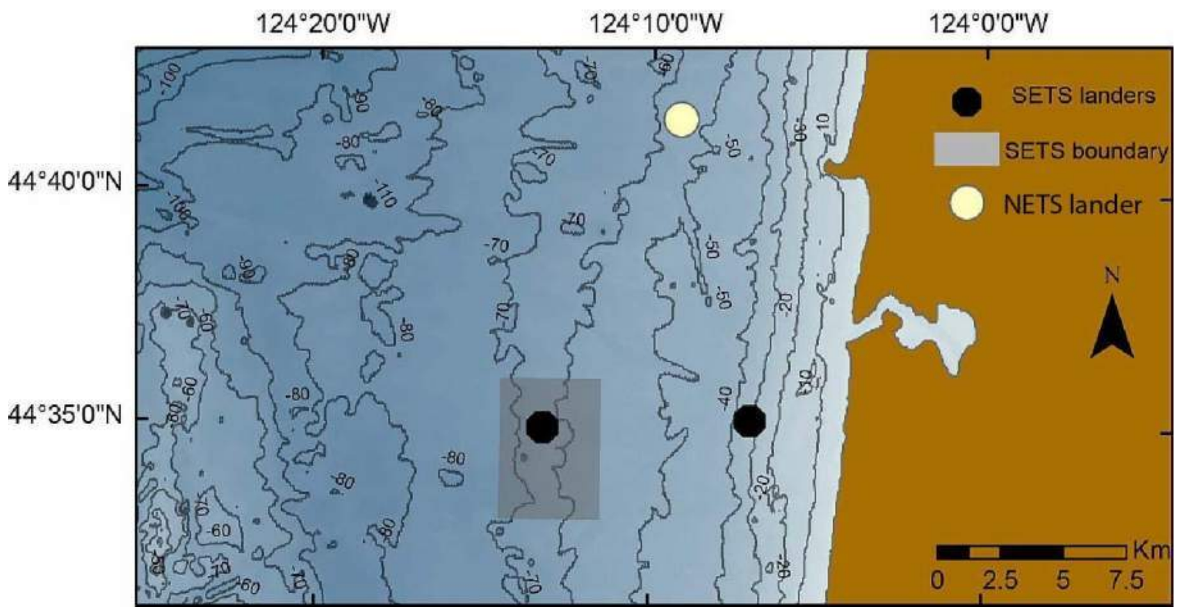

FIGURE 1: LOCATIONS OF THE PASSIVE ACOUSTIC LANDER MOORINGS DEPLOYED AT PACWAVE NORTH (2010-2011) AND PACWAVE SOUTH (2014). DEPTH CONTOURS ARE SHOWN IN 10 M INTERVALS.

In addition to ambient noise level measurements obtained from acoustic recordings by the AUH hydrophones, a C-POD© was mounted on the offshore PacWave South lander system. Acoustic "click" train detections yield species identification from the C-POD instrument also providing important information regarding the vocal presence of high frequency odontocetes (harbor porpoise in particular) at frequencies up to 180 kHz (above the 13 kHz cut-off of the hydrophones). Species in the greater Project area that can be detected by the C-POD include Cuvier's beaked whale, killer whale, false killer whale, short-finned pilot whale, common dolphin, Pacific white-sided dolphin, Risso's dolphin, and harbor porpoise.

A limitation of the C-POD is that it does not record acoustic data, but instead relies on sophisticated algorithms to detect and identify the vocal presence of particular species. In an effort to record and characterize high frequency acoustic signals generated by sound sensitive odontocetes often linked with particular behavior within the PacWave South Project area and inside REEF site, OSU made a series of short term (~10 day) deployments of lightweight moorings equipped with specialized DMON (Digital Monitoring) tag recorders on lease from Woods Hole Oceanographic Institution. The DMONs recorded on a duty cycle 1 minute of every 10-minute period, capturing acoustic data and targeting bioacoustics signals up to 200 kHz.

To address potential spatial variability in sound levels, OSU also conducted a series of recordings within the Project area using an autonomous drifting underwater hydrophone (ADUH). The ADUH was deployed at a target depth of 10 m below the sea surface, operating continuously at the same recording frequency as the AUH lander hydrophones and providing frequency content up to 13 kHz. The instrument package can be deployed upstream of an acoustic source target of interest, recovered and redeployed for a series of spatially offset drifts within the PacWave South Project area. This sampling technique may also be used for future rapid assessment and monitoring of noise generated during site construction and operational testing activities.

Several technical and mooring survivability challenges severely limited the ability of OSU to accomplish the objectives of the acoustic site characterization as proposed during the 2014-2015 study year; most notably, the loss of the PacWave South acoustic lander described in Section 2.3 below. In order to achieve acoustic study project objectives including ambient noise level measurements near and within the PacWave South project site, OSU deployed an acoustic mooring at the end of June 2015 in the SW corner of the project site (Figure 2). Unlike the hydrophone landers used in 2014, the mooring deployed in 2015 consisted of an AUH hydrophone instrument suspended 10 m above the seafloor with a steel float (Figure 3). The AUH was configured to record continuously providing frequency content from 5 Hz - 13 kHz. We acknowledge the limitation of the acquisition system that was deployed in June 2015 with an upper recording limit of 13 kHz and have upgraded the hydrophone technology to cover the NMFS recommended range 20 Hz – 20 kHz for later deployments. The mooring was recovered February 9, 2015 after months of bad weather and ship scheduling difficulties. Recordings were made on a duty cycle recording 10 minutes at the top of every hour. Memory storage reached capacity on November 10, 2015, at which time the hydrophone ceased recording. These acoustic measurements will provide further baseline spectral characterization information as well as bioacoustic survey information of marine mammal presence at the PacWave South project site.

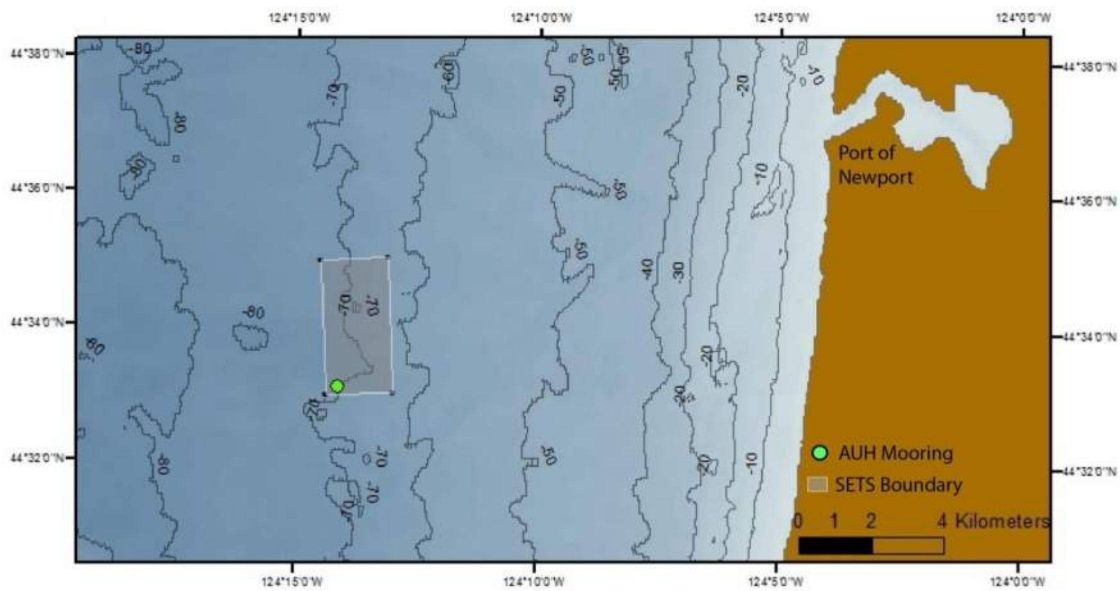

FIGURE 2. MAP WITH THE 2015 AUH MOORING LOCATION AND PACWAVE SOUTH BOUNDARY. BATHYMETRY CONTOURS SHOWN IN 10 M INTERVALS

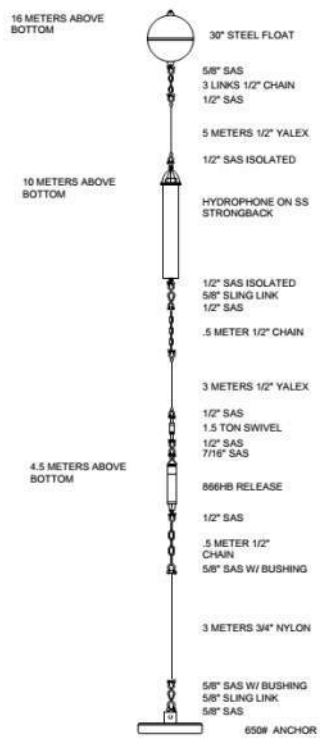

FIGURE 3. MOORING DIAGRAM OF THE AUH HYDROPHONE DEPLOYED JUNE 2015 – FEBRUARY 2016 AT THE PACWAVE SOUTH PROJECT SITE.

2.2. Schedule & Frequency

The deployment and recording schedule of the methods described in the section above for collecting ambient noise level measurements and passive bioacoustic surveys is summarized in Table 1. The landers for continuous acoustic recordings and C-POD detection were scheduled for deployment April – July 2014. The ADUH drifter recording missions were carried out 3 times spanning September 2013 – June 2014, and the DMON recordings were carried out in a series of ~ 10 day deployments from May – October 2014. The PacWave South mooring was deployed in June 2015 and recovered February 2016, but due to data storage limitations recorded up to November 10, 2015.

1. Acoustic Landers: PacWave South and REEF; continuous AUH and C-POD: Deployed April 1-July 26, 2014
2. ADUH drifter: September 2013, February 2014, June 2014
3. DMONs: May 16-23; June 12-18; June 26-July 7; July 29-August 8; September 16-30; September 30-October 10
4. PacWave South Acoustic Mooring: June 25, 2015-February 9, 2016 (data June 25-November 10)

Table 1. Hydrophone recording method deployment schedules. 'X' indicates deployment periods for tools 1-3. Yellow squares indicate recording period for the AUH mooring, although it was deployed for all months included in the table.

Method	Sep '13	Oct	Nov	Dec	Jan '14	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct '14
1.Landers AUH+CPOD								X	X	X	X			
2. ADUH	X					X				X				
3. DMON									X	X	X	X	X	X
4. AUH mooring	Jun '15	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb '16					

2.3. Constraints & Limitations

Several technical and mooring survivability challenges severely limited the ability of OSU to accomplish the objectives of the acoustic site characterization as proposed during the 2014-2015 study year; most notably, the loss of the PacWave South acoustic lander and the attached C-POD. Mooring operations and recovery efforts for the PacWave South acoustic lander are outlined below:

PacWave South/Reef Acoustic Lander operations 2014-2015

April 1, 2014 PacWave South/reef landers deployed from R/V *Elakha*

June 26 Attempted communication and recoveries using acoustic release and ship board transducer – both lander releases not responding - R/V *Elakha*

July 29 Contracted mini-ROV salvage company for recovery operations
- successful recovery of REEF inshore lander (systems heavily damaged)
- failed recovery attempt of PacWave South offshore lander plus C-POD, not able to communicate or locate during search – environmental conditions (wind, current) deemed too rough for the deeper water search - R/V *Elakha*

Sep. 30 Acoustic release interrogated again at PacWave South lander site with shipboard transducer – no replies – R/V *Elakha*

Jan. 12, 2015 Repeat mini-ROV recovery attempt using ROV mounted sonar – search area covered ~15 acres of seafloor surrounding the deployment site - lander could not be located – R/V *Elakha*

Due to the extensive search and recovery efforts detailed above, OSU deemed the first PacWave South acoustic lander lost. Upon recovery, the acoustic release messenger buoy system of the inshore REEF lander was discovered to have sustained catastrophic damage at some point during its deployment. The fine dredge spoils covering the entire mooring system suggests nearby or co-located dumping by the USACE dredge vessel *Yaquina* as a possible cause. Additionally, an electronic system failure of a key component of the AUH hydrophone data acquisition system introduced significant digital noise to the recordings rendering the acoustic data collected at the REEF site unusable for calibrated ambient noise level measurements. Despite this setback, the system failure does not affect the capability for detection and classification of acoustic sources within the data, still providing effective passive acoustic monitoring of marine species and vessel traffic at the REEF site.

The PacWave South AUH mooring deployed in 2015 was configured to record ten minutes of every hour from June 24-November 10, 2015. A long-term spectrogram (Figure 4) calculated from 10 minute averages illustrates the frequency content and variability of ambient noise levels during the ~ 4 month acoustic record. Mooring "self-noise" contamination begins to emerge within the record near August 6, 2015 affecting frequencies in discrete bands ranging from 400 – 5000 Hz, with highest amplitudes in the 600-1200 Hz range. This "self-noise" becomes increasingly louder and more frequent as the weather conditions degraded later in the fall season and the compliancy of the mooring system became more active (Figure 4). The mooring generated, "self-noise" contamination sounds are the result of wear on the rubber and chaffing noise mitigation materials that were wrapped over the chain and metal shackle components of the mooring system. In particular, the connection point between the steel float and chain links developed an identifiable "rubbing" sound of metal on metal that appears randomly and gets progressively louder and more frequent. An automated classifier based on an energy summation algorithm was developed and tuned for the mooring "self-noise" signal and applied to the data set to identify short periods (< 1 sec) of contaminated data. A total of 194,570 individual "self-noise" periods were detected revealing the progressive increase in their occurrence through the duration of the deployment (Figure 5). Due to the high density of detected "self-noise" and its influence on measured noise levels, analysis of ambient noise is limited to the time period from June 24 – August 6, 2015 prior to the development of the contamination signal.

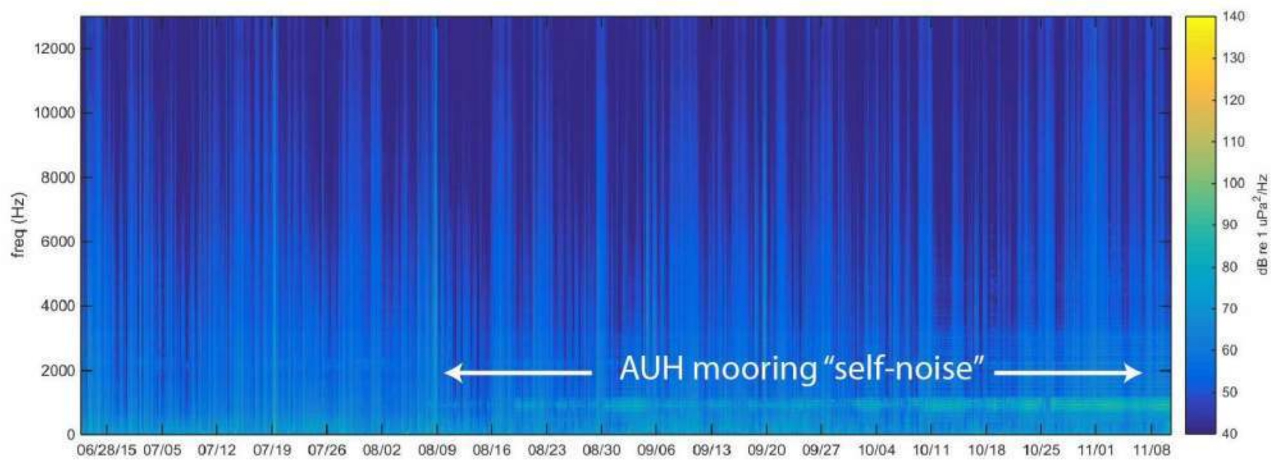

FIGURE 4. A SPECTROGRAM FROM 10 MINUTE AVERAGES SHOWING TIME DEPENDENCY AND SPECTRAL CONTENT OF NOISE LEVELS DURING THE ~ 4 MONTH DEPLOYMENT. ALSO, NOT THE DISCRETE BANDS PRODUCED BY MOORING "SELF-NOISE" THAT BECOME PROGRESSIVELY LOUDER THROUGHOUT THE RECORDING PERIOD.

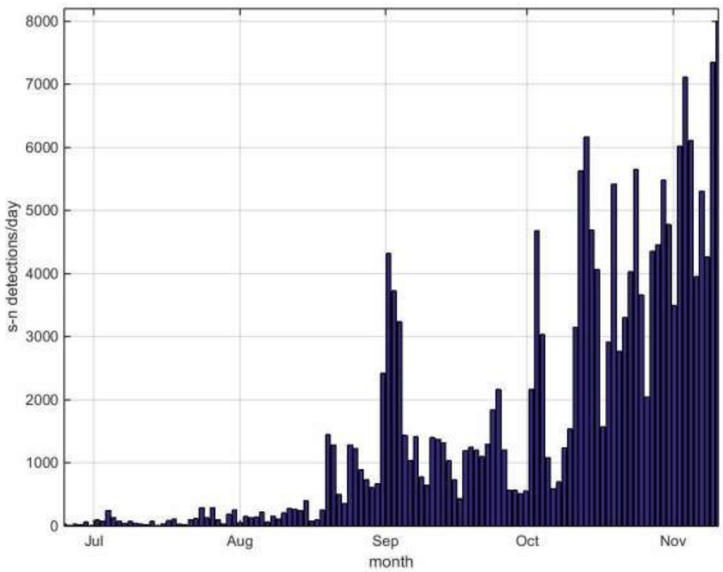

FIGURE 5 THE DISTRIBUTION OF MOORING "SELF-NOISE" AUTOMATED DETECTIONS SHOWING A PROGRESSIVE INCREASE AS THE WEATHER CONDITIONS BECAME MORE ENERGETIC.

2.4. Analysis

Acoustic time series are corrected to absolute pressure using the hydrophone sensitivity and pre-amplifier gain. The spectral structure of the frequency content is calculated from 1 second data intervals at 1 Hz resolution and then averaged over each 10 minute date file to produce a long term spectral average for comparison of trends in discrete frequency bands over time. Similarly, data files are analyzed for visual spectral recognition of discrete signals using the open access acoustic analysis software Ishmael. Spectrograms dominated by vessel noise are identified by strong consistent tones across a broad frequency range or interference patterns (e.g. Lloyd Mirror Effect) that distinguish these recordings from other sounds. Visual inspection of high temporal and frequency resolution spectrograms (≤ 1 s/ 1 Hz) are used to identify marine mammal vocalizations.

Additionally, from the absolute pressure time series, root mean square sound pressure levels (SPL_{rms}) are calculated over 10 second data intervals to capture noise level variability associated with typical incident wave periods.

$$SPL_{rms} = 20\log_{10}\left({}^{p}/_{p_{ref}}\right)$$

To correlate with environmental variables, SPL_{rms} values are then averaged over the same 1 hour sampling period as the met-ocean data from the National Data Buoy Center's (NDBC) Stonewall Bank Station 46050. Likewise, the cumulative distribution of 10 second SPL_{rms} values are used to describe the range and temporal density of noise levels in the project area.

The recordings from PacWave South provide analysis for a percentile-based representation of the cumulative distribution of spectral energy levels to establish a quantitative framework of baseline conditions for future acoustic impact comparisons of project activities (i.e., Figure 6 below from PacWave North data). For instance, during site construction, measured acoustic energy levels can be compared on a frequency-by-frequency basis with the cumulative distribution of these baseline measurements to assess the contribution and acoustic impact of site construction noise on ambient levels. Furthermore, median spectral levels (50th percentile) can be used to quantitatively describe the most “typical” acoustic conditions encountered at the PacWave South project site (Klinck *et al.*, 2013).

Passive bioacoustic surveys for marine mammals and fish are initially performed by visual spectral recognition of discrete signals. An analyst “scrolls” through time averaged spectrograms of the data using an acoustic data analysis software package called Ishmael (Mellinger, 2001) to visually identify discrete marine mammal and fish vocalizations. Once an adequate number of vocalizations or “calls” have been identified within the data set, an automated detection algorithm based on spectral characteristics of the signal is developed and applied to the entire data set. Positive detections are then catalogued and reviewed by the analyst for accuracy.

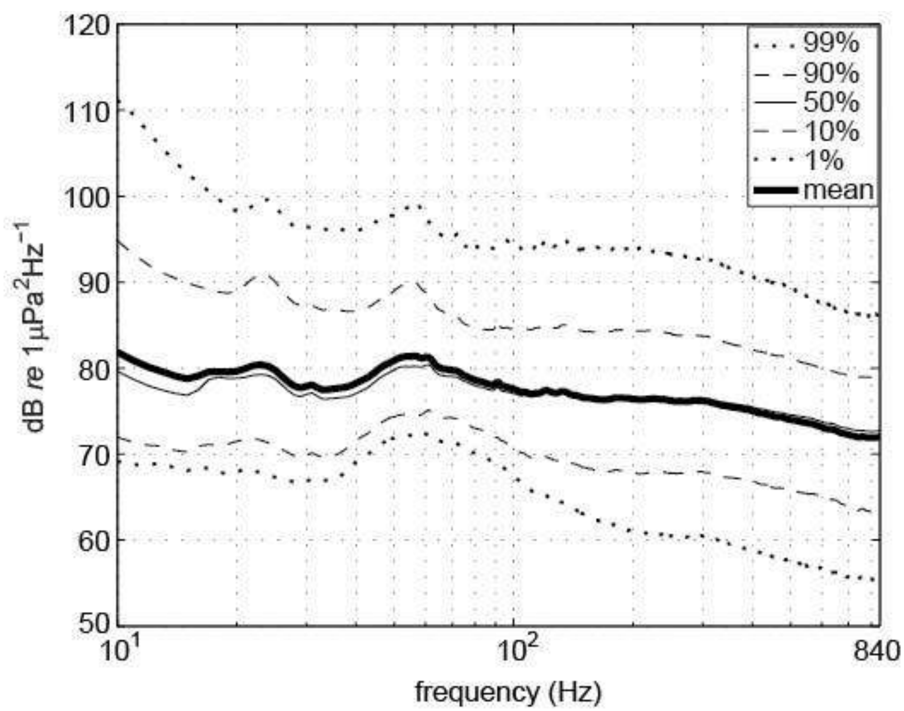

FIGURE 6: EXAMPLE OF THE SELECTED PERCENTILES FROM THE CUMULATIVE DISTRIBUTION OF SPECTRAL ENERGY LEVELS RECORDED AT PACWAVE NORTH (FROM HAXEL ET AL., 2013), PROVIDING A QUANTITATIVE BASELINE FOR COMPARISONS WITH FUTURE NOISE LEVEL MEASUREMENTS. NOTE THE LOG SCALED HORIZONTAL AXIS EMPHASIZING THE LOWER FREQUENCIES.

3. RESULTS

3.1. Results from Autonomous Underwater Hydrophones (Drifting, Moored, and Lander) and DMON Deployments

ADUH: This drifting hydrophone system samples continuously at 32 kHz with a 13 kHz cutoff, and is deployed at a target depth of 10 m below the sea surface. Environmental conditions during the drifting recordings were as follows:

Sep 2013: wind speeds ~ 4 m/s; significant wave heights ~ 2.2 m
Feb 2014: wind speeds ~ 8 m/s; significant wave heights ~ 1.5 m
Jun 2014: wind speeds ~ 8 m/s; significant wave heights ~ 1.3 m

Time averaged spectral energy levels generally remained consistent between the acoustic recording periods and similar environmental conditions (Figure 7). The elevated energy levels associated with the September 2013 recording reflect the visual presence of commercial fishing vessels operating within the project site.

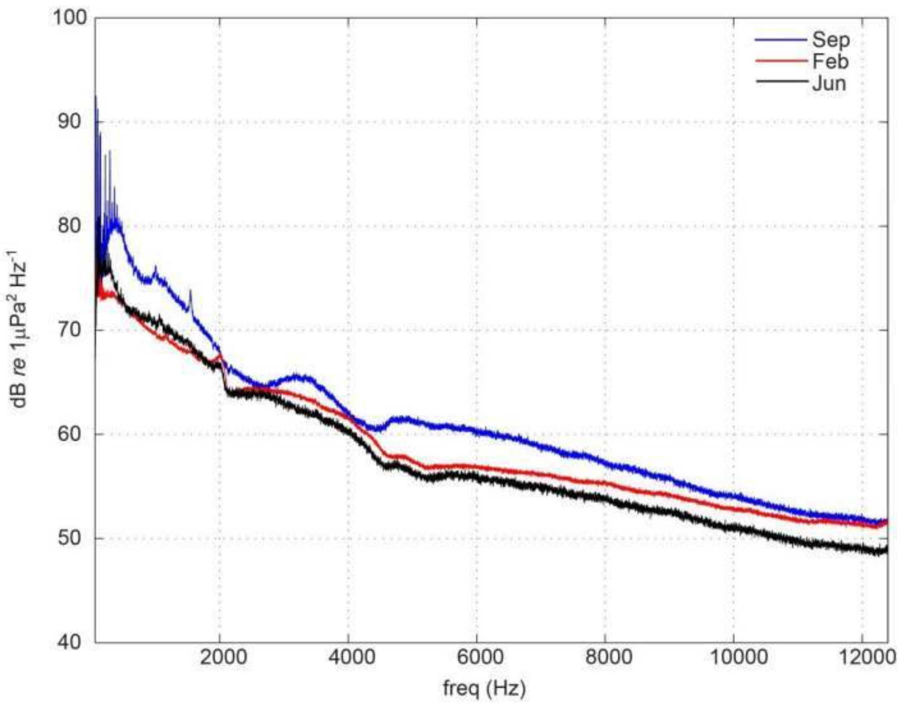

FIGURE 7. A COMPARISON OF SPECTRAL LEVELS (60HZ – 13KHZ) FROM THE SEASONAL ADUH RECORDINGS. SPECTRAL LEVELS ARE CALCULATED BY AVERAGING 1 SECOND DATA WINDOWS OVER ~30 MINUTE TIME PERIODS.

2014 REEF AUH Lander: Analysis of passive bioacoustic surveys for marine mammals and fish using the REEF lander has identified both humpback whale (*Megaptera novaeangliae*) and killer whale (*Orcinus orca*, Figure 8) vocalizations within the four-month REEF acoustic lander data. Visual spectral recognition analysis for killer whale signals identified calls on 7 days (April 8, 9, 19, 20, May 16 & 26, and June 10) within the acoustic data set spanning April 1-July 26, 2014.

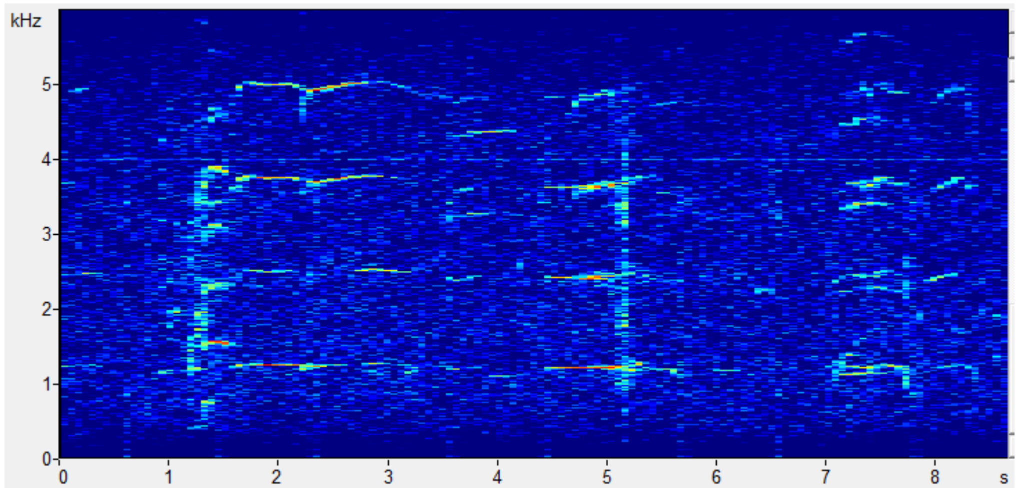

FIGURE 8. A SPECTROGRAM SHOWING KILLER WHALE VOCALIZATIONS FROM THE REEF LANDER AUH. NOTE THE BROADBAND DIGITAL NOISE SPIKES NEAR 1 AND 5 SECOND MARKS.

DMON: There was 94% vocal presence of harbor porpoise (*Phocoena phocoena*) during the recording effort, with detections at the REEF station outnumbering those at PacWave South site during similar recording periods. These vocalizations can be put in a behavioral context: whether the animal is in a foraging ("buzz") or navigational mode ("clicks") based on the time interval between clicks (Verfuss *et al.*, 2009). See the Marine Mammal Site Characterization Report and Holdman et al. (2019) for further details.

2015 PacWave South AUH: A spectrogram consisting of 10 minute spectral averages is plotted with records of significant wave heights (Hs – red line) and wind speeds (wspd – black line) from NDBC station 46050 (Figure 9). Conditions were recorded with wave heights ranging 0.7 – 3.1 m and dominant periods (Tp) 3.6 – 19.1 seconds and wind speeds ranging 0.3 – 12.5 m/s. NOTE: the conditions experienced in the reporting period for uncontaminated noise are almost entirely below small craft advisories [defined as sustained winds of 21 to 33 knots, and/or wave heights exceeding 10 feet (3.05 m) or wave steepness values exceeding local thresholds]. Only July 18, 2015, exceeded those conditions with wind speeds of 9 m/s and wave height of 3.08 m measured at NDBC station 46050.

Short time interval, broadband increases on the order of 15 – 20 dB above background noise levels (e.g. July 19; Figure 9) are associated with passing ships. The more persistent periods of ~5 dB increases (e.g. July 28-30; Figure 9) are linked with higher environmental energy conditions and surface-generated sound sources (wind, waves).

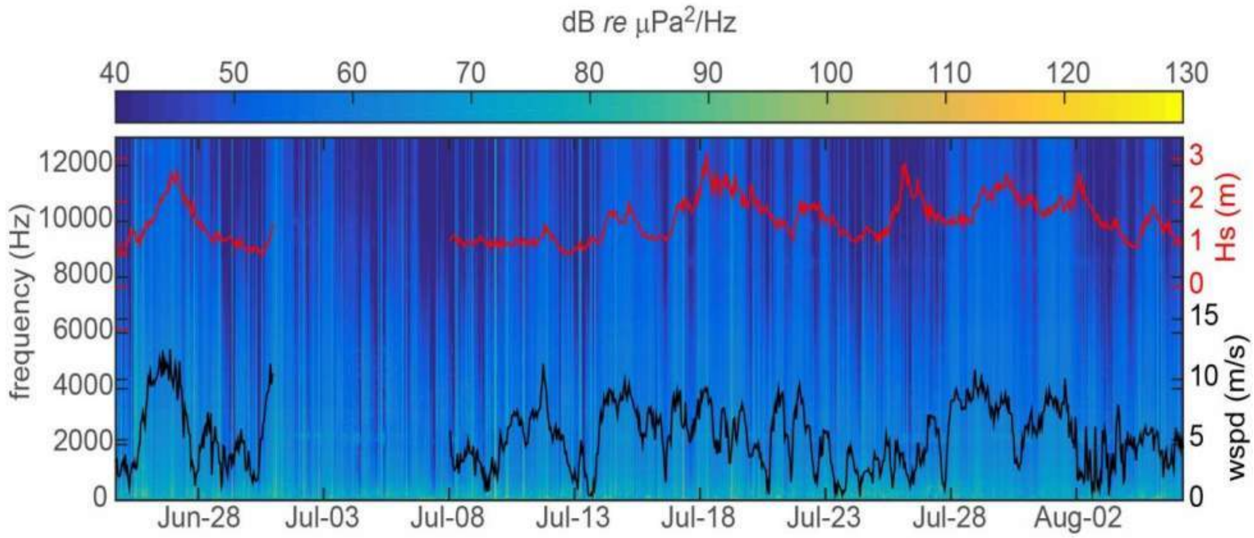

FIGURE 9 A SPECTROGRAM FROM 10 MINUTE AVERAGES SHOWING SPECTRAL ENERGY LEVELS PLOTTED WITH SIGNIFICANT WAVE HEIGHTS AND WIND SPEEDS FROM THE NDBC STATION 46050 FOR THE PERIOD FROM JUNE 24 TO AUGUST 6, 2015.

SPL_{rms} from 7 Hz – 13 kHz was used to generate a cumulative distribution function (CDF) of noise levels (Figure 10) where the 50th percentile (101 dB_{rms} re:1 µPa) was representative of a “typical” background sound level at PacWave South (NMFS 2012). Baseline monitoring recorded minimum SPL_{rms} levels for this time period of 83 dB_{rms} re:1 µPa, while local vessels generated the maximum rms sound pressure level (138 dB_{rms} re:1 µPa) from a total of 61,380 SPL_{rms} values. Despite the measured maximum value of 138 dB, less than 1% of the measurements surpassed the 116 dB level.

Throughout the ~ 6 week data period, 16 instances of data clipping, where vessel noise saturated the hydrophone sensor were observed, limiting the maximum noise level measurements to values below their actual levels. Therefore, maximum levels reported represent an underestimate of the highest acoustic energy events.

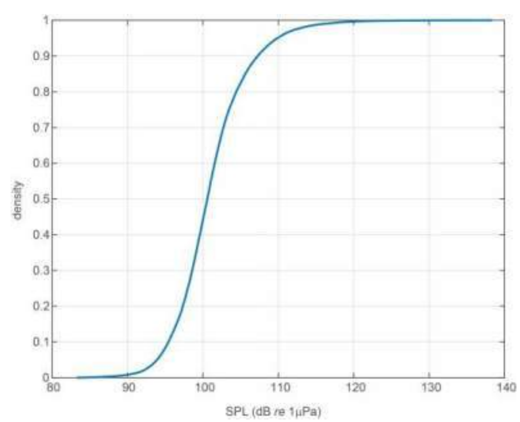

FIGURE 10 THE EMPIRICAL CUMULATIVE DISTRIBUTION FROM 10 SECOND SPL_{RMS} CALCULATIONS (N=61,380) FOR THE PERIOD FROM JUNE 24 TO AUGUST 6, 2015.

An example spectrogram showing a passing ship's propeller blade noise is shown in Figure 11 (top) observed near the beginning of the deployment in June 2015. Despite rising levels of data contamination during the deployment from the compromised mooring system, humpback whale vocalizations (e.g. Figure 11 bottom) were observed with increasing regularity from early September through the end of recording on November 10, 2015. An automated detection algorithm for humpback calls was applied to the data set, but due to the overlapping frequencies, it was confounded by mooring noise. Visual spectral recognition analysis for killer whale signals in the 2015 PacWave South acoustic mooring data identified 3 days (July 16, July 28, and August 11) where killer whales were vocally active in the vicinity of the hydrophone between the recording period June 24-November 10, 2015.

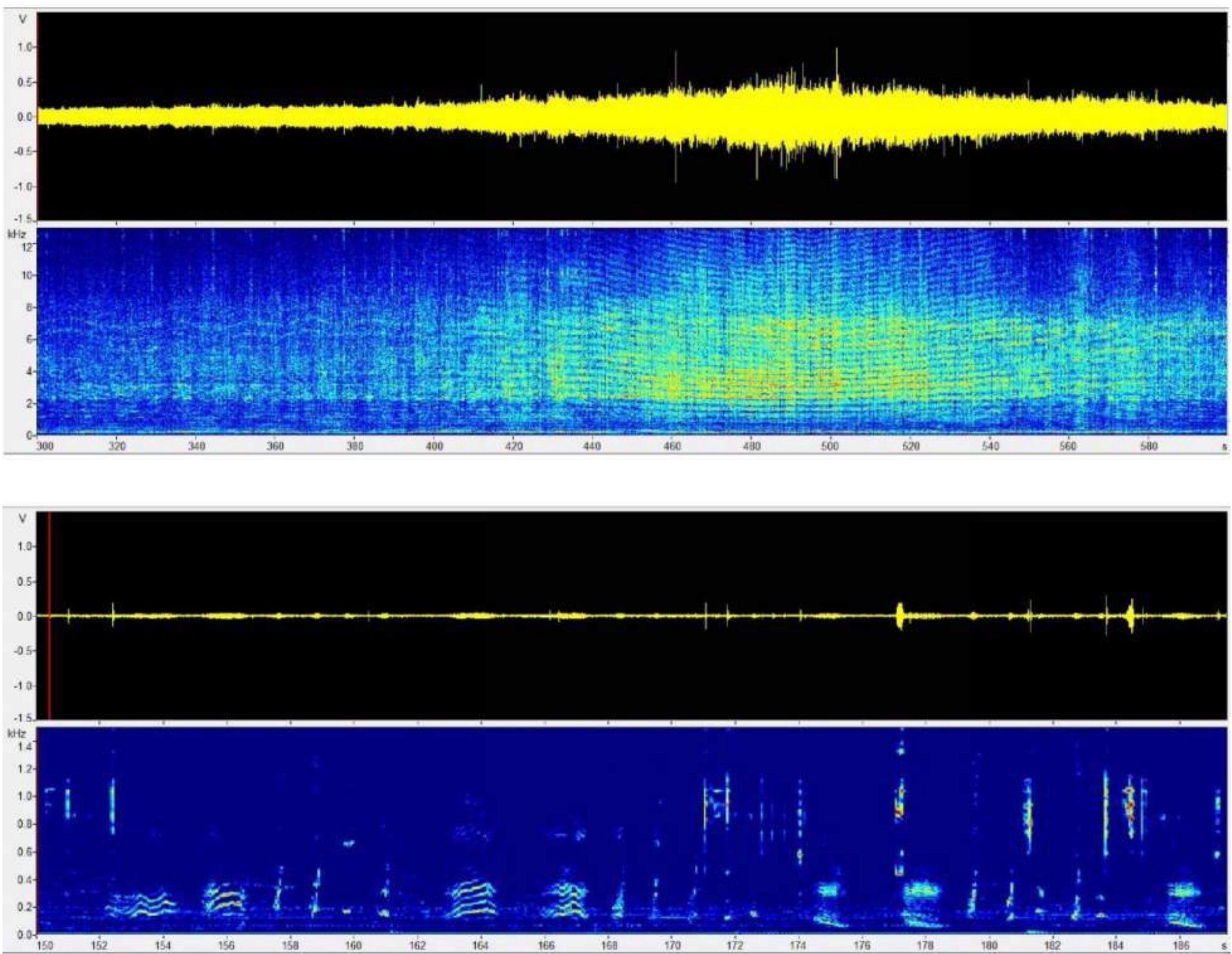

FIGURE 11. (TOP) A SPECTROGRAM FROM A PASSING SHIP AT PACWAVE SOUTH IN JUNE 2015 SHOWING PROPELLER BLADE NOISE. (BOTTOM) A SPECTROGRAM WITH HUMPBACK WHALE VOCALIZATIONS FROM A RECORDING AT PACWAVE SOUTH ON OCTOBER 15, 2015.

3.2. Relation to environmental conditions

There was little correlation between the range of wave energy conditions experienced during the summer of 2015 and recorded acoustic noise levels as illustrated in Figure 12. This plot compares the average rms sound pressure levels (SPL_{rms}) observed within discrete bins of Hs and Tp (values are reported when at least 2 periods of similar environmental conditions are observed). In fact, the highest intensity average SPL_{rms} values occurred during the second lowest wave height range (1.0 – 1.5 m). The lowest intensity sounds mostly occurred during the lowest energy (0.5 – 1.0 m @ 5 – 10 seconds) period but also were observed in the highest energy (2.5 – 3.0 m @ 10 - 11 seconds) period.

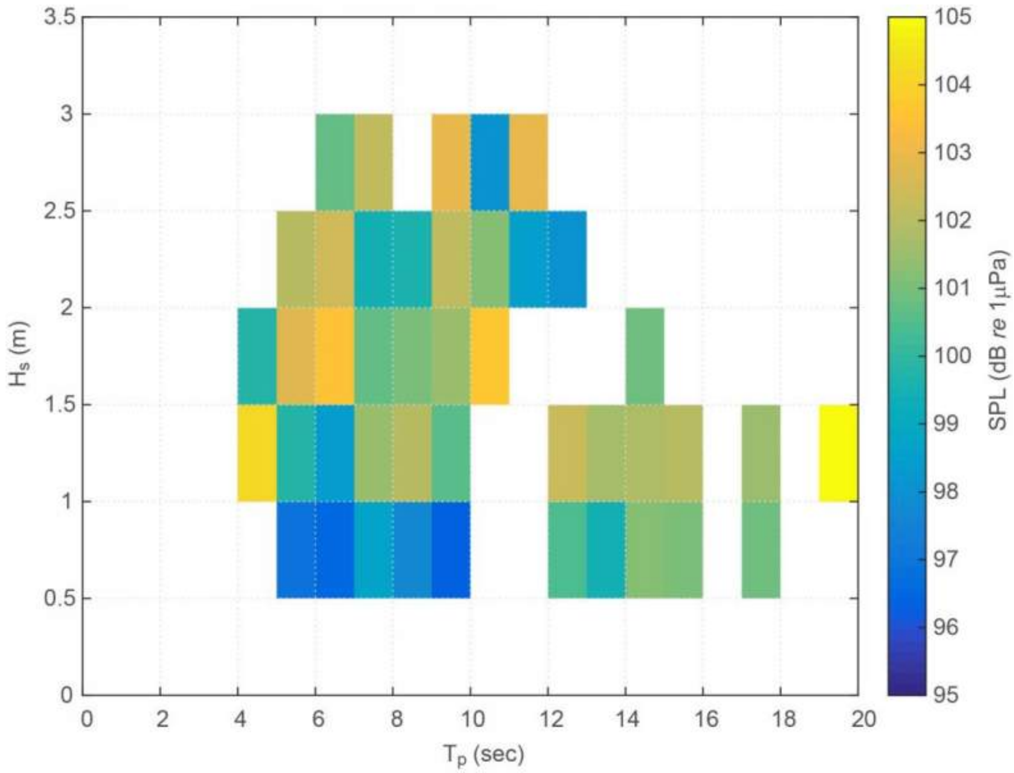

FIGURE 12 ACOUSTIC ENERGY LEVELS AS A FUNCTION OF ENVIRONMENTAL WAVE CONDITIONS JUNE 24 TO AUGUST 6, 2015.

To isolate the contributions of different sources of noise at PacWave South, times with elevated Hs (waves), wind speeds (wind), and vessel noise were identified in spectrogram displays and buoy data. A plot comparing these representative spectra from 10 minute averages of acoustic time series indicates vessel generated sounds as a dominant source in the PacWave South area (Figure 13). Spectra labeled waves (Hs =2.6 m; Tp = 11.4 sec; wspd = 1.9 m/s) and wind (Hs =1.2 m; Tp = 4.4 sec; wspd = 11.3 m/s) show slight differences with wind-generated surface processes resulting in noise levels 2-6 dB higher than from waves in frequencies of 100-1500 Hz. More importantly, vessel labeled spectra show a dramatic wideband increase of 20 dB despite less energetic environmental conditions (Hs =1.0 m; Tp = 9.0 sec; wspd = 3.6 m/s), emphasizing the acoustic influence of vessel traffic as a dominant sound source in the PacWave South area. In both the wind and wave labeled spectra, chain noise is evident in the 2 – 3 kHz band (Figure 13). Chain noise is observed throughout the dataset at varying levels and frequencies suggesting multiple sources that may include USCG navigation buoys, oceanographic moorings, and fishing gear in and nearby the PacWave South project area.

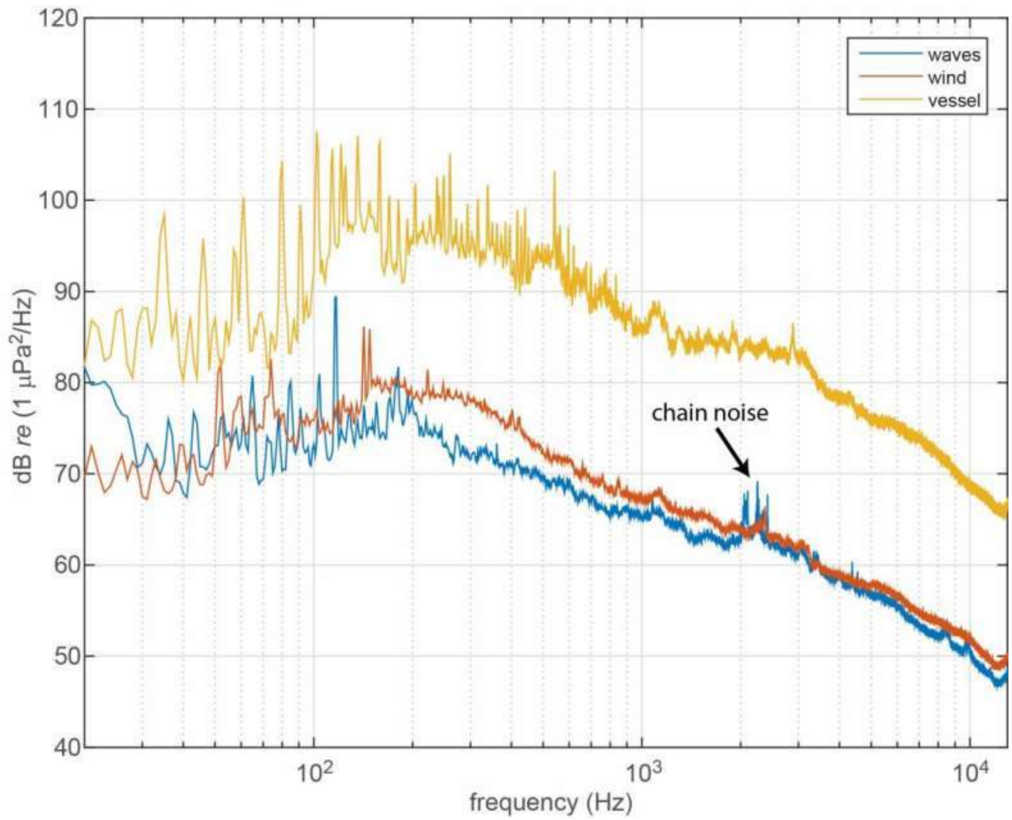

FIGURE 13 REPRESENTATIVE SPECTRAL ENERGY LEVELS FROM 10 MINUTE PERIODS FOR THE PERIOD FROM JUNE 24 TO AUGUST 6, 2015. "WAVES" REPRESENTS THE SPECTRAL ENERGY WHEN WAVES ARE LARGER AND WINDS ARE LOWER (HS =2.6 M; TP = 11.4 SEC; WSPD = 1.9 M/S); "WIND" REPRESENTS THE SPECTRAL ENERGY WHEN WAVES ARE LOWER BUT WINDS ARE STRONGER (HS =1.2 M; TP = 4.4 SEC; WSPD = 11.3 M/S); AND "VESSEL" INDICATES THE SPECTRAL ENERGY WHEN THE SPECTROGRAM IS DOMINATED BY VESSEL NOISE AND OCEAN CONDITIONS ARE LESS ENERGETIC (HS =1.0 M; TP = 9.0 SEC; WSPD = 3.6 M/S).

The contribution from wind generated surface processes to noise levels is shown in Figure 14. Overall SPL_{rms} levels (7 Hz – 13 kHz) are not strongly affected by rising wind speeds at the range of velocities experienced in this reporting period (top panel). Meanwhile, a band average (500 Hz – 5 kHz) of the frequencies most affected by winds indicates a relationship between noise levels in this band and rising wind speeds (lower panel). As winds reach 5 – 6 m/s, noise levels in this band begin to track upward at a logarithmic scale. Therefore, the wind-generated processes at these scales contribute to noise levels within the "wind band" but do not strongly influence the broad spectral SPL_{rms} levels, which are dominated by lower frequency energy (e.g. passing vessels).

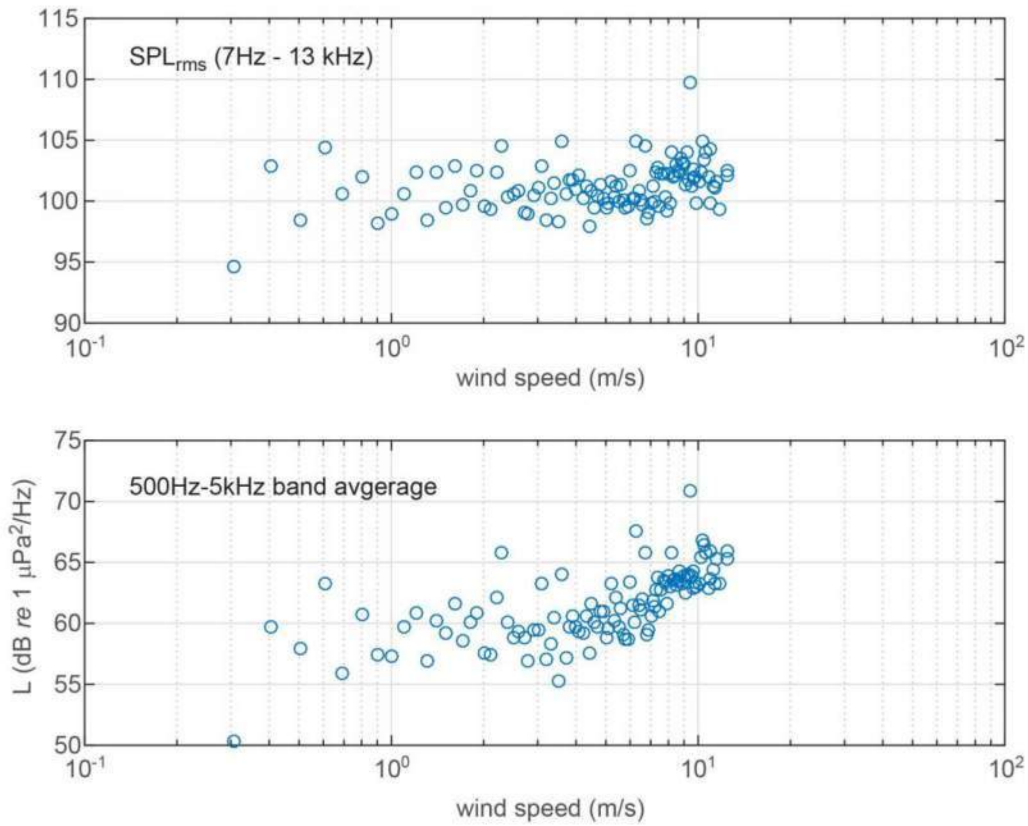

FIGURE 14 (TOP) SPL_{RMS} LEVELS AVERAGED IN 10 CM/S WIND SPEED BINS. (LOWER) BAND AVERAGED NOISE LEVELS IN 10 CM/S BINS.

3.3. Opportunistic Analysis

An opportunistic surrogate for WEC mooring system noise in increasing environmental energy conditions is shown in a plot similar to Figure 12 that includes the entire acoustic data set and a broader range of sea states through November 10, 2015 (Figure 15). Above 3 m and/or 12 second periods, noise levels begin to rise systematically with increasing wave heights and periods. Although the mooring “self noise” occurrences increase as a function of sea state and time [as evidenced by the results of the automated detector (Fig. 5)], the contribution of this contamination signal to the broadband noise levels is complex due to its convolution with the naturally produced surface noise in higher energy conditions.

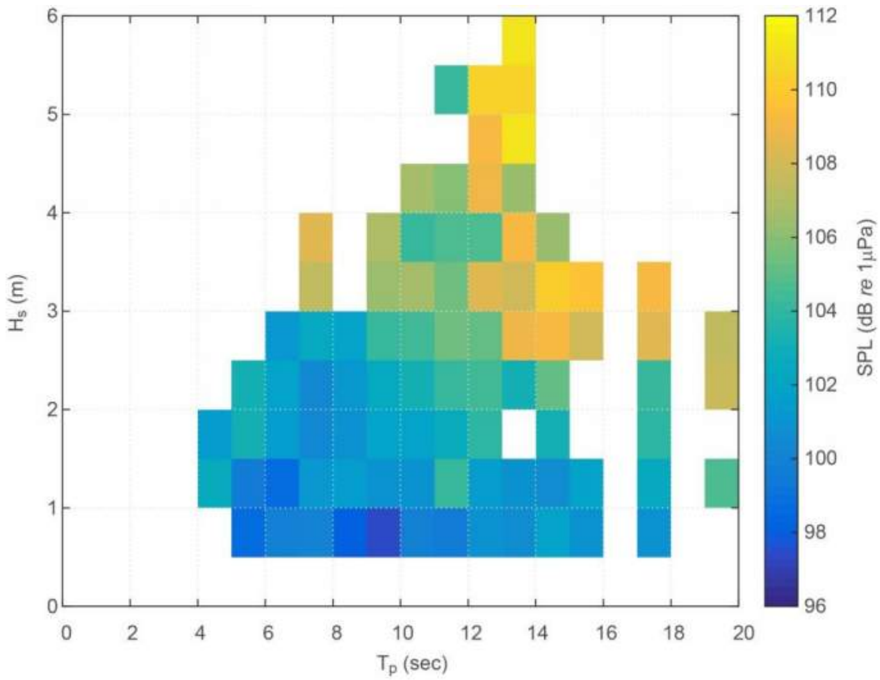

FIGURE 15 ACOUSTIC ENERGY LEVELS AS A FUNCTION OF ENVIRONMENTAL WAVE CONDITIONS THROUGHOUT THE DEPLOYMENT INCLUDING NOISE LEVELS CONTAMINATED BY MOORING "SELF NOISE".

4. DISCUSSION

Despite the loss of the initial PacWave South acoustic lander, results from bioacoustic surveys using the REEF lander deployment data reveal significant information regarding the seasonal presence of humpback and killer whales during the April-July time period. Additionally, DMON deployments indicated frequent use of these areas from May-October by harbor porpoise with higher levels of acoustically active animals at the inshore (REEF) than offshore (PacWave South) stations. The close proximity of the PacWave South project site to the Yaquina Bay port entrance and navigational corridor presented a significant challenge for maintaining the acoustic instrumentation during the 2014 study.

The 2015 PacWave South mooring survived the 8 month deployment period, returning high quality acoustic data up to 13 kHz from June 25-November 11, 2015. Results indicate for the range of environmental conditions experienced during the June 24-August 6, 2015, time period, changes in sea state had a limited effect on ambient noise levels. Higher sea states will further elevate natural ambient noise conditions (mostly in frequencies from 500 Hz -10 kHz), with increases of ~25 dB from sea state 0 to sea state 6 (Wenz 1962). This is on the order of the observed increases in spectral energy levels associated with nearby vessel noise at the PacWave South project site. The differences in these elevated levels from ship traffic verses sea state are readily identified in spectrogram displays, with ship noise containing strong tonal character often modulated by interference patterns, while weather related noise is broadband and diffuse across the recorded spectrum. Passing vessels have the strongest short-term (10 minutes) transient influence on ambient noise at PacWave South, raising broadband acoustic levels across the recorded spectrum on the order of ~20 dB, while natural sources at the highest environmental energy levels experienced during this study raise spectral levels (above

500 Hz) ~5 – 6 dB. Despite a significant reduction in the amount of metal hardware (chain, etc.) as well as the use of rubber insulation to mitigate chain noise, near the end of the deployment mooring system noise began leaking in to the record. Future deployments will include jacketed wire instead of chain elements to quiet mooring system noise levels.

5. References

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APPENDIX E
Navigation Safety Risk Assessment

Navigational Safety Risk Assessment

PacWave South

FERC Project No. 14616

Oregon State University
Corvallis, OR

Contents

Tables

Figures

1 Introduction

Oregon State University (OSU) is filing with the Federal Energy Regulatory Commission (FERC) an application for a license for the installation and operation of the PacWave South (Project; formerly known as Pacific Marine Energy Center South Energy Test Site [PMEC-SETS]), a grid-connected wave energy test facility (FERC Project No. P-14616). The Project would be located in the Pacific Ocean, approximately 6 nautical miles off the coast of Newport, Oregon on the Outer Continental Shelf (OCS) and would occupy an area of approximately 2 square nautical miles (1,695 acres). The Project would transfer power to the grid through four buried subsea cables running from the test site to a terrestrial cable connection point at Driftwood Beach State Recreation Site in Seal Rock, Lincoln County, Oregon (Figure 1-1) and then on to a grid connection point with the Central Lincoln People's Utility District (CLPUD) about 0.5 miles to the east and south. The OCS is federal land administered by the Bureau of Ocean Energy Management (BOEM). The terrestrial components of the Project would be sited on state, county, and privately-owned lands. The PacWave South would have a maximum capacity of up to 20 megawatts (MW). The Project would serve as an integrated test center to evaluate the performance of commercial scale and near-commercial scale wave energy converters (WECs).

Subsection 8(p)(1)(C) of the Outer Continental Shelf (OCS) Lands Act (43 U.S.C. § 1337(p)(1)(3)), which was added by Section 388 of the Energy Policy Act of 2005 (EPAct), gave the Secretary of the Interior the authority to issue leases for marine hydrokinetic projects on the OCS. This authority has been delegated to the BOEM. OSU submitted an Unsolicited Request for Renewable Energy Research Lease to BOEM on October 29, 2013; on June 19, 2014, BOEM determined that it is appropriate to issue a lease for the Project on a non-competitive basis.

The U.S. Coast Guard (USCG) is a cooperating agency under the National Environmental Policy Act (NEPA) with BOEM or any other lead permitting agency considering the issuance of a lease, right of use and easement or right-of-way for an Offshore Renewable Energy Installation (OREI). The USCG's role is to assess navigation impacts of an OREI and forwarding such considerations to the lead permitting agency. This Navigational Safety Risk Assessment is intended to assist the USCG in their assessment of the impacts on navigational safety by identifying the potential risks and evaluating potential measures that could be implemented to mitigate the increased risks associated with the proposed project.

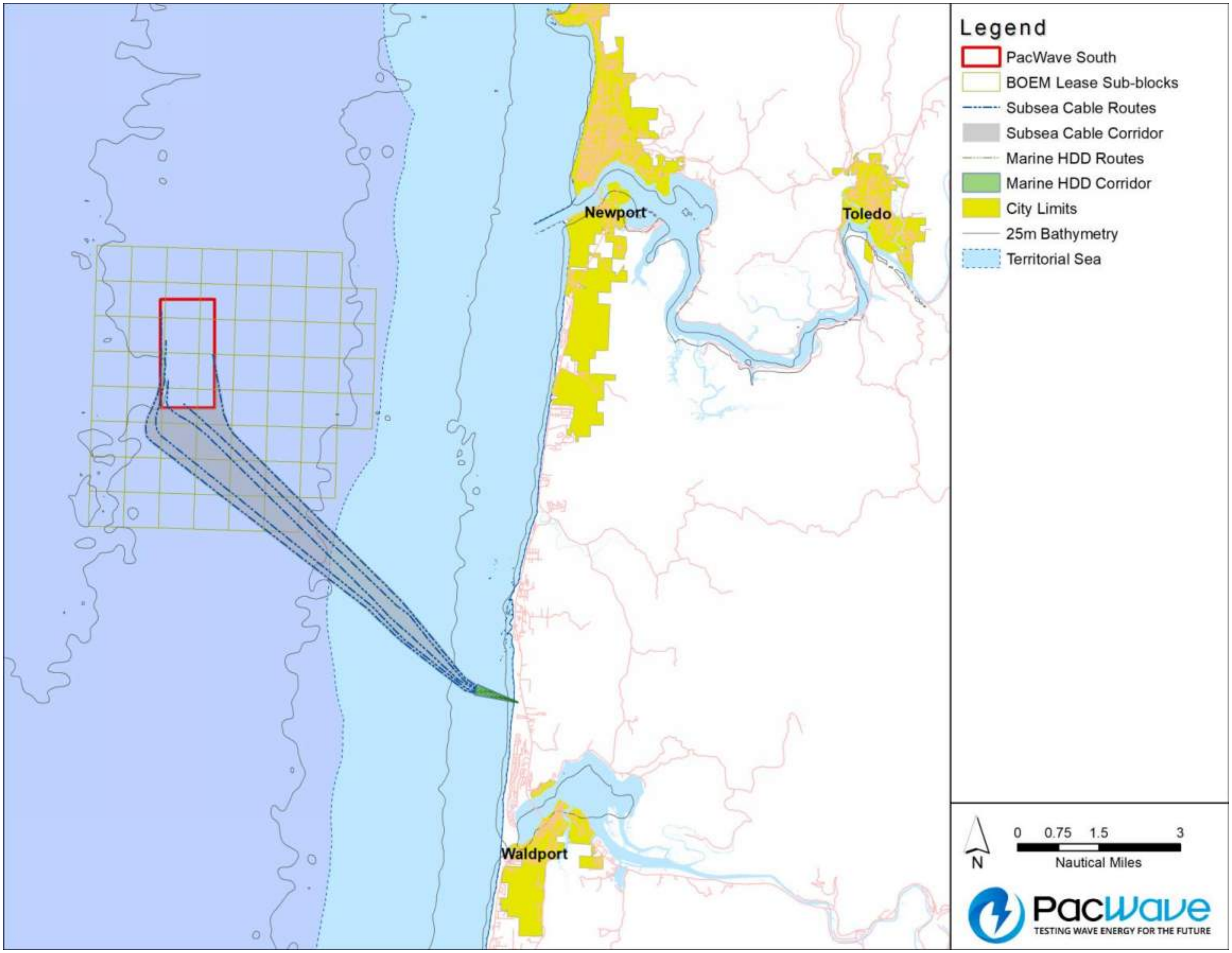


Figure 1-1. PacWave South marine Project area.

1.1 Purpose of Action and Need for Power

1.1.1 Purpose of Action

The purpose of the action is to obtain a 25-year FERC license allowing OSU to install and operate the PacWave South, a grid-connected wave energy test facility to conduct testing of WECs. Research on and testing of WECs is needed to advance the development of marine renewable energy technologies by providing facilities for full-scale, open-ocean testing of WECs to promote the responsible development of marine renewable energy in the U.S. As such, this Project would support the mission, vision, and goals of the Department of Energy's (DOE) Office of Energy Efficiency and Renewable Energy Water Power Technologies Office to improve performance, lower costs, and accelerate deployment of innovative technologies for clean, domestic power generation from resources such as hydropower, waves, and tidal technologies. Testing conducted at PacWave South would advance the development of WECs, and thus further the nation's efforts to reduce its greenhouse gas emissions, diversify its energy supply, provide cost-competitive electricity to key coastal regions, and stimulate revitalization of key sectors of the economy.

1.1.2 Need for Power

PacWave South would serve as an integrated wave energy test center to evaluate the performance of commercial scale or near-commercial scale WECs. As a secondary benefit, the Project would provide electricity to the Oregon coast region. PacWave South would have a maximum installed capacity of 20 MW. This capacity is based on the Oregon Wave Energy Trust (OWET) sponsored market analysis that forecasted future demand for berthing capacity at PacWave South (OWET 2014).

The power generated at PacWave South would vary depending on the WEC types and testing conditions; preliminary estimates range from 150 kilowatts (kW) to 2 MW per WEC. As a result, the energy capacity of PacWave South would vary over the life of the project. OSU expects that the capacity and number of WECs at PacWave South would be low in the initial operations term and increase gradually as the industry advances.

As noted above, the primary purpose of PacWave South is to serve as an integrated test center to evaluate the performance of commercial scale and near-commercial scale WECs; energy generation is a secondary benefit. However, OSU believes that once the Project develops, the capital costs of wave energy would become more competitive with traditional generation.

The Project would connect to the CLPUD system, which serves over 38,000 customers including residential, commercial, and industrial users (CLPUD 2014). CLPUD is the fourth largest utility in Oregon (Oregon Department of Energy [ODOE] 2012) and receives all its required energy from the Bonneville Power Administration (BPA). The energy supplied by the Project would offset only a minor part of the total demand. CLPUD serves less than 3 percent of Oregon's electrical load and is considered a "small utility" (ODOE 2012) under Oregon's Renewable Portfolio Standard (ORS 469A). As small utility, CLPUD is required to provide 10 percent of its power with renewable resources by 2025 (ORS 469A.055). The Project could generate up to 20 MW, which is small compared to regional demand, but would contribute renewable energy to CLPUD's future Renewable Portfolio Standard obligation.

Power generated by the Project would also support Oregon's goal to develop wave energy as a source of future renewable energy. The State of Oregon Biennial Energy Plan 2015-17 highlights that "Oregon is at the crossroads of a developing marine energy industry, with a powerful wave climate and an environment suited for testing wave energy conversion technologies. Oregon is becoming the place to develop WECs from concept to full-scale deployment and learn how well they work in the marine environment" (ODOE 2015). Regionally, the Northwest Power Council (2016) predicts the electricity demand in the Pacific Northwest to increase 1 0.5 to 1.0 percent per year, between 2015 and 2035. The testing of wave energy technology at PacWave South would advance the commercialization of wave energy and add to the diversification of Oregon's energy sources.

2 Existing Conditions

2.1 Waterway Characteristics

2.1.1 Wind, Waves, and Currents

The high level of wave energy that exists on the Oregon coast is caused by prevailing western winds and the large fetch of the North Pacific Ocean (Boehlert et al. 2008). Wave energy on the coast varies considerably by season, such that the wave energy flux is approximately eight times greater during winter than summer (Bedard 2005). Episodic winter storms bring large waves from the west and southwest. Currents generated by these waves are uniform throughout the water column, and may have a substantial influence on the transport of fine sediments (silt and clay) at depths of greater than 120 ft (USACE and EPA 2001). The regional-scale circulation of ocean surface waters on Oregon's continental shelf varies seasonally with changing wind stress patterns and is dominated by the southward-flowing California Current (USACE and EPA 2001). During the summer, offshore high-pressure weather systems and associated northerly or northwesterly winds drive upwelling of deep, dense, cold water toward the ocean surface. In contrast, low-pressure offshore weather systems during winter drive southwesterly storm winds that result in downwelling of nearshore surface water, and nearshore surface circulation is dominated by the northward flowing Davidson Current.

On the inner continental shelf (depths less than about 35 m), water circulation is influenced by a combination of wind-driven currents, wind waves, tidal currents, and estuarine induced currents (USACE and EPA 2001). On the middle continental shelf (depths of 35 to 90 m), water circulation is influenced mainly by wind-driven currents., whereas on the OCS (90 to 180 m), shoaling waves and regional-scale currents control water circulation seasonally (USACE and EPA 2001). The net direction of bottom currents on the mid- to outer-OCS is northward; the subsurface part of the Davidson Current is believed to flow northward year-round (USACE and EPA 2001).

Based on site-specific surveys, water depth at the Project site ranges from 65 to 79 m (Goldfinger et al. 2014). Figure 2-1 illustrates bathymetry at the offshore test site;

bathymetry along the proposed cable route is shown in Figure 2-2. (Note that both figures are based on less accurate, pre-survey data.)

Direct measurements of wave climate information have been collected through in-situ measurements at OSU's PacWave North[1] (formerly known as Pacific Marine Energy Center North Energy Test Site [PMEC-NETS]) (Cahill 2014), which is considered to be reasonably representative of PacWave South given the relative proximity of the two sites (the sites are 9 miles apart). Cahill (2014) compared wave measurements at PacWave North collected from August to October 2012 and August to October 2013, to the National Data Buoy Center (NDBC) Buoy 46050, located 20 nautical miles west of Newport, to develop a representative, 18-year, dataset of wave parameters for PacWave North. Annual average wave heights are approximately 2 m, with the highest annual average exceeding 2.5 m. The annual average wave energy flux fluctuates between approximately 30 kW/m and 60 kW/m. The average wave power across the entire 18-year period of record was 40 kW/m. Strong seasonal trends were documented from this analysis: during winter, as would be expected, higher wave height, longer wave period, and a greater available wave energy resource occurs. Wave power during December is on average approximately eight times greater than in June, July, and August (Cahill 2014).

[1] PacWave North is an existing wave energy test facility developed by OSU in 2012. The facility, which is north of the proposed PacWave South site, is not grid connected and is not part of the PacWave South license application.

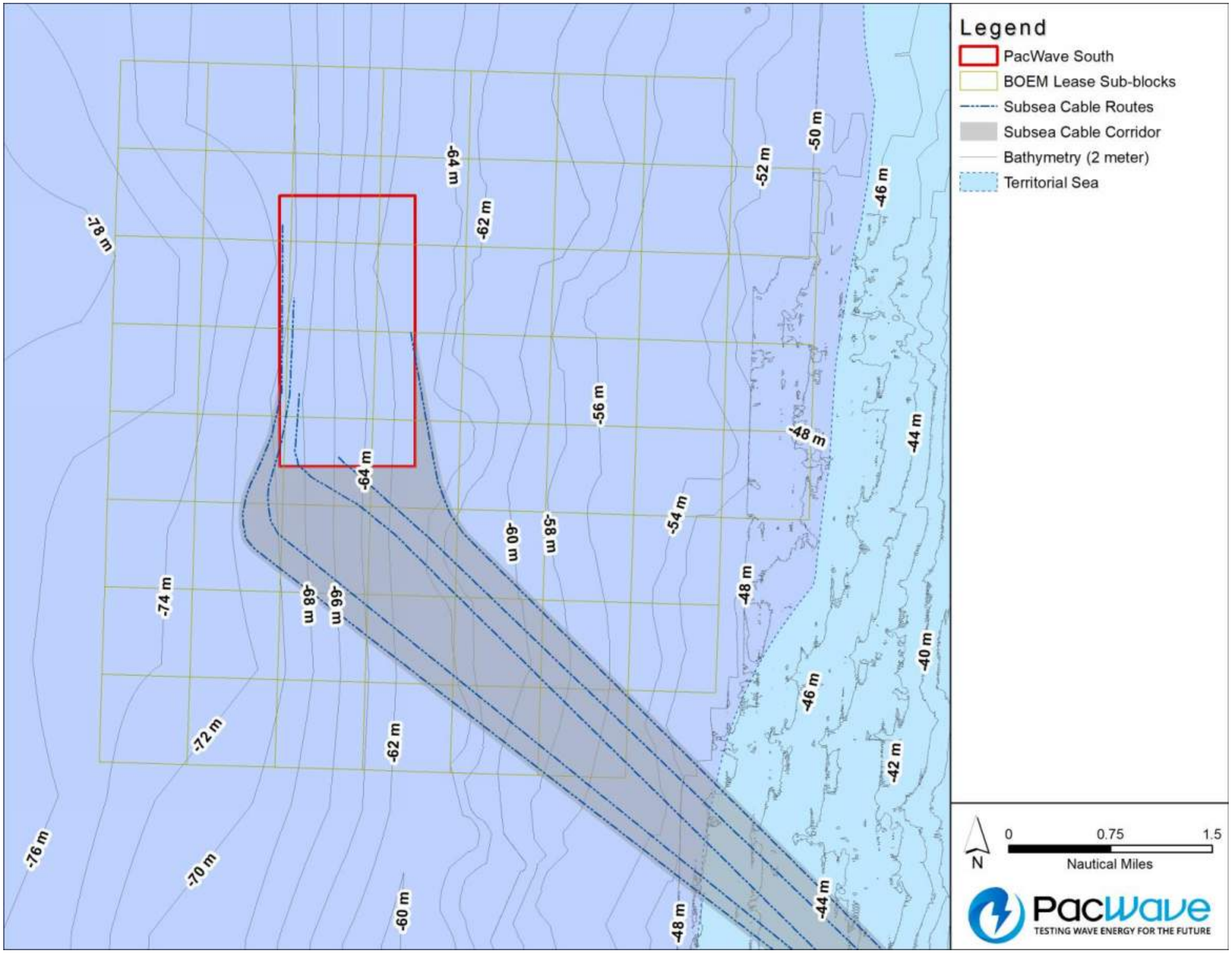


Figure 2-1. PacWave South bathymetry.

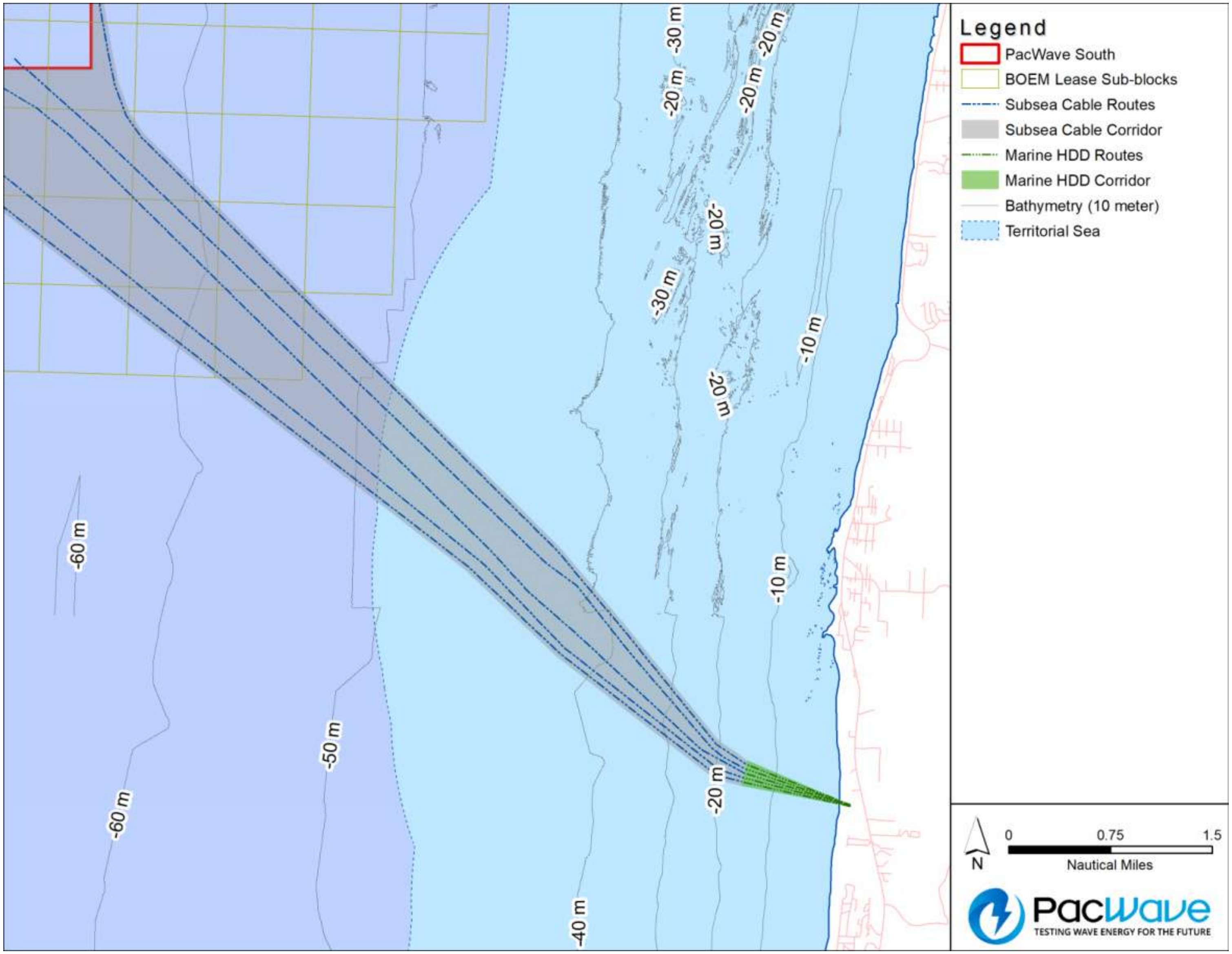


Figure 2-2. Cable Route bathymetry.

2.1.2 Water Quality

Part of the Project's cable route would be located within the territorial limits of the State of Oregon, and installation of the cables must comply with the water quality standards outlined in the Oregon Administrative Rules (OAR) 340-041. Relevant rules applicable to the Project are the following:

(1) support aquatic species without detrimental changes in the resident biological communities;

(2) prevent a reduction in ambient dissolved oxygen concentrations;

(3) maintain pH between 7.0 and 8.5;

(4) prevent water temperature increases that adversely affect fish or other aquatic species; and

(5) prevent the introduction of toxic substances above natural background levels in amounts, concentrations, or combinations that may be harmful to aquatic life, public health, or other designated beneficial uses.

The designated beneficial uses for marine waters adjacent to the Mid-Coast (which contain the Project area) are industrial water supply, fish and aquatic life, wildlife and hunting, fishing, boating, water contact recreation, aesthetic quality, commercial navigation, and transportation.

ODEQ administers 15 statewide narrative criteria for water quality, per Oregon Administrative Rules 340-04; these include the following criteria relevant to this Project:

(1) creation of tastes or odors or toxic or other conditions deleterious to aquatic life or affecting the potability of drinking water or the potability of fish or shellfish;

(2) formation of appreciable bottom or sludge deposits or the formation of any organic or inorganic deposits deleterious to aquatic life or injurious to public health, recreation, or industry;

(3) objectionable discoloration, scum, oily sheens, or floating solids, or coating of aquatic life with oil films; and

(4) aesthetic conditions offensive to human senses of sight, taste, smell, or touch.

Water quality on the Oregon coast varies seasonally. During winter, temperatures of nearshore surface waters are generally around 9 to 10°C and salinities range from about 30 to 32 practical salinity units (PSU; Boehlert et al. 2008, Landry et al. 1989). Light transmission is higher during winter and decreases with the transition to spring/summer upwelling conditions, when phytoplankton blooms occur (Boehlert et al. 2008). Spring/summer upwelling results in a net transport of shallow water to the west, bringing deeper, colder, more saline water onto the inner shelf. Summer surface temperatures are about 8 to 14°C and salinities are about 30 to 32 PSU (Boehlert et al. 2008, Landry et al. 1989). Wind and wave conditions are relatively calm during the early spring (March and April), and early fall conditions (September and October) transition between oceanographic regimes (Boehlert et al. 2008).

Water quality data taken in proximity to the marine Project area are available in the ODEQ Laboratory Analytical Storage and Retrieval (LASAR) Database, and sediment quality data were reported during studies performed prior and subsequent to designation of the dredged material disposal areas offshore of Newport. Also, on June 10, 2003, ODEQ collected water quality data just west of PacWave South (Site ID 30223). Two readings were taken every half meter throughout the water column (e.g., near surface to near bottom at 60 m). The average is provided at three sampling depths in Table 2-1. Chlorophyll α, water temperature, dissolved oxygen concentrations, and transmittance differed most substantially near the surface. All parameters, with the exception of transmittance and salinity, typically decreased with increasing depth.

Table 2-1. Average water quality data from ODEQ Site 30223

Parameter	Sampling Location		
	Near Surface (2 m)	Mid-Water (30 m)	Near Bottom (60 m)
Chlorophyll a (µg/L)	14.5	0.6	0.2
Dissolved oxygen (mg/L)	10.0	5.9	3.1
Salinity (ppt or PSU)	31.5	33.0	34.0
Temperature (°C)	12.0	8.2	7.5
Transmittance (percent)	76.0	94.0	93.5
Dissolved oxygen (percent saturation)	113.5	61.5	32.0

Source: ODEQ 2014
Notes: µg/L = micrograms per liter, mg/L = milligrams per liter, ppt = parts per thousand (equivalent to PSU), °C = degrees Celsius

Sediment samples were also taken from sites outside Yaquina Bay in various years from 1984 to 2000, mostly in summer and fall (USACE and EPA 2001). The 18 sample locations are in the open waters offshore of Yaquina Bay, an area that, like the test site and most of the cable route, has a uniform sand bottom. Metals concentrations detected in all samples were far below the screening levels outlined in the USACE's Sediment Evaluation Framework for the Pacific Northwest (USACE et al. 2009). All detected concentrations of organic compounds were either below the USACE's Sediment Evaluation Framework screening levels or below laboratory reporting limits.

2.2 Maritime Traffic and Vessel Characteristics

Waters in the vicinity of the Project are used by a variety of recreational, charter, and commercial boats. Vessel traffic is often concentrated near the mouth of the Yaquina River and near the Port of Newport (Figure 2-3). The Yaquina River supports commercial traffic, primarily fishing vessels, research vessels from NOAA and OSU, and occasional lumber cargo vessels. To avoid conflicts between commercial crab fishermen and ocean going tugs that are towing barges, the Washington Sea Grant program helped broker an agreement that provided navigable towboat and barge lanes through the crabbing grounds between Cape Flattery and San Francisco. Based on the 2012 edition of the Washington Sea Grant Tow Lane Charts, the Project's WEC deployment area would overlap with an existing tow lane off the coast of Newport. However, OSU has been worked with the crabbers and tow boat operators and all parties have agreed to modify the Newport Entrance towlanes so they avoid the Project's WEC deployment area.

The USACE maintains the Yaquina Bay federal navigation channel to federally authorized depths by periodically dredging naturally occurring sedimentary material. Dredge material from this area has been placed at one of the two USACE designated Ocean-Dredged Material Disposal Sites (ODMDS North and South) located off the coast of Newport in the Yaquina Bay area (USACE and EPA 2012). The ODMDS sites are located about 6 nautical miles northeast of PacWave South and about 10 nautical miles north of the subsea cable route. The test site would be marked to aid navigation for vessel traffic and fishing activities, but OSU is not seeking a closure of the area.

Figure 2-3 shows the relative density of all ships in the project vicinity for the years 2011 and 2013, based on the NOAA Office of Coastal Management, available via the Marine Cadastre (www.MarineCadastre.gov). Separate figures showing the relative densities of cargo ships (Source: www.MarineCadastre.gov.

Figure 2-4), fishing vessels (Source: www.MarineCadastre.gov.

Figure 2-5), passenger vessels (Source: www.MarineCadastre.gov.

Figure 2-6), pleasure craft and sailing vessels (Source: www.MarineCadastre.gov.

Figure 2-7), tanker vessels (Source: www.MarineCadastre.gov.

Figure 2-8), and tug and towing vessels (Source: www.MarineCadastre.gov.

Figure 2-9) are also included.

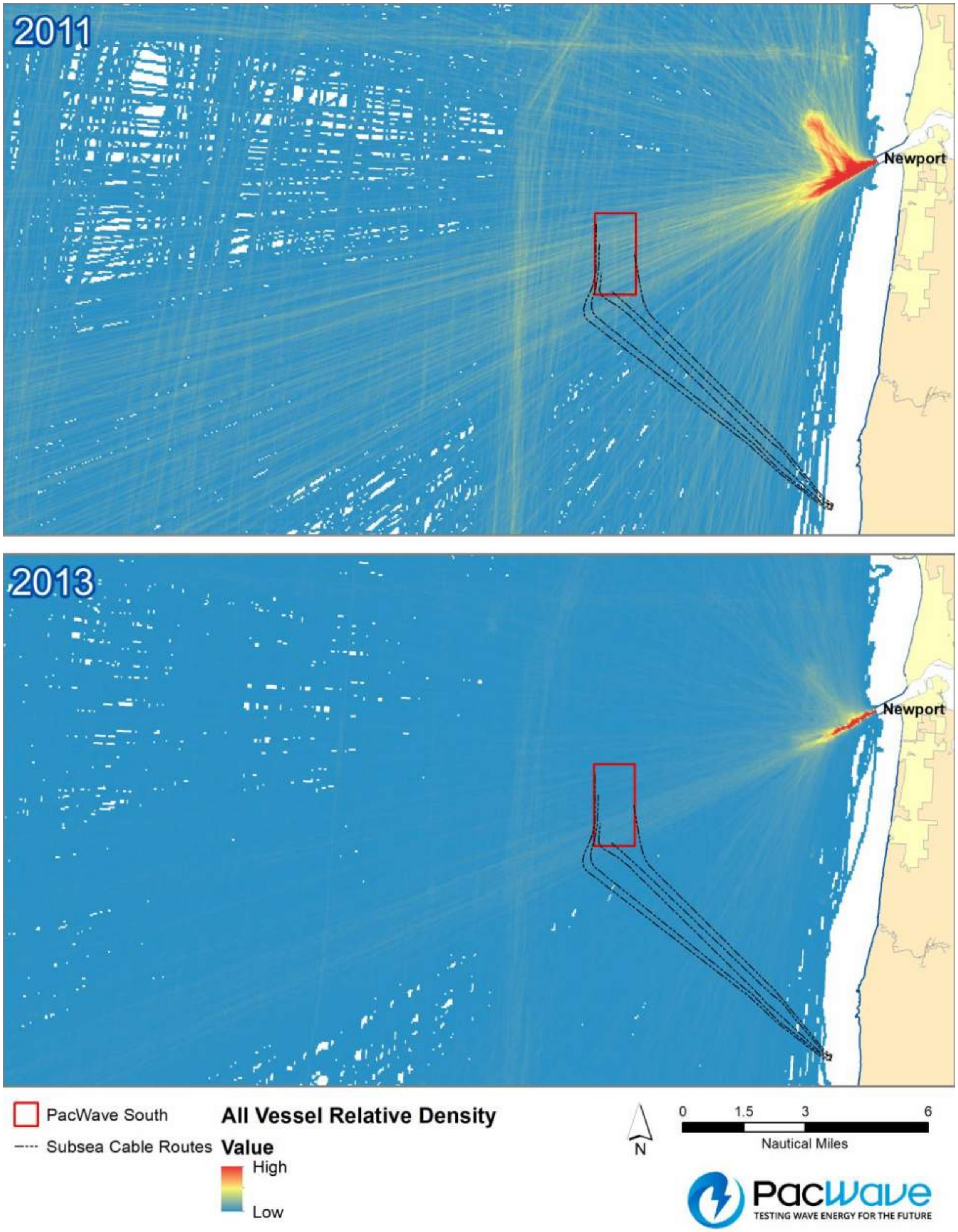
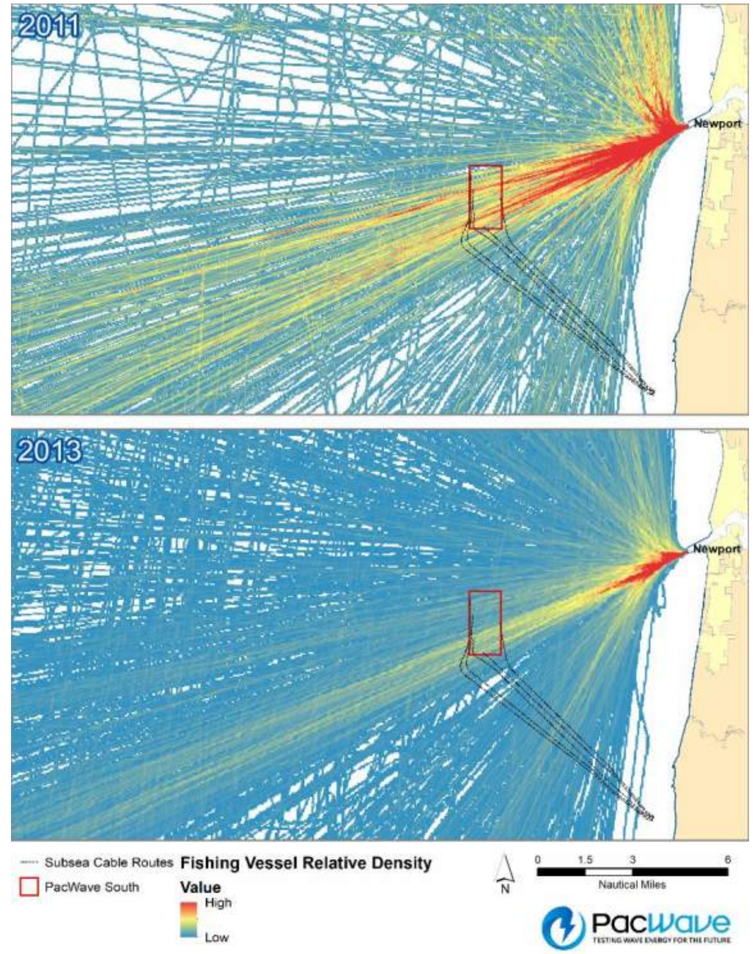


Figure 2-3. Relative density of all vessels in the PacWave South marine Project area.

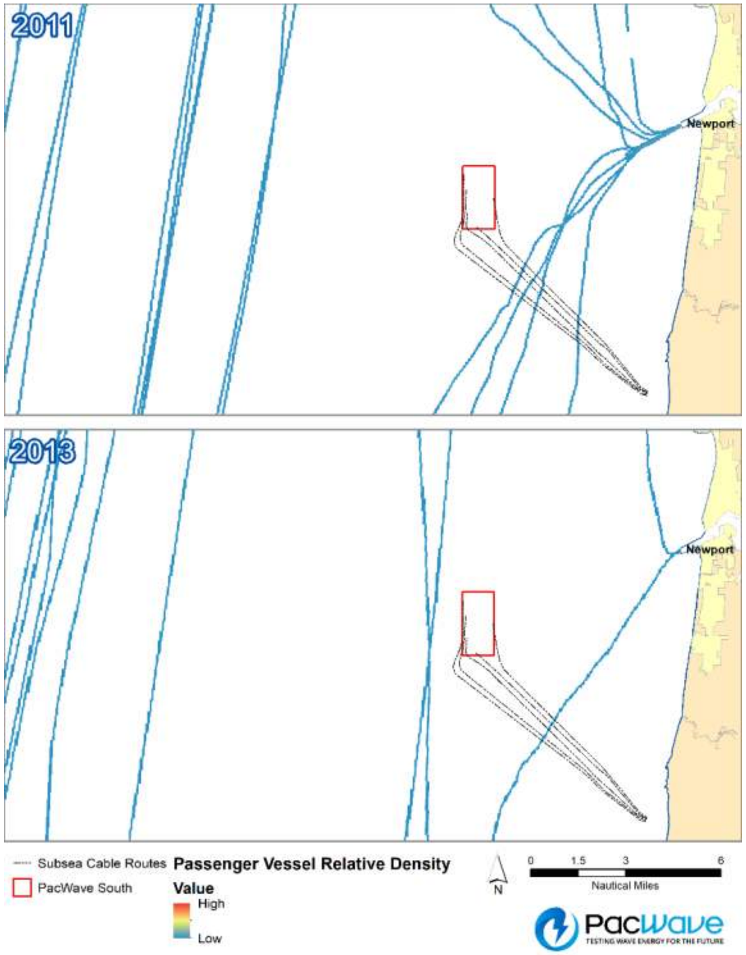
Source: www.MarineCadastre.gov.

Figure 2-4. Relative density of cargo vessels in the PacWave South marine Project.



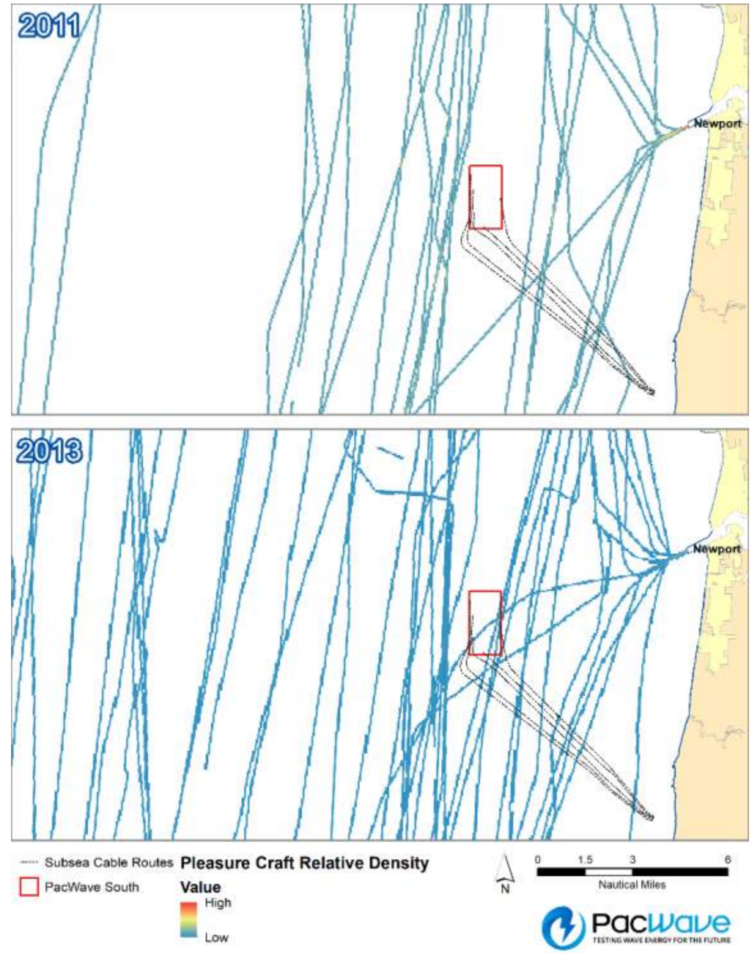
Source: www.MarineCadastre.gov.

Figure 2-5. Relative density of fishing vessels in the PacWave South marine Project area.



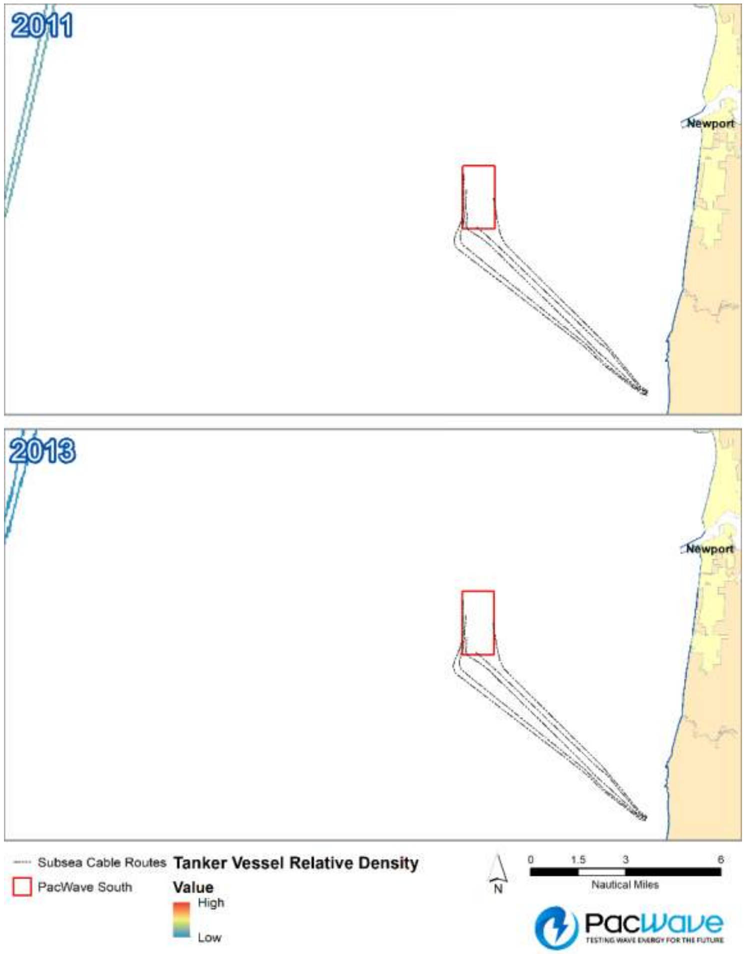
Source: www.MarineCadastre.gov.

Figure 2-6. Relative density of passenger vessels in the PacWave South marine Project area.



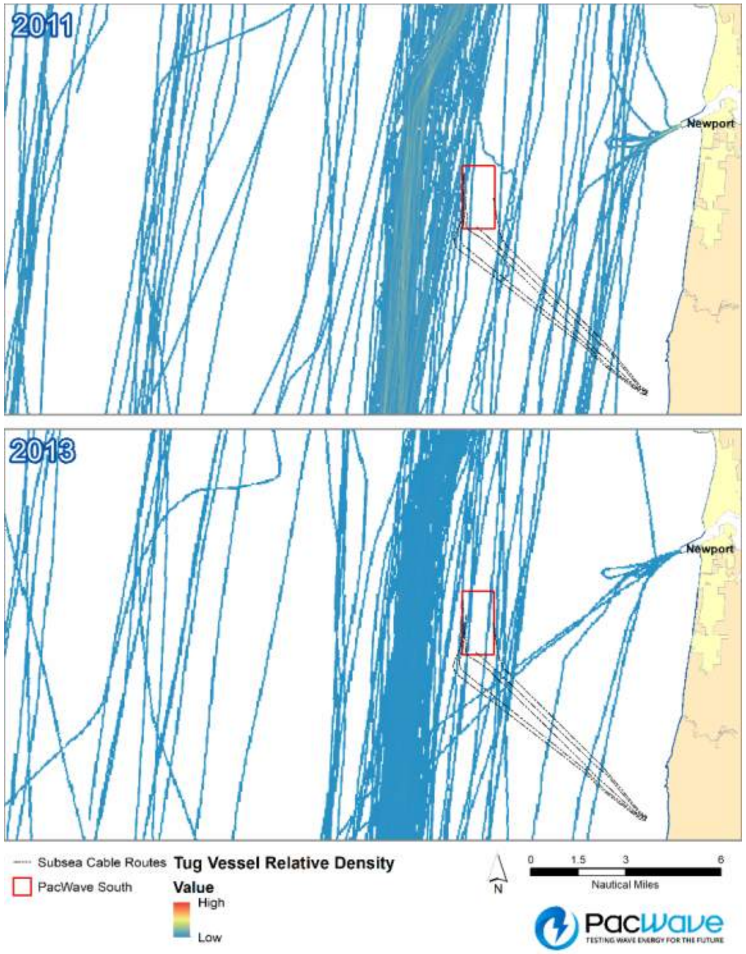
Source: www.MarineCadastre.gov.

Figure 2-7. Relative density of pleasure craft and sailing vessels in the PacWave South marine Project area.



Source: www.MarineCadastre.gov.

Figure 2-8. Relative density of tanker vessels in the PacWave South marine Project area.



Source: www.MarineCadastre.gov.

Figure 2-9. Relative density of tug and towing vessels in the PacWave South marine Project area.

3 Proposed Action

OSU would construct and operate an offshore test site composed of four test berths that could collectively support the testing of up to 20 WECs. The Project would include moorings, anchors, marker buoys, subsea power and communication cables, subsea connectors and hubs, monitoring instrumentation, and onshore facilities. The PacWave South test site would occupy approximately 2 square nautical miles in federal waters about 6 nautical miles off the coast of Newport, Oregon. Water depths at PacWave South range from 65 to 79 m and OSU expects to test various types of deep water WECs (described in more detail below); however, it would not be feasible to test shallow water or shoreline-based WECs at this site. OSU would oversee and manage all activities, and developers deploying WECs at PacWave South would be subject to test center protocols and procedures.

The Project site was selected in consultation with Fishermen Involved in Natural Energy (FINE), a committee established by Lincoln County to ensure the fishing community was represented in discussions about offshore renewable energy in the region. FINE identified a 6 square nautical mile area off the coast of Newport that the fishermen felt would be both a suitable and acceptable area within which to locate PacWave South based on their extensive knowledge of the local marine environment. It was also a site FINE felt would have minimal effects on other ocean users. Based on the area identified by FINE, OSU submitted a research lease application to BOEM. OSU subsequently conducted site-specific marine surveys and gathered information from agencies and stakeholders to characterize the physical and biological conditions of the area and used this information to select a 2 square nautical mile test site. The coordinates for the corners of the 2 square nautical mile Project site are below:

NW:	44° 35' 00.00"N	124° 14' 30.00"W
NE:	44° 35' 02.75"N	124° 13' 06.17"W
SE:	44° 33' 02.75"N	124° 12' 58.51"W
SW:	44° 33' 00.00"N	124° 14' 22.41"W

Primary Project components include WECs, marker buoys, anchors and mooring systems, support buoys and instrumentation, subsea connectors and hubs, subsea transmission and auxiliary cables, and a utility connection and monitoring facility (UCMF) to transfer power to the grid. The WECs, support buoys, anchors and mooring systems, and subsea connectors would be located in the test berths. From the subsea connectors, the subsea cables would transmit medium voltage alternating current (AC) power and data from the PacWave South test berths to shore. Around the 10-m (33 ft) isobath (i.e., depth contour), each subsea cable would enter a dedicated conduit, installed by horizontal directional drilling (HDD), running to an onshore cable landing point, or beach manhole. Each of the five beach manholes would consist of an approximately 10 x 10 x 10 ft buried concrete splice vault. Within the beach manholes, the subsea cables would be connected to terrestrial cables, which would connect to the onshore UCMF.

3.1 Marine Facility Description

3.1.1 Wave Energy Converters (WECs)

WEC technology is expected to evolve over the duration of the Project's FERC license and various types of WECs would be tested. To accommodate near-term and long-term industry needs, OSU surveyed and interviewed WEC technology developers to ascertain what types of WECs could be reasonably expected to be deployed at PacWave South, based on the location of the test site (e.g., water depth and wave resources) and present state of technology. Based on this research, the following WEC types are expected to be texted (singly or in arrays) at PacWave South (Figure 3-1):

Point absorbers: floating or submerged structures with components at or near the ocean surface that capture energy from the motion of waves, which drives a generator. Point absorbers may be fully or partly submerged.

Attenuators: structures that respond to the curvature of the waves rather than the wave height. These WECs may consist of a series of semi-submerged sections linked by hinged joints. As waves pass along the length of the WEC, the sections move relative to one another. The wave-induced motion of the sections is captured and used to drive a generator.

Oscillating water columns (OWC): structures that are partially submerged and hollow (i.e., open to the sea below the water line), enclosing a column of air above the water. Waves cause the water under the device to rise and fall, which in turn compresses and decompresses the air column above. This air is forced in and out through a turbine, which usually has the ability to rotate regardless of the direction of the airflow (i.e., a bi-directional turbine).

Hybrids: WEC types that use two or more of the above-listed technology types. For example, some WECs that are the relative size and shape of a point absorber may generate power through movements that resemble an attenuator. Another example is a class of WECs with moving masses that are internal to a hull with no external moving parts exposed to the ocean. An example of this technology is the Vertical Axis Pendulum, which consists of a structural hull that contains all moving parts; inside, a pendulum rotates and converts the kinetic energy of the ocean waves into electrical power.

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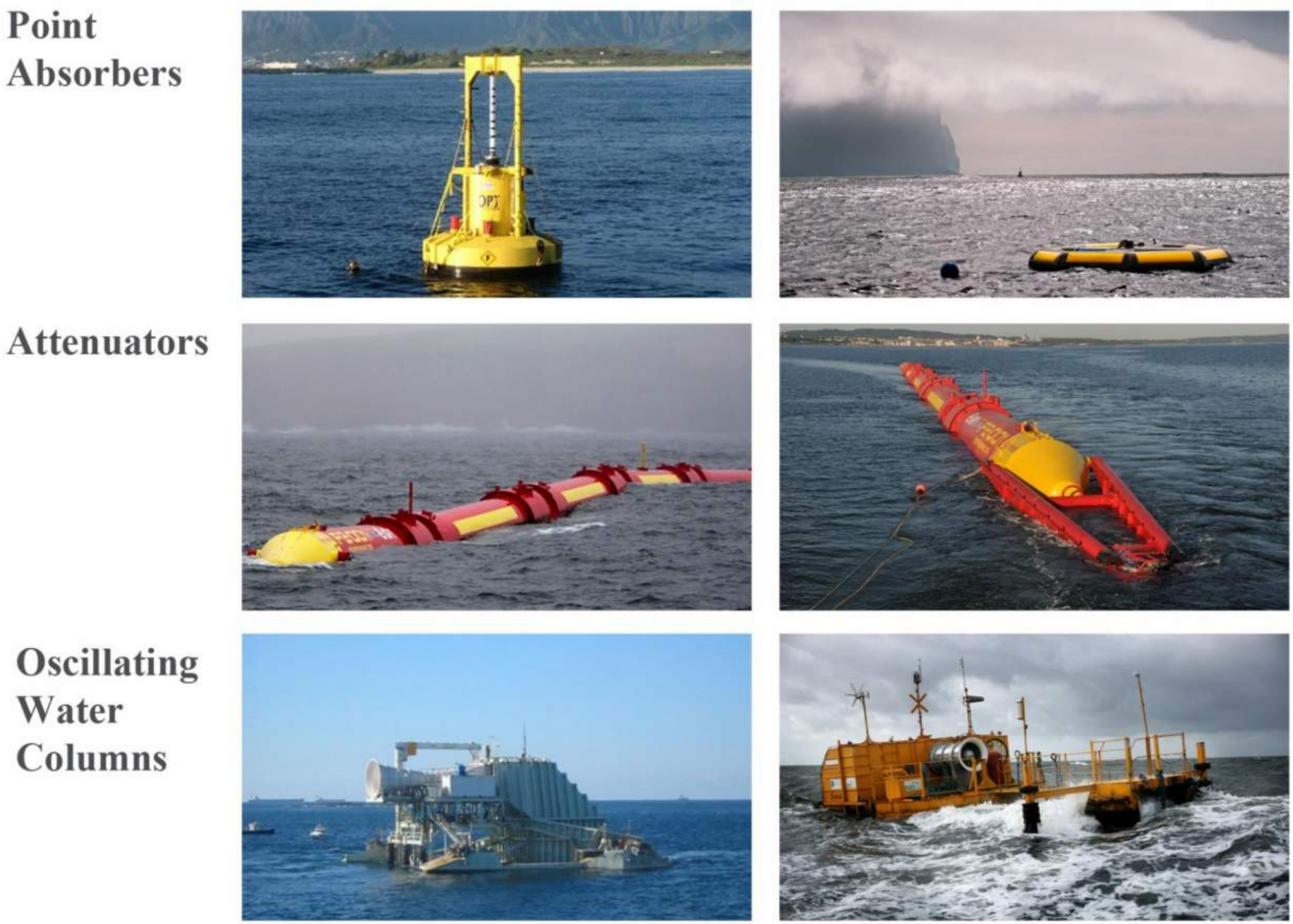


Figure 3-1. Examples of different types of WECs.

To allow for the testing of arrays of WECs, PacWave South could accommodate the deployment of up to 20 WECs (total) at one time. However, OSU expects that the number of WECs deployed at PacWave South would vary throughout the license term and that fewer WECs would likely be deployed in the initial years of operation (i.e., the first five years or so). To evaluate the true range of potential effects that the Project might have over a 25-year license term, the Final License Application and Applicant Prepared Environmental Assessment evaluates both an initial development scenario and a full build out scenario, as follows:

Initial Development Scenario (Figure 3-2) – 6 WECs consisting of:

Berth 1 = 1 point absorber;

Berth 2 = 1 OWC;

Berth 3 = 1 attenuator; and

Berth 4 = 3 point absorbers with shared anchors.

*Full Build Out Scenario (*Figure 3-4) – 20 WECs consisting of:

Berth 1 = array of 5 point absorbers;

Berth 2 = array of 5 OWCs;

Berth 3 = array of 5 point absorbers; and

Berth 4 = array of 5 attenuators.

WECs would likely be deployed 50 to 200 meters or more apart from each other within a berth[2] (Figure 3-4 and Figure 3-5). The PacWave South would have a maximum installed capacity of 20 MW. The rated capacity of individual WECs would vary; preliminary estimates range from 150 kW to 2 MW per device. Based on these estimates, the installed capacity for the initial development scenario is expected to range from 750 kW to 10 MW, and the installed capacity for the full build out scenario is expected to range from 10 to 20 MW. Because the rated capacity of WECs would vary, the average power output from PacWave South would also vary. Accordingly, the average capacity factor, availability, and value of installed capacity would change over time.

Supporting buoys and instrumentation would also be used on site, to gather data on site conditions and support testing operations. This equipment would likely be similar to those previously deployed at OSU's nearby PacWave North.

[2] The referenced distance refers to the separation of the WECs; the moorings may be located closer to each other.

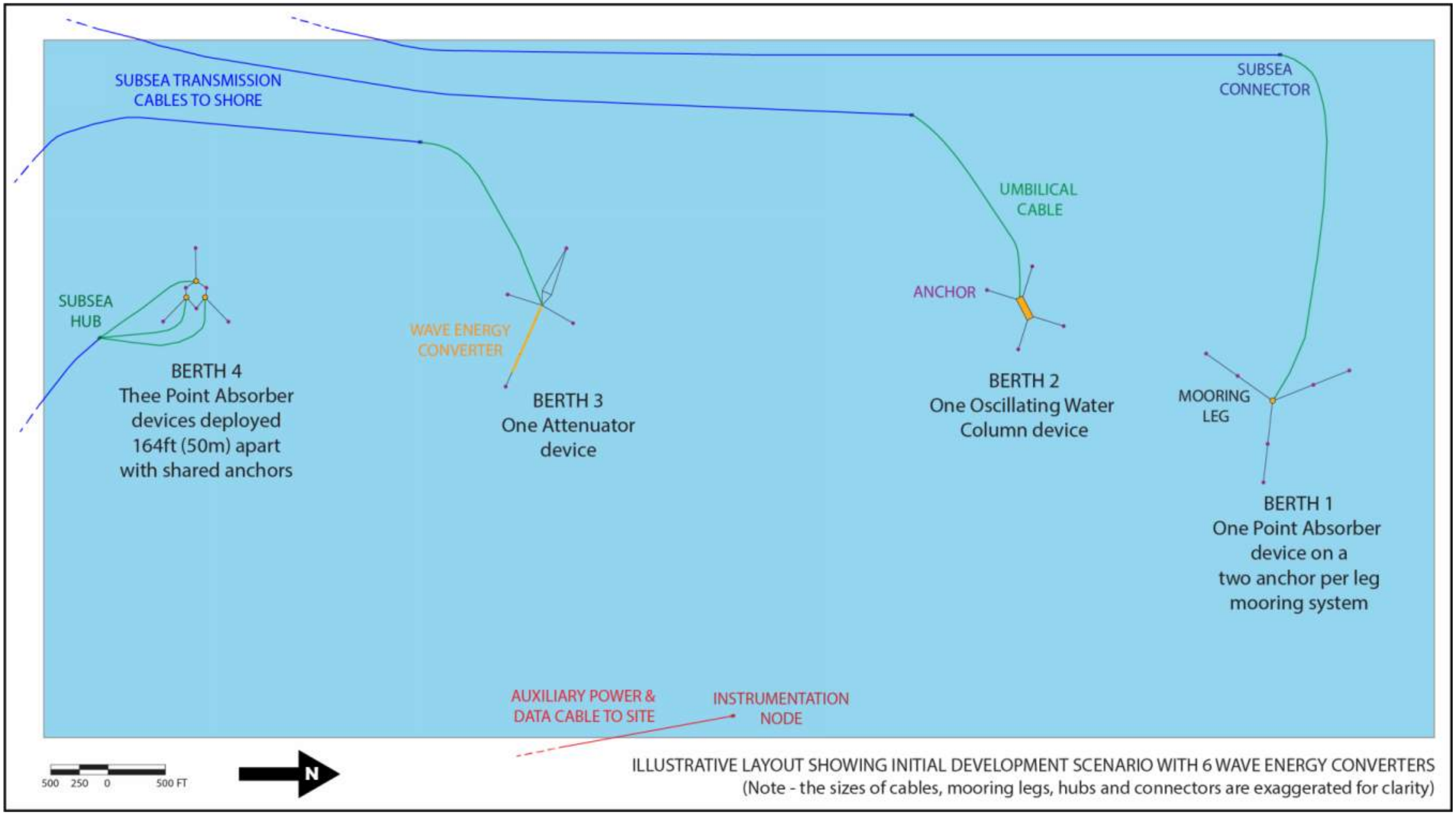


Figure 3-2. Illustrative test berth configuration for the initial development scenario. Note, actual deployment would vary.

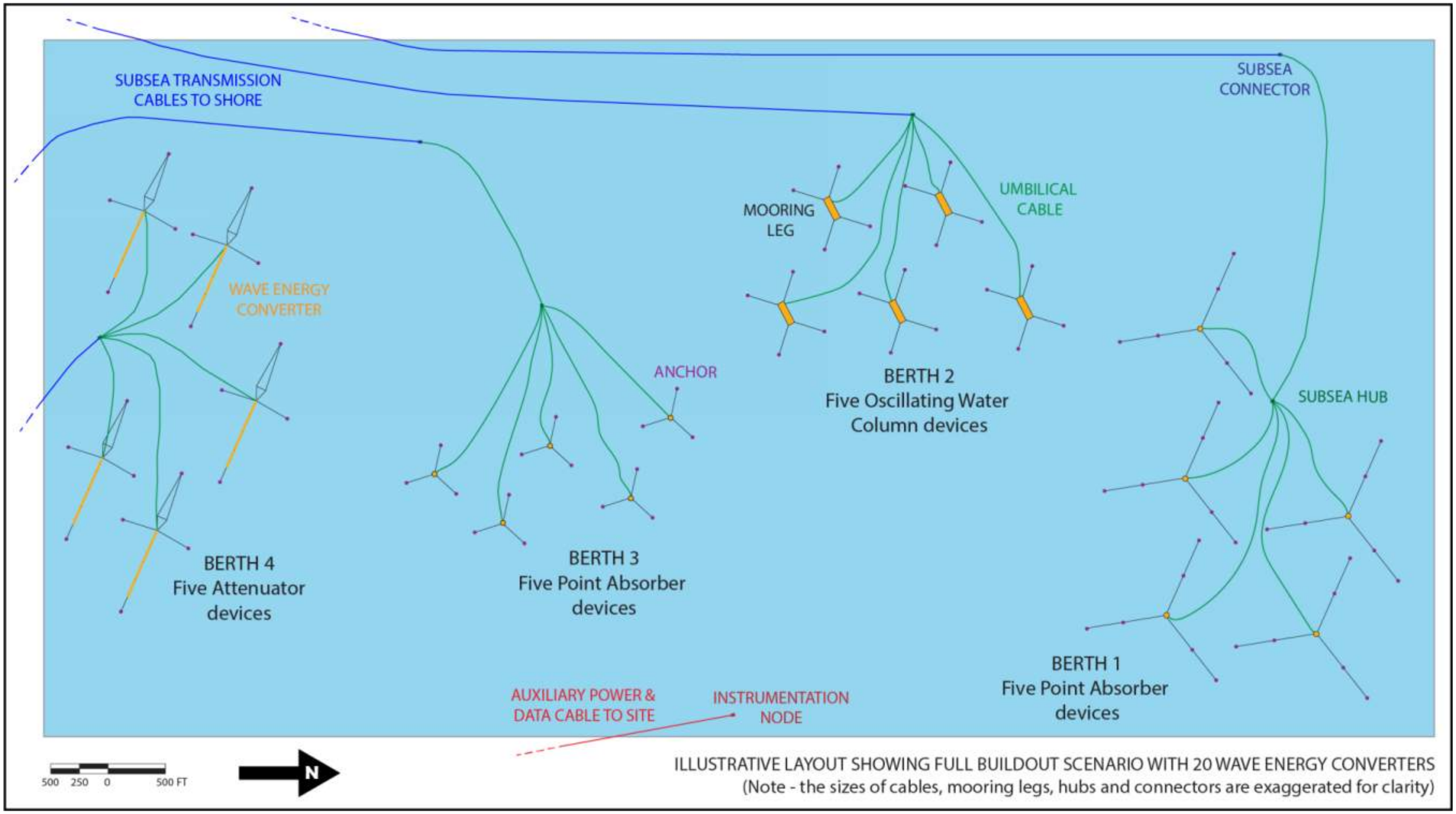


Figure 3-3. Illustrative test berth configuration for full build out of scenario. Note, actual deployment would vary.

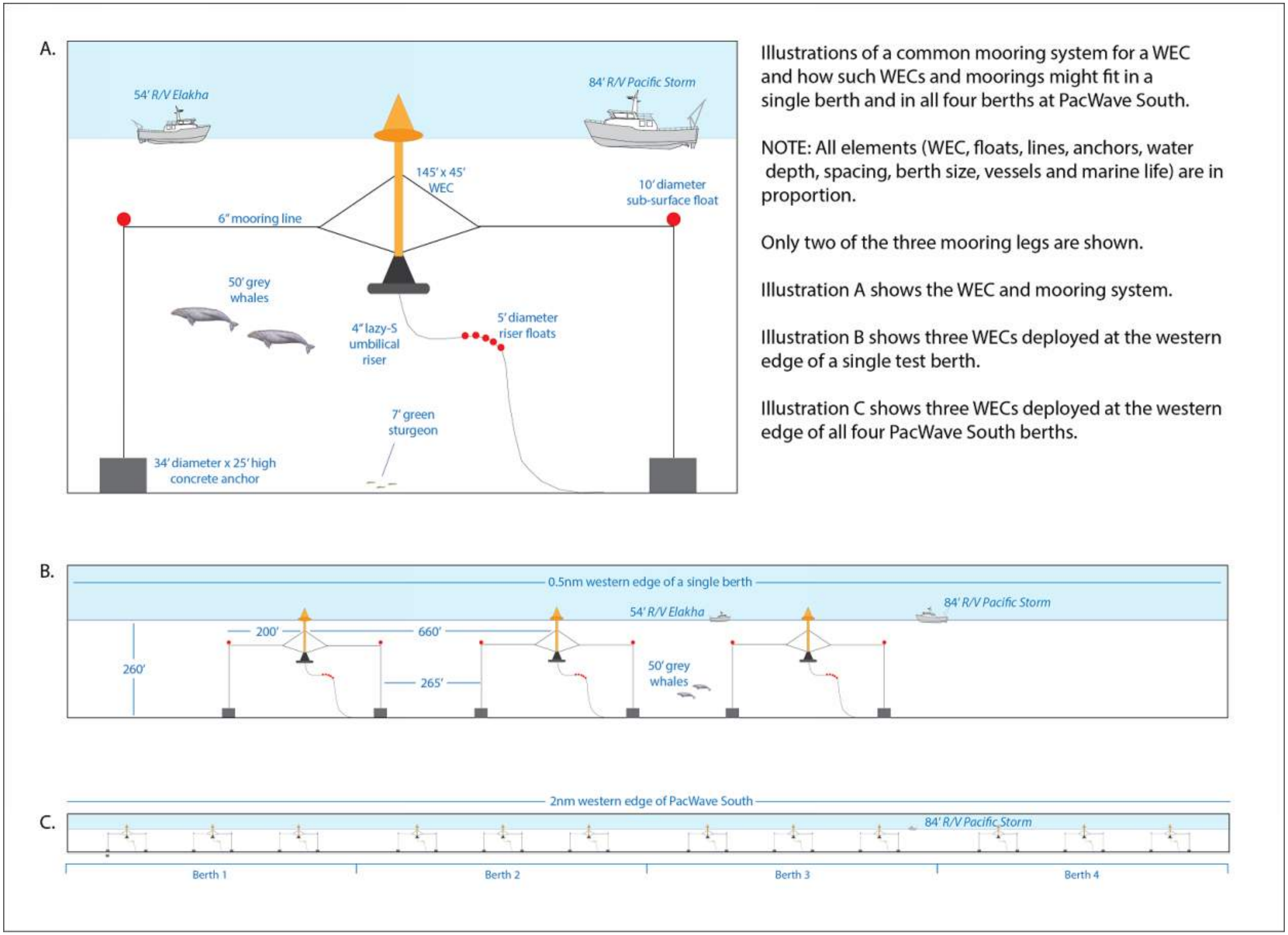
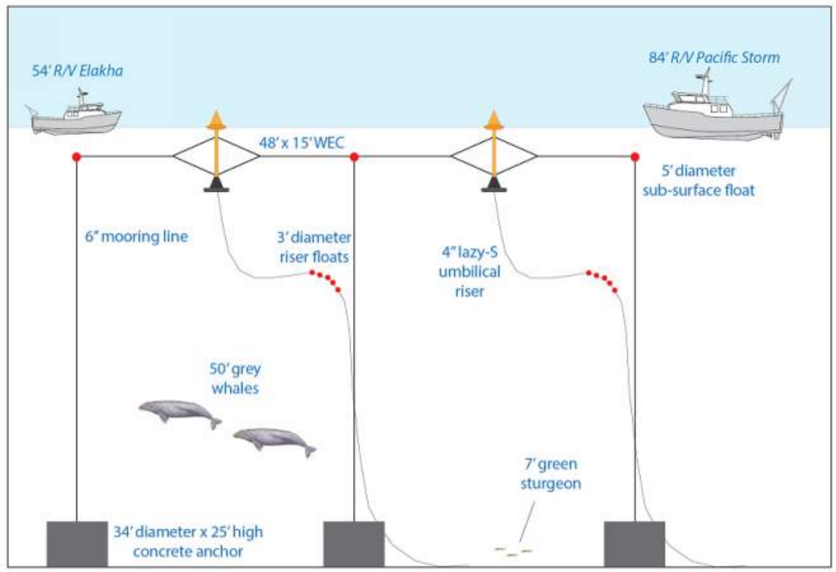


Figure 3-4. Scale drawing of WEC spacing at 200 m spacing (660 ft).

A.



Illustrations of a WEC array with 164 ft (50 m) spacing between devices and how such an array and moorings might fit in a single berth and in all four berths at PacWave South.

NOTE: All elements (WEC, floats, lines, anchors, water depth, spacing, berth size, vessels and marine life) are in proportion.

Only two of the three mooring legs are shown.

Illustration A shows a two WEC array and mooring system.

Illustration B shows a three WEC array deployed at the western edge of a single test berth.

Illustration C shows a three WEC array deployed at the western edge of all four PacWave South berths.

B.

C.

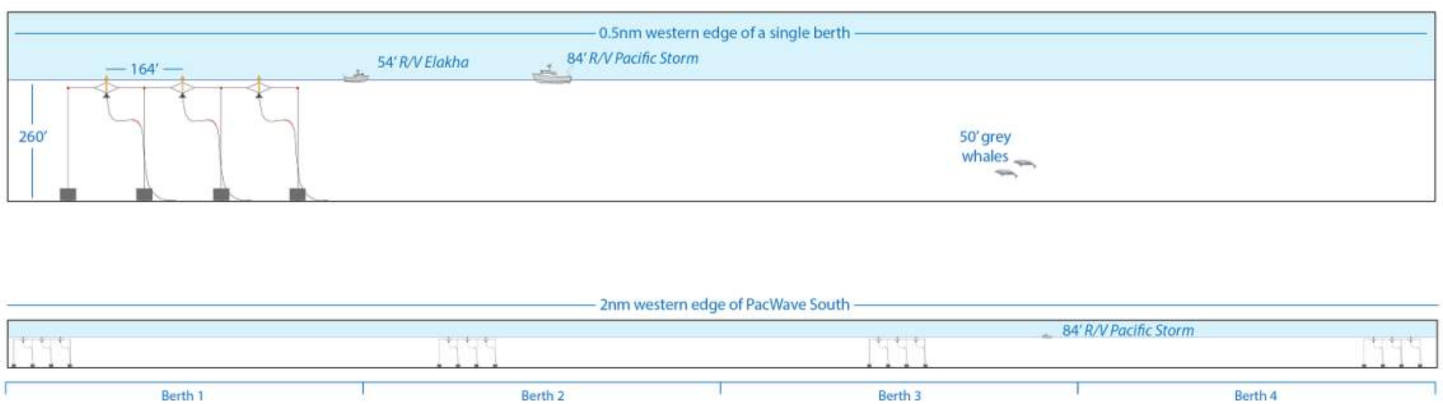


Figure 3-5. Scale drawing of WEC spacing at 50 m spacing (164 ft).

3.1.2 Anchor and Mooring Systems

The specific anchor types and mooring configurations at PacWave South would vary based on the specific WECs deployed. However, because the physical and environmental conditions within the Project site are relatively uniform, the general types of anchoring and mooring systems would not vary substantially. Furthermore, the anchors and mooring systems used at PacWave South would be the same as or similar to those commonly used for other applications in the marine environment. An OWET-funded report, titled *Advanced Anchoring and Mooring Studies,* describes common types and features of mooring systems (Sound & Sea Technology 2009).

Results of the OSU survey of WEC technology developers indicate that anchoring systems used at PacWave South would likely include gravity based anchors, drag embedment anchors, suction anchors, and plate anchors (Figure 3-6). In some cases, a combination of anchor types might be used. The survey results also show that anchors would likely consist of steel, concrete, or a combination of the two. All concrete anchors would be fully cured prior to deployment.

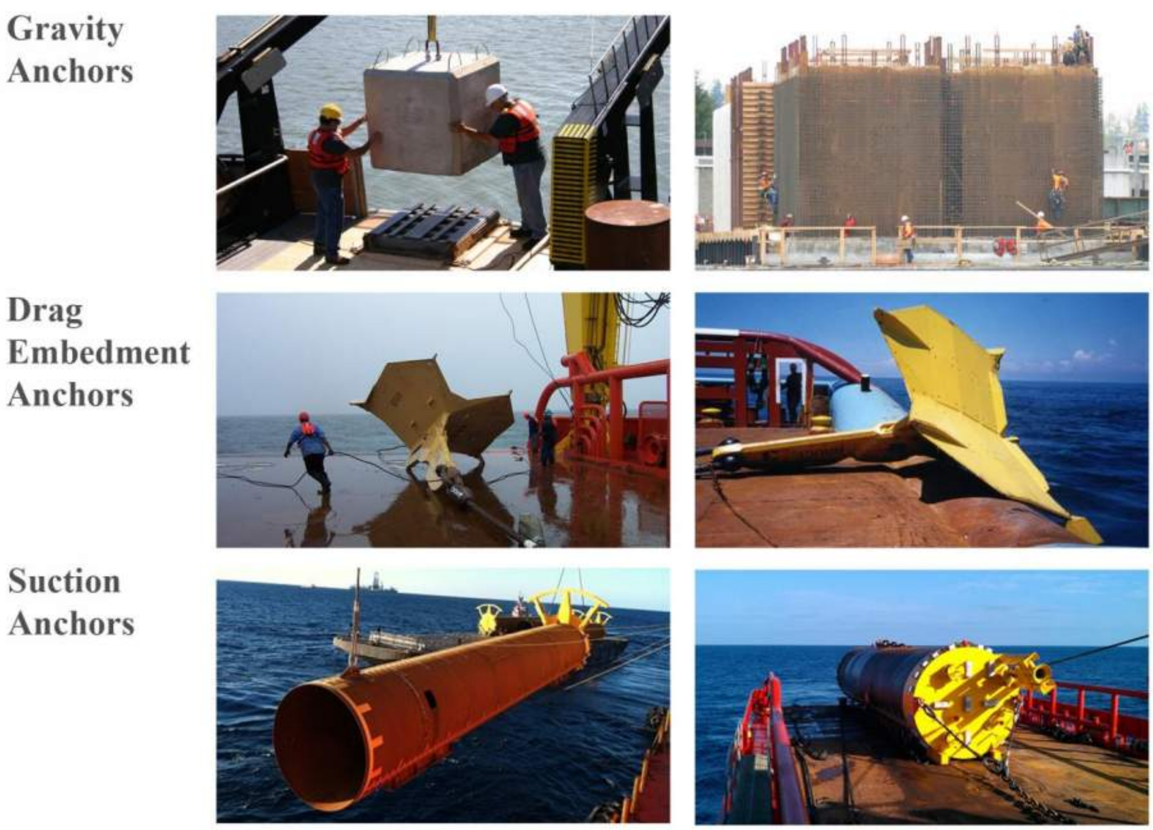


Figure 3-6. Examples of different anchor types

The maximum estimated area covered by the anchors (i.e., anchor footprint) under the initial and full build out scenarios are provided in Table 3-1. The estimates are based on exclusive use of 34-ft-diameter cylindrical gravity anchors as these represent the largest anchors that might be expected to be used at PacWave South; however, other types of smaller anchors would likely be used for many of the WECs, and shared anchors may be used for some WECs when feasible. Therefore, so the actual seafloor anchor footprint is expected to be considerably smaller than the estimates in Table 3-1.

Table 3-1. Estimated maximum anchor footprints for initial development and full build-out scenarios by berth.

Scenario	WEC Type	No. WECs	Total No. Anchors	Maximum Seafloor Anchor Footprint (ft^2)*
Initial Development				
Berth 1	Point absorber	1	6	5,448
Berth 2	OWC	1	4	3,632
Berth 3	Attenuator	1	4	3,632
Berth 4	Point absorber with shared anchors	3	7	6,356
			Maximum Total Anchor Footprint =	***19,068 ft^2 (0.4 acres)***
Full Build Out				
Berth 1	Point absorber	5	30	27,240
Berth 2	OWC	5	20	18,160
Berth 3	Point absorber	5	30	27,240
Berth 4	Attenuator	5	20	18,160
			Maximum Total Anchor Footprint =	**90,800 ft^2 (2 acres)**

* Based on the total footprint of 34-ft-diameter gravity anchors (908 ft^2 per anchor), representing the largest possible footprint per anchor; other anchor types will have a considerably smaller footprint.

The OSU survey of WEC technology developers also asked developers about mooring systems, and analysis of the results shows that most WECs would use single- or three-point mooring systems (25 percent and 28 percent of responses, respectively). Mooring systems are generally classified by their configuration (e.g., single- or multi- leg) and components (i.e., anchors, buoys, and lines). As with anchor types, mooring lines would consist of types commonly used in the marine industry (e.g., chain, steel wire, or synthetic materials). Like the rest of the marine industry, WEC technologies use various combinations of these anchor types and mooring system components. Mooring infrastructure may also include buoys and/or subsurface floats, which would be treated with an antifouling paint or coating to reduce biofouling; only TBT-free antifouling agents would be used at PacWave South and anti-fouling coatings would be fully cured prior to deployment. Although these components can be combined in various ways, there are only a few different component types (i.e., three common types of mooring line and four common types of anchor), as shown in Table 3-2.

Table 3-2. Standard mooring systems configurations and components

CONFIGURATION
A. Single Leg
B. Multi Leg
1. Three-point
2. Four-point
3. Five-point
4. Six-point
i. Catenary
ii. Taut

COMPONENTS		
Anchors (steel/concrete/both)	**Buoys**	**Lines**
A. Gravity/deadweight	A. Steel	A. Chain
B. Drag embedment	B. Composite	B. Wire rope
C. Pile or suction	1. Surface	C. Synthetic
D. Plate	2. Subsurface	

Sample mooring and anchor specifications for different types of WECs are presented in Table 3-3.

Table 3-3. Illustrative WEC mooring and anchoring configurations.

	Point Absorber	Point Absorber	Attenuator	Oscillating Water Column
Mooring Configuration	Single leg	Multi-leg Catenary	Multi-leg Catenary	Multi-leg Taut
Approx. Water Depth (ft)	250	250	250	250
Line Length per Leg (ft)	~300	~600	~400	~350
Line Material	Chain & wire rope	Chain & synthetic rope	Chain & synthetic rope	Wire & synthetic rope
No. of Legs	1	3	4	4
No. of Anchors Per Leg	1	2	1	1
Anchor Type	Suction	Drag & Gravity	Drag	Gravity
Anchor Sizes (ft)	DxH (Qty) 6x8 (1)	LxWxH (Qty) Drag: 12x13x8 (3) Gravity: 8x6x4 (3)	LxWxH (Qty) 16x18x11 (3) 22x24x15 (1)	DxH (Qty) 34x25 (4)
Anchor Material	Steel	Drag: Steel Gravity: Steel & concrete	Steel	Steel & concrete

* Note: D = Diameter; H = Height; L = Length; W = Width; H = Height; (Qty) = number of anchors.

Anchor installation and removal would be infrequent. The OSU industry survey and OWET market analysis indicate that most developers plan to deploy WECs for multi-year test periods (e.g., 3–5 years), so anchors would likely also be deployed for multi-year periods. Furthermore, it is unlikely that anchor systems would be adjusted during a WEC test due to the high costs associated with installing and removing them. Therefore, disturbance due to anchor installation and removal operations within a berth should only occur occasionally (e.g., once a year, or perhaps only once every several years). Additionally, these activities rely on specific weather windows, so the timeframes within which anchor installation and removal could occur are limited. Finally, it is OSU's intent to reuse anchors wherever practicable. If an incoming WEC developer could use an anchor and/or mooring configuration that was already in place from a previous test, then the anchors could be left in place to limit seafloor disturbance.

3.1.3 Power Transmission and Grid Interconnection

3.1.3.1 Subsea Connectors

Power generated by WECs would be transferred via umbilical cables to a subsea connector attached to the end of a subsea cable and located on the seafloor at each test berth; from there, electricity would be transmitted from the subsea connector via the subsea cable to shore. As the WECs will be on or near the surface, the umbilical cables will run from the WEC to the seafloor and will therefore, be partially suspended in the water column. The common configuration for such umbilical cables is to attach subsurface floats to create a lazy-S, which maintains tension but allows enough motion to prevent the umbilical from being damaged by WEC movements. There would be one umbilical cable per WEC. If a developer were testing an array of devices, or needed additional power conditioning or conversion support, the umbilicals would all connect to a client-supplied hub, which would then connect to the PacWave South subsea connector at that berth.

The final subsea connector choice will depend on a number of factors including the final cable specification. Subsea connectors are also an area of on-going research and development. However, one option is the GreenLink Inline Termination manufactured by MacArtney Underwater Technology (Figure 3-7). The connector has no external moving parts and can be dry, oil, gel or nitrogen filled as required.

Figure 3-7. Example of subsea connector (MacArtney's GreenLink Inline Termination).

It is a "drymate" system, which requires the connector to be winched onto a vessel for a WEC to be connected or disconnected.

Using a system like this would allow test clients to easily connect their WECs to the subsea cables, monitor device performance, and export power to the grid via the onshore UCMF. Subsea connector systems such as this typically have built-in cathodic protection and are expected to operate for up to 25 years. The subsea connectors would be installed at the same time as the subsea cables to shore.

3.1.3.2 Subsea Cables

Four subsea transmission cables are planned, one for each of the four test berths. In addition, an auxiliary cable would also connect power to the site. The subsea transmission cables would transfer power back to shore and allow for the monitoring and control of WECs via fiber optic elements incorporated into the transmission cables themselves. The cable corridor dimensions and routing are described in further detail below.

The auxiliary cable will increase the monitoring capabilities at PacWave South. An auxiliary cable would allow for extended deployments of instruments or equipment with high data bandwidths or power requirements. Cabling instruments could also greatly reduce maintenance costs associated with some instrumentation (e.g. acoustic landers require battery replacements every few months) and increase the possibility for real-time data. Field testing cutting edge technology and having real-time data for environmental and device monitoring will greatly enhance the PacWave South testing capabilities, and could potentially benefit other offshore projects and marine industries that require technological solutions.

OSU anticipates that the subsea transmission cables would be three-conductor, AC cables with a rated voltage of 35 kV, like the cable shown in Figure 3-8. At present, OSU is considering cables with either 70-mm^2 or 50-mm^2 copper conductors, which are slightly less than 4 inches in diameter and weigh between 7 and 8 pounds per foot. The exact specifications for the subsea cables would be developed during final design. All the cables would use standard industrial shielding and armoring (e.g., galvanized steel wires), as illustrated in Figure 3-8. Electric fields from energized AC cable conductors are shielded effectively by metallic sheathing and armoring.

Figure 3-8. Example of medium-voltage subsea cable.

Within the Project site, the umbilical cables and a segment (approximately 300 m) of the subsea cables would remain unburied to allow for access during WEC deployment and removal, and maintenance activities (Figure 3-9); however, the majority of the subsea cables segment would be, to the extent practicable, buried to a target depth of 1–2 m from the offshore test site to the HDD conduits. In areas where the seafloor is rock (due to unsuitable seafloor conditions), the cables would be laid on the seafloor and protected by split pipe, concrete mattresses, or other cable protection systems. The subsea cables will enter HDD-installed conduits at approximately the 10-m isobath and continue to shore passing under the beach and dune systems and into the parking lot at Driftwood Beach State Recreation Site (Figure 2-10). The industry best practice for minimum spacing between buried subsea cables is 1.5 times the water depth. The eastern edge of the Project site is in approximately 65 m of water, and the HDD conduits would be located in approximately 10 m of water. Accordingly, the minimum spacing between each cable at the edge of the Project site would be at least 100 m (i.e., 65 m x 1.5 = 97.5 m), and the minimum spacing between each cable at the HDD conduit would be approximately 15 m, resulting in a cable corridor that converges at least 400 m at the offshore test site to a minimum of 60 m at the nearshore HDD conduits. As the seafloor does not shelve evenly, the cable corridor would not widen at a constant rate between the HDD conduits and the Project Site (see Figure 3-9).

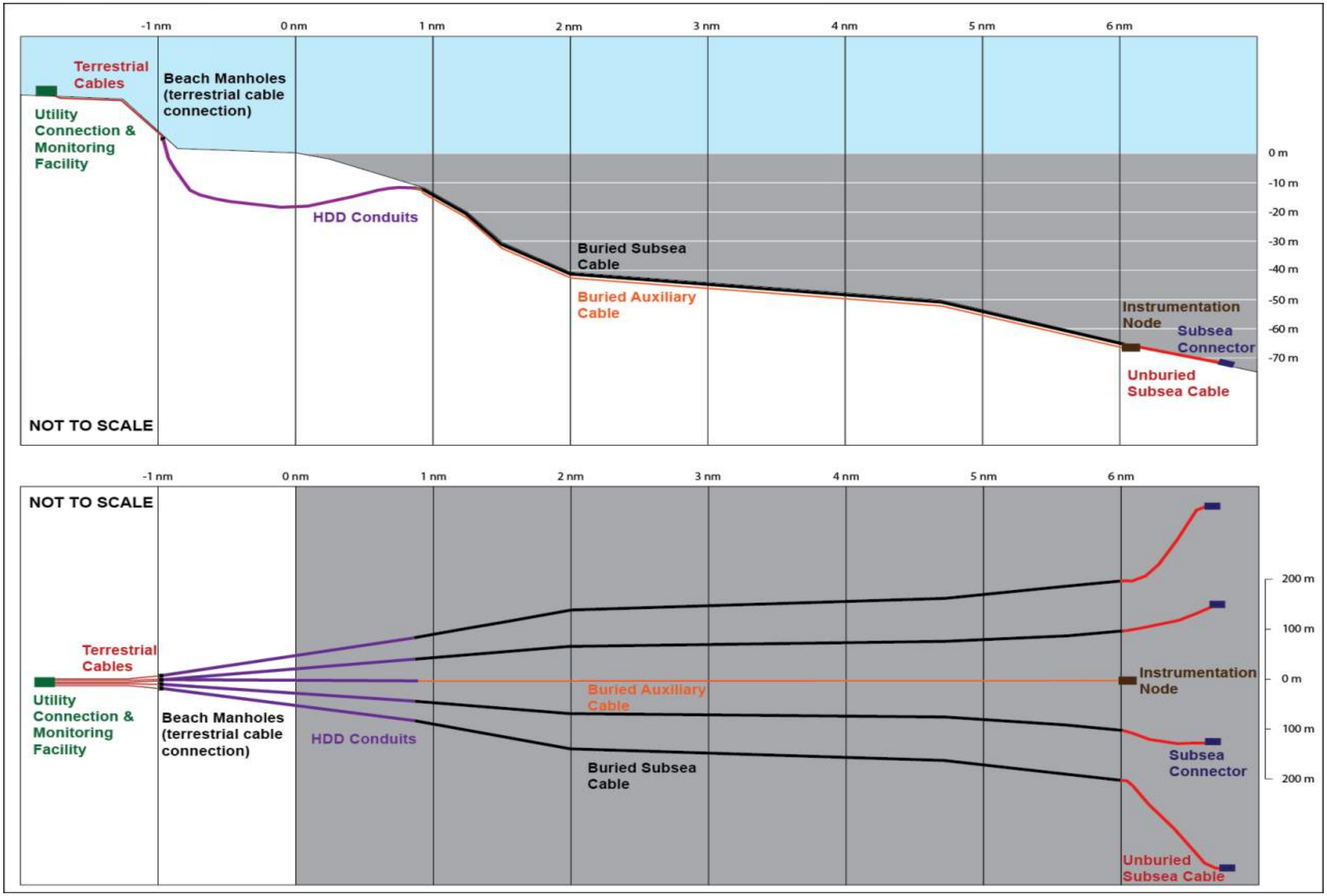


Figure 3-9. Subsea cables schematic. Note, these schematics are illustrative and are not to scale.

While a number of cable route corridor alternatives were evaluated, OSU has selected one cable corridor for the Project. The proposed corridor runs south of an area of rocky geology that extends along the coast to the north, and the cables would come ashore at Driftwood Beach State Recreation Site in Seal Rock (Figure 3-10). The subsea cables would be buried approximately 1 to 2 m below the seafloor to around the 10-m isobath, using a jet plow or a similar technique. Jet plowing is a common technique used for burying subsea cables. This technique uses a plowshare and high pressure water jets to fluidize a trench in the seafloor. Using a dynamically positioned cable ship and towed plow device, installers simultaneously lay and embed the subsea cables. Cable installation would take approximately 30 days for active installation of all 5 cables assuming no weather delays, and 10 days for post-installation inspections. During cable installation a constant tension must be maintained to ensure the integrity of the cable. Each of the subsea cables will weigh between 175 to 275 tons (equivalent to 14 to 22 regular school buses) therefore any significant stoppage or loss of position during jet plow activities has the potential to result in significant damage to the cable. As with all cable laying operations, these activities at PacWave South will need to occur 24-hours a day until installation is completed. Dynamic positioning ships that are often used for cable laying may need to come from as far away as Europe, and may install the cables without utilizing the Port of Newport.

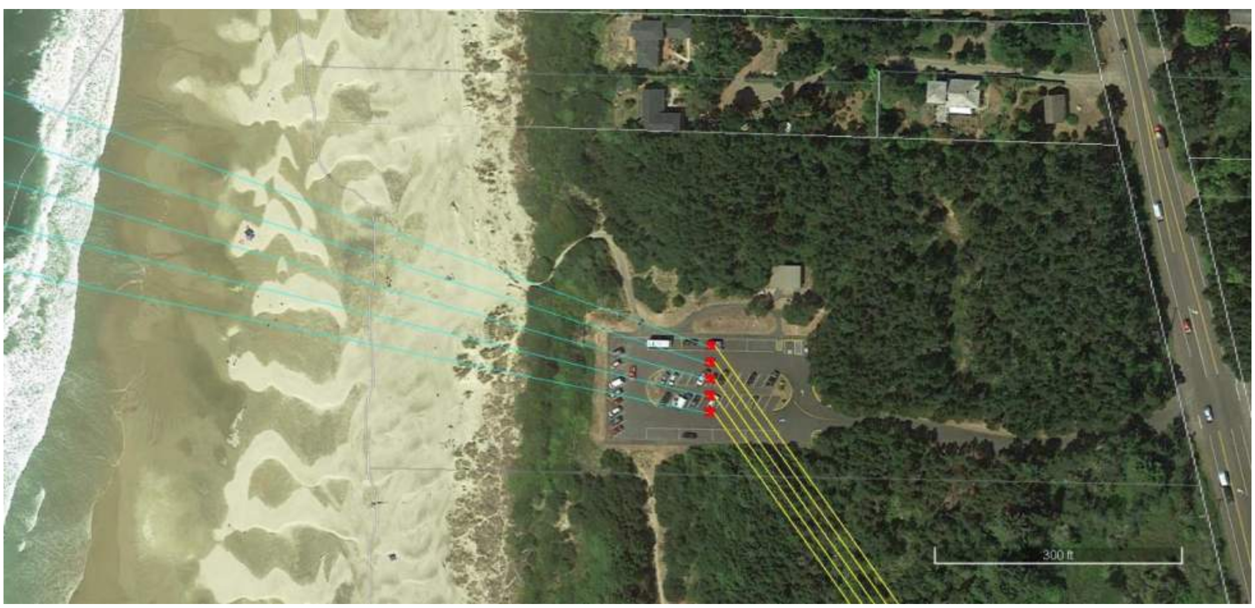


Figure 3-10. PacWave South landfall, Driftwood Beach State Recreation Site. Beach manholes are shown in red, the buried HDD conduits to the test site are shown in green, and the underground HDD conduits to the Utility Connection and Monitoring Facility are shown in yellow.

HDD would be used to install five separate conduits (for four subsea transmission cables and one auxiliary cable) from the Driftwood site, beneath the beach and dune system and, out to about the 10-m isobath, a distance of about 0.6 nautical mile (Figure 3-9). The HDD would likely be accomplished using a “drill and leave” technique where the drill pipe is left in place and becomes the cable conduit. This technique allows for installation of the conduits in a single pass and eliminates the need for successive reaming and conduit pullback. The HDD laydown area would be in the Driftwood Beach State Recreation Site and each bore would be spaced about 20 ft apart at the shoreside end. Drilling fluids, generally a mixture of bentonite clay and water, would be circulated through the drilling tools to lubricate the drill bit and conduits, and to remove drill cuttings. The HDD would be conducted per the requirements of an HDD Contingency Plan.. Each HDD bore is expected to take up to one month to complete, and multiple drill rigs may be used. The four transmission cables and auxiliary cable would each run through separate HDD conduits to individual, onshore cable splice vaults, known as beach manholes, where the subsea cables would transition to terrestrial cables. It is anticipated that there would be five beach manholes, which would be made of precast concrete. The buried concrete vaults would measure 10 ft deep, 10 ft wide and 10 ft long. Access to each beach manhole would be via a standard manhole cover, similar to those used to access underground utilities (sewer, power, and telephone). The proposed Project subsea cable route would be about 8.3 nautical miles (nm), consisting of about 3.7 nm located on the OCS, 4.0 miles in the Territorial Sea and 0.6 miles of HDD conduit in the nearshore zone.

4 Risk Assessment

4.1 Change Analysis

As described in the U.S. Coast Guard’s Risk-Based Decision-Making Guidelines, Change Analysis is a method of risk assessment that looks systematically at what changes may occur if the new facility is established. The proposed PacWave South Project will be operating in an established navigable waterway and will bring a change to that waterway. The Change Analysis is a qualitative tool to examine the possible effects of these changes, determine if mitigation measures should be implemented so that the maritime transportation system (MTS) can safely handle or absorb these changes.

In accordance with Enclosure (4) to NVIC 0207 - Guidance on Conducting and Reviewing a Navigational Safety Risk Assessment, the following items were assessed for potential differences from normal maritime activity:

1. Visual Navigation and Collision Avoidance
    - Additional structures in the waterway,
    - Potential obstruction of views of the coastline or other navigational features,
2. Communications, Radar, and Positioning Systems
    - Potential for structures to produce radio, radar, or sonar interference,
    - Additional acoustic noise or noise absorption or reflections,
    - Potential for electro-magnet fields from structures, generators, and seabed cabling.

This section summarizes the results of the Change Analysis.

4.1.1 Visual Navigation and Collision Avoidance

4.1.1.1 Additional structures in the waterway and potential for collision

The placement of WECs off the Oregon coast could have a potential adverse effect on safe navigation in and around the proposed Project site, especially during inclement weather or periods of reduced visibility. However, the proposed lighting and marking of the structures, as well as a proactive approach in adhering to the navigation rules by construction and service vessels, should serve to mitigate those risks. Offshore energy facilities are not new to the maritime industry, and have been routinely constructed in areas such as the North Sea and Baltic Sea to name a few, although they are new to the U.S. coastline. The infringement of WECs into the marine environment has not significantly impacted safe navigation, and maritime commerce still flows freely in and out of Northern Europe. The key to safe navigation in the vicinity of these installations is situational awareness, sharing of information, and due diligence by the mariner.

Installation, Maintenance, and Removal

No navigational closures are anticipated for the Project (i.e., no exclusion zones). However, the Project would increase the volume of marine traffic (e.g., construction and maintenance vessels), which in turn, could present navigation hazards to other users. A number of vessels, including tugs, installation vessels, and other workboats would be employed during installation, maintenance, and removal of the Project. This would require multiple trips from the Newport or other ports to the Project site to install the WECs, anchors, and moorings. Despite this increase in vessel activity, Project-related vessel traffic is not anticipated to affect navigation because the vessels used for the Project would be similar to other boats found along the coast, and usage would be intermittent.

Operational Phase

There is the potential that passing vessels could collide with the WECs deployed at PacWave South. Operation of the Project would result in the long-term deployment of WECs (e.g., 3 – 5 years). The WECs could pose a navigational hazard while stationary or if dislodged from a mooring. USCG Local Notice to Mariners would be requested to inform mariners traveling in the vicinity of Project structures or activities to be avoided (e.g., during deployment of Project infrastructure and WECs). Navigational markers and lighting would be used to identify navigational hazards.

The Project would be located in the southern corner of an existing tow lane off the coast of Newport; however, OSU has been working with the crabbers and tow boat operators and has secured an agreement to adjust the towlanes to avoid PacWave South. OSU selected the Project site after an extensive public outreach program as part of the technical evaluation of candidate sites. The Ports of Newport and Toledo, FINE, and the public at large were heavily involved with this process, and this site was selected to minimize potential effects to ocean users, including to navigation.

Project components would be fabricated at existing land-based facilities prior to being installed at the test site. The Port of Newport would likely serve as the primary staging areas for PacWave South. The subsea cables, WECs, mooring and anchor systems, navigational buoys, and monitoring equipment, would be staged at mobilization sites for the installation vessels to pick up and transport to the Project site. In addition, OSU would develop a Removal and Decommissioning Plan for the facility. OSU anticipates that this plan would be developed in the future as a license term nears its end and implemented when the Project is decommissioned.

In the unlikely event that a WEC has a catastrophic emergency and separated from its mooring, the WEC would be a navigational hazard. OSU will require that each WEC be equipped with automatic identification system (AIS) equipment to allow for monitoring of its location. In such an event, OSU would implement the Project Emergency Response and Recovery Plan to coordinate with agencies and retrieve the WEC.

To limit the potential for vessel collisions with Project structures, OSU proposes to properly illuminate the WECs and Project structures and OSU will require that each WEC be equipped AIS equipment. The site boundaries would be clearly marked on NOAA navigation charts. OSU would implement any navigational measures required by the USCG (e.g., special designations, restrictions, notices, etc.).

The presence of the WECs and moorings would result in some reduction of the area available commercial and recreational crabbing and fishing. Entanglement of commercial and recreational fishing gear with the Project could occur, especially with vessels engaged in salmon trolling and Dungeness crab fishermen. To minimize the effects of the Project on commercial and recreational crabbing and fishing, OSU consulted with FINE and other stakeholders as part of the outreach efforts and site selection process. During severe storm conditions, strong wind and waves may cause crab pots to move, and they could drift into the Project site and become entangled in mooring systems. Nevertheless, the overall potential impact on commercial and recreational fishing from the Project is expected to be minor because of the small Project footprint of compared to the surrounding area open for fishing. In addition, the area and equipment will be well marked on nautical charts and lit in accordance with International Regulations for Preventing Collisions at Sea (COLREG) requirements. Notifications as to site coordinates would be posted with the USCG for inclusion in the Local Notices to Mariners and marine safety broadcasts. OSU would conduct additional outreach to inform mariners traveling in the vicinity of Project structures or activities to be avoided (e.g., e-mail notifications to local safety and industry committees, stakeholder database notification by e-mail, flyers posted at marinas and docks). Furthermore, OSU would periodically search for and remove entangled gear from the Project and, if possible, return the gear to the owner.

The selection of the Project site was based on a combination of community input and preferred site criteria, including physical and environmental characteristics, subsea and terrestrial cable route options, port and industry capabilities, potential impacts to existing ocean users, permitting considerations, stakeholder participation in the proposal process, and support of the local fishing communities. Since identifying the PacWave South study area off the coast of Newport, OSU has continued to maintain ongoing communication and coordination with the local community and with the fishing industry in particular.

The system would be monitored on a regular basis for positional stability and to ensure that no variations in the placement have occurred.

4.1.1.2 Potential obstruction of views of the coastline or other navigational features

Portions of the Project that could potentially obstruct views of the coastline or other navigational features would include the parts of the WECs that would be above the water surface during clear days and navigational lighting during clear nights. OPT's PB150, an example of a point absorber WEC, would extend about 30 feet above the water and be 31 feet wide. An oscillating water column WEC would be a larger structure than a point absorber (estimated to extend up to 35 feet above the water surface). The range of visibility would vary depending on time of day and weather conditions.

For smaller vessels, WECs would be deployed approximately 50 - 200 m apart from each other within a berth as discussed in Section 3.1.1, potentially partially obscuring, but not completely blocking views of the coastline or other navigational features. Due to the distance of the WECs from the coastline (over 6 nautical miles from shore), obstructed views would be restricted to those vessels in the immediate vicinity of the WECs. The fixed location of the individual WECs also provides mariners with a suitable means of visually determining position. The multiple points of reference presented by each WEC may be used with common coastal or terrestrial navigation methods.

4.1.2 Communications, Radar, and Positioning Systems

4.1.2.1 Potential for structures to produce radio, radar, or sonar interference

There is potential that the WECs could produce radio frequency interference such as shadowing, reflections or phase changes, and emissions with respect to any frequencies used for aviation, marine positioning, navigation, or communications, including automatic identification systems.

The primary means of communication for vessels operating in the project vicinity is Very High Frequency (VHF) radio. Although not all vessels are required to carry a VHF radio, such as recreational vessels less than 65.6 ft (20 m), it is common for most vessels to be equipped with a radio installation. VHF radio provides users with a clear, line-of-sight communications capability with a range of approximately 25 miles (40 km). The effective range of VHF can vary greatly depending on propagation factors, height-of-eye of the antenna, and transmitter power). Vessels operating in the project vicinity are not expected to encounter any interference with marine radio communications equipment during installation, operation, or removal.

While offshore wind turbines are known to potentially impact aviation activity due to interference with radars that manage aircraft operations (TetraTech 2012), limited research has been completed on the potential operational effects of wave energy facilities on radio, radar, or sonar. Wind turbines are very high vertical structures that can potentially interfere with certain electromagnetic transmissions and rotating blades may generate more interference on the radars than much shorter WECs that would not have rotating blades. The devices and the associated test site infrastructure are not expected to present any hazard to communication, radar and positioning systems during operations (Monroe and Bushy 1998).

4.1.2.2 Additional acoustic noise or noise absorption or reflections

In-air and underwater noise will be generated during the installation and operation of the PacWave South and installation of the WECs. For purposes of this analysis, the greatest concern would be in-air noise generated that may increase physical risks to vessel crews or that may interfere with aids to navigation sound signals and sound signals from vessels operating in the vicinity of the WECs during installation. Potential risk and interference associated with underwater noise was also considered.

Installation, Maintenance, and Removal

The most significant source of noise (both in-air and underwater) during installation, maintenance, and removal of the project will result from the increase in vessel traffic traveling to and from the project site. Vessels used during initial project installation and WEC installation, maintenance, environmental monitoring, and decommissioning (e.g., anchor handling and towing tugs, material transport barges, research vessels, and crew vessels) would regularly transit between Newport and PacWave South. Installation of the anchoring and mooring system for this project will not involve percussive pile driving or drilling, the most significant noise source during most marine construction (Halcrow Group 2006). Neither installation nor operation of the PacWave South project will involve any activities creating a comparable noise level to pile driving activity. A vessel with dynamic positioning thrusters may be used for the jet plow installation of the transmission cables to shore. In its Environmental Assessment for the Virginia Offshore Wind Technology Advancement Project on the Atlantic Outer Continental Shelf Offshore Virginia, BOEM (2014) estimated that the sound source-level for the dynamic positioning cable laying vessel would be 177 dB re 1 μPa at 1 m.

FERC (2007), in the Makah Bay Environmental Assessment, concluded that they expected above-water sounds related to installation and increased vessel traffic to be largely damped by ambient ocean noise on all but the calmest of days.

Vessels transmit underwater sound through water predominantly through propeller cavitation, although other ancillary sounds may be produced, and the intensity of sound from service vessels is roughly related to ship size and speed (Hildebrand 2009). Large ships tend to be noisier and have lower frequencies than small ones, and ships underway with a full load (or towing or pushing a load) produce more sound than unladen vessels (Hildebrand 2009). For vessels used at PacWave North, NMFS (2012) assumed that “sound intensity generated by tugs, barges, and diesel-powered vessels (i.e., the types that would be used for Project installation and maintenance) when fully underway (traveling to and from the test site) or due to cavitation during starts and stops, would be no greater than 130 to 160 dB (re: 1 μPa) over a frequency range of 20 Hz to 10 kHz” (also see Richardson et al. 1995, DOE 2012). This assumption would also be applicable to PacWave South. These levels would occur when vessels are fully underway, coming to or leaving the site, which for most trips between the test site and Newport would last 1 to 1.5 hours. The sound intensity would be lower when the vessels are operating at very slow or idle speed, which is likely to occur at the Project’s WEC deployment area when conducting monitoring or maintenance activities.

Yaquina Bay is a large commercial harbor with large numbers of recreational, charter, and commercial boats, and vessel traffic is often concentrated near the mouth of the bay, so it is assumed that Project-related vessel sounds would not be significantly greater or different than existing conditions.

Operation Phase

During operation, in-air and underwater sound may be generated by waves splashing against the WECs and other structures or by the moving components of the WECs and moorings. Due to the variety and complexity of differing sound sources within an array, it is difficult to model or predict the sound signature (Wilson et al. 2014).

The WECs would be expected to emit mechanical noise during operation. Operational noise would originate in the above-water portion of the devices and would be projected into the water, potentially producing both above-water and below-water noise impacts. According to the Minerals Management Service (MMS), "[o]nce installed, wave energy technologies would produce low-intensity, broadband noise of a repetitive continuous nature, similar in character to noise from ship operations. Such noise would be expected to have minimal impacts to human and marine populations" (MMS 2007). Previous research by EPRI reports that "…noise from wave power plant machinery will generally increase in proportion to the ambient background noise associated with surface wave conditions, thus tending to minimize its noticeable effect" (EPRI 2004).

Based on underwater sound monitoring, the operational sounds of the test WET-NZ device at PacWave North was within the range of ambient conditions and did not exceed NMFS' 120 dB marine mammal harassment threshold. The maximum sound pressure level (SPL) attributed to Columbia Power Technologies' 1/7-scale WEC was measured from 116 to 126 dB re: 1 μPa in the integrated bands from 60 Hz to 20 kHz at distances from 10 to 1,500 m from the SeaRay (Bassett et al. 2011). From this, the SPL was estimated at 145 dB re: 1 μPa at 1 m, and126 dB re: 1 μPa at 10 m (Thomson et al. 2012, as cited in NAVFAC 2014). In the EA prepared for the Hawaii Wave Energy Test Site, engineers conservatively assumed that a full-sized WEC would be 3–6 dB louder than the 1/7 scale version, and estimated that the maximum SPL for a WEC would be 148–151 dB re: 1 μPa at 1 m (NAVFAC 2014). The maximum SPL generated by WECs off the west coast of Sweden was reported at 133 dB re 1 μPa at 20 m with an average of 129 dB re 1μPa (Haikonen et al. 2013). Other analysis suggests that WECs would result in sound only in the range of 75 to 80 dB, with somewhat higher frequencies than light- to normal-density shipping sound (Sound & Sea 2002 cited in Department of the Navy 2003). Ambient sound levels are expected to approach 120 dB RMS re: 1μPa; baseline underwater sound monitoring at PacWave South recorded SPLs of between 83 and 116 dB RMS re: 1 μPa (Haxel 2016).

Due to the low levels of sound emitted as a result of the Project, no adverse effects on navigation systems from acoustic interference arising from the infrastructure or devices likely to be employed at the PacWave South are anticipated to occur. Because of the uncertainty of the WEC type and size that will be deployed at PacWave South, as well as the exact sound signatures, OSU would implement the Acoustic Monitoring Study under the Adaptive Management Framework to detect and, if needed, mitigate unanticipated adverse effects of WEC-related sound.

4.1.2.3 Potential for electromagnetic fields from structures, generators, and seafloor cabling

EMF transmissions would be generated by the WECs, the umbilical cables (connecting the WECs to the subsea connectors), the hubs and subsea connectors, and the subsea cables to the shore. Each test berth could accommodate a WEC or array of WECs with a maximum capacity, based on cable specifications, of 8 MW (although not all 4 berths could be at capacity at any one time); the capacity of the umbilical cables would correspond with the WECs. All the power cables would be shielded and armored, and would not emit any electric fields directly; however, weak electric fields could be induced by the movement of fish and currents through the magnetic fields produced by the cable.

Observations at energized transmission cables indicate rapid dissipation of EMF with distance from the cables. In studies of the Las Flores Canyon submarine power cables (6-7 inch diameter, 36 kV, unburied) that cross the Santa Barbara Channel to oil platforms, EMF (as recorded in µT– a measure of the magnetic field) is reported to dissipate to background levels at a distance of about 1 m from the cable (Love et al. 2015, 2016). Studies of a 33 kV three-conductor buried power cable crossing the River Clyde in Scotland indicate measurable (nT – 1,000 times smaller than the µT measured by BOEM for the Las Flores Canyon cables) magnetic fields up to 10 m away from the cable (CMACS 2003). Field magnetic profiles of 10 subsea cables, many of which transmit considerably higher voltage than the 36 kV cables at PacWave South, indicate very rapid decay of magnetic field strength moving away from the cable (Normandeau Associates et al. 2011).

From the offshore test site, the majority of the cables would be buried 1-2 m (3-6 feet) below the seafloor, except within the footprint of the test site. Burial of the cable at a depth of 1 m will reduce the magnetic field at the seafloor by around 80 percent (Normandeau et al. 2011). Therefore, it is likely that EMF generated by the Project cables will be similar or less than other cables that have been measured, and that EMF generated by power cables above ambient levels would not extend much beyond 1-2 meters.

4.2 Risk Mitigation Strategies

As noted previously in this report, some aspects of the installation and operation of the PacWave South in the waters off the coast of Oregon has the potential to increase the risk to navigation safety in the area. However, mitigation measures applied to those aspects have been shown to effectively minimize or control the risk to an acceptable level. A change analysis of each phase was conducted examining the state of normal activities in the absence of the project and the change that may be effectuated by the existence of the project. Where increased risk was identified, possible risk control strategies were developed, and the risk reevaluated.

OSU will implement the following risk mitigation strategies during the installation, operation, and removal of the project:

- Mark Project structures with appropriate navigation aids, as required by the USCG.

- Conduct outreach to inform mariners of Project structures or activities to be avoided in the area (e.g., USCG Local Notice to Mariners, flyers posted at marinas and docks).
- Monitor position of equipment and effectiveness and operation of navigational markers.
- Develop and implement an Emergency Response and Recovery Plan.
- Install subsurface floats at sufficient depth to avoid potential vessel strike.
- Periodically search for and remove entangled gear from the Project and, when possible, return the gear to the owner to minimize effects on commercial fishing.
- Work cooperatively with commercial, charter and recreational fishing entities and interests to avoid and minimize potential space-use conflicts with commercial and recreational interests during construction and operation.
- Bury submarine cables 1 to 2 m deep where feasible to minimize interactions with fishing gear and anchors.

5 Conclusion

This assessment has been conducted using a qualitative “Change Analysis” to evaluate the changes in normal operations and conditions that may introduce significant risks as a result of the installation, operation, and removal of the WECs.

After considering environmental factors, vessel fleet characteristics, routes, and waterway characteristics in the vicinity if the project, it has been determined that the introduction of the WECs in the project area will not significantly affect navigation safety. While this assessment acknowledges there is the potential for some increased risk during inclement weather or periods of reduced visibility, sufficient mitigating factors exist to substantially reduce the risk. Specifically:

- The proposed lighting and marking of the structures, outreach to mariners, and other risk mitigations factors listed above, as well as a proactive approach in adhering to the navigation rules by construction and service vessels, should serve to mitigate the additional risk to navigational safety caused by additional structures and vessels in the waterway.
- The WECs may cause some limited obstruction of views of the coastline or other navigational features, but this will be restricted to the immediate project vicinity and the WECs will create multiple points of reference for visual navigation.
- The WECs are not expected to cause any interference with communications, radar, or sonar.
- In-air and underwater noise levels during installation and operation of the WECs will not cause increased health and safety risk nor adversely affect passing vessels, aids to navigation, or sonar in the project area.

- No adverse effects on navigational systems from EMF are anticipated to occur due to the near ambient levels and the rapid dissipation of EMF generated by the project.

Table 5-1 summarizes the results of the change analysis conducted for the project.

Table 5-1. Risk Assessment Conclusions

Potential Concern	Change	Increased Risk	Mitigation Available	Conclusion
Visual Navigation and Collision Avoidance				
Additional structures in the waterway and potential for collision	Yes	Yes	Yes	Acceptable level of risk
Potential obstruction of views of the coastline or other navigational features	Yes	No	N/A	Acceptable level of risk
Communications, Radar, and Positioning Systems				
Potential for structures to produce radio, radar, or sonar interference	No	No	N/A	Acceptable level of risk
Additional acoustic noise or noise absorption or reflections	Yes	Possible	Yes	Acceptable level of risk
Potential for electro-magnetic fields from structures, generators, and seabed cabling	Yes	No	N/A	Acceptable Level of Risk

As the process moves forward, OSU will continue to look for potential differences to normal activities and implement the Risk Based Decision Making (RBDM) Guidelines to devise strategies to minimize any potential negative effects to the safety of navigation posed by operations related to the construction of the PacWave South.

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APPENDIX F

Operations and Management Plan

OPERATIONS AND MAINTENANCE PLAN

CONTACT: DAN HELLIN, OPERATIONS & LOGISTIC MANAGER, PACWAVE
P: 541-737-5452 DAN.HELLIN@OREGONSTATE.EDU

This Plan describes the operations and management (O&M) activities, which are anticipated at PacWave South (formerly known as Pacific Marine Energy Center South Energy Test Site [PMEC-SETS]). The Plan addresses the O&M associated with the PacWave South offshore and terrestrial project infrastructure. Clients who are testing at PacWave South will be required to develop their own O&M Plans, which will need to be approved by OSU.

The PacWave South O&M plan includes the following topics:

1. Continuous onshore monitoring;
2. Preventative maintenance and site inspections;
3. Routine maintenance;
4. Unplanned maintenance;
5. Supporting documentation;
6. Management and storage of spare parts and equipment; and
7. Special environmental considerations during operations and maintenance.

These topics are discussed below.

NOTE: the frequency of these activities will likely be higher at the start of operations and be adjusted based on field observations and experience.

1. CONTINUOUS ONSHORE SYSTEM MONITORING

Onshore monitoring of PacWave South project facilities is anticipated to be conducted on a continuous basis via the Supervisory Control and Data Acquisition (SCADA) system that will be part of the Utility Connection and Monitoring Facility (UCMF). A System Operator will be responsible for monitoring the sensor and alarm systems and identifying when a potential unexpected event or system failure has occurred. This System Operator's role may be filled by various individuals including the PacWave South Ocean Test Facility Manager or Facility Engineer, with overall effort likely commensurate with the number of WECs under test. (NOTE: as the staffing structure for PacWave South is under development, job titles used in this Plan may change).

The System Operator will be the first point of contact for notification by operations and maintenance personnel, regulatory agencies, and the general public of a potential incident.

The operator(s) will be knowledgeable and have the necessary training to perform all routine operational and emergency procedures.

Coverage will be available on a 24/7 basis. Operators will be alerted to any problem requiring operator intervention by suitable means. Emergency call-out arrangements and assistance will be in place to respond to major incidents.

Routine work will be carried out during normal facility working hours, weather permitting and with consideration for safety and protection of personnel, the general public, and the environment.

2. Preventative Maintenance/Site Inspections

Offshore site inspections are planned to occur quarterly, weather permitting, and are anticipated to include inspection of all components of PacWave South visible from the sea surface to check connections, corrosion, wear and tear, etc.

Inspections will be made of all corner marker buoys and other Aids to Navigation; and environmental monitoring instruments. OSU personnel will also visually inspect clients' WECs, moorings and floats and notify clients if a potential issue is identified. Clients will also be required to inform PacWave South personnel if they identify any operational or maintenance issues with any component of the PacWave South Project.

As part of the environmental monitoring plans, ROV inspections will be conducted in and around offshore project components. Even if no WECs are being tested, all project components will be inspected at least every 3 years. Inspections will likely occur more frequently at the start of operations to determine rates of corrosion, and wear and tear.

As described in PM&E measures (Appendix I), ROV inspections will be conducted along the routes of the buried subsea cables from PacWave South, back to the HDD breakout point off Driftwood Beach State Recreation Site. Two cables routes will be surveyed each year, meaning each cable route will be inspected every 2.5 years. This is expected to reveal if any portions of the cables have become unburied.

Project personnel will be required to alert the System Operator if they learn of any issue from other ocean users (e.g. entangled gear, malfunctioning navigation lights).

Where practicable, offshore instruments and buoys will be fitted with tracking systems to alert PacWave South personnel if components move off station.

At least once a month the Operator or qualified designee will visit the UCMF location for a routine inspection. The UCMF will be fenced, alarmed and will be monitored by CCTV.

It will be possible to run a full diagnosis of the PacWave South remotely via the SCADA system. This diagnostic is anticipated to be run a minimum of once per week.

Inspection reports will be generated.

3. Routine Maintenance

Corner marker buoys will be serviced on a regular schedule. It is anticipated that each buoy will be serviced every two to three years. The frequency of service will depend on the hardware installed and rates of corrosion, wear and tear, and weather conditions. A full service will generally require a buoy be brought to shore. Once on shore, the buoy will be de-fouled, scraped, the surfaces will be prepared and it will then be repainted. Worn parts will be replaced, lights will be checked, and all mooring hardware will be replaced. OSU will ensure that any paints are fully cured before the buoy is redeployed.

Subsea connectors will be inspected when WECs are being connected or disconnected and will be serviced on a schedule determined by the manufacturer. For example, MacArtney recommends that their Greenlink inline connector be serviced every 5 years even if no WECs have been connected to it. The connector will need to be winched onto the deck of a suitable vessel and serviced at sea. Once the service is completed, it will be lowered back to the seafloor.

Environmental monitoring equipment will be serviced when instruments are retrieved to download data and/or replace batteries, or on a schedule determined by the manufacturer. Instrument mooring systems will be serviced and replaced on a regular basis. Instruments may require periodic cleaning during deployments to removed excessive bio-fouling. This would likely be done at sea.

The following project components do not require routine maintenance:

- Subsea cables running to shore;
- Auxiliary cable running to the offshore test site;
- HDD conduits;
- Beach manholes/splice vaults at Driftwood;
- Terrestrial cables running to the UCMF; and
- Pull boxes on the UCMF property.

Planned offshore maintenance would typically be carried out over the summer months. A maintenance schedule will be established for the UCMF and other infrastructure at that facility. The equipment at the UCMF will be serviced on a schedule determined by the manufacturer or recommended by Central Lincoln People's Utility District.

4. Unplanned Maintenance

Any unscheduled maintenance will be completed as necessary, with consideration for weather conditions, safety of personnel and protection of the environment.

5. Supporting Documentation

Reports will be produced following each quarterly inspection, equipment inspection, and maintenance procedure in accordance with the PacWave South operating procedures.

6. MANAGEMENT AND STORAGE OF SPARE PARTS

Spare parts will be provided as required for maintenance and will be available at PacWave South, at OSU, or from suppliers of instruments and other equipment. Once operational, the need for spare parts will become clearer and the inventory of spares can be adjusted as necessary.

7. SPECIAL ENVIRONMENTAL CONSIDERATIONS DURING OPERATIONS AND MAINTENANCE

As part of its FERC license application, OSU has proposed PM&E measures, including taking field measurements, monitoring for various types of potential impacts, and identifying and mitigating risks to protected resources. During O&M activities, OSU will carry out any obligations it may have under those PM&Es and pursuant to the Project license (e.g., to report marine mammal sightings and to make opportunistic visual inspections for derelict gear). Similarly, during PM&E-related site visits, OSU will conduct visual inspections of the project works as provided above. Any O&M concerns identified during such activities will be reported to the Systems Operator.

APPENDIX G
Emergency Response and Recovery Plan

EMERGENCY RESPONSE AND RECOVERY PLAN INCLUDING SPILL CONTINGENCY

CONTACT: DAN HELLIN, OPERATIONS & LOGISTICS MANAGER, PACWAVE
P: 541-737-5452 DAN.HELLIN@OREGONSTATE.EDU

1. EMERGENCY RESPONSE AND RECOVERY PLAN

This Emergency Response and Recovery Plan (Plan) addresses the major types of emergency conditions that could occur during normal operation and maintenance activities at PacWave South (formerly known as Pacific Marine Energy Center South Energy Test Site [PMEC-SETS]), identifies lines of communication with regulatory agency personnel, and establishes response actions for emergency situations. Implementation of procedures described in this Plan will minimize the potential for adverse effects in the event an emergency situation was to occur. It is imperative that detection and evaluation of a system failure that threatens human health and safety and/or the environment be carried out expediently so that the response measures contained in this Plan can be effectively implemented.

1.1 Statement of Purpose

The purpose of the Plan is to minimize hazards to human health and safety and the environment from system failures. This Plan establishes specific procedures for the notification of agencies that have jurisdiction over some or all of the resources that may be affected by an unexpected event. The Plan also establishes responses in the event of a system failure.

This Plan provides notification procedures and preparedness actions for six types of situations:

- Wave energy converter (WEC) has moved outside of operational boundaries, including becoming submerged;
- Electrical fault has occurred either offshore or onshore;
- Fluid has leaked out of a WEC;
- Navigational lighting failure;
- Subsea or terrestrial transmission cables is damaged or exposed; and
- Vessel collision with one or more WEC components.

Although some WECs are expected to contain some oil-filled equipment, the PacWave South project is not required to prepare a Spill Prevention, Control and Countermeasure Plan or a Facility Response Plan under the Environmental Protection Agency's (EPA) Oil Pollution Prevention regulations. OSU has developed this Plan to prevent and, if needed, mitigate minor spills or leaks of fluids into the marine environment. The implementation of this Plan, combined with the use of licensed and insured operators with their own spill response plans, will minimize the potential for spills.

2. General Responsibilities

This section describes the general responsibilities of OSU personnel under this Plan.

2.1 OSU Responsibilities

OSU has the primary responsibility for providing the initial response to all incidents that are not caused directly or indirectly by one of its contractors. OSU personnel will coordinate emergency response activities even if the incident involves a client's device or equipment.

System Operator

The System Operator is responsible for monitoring the sensor and alarm systems and identifying when a potential unexpected event or system failure has occurred. This responsibility could be taken by various individuals including the Ocean Test Facility Manager or Facility Engineer. (Job titles used in this plan may change.)

The System Operator is the first point of contact for notification by operations and maintenance personnel, regulatory agencies, and the general public of a potential incident. When notified of the potential for an unexpected event, the System Operator on duty will record the following information:

a. Date and time of call or alert;
b. From whom the call was received and contact information (e.g., cell phone);
c. Background / how incident occurred and estimated volume or extent of spill (if applicable);
d. Location and time of the incident;
e. Severity of the incident – threat to people, property or the environment;
f. Description of actions taken; and
g. Weather conditions.

Upon receiving notice of a potential system failure or unexpected event, the System Operator will call the Response Coordinators on the Notification Flowchart (Figure 1) in the order listed ANY TIME OF THE DAY OR NIGHT until contact is made. The System Operator is then responsible for continuing to monitor system operations, informing the Response Coordinator of any change in conditions, and taking other actions as instructed by the notified Response Coordinator.

Response Coordinator

Upon receiving notice of a potential system failure or unexpected event, the Response Coordinator (who may also be the Ocean Test Facilities Manager or another designated individual) is responsible for verifying that an operations failure has occurred. This assessment should be completed in coordination with the System Operator and any outside agencies who can provide relevant information.

After making a determination that an operations failure has occurred, the Response Coordinator is responsible for notifying or assigning personnel to notify individuals and the agencies of current conditions in accordance with the Notification Flowchart (Figure 1). In the event of multiple operations failures, the Response Coordinator will prioritize activities based on the level of threat first to human health and safety, and then to the environment.

The Response Coordinator is responsible for coordinating appropriate mitigation actions by using available monitoring systems to assess the nature of the event. The Response Coordinator will establish an Incident Command System, which organizes the functions, tasks, and staff within the overall response. The Response Coordinator will act as the Incident Commander in the initial stages of the event but under the Oregon Emergency Response System Plan the "first public safety official on the scene" will normally assume control of the site during the "emergency phase" of an incident. The Response Coordinator will ensure that responsible parties are identified for the following five areas:

- Command - setting response objectives and undertaking coordination.
- Operations - undertaking tactical response actions.
- Planning - investigating and establishing technical basis for action plans.
- Logistics - providing equipment and services.
- Finance - managing finances and administration.

The Response Coordinator shall ensure that all OSU personnel and contractors work cooperatively with state and federal agencies. To ensure all activities are carried out in an efficient and safe manner, the Response Coordinator is responsible for obtaining information on conditions at the array including existing and forecasted precipitation, storm events, and predicted wind speeds as needed.

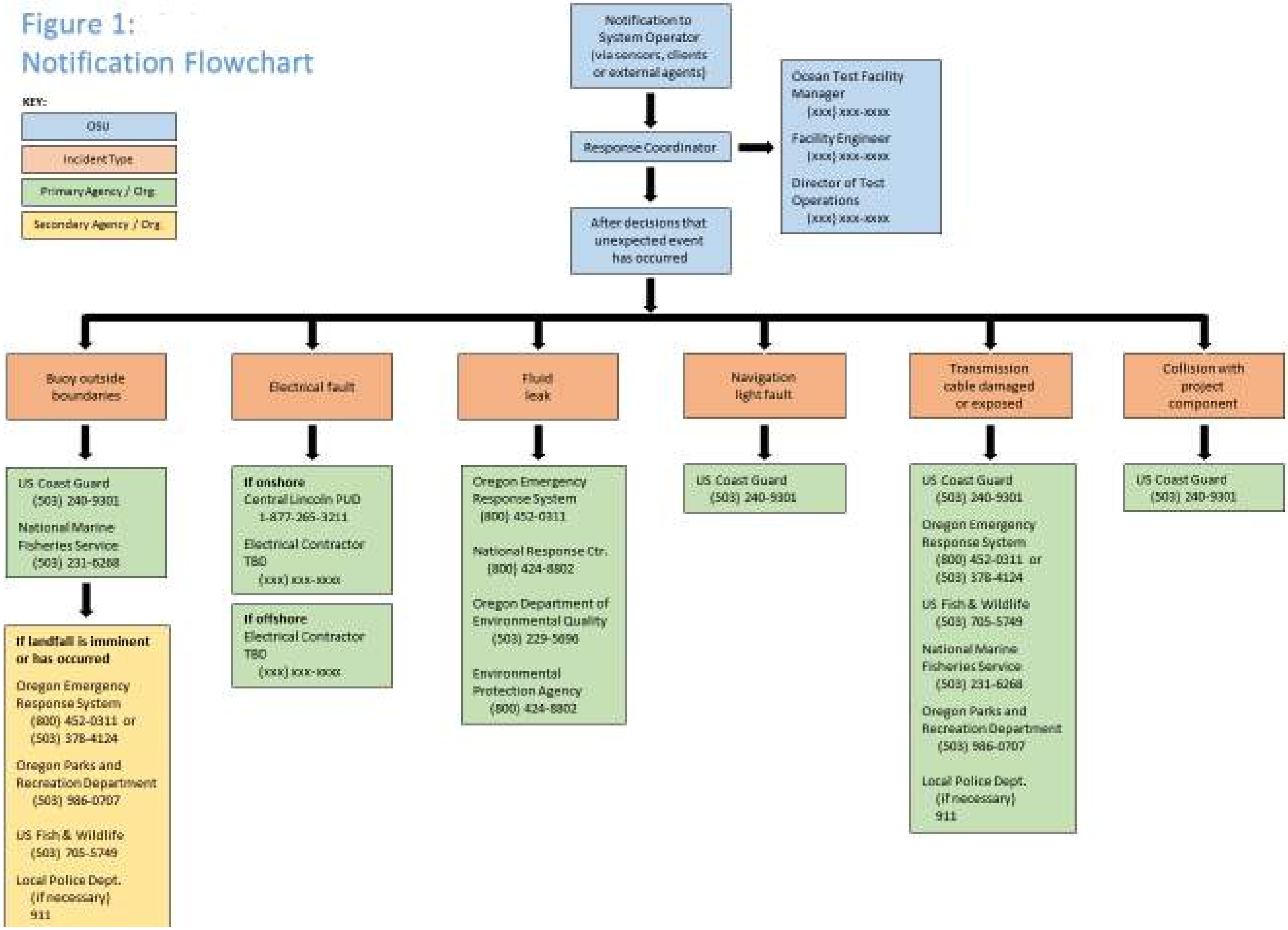
Key information from the National Weather Service includes:

- Weather Data including 20-minute precipitation, wind direction and wind speed.
- National Weather Service's 1- to 5-day precipitation forecast.
- National Weather Service's Warning Forecasts.

3. RESPONSES

Emergency situations that could occur at PacWave South have been assessed, and response protocols are described below. The notification process is illustrated in Figure 1.

Figure 1: Notification Flowchart



WEC has Moved Outside of Operational Boundaries, Including Becoming Submerged

OSU will require that each WEC has Automatic Identification System (AIS) or similar equipment installed on it. OSU will monitor the system on a regular basis for positional stability and to insure that no variations in the placement have occurred.

If a WEC has moved outside of the pre-set operational boundaries and is still in the water, or if the equipment has become submerged, the Response Coordinator will engage a subcontractor to secure the unit and tow it to a suitable location. A list of pre-screened contractors will be developed as this plan is finalized. The Response Coordinator will also notify the U.S. Coast Guard (USCG) of the failure and: a) consult with them as to the best course of action; b) request that a Local Notice to Mariners to be posted; c) and obtain any necessary approvals and permits. The Response Coordinator will also contact the National Marine Fisheries Service (NMFS) to apprise them of the situation and responses to date.

If a WEC has made landfall or it appears that landfall is possible, the Response Coordinator will contact the Oregon Emergency Response System (OERS) and the Oregon Parks and Recreation Department (OPRD) to consult as to the best course of action. The Response Coordinator will either assign personnel or engage a contractor to provide crowd control and deploy appropriate warning indicators (e.g., fencing, construction tape, warning lighting). OSU will also obtain any necessary approvals and/or permits. In addition to OSU personnel and/or contractors, the Response Coordinator may request assistance from the OPRD, and/or the Oregon State Police (OSP) and the local police department for crowd control assistance.

The Response Coordinator will attempt to consult with the OERS, OPRD, and U.S. Fish and Wildlife Service (FWS) Newport Field Office regarding any potential impact on snowy plover. Prior to any vehicles accessing beach locations, the Response Coordinator will consult access descriptions, road maps, and maps of ecologically sensitive regions to identify the most appropriate route. The Response Coordinator will confirm the proposed route with the OERS, OPRD, and FWS, as available.

If a WEC has made landfall, the Response Coordinator will engage a subcontractor to determine the best method of removing the equipment. The Response Coordinator will attempt to confirm the proposed response and vehicular route with the OERS, OPRD, FWS, and NMFS so as to minimize any resource concerns.

Electrical Fault has Occurred Either Offshore or Onshore

The most likely cause of an electrical fault in the offshore component of the project is a defect in an umbilical cable, subsea cable, subsea connector, or a WEC electrical component. In such an event, the Response Coordinator will consult with the client and then engage a subcontractor to identify and correct the problem once weather conditions permit.

In the event of an onshore electrical failure, the Response Coordinator will consult with CLPUD to determine the best course of action to identify and correct the problem.

Fluid has leaked out of a WEC

If there is evidence that fluid has leaked out of the equipment, the Response Coordinator will follow the protocols established in this Plan. Contractors will be alerted to watch for sheens on the water or other signs that an oil leak has occurred. Materials Safety Data Sheet (MSDS) for the materials in all devices under test will be available to the Response Coordinator. While these protocols will be utilized to direct mitigation actions, the primary elements include:

- ➢ Stop spill or leak if possible and contain spilled materials;
- ➢ Contact OERS Spill Reporting Hotline, and the National Response Center; and
- ➢ Engage a professional environmental firm to assist with cleanup operations, as necessary.

Agency Notification

The Response Coordinator is required to notify certain emergency response agencies if a reportable quantity of oil has leaked, as follows:

1. Oregon Department of Environmental Quality (DEQ) defines a reportable quantity of oil as:
   a. If spilled into waters of the state, or escape into waters of the state is likely, any quantity of oil that would produce a visible oily slick, oily solids, or coat aquatic life, habitat or property with oil, but excluding normal discharges from properly operating marine engines; or
   b. If spilled on land, any quantity of oil over 42 gallons (one barrel).
2. EPA defines a reportable quantity of oil as such quantities that the Administrator has determined may be harmful to the public health or welfare or the environment of the U.S. A “harmful quantity” is any quantity of discharged oil that:
   a. Violates applicable water quality standards; or
   b. Causes a film or sheen upon or discoloration of the surface of the water or adjoining shorelines; or
   c. Causes a sludge or emulsion to be deposited beneath the surface of the water or upon adjoining shorelines.

If a reportable quantity of oil/hydraulic fluid is spilled into the Pacific Ocean, the Response Coordinator must contact the following emergency response entities **immediately** after learning of the spill:

- ➢ Call the OERS 24-hour oil spill reporting hotline at **1-800-452-0311** (in-state) or 1-503-378-4124 (out-of-state), and
- ➢ Call the National Response Center at **1-800-424-8802**.

The following information will be required when reporting the spill:

- Your name, title, and phone number.
- Location/time of incident.
- Type and quantity of materials involved.
- Source and cause of the incident.
- Weather conditions at the incident location.
- On-scene contact and how to reach them.

- Severity of incident - danger or threat to people, property, or the environment.
- Actions taken - containment, evacuation.

The Response Coordinator shall record the name of the individual taking the incident call and the incident reporting number given.

Navigational Lighting Failure

The most likely cause of a navigational lighting failure is either an electrical failure or structural damage. The Response Coordinator will first utilize the online monitoring system in an attempt to identify the cause of the failure, and will notify the USCG of the failure and consult with them as to the best course of action. If requested by the USCG, the Response Coordinator will engage a subcontractor to inspect and repair the device once weather conditions permit.

Subsea or Terrestrial Transmission Cables is Damaged

The most likely cause of subsea or terrestrial cable damage is a storm or other extreme environmental condition. The Response Coordinator will notify the FWS, NMFS, the OPRD, and the USCG of the situation and consult as to the best course of action. The Response Coordinator will either assign personnel or engage a contractor to provide crowd control and deploy appropriate warning indicators (e.g., fencing, construction tape, warning lighting). In addition to OSU personnel and/or contractors, the Response Coordinator may request assistance from the FWS, the OPRD, and/or the OSP and local police departments for crowd control assistance.

Collision with WECs or Other Project Equipment

In the unlikely event of an impact to WEC or other equipment by a vessel, the Response Coordinator will engage a subcontractor to inspect and either repair or remove the instrument, as appropriate, once weather conditions permit. Contractors will be alerted to watch for sheens on the water or other signs that an oil leak has occurred. The Response Coordinator will also notify the USCG of the collision and consult with that agency as to the best course of action.

Once the incipient situation has been abated, the Response Coordinator will supervise the completion of the response action. This activity includes, at a minimum, the following:

- Ensure that operations and equipment are restored to previous status;
- Notify any regulatory agencies contacted that the situation has been corrected; and
- Prepare incident investigation report.

4. PREPAREDNESS

Surveillance

OSU personnel and clients will continuously monitor the operating units through the use of sensors on key operating parameters, including position, hydraulic pressures, temperatures, voltages, and leak detectors.

Response during Periods of Darkness

The equipment at PacWave South will be illuminated at night in accordance with USCG regulations. Operation and maintenance personnel will utilize vessel and portable hand-held floodlights to illuminate any unlit or poorly lit areas of the site if required.

Response during Weekends and Holidays

The same procedures of operation and monitoring of the facilities are performed by the Site Supervisor every day, including weekends and holidays. Therefore, the response time during weekends and holidays would be the same as normal weekdays. The Response Coordinator can be contacted by telephone during non-working hours, including weekends and holidays.

Response during Periods of Adverse Weather

In adverse conditions, the Site Supervisor would monitor the system operations through the online monitoring system. Operators will remotely check the position of the units during and after storm events, as this would be the most likely time for a system failure.

Alternate Systems of Communication

The communications network between the Site Supervisor and Response Coordinators will consist of multiple systems such as landline telephones, cellular telephones, and pagers.

5. Incident Review

After a system failure situation has been abated, the Response Coordinator will complete an Incident Investigation Report. This document will include, at a minimum, a description of events leading to the incident and subsequent actions. Reports should include the following information:

- Date, time, and nature of incident;
- Name(s) of personnel involved;
- Names of external entities contacted (e.g., service providers, regulatory agencies);
- Description of response actions performed;
- Evaluation of effectiveness of response actions; and
- Proposed methods of prevention of future emergencies.

The Incident Investigation Report will be reviewed with management and kept on file with OSU. Additional copies will be provided to involved agencies as requested.

APPENDIX H
Monitoring Plans

H-1: Monitoring Plan – Benthic Sediments
H-2: Monitoring Plan – Organism Interactions
H-3: Monitoring Plan – Acoustics
H-4: Monitoring Plan – Electromagnetic Field

H-1

Monitoring Plan – Benthic Sediments

MONITORING PLAN – BENTHIC SEDIMENTS

CONTACT: DAN HELLIN, OPERATIONS & LOGISTICS MANAGER, PACWAVE
P: 541-737-5452 DAN.HELLIN@OREGONSTATE.EDU

PRINCIPLE INVESTIGATOR: SARAH HENKEL, ASSISTANT PROFESSOR, HATFIELD MARINE SCIENCE AND DIRECTOR OF ENVIRONMENTAL RESEARCH, OSU, 541-867-0316, SARAH.HENKEL@OREGONSTATE.EDU (NOTE: STAFF CHANGES MAY OCCUR, BUT OSU FACULTY MEMBERS WILL LEAD THIS STUDY)

1. INTRODUCTION/OVERVIEW

1.1 Resources of Interest

The resources of interest are the benthic habitat and associated invertebrates and fish in and around the Project area, which is south of the Yaquina Bay on the central Oregon coast. The entire Project area is Critical Habitat for green sturgeon and is designated EFH (Essential Fish Habitat). The PacWave South (formerly known as Pacific Marine Energy Center South Energy Test Site [PMEC-SETS]) Project area consists of primarily medium sand in the 60-70 m contour with similar grain sizes found shoreward at 50 and 40 m. Benthic sampling around both PacWave South and PacWave North (formerly known as Pacific Marine Energy Center North Energy Test Site [PMEC-NETS]) indicate substrate composition on the mid to inner shelf along this section of the Oregon coast consists of medium to coarse sand with larger grain sizes found with increasing depth (Henkel 2016). Mapping data indicate a potential transition to fine sand at deeper depths (70+ m). Thus, while the habitat in the Project area is EFH, it also is highly common and abundant on the Oregon central coast. At these depths, we have observed differences in macrofaunal invertebrate assemblages associated with differences in median grain size; however, this is primarily in the relative abundances of the same suite of species. At 50 m and shallower, some seasonal differences in sediment conditions and macrofaunal invertebrate abundances have been noted; however, this is generally not the case at depths deeper than the winter dominant wave base (~ 50 m on this part of the Oregon coast). The fish assemblages in this area are typical for sedimentary (sand and/or mud) areas on the Oregon mid to inner shelf. Comparisons of beam trawl collections from PacWave North, OPT's Reedsport site, and a third surveyed area north of Coos Bay showed that benthic species assemblages differed more by depth than they do by collection location. This indicates that the PacWave South area is likely not a unique area for benthic fish species in Oregon.

1.2 Potential Effects/Issue Summary

The subsea cables, subsea connectors, and anchors would result in both temporary and long-term alterations of benthic habitat in the Project area. Temporary disturbances may be recurring at various intervals over the 25-year term of the project if anchors and other bottom components are removed and re-installed for different devices under test.

The subsea cables, extending from the subsea connectors to the HDD conduits near shore, would be installed in trenches 1 to 2 m below the seafloor using jet plowing or other trenching methods. This would cause temporary displacement of unconsolidated sediments as the cable is buried. Benthic and infaunal organisms (e.g., amphipods, bivalves, and polychaetes) within the pathway of the plow would be removed, displaced, or killed during the trenching process. Additionally, as the plow moves along the seafloor, slow-moving infaunal or surface dwelling organisms located in the path of the plow's skids or wheels that span the trench likely would be killed. Mobile invertebrates (e.g., crabs), fish species that feed on or near the bottom, and species that shelter on the bottom at times would likely move away from the immediate vicinity of the anchors and cable and move to nearby areas during deployment and removal activities. While these activities would result in short-term benthic habitat disturbance, benthic fauna (e.g., polychaetes, clams, and amphipods) that inhabit the area are likely to be adapted to dynamic ecosystems and likely would be unaffected by sediment burial. Core samples taken at varying distances perpendicular to a 76 cm (30") diameter exposed sewage pipeline in Bazan Bay, British Columbia, three years after installation did not show differences in sediment composition with distance from the pipeline but increasing diversity and richness (but not abundance) of infauna were detected with increasing distance from the pipeline (Glaholt 2008). The effect of distance depended on location along the pipeline: distance was a significant predictor for richness in the shallower (10 m) eelgrass habitats but not for the deeper (20 m) open silt/mud bottom. In terms of community composition, where differences were detectable, they were only apparent within the first 1 m of the pipeline in the shallow eelgrass habitat but none were detected in the deeper habitat. Based on the pipeline study, any lasting disturbances due to structure placed in sedimentary habitat are expected to be very localized, if detectable at all.

Project components located on the seabed can cause scour; in particular, the placement of anchors on the seabed could result in localized areas of scour or deposition. Based on reviews of bottom changes resulting from deployment of artificial reefs and offshore oil platforms, sedimentary changes could be expected to occur at least 20 m away from an anchor installation (Henkel et al. 2014). The particle size range found at PacWave South likely is less susceptible to movement than areas having finer grained sediment. Anchors may also reduce available benthic foraging habitat, although the total area lost by anchors is expected be less than 0.1% of the total Project Site surface area, as quantified in the table below. There would be an additional small area of long-term loss of unconsolidated sand habitat due to the footprint of the subsea connectors (four subsea connectors, each having a footprint of about 30 square feet).

Table 1. Estimated maximum anchor footprints for initial development and full build-out scenarios. Since a combination of different anchor types would be used, the gravity anchor footprint represents a maximum estimate, and the embedded anchor footprint represents a minimum estimate. These values do not include estimates of surrounding sediment disturbance from installation/embedment.

Build Out Scenario	No. WECs	No. Anchors Total	Maximum Seabed Anchor Footprint (ft^2)*
Initial Development	6	21	19,068
Full Build Out	20	100	90,800

* Based on the total footprint of 34-ft-diameter gravity anchors (908 ft^2 per anchor), representing the largest possible footprint per anchor; other anchor types will have a considerably smaller footprint.

Since Project components on the seafloor would be placed in a portion of the OCS that is sandy and generally devoid of vertical habitat features on the seabed, they would add complexity to the homogenous sandy seabed, which could result in changes in community composition, species interaction, and predator-prey interactions in the Project area. In particular, the introduction of Project-related structures could result in localized habitat changes as the hard structures are colonized (biofouled) by algae and invertebrates, such as barnacles, mussels, bryozoans, corals, tunicates, tube-dwelling worms, molluscs and crustaceans (Boehlert et al. 2008). Project structures at or near the bottom (e.g., anchors) may also act as an artificial reef and provide habitat for structure-oriented fishes, such as rockfish (Danner et al. 1994, Love and Yoklavich 2006), which could have cascading effects on the sedimentary species normally found there.

2. Need for Information

The presence of Project structures on the seafloor, such as anchors and subsea cables, may alter benthic habitat conditions, subsequently affecting resident invertebrate species (mostly macrofaunal but potentially including mobile megafauna such as crabs and seastars). While direct effects to the benthic community are not anticipated to be significant, they could result in indirect effects to the local marine community. Colonization of biofouling species on Project structures as well as attraction by structure-oriented invertebrates and fishes could change the local marine species composition, which could affect predator/prey interactions.

Sampling around the Ocean Sentinel anchors at PacWave North revealed initial small changes to sediment median grain size after installation. However, these changes were slight and resulted in sediment characteristics not unlike surrounding areas. Collected macrofaunal assemblages were statistically indistinguishable from other sampling stations of similar depth at NETS and SETS. However, the Ocean Sentinel anchors were relatively small and there were only three. Thus, questions remain as to whether broader scale changes may occur with many more anchors, potentially with overlapping radii of influence. Observations of the fouling community on the Ocean Sentinel anchors after removal in November 2015 indicated very little accumulation of biomass: mostly Balanoid barnacles, a small number of chitons (molluscs), bryozoans, and a single anemone across all three anchors after over 2 years of deployment. The surface floats had considerably more biomass including large gooseneck barnacles, mussels, and seaweed. Although the potential for significant shifts in community composition is low (based on the slow rate of biomass accumulation and few species observed), there is potential for broader scale changes with a large number of anchors and mooring systems. Therefore, monitoring will be conducted to measure and evaluate changes in the benthic community, and the results of this benthic monitoring will be used to inform and detect potential changes in the local marine community.

3. Goals/Objectives

The overall goal of this benthic monitoring plan is to track changes to benthic habitat and potential effects on organisms associated with such habitat changes. The information will be used to inform implementation of Mitigation Measure 2 and potentially modify this monitoring plan as necessary to ensure protection and conservation of marine resources from potential Project effects.

3.1 Study Objective

The first specific objective is to monitor for changes to the sediment characteristics in the vicinity of bottom-mounted wave energy converter (WEC) components (e.g., anchors) and determine what (if any) changes in sediment characteristics result in changes to the benthic macrofaunal invertebrate communities. We expect to observe localized changes in median grain size associated with the installation of bottom-mounted WEC components. We anticipate that any such changes to sediment characteristics will occur relatively rapidly after installation and are likely to recover over time. A second objective is to assess whether these changes to sediment characteristics result in changes to benthic macrofauna by tracking species abundances. If changes to sediment characteristics and/or benthic organism community metrics are detected, a follow up objective is to determine the recovery period of the habitat and/or organisms. Recovery will be defined as when the impact station samples are statistically similar to pre-installation or reference station samples.

The information will be used to inform implementation of Mitigation Measure 2 and/or to modify this monitoring plan as necessary to ensure protection and conservation of marine resources from potential Project effects.

4. Data Collection and Analysis

4.1 Methods & Equipment

Box Coring

Sediment and macrofaunal samples will be collected with a modified Gray-O'Hare 0.1 m^2 box core. Macrofauna are defined here as infauna and epifauna retained on a 1 mm mesh sieve. Site characterization at PacWave South and sampling at PacWave North indicate slight seasonal differences (mostly at shallower depths) between "spring/early summer" (April – June) and "late summer" (August – October). Thus samples within and outside the Project Site will be collected in each of these seasons to account for any seasonal variability.

Once the timeframe and plans for cable installation are finalized, samples will be taken along the cable routes corridor (corridor containing all the cables) at each 5 m depth bin starting offshore of the approximate location/depth of the HDD bore (e.g., 20 m, 25 m, 30 m…, 65 m) with three samples collected at each depth (one each north of, within, and south of the cable corridor). This sampling will be planned as close as possible to the start of cable-laying so that the sampling can be repeated after the cable installation in the same season. After cable installation the "within corridor" set of sampling stations will no longer be sampled due to risk of hitting a cable, so a second set of grabs south of the corridor will be collected (since if there was transport and then re-deposition of sediment, we would expect it to be southward). We then will sample the same stations one year later in the same season(s) to assess if there are any persistent changes of significance associated with the cable installation.

In order to assess potential sediment and macrofaunal invertebrate changes associated with the installation and testing of devices, 14 reference stations will be established outside the Project Site (in the larger Project area) that will be maintained as permanent stations to track seasonal or inter-annual changes presumably not associated with the Project. These reference stations will be 250 and 500 m inshore of the eastern edge of each berth and 250, 500, and 750 m from the northern and southern edge of the Project Site. Four fixed test berth stations (one in each berth) also will be established; it is important to recognize that these stations may be unavailable to sample at times, depending on the exact location and configuration of Project structures and devices. These four fixed test berth stations, along with the reference stations, will be sampled in the two seasons prior to installation of the first WEC(s). Additionally, in the season prior to WEC installation in any particular berth, 6 random stations will be sampled in that berth to serve as pre-installation comparators to the “anchor grabs” collected post-installation as described below.

Once WECs are installed in the Project Site, sampling will occur around each of the anchors in addition to reference station sampling. (If there are more than three anchors of the same type within a single berth, only 3 of the anchors will be sampled.) Grabs will not be collected around the subsea connectors as they have critical electrical components in them, and we will not risk dropping the box corer on them. Observations of sediment changes around anchors at NETS indicated that changes to sediment resulting from the anchors are unlikely to persist beyond 150 m from project structures. To be certain that potential effects do not extend further at PacWave South (where anchors are anticipated to be larger), grabs will be taken at distances of 50 m, 250 m, and 400 m away from each of the sampled anchors in the direction of the prevailing current. Post-installation sampling will also be planned for both the “spring” and “late summer” to account for any seasonal variability. The specific frequency and duration of post-installation sampling of any one device will depend on how long the components are in the water, as well as the number, type, size, and configuration of the components.

One grab sample will be taken at each of the above-described stations; subsamples of sediment will be collected to determine percent silt-clay of sediment and median grain size (MGS); the remainder then will be sieved onboard through a 1.0 mm screen; and all collected organisms will be preserved in a mixture of 10% buffered formalin and seawater. At each sampling station, vertical water-column profiles of conductivity, temperature, depth, dissolved oxygen, and turbidity, and pH will be obtained with a Sea-Bird Electronics CTD unit.

Upon return to the laboratory, organisms will be transferred to 70% ethanol then sorted into major taxonomic groups by Oregon State University (OSU) staff. Crustaceans, polychaetes, and other worm-like creatures will be sent to contracted taxonomic experts. These taxonomic experts are the same individuals contracted for the 2003 WEMAP samples and that we have used for all the Henkel lab studies to date to ensure consistency of identification between all datasets. OSU laboratory staff will identify molluscs, echinoderms, and remaining taxa. Although the box corer occasionally captures megafauna such as sea urchins or sea stars, their records would be removed from the data prior to analysis since they are not part of the “macrofaunal community”. However, we will note their occurrences. For consistency, the collection and processing procedures described above are identical to those previously used at PacWave North and SETS.

4.2 Schedule & Frequency

All sampling will continue as described below and in Mitigation Measure 2 for five years after initiation of the project with at least nine (9) anchors in place. At the five-year mark, the Adaptive Management Committee (AMC) will convene to discuss the efficacy and appropriateness of the sampling plan, and whether objectives have been met.

4.2.1 Project Site

Site characterization at PacWave South and sampling at PacWave North indicated slight seasonal differences in the presence of fine sediment and organism composition mostly at shallower depths (30 to 40 m) between "spring/early summer" (April – June) and "late summer" (August – October), although sampling to date has not indicated seasonal variability in the depths of the Project Site (deeper than 50 m). Reference stations as well as pre-installation within berth grabs will be collected in the season prior to installation of the WEC(s), likely spring. We anticipate the first post-installation sampling will occur in late summer/fall. We will again conduct surveys the following spring to compare to pre-installation collections from the same season. If installations are made in periods other than the expected summer months, we will ensure that pre- and post-installations surveys are conducted in matching seasons. The exact timing (within the ranges provided) of pre-and post-installation sampling will depend on the weather conditions and the installation schedule for each berth.

For each tested device, at least one post-installation survey will be conducted (regardless of the duration of the test). Since surveys will be conducted twice a year, the total number of post-installation surveys for any one WEC will depend on the duration of the test. After five years of surveys the findings of those post-installation surveys will inform subsequent sampling to be determined through the adaptive management process. For example, if the "impact" stations are indistinguishable from the reference stations, further monitoring may not be necessary, but if the "impact" stations have unique sediment characteristics or organisms, continued monitoring may be warranted.

4.2.2 Cable Route

Box cores will be taken along the cable corridor as described above once before installation (either in the spring or fall), as well as two seasons after the installation to ensure at least one survey matches the season of the pre-installation survey.

4.3 Constraints & Limitations

A constraint in developing this monitoring plan is the variability associated with the Project as a test center. To overcome that, we have written this study to be applicable to deployments of various size, number, and location of device components, the distance between them, and the number and type of mooring hardware associated with the Project components of interest. The major constraint of any ocean-going field project is weather conditions and vessel availability. However, because site characterization revealed little seasonal variability at the depths of the PacWave South project site and just two major seasons at shallower depths, we have more flexibility in making collections without potentially confounding the findings with "normal" intra-annual variability. We are confident we can successfully conduct surveys sometime in the April to June window and again in the August to October window. OSU will notify the AMC within 10 days of the close of each seasonal window (end of

June/October) if it seems unlikely we will not be able to complete the sampling within that window to discuss whether sampling should be attempted within the next month or deferred until the following season. Furthermore, any inability to perform this study within the time period or spatial extent described here would be communicated to members of the AMC within 10 days from the date determined by OSU that it is unable to complete the tasks identified in this plan, and a contingency plan developed and submitted to the AMC within 30 days after notification.

4.4 Analysis

Analysis of the box coring data will be similar to the analyses we have conducted of all the PMEC data to date. Grain size data will be analyzed using ANOVAs or general linear models to test for differences among distances from the anchors, depths, seasons, reference stations outside the Project Site versus impact in the Project Site, pre- versus post-installation for the cable route, and potentially other factors we haven't anticipated. For assemblage analyses, Shannon–Weaver diversity (H') and species richness (S) will be calculated for each sample and similarly compared using ANOVAs or GLMs. Species count data will be transformed for multivariate analyses and resemblance matrices determined. Cluster analysis will be conducted on the transformed density datasets in order to produce groups of similar stations based on the species abundances. The SIMPROF routine in Primer 6 (Clarke 1993) will be used to determine if clusters in the dendrogram have statistically significant structure. We will specifically investigate whether impact stations differ from reference stations and if there is structure among the impact stations related, for example, to distance from the device component or a trajectory over time. Pre- and post-installation observations also will be compared with the PacWave South site characterization observations made 2013 to 2015, as well as the PacWave North surveys conducted 2010 to 2015 to determine if post-installation sediment conditions and/or organisms abundances are within the range of what is "normally" found on the central Oregon coast.

5. Results

Box coring results will include graphs and maps showing sediment grain size. A species list including number of collected individuals of each species during each survey will be included. Cluster dendrograms and/or multidimensional scaling plots will be used to visualize the similarity and differences of stations based on species composition. If significant and interesting patterns of species composition warrant, maps showing species assemblage clusters like the one in the Benthic Site Characterization report may be created.

6. Reporting

Once the activities under this plan commence, they will be reported annually in OSU's Annual Report, which will be filed with FERC and provided to the AMC. The annual reporting will include the components described below; it will also identify any relevant new information considered in the findings or future monitoring.

6.1 Monitoring Summary

OSU will summarize all activities undertaken in implementing the monitoring plan, including a table with monitoring dates and locations if appropriate. OSU will describe any deviations from the monitoring plan (e.g., modified sampling frequency due to adverse weather conditions) and discuss implications of any such deviations. OSU will describe any changes to monitoring as a result of adaptive management or mitigation measures that were implemented during the course of the reporting period, if applicable.

6.2 Results & Conclusions

The AMC will discuss the monitoring results and any significant findings or conclusions, and whether or not the findings exceed thresholds identified in Mitigation Measure 2. The AMC will be given the opportunity to provide feedback on the study results prior to any official filing, and if they exist, OSU will describe any disagreements over characterization of results in its final report.

6.3 Future Monitoring

OSU will describe in its Annual Report monitoring activities that are planned for the next reporting period. OSU will provide a list of any proposed modifications to the monitoring plan to the AMC, including any adaptive management criteria or response actions, and rationale for the changes.

7. References

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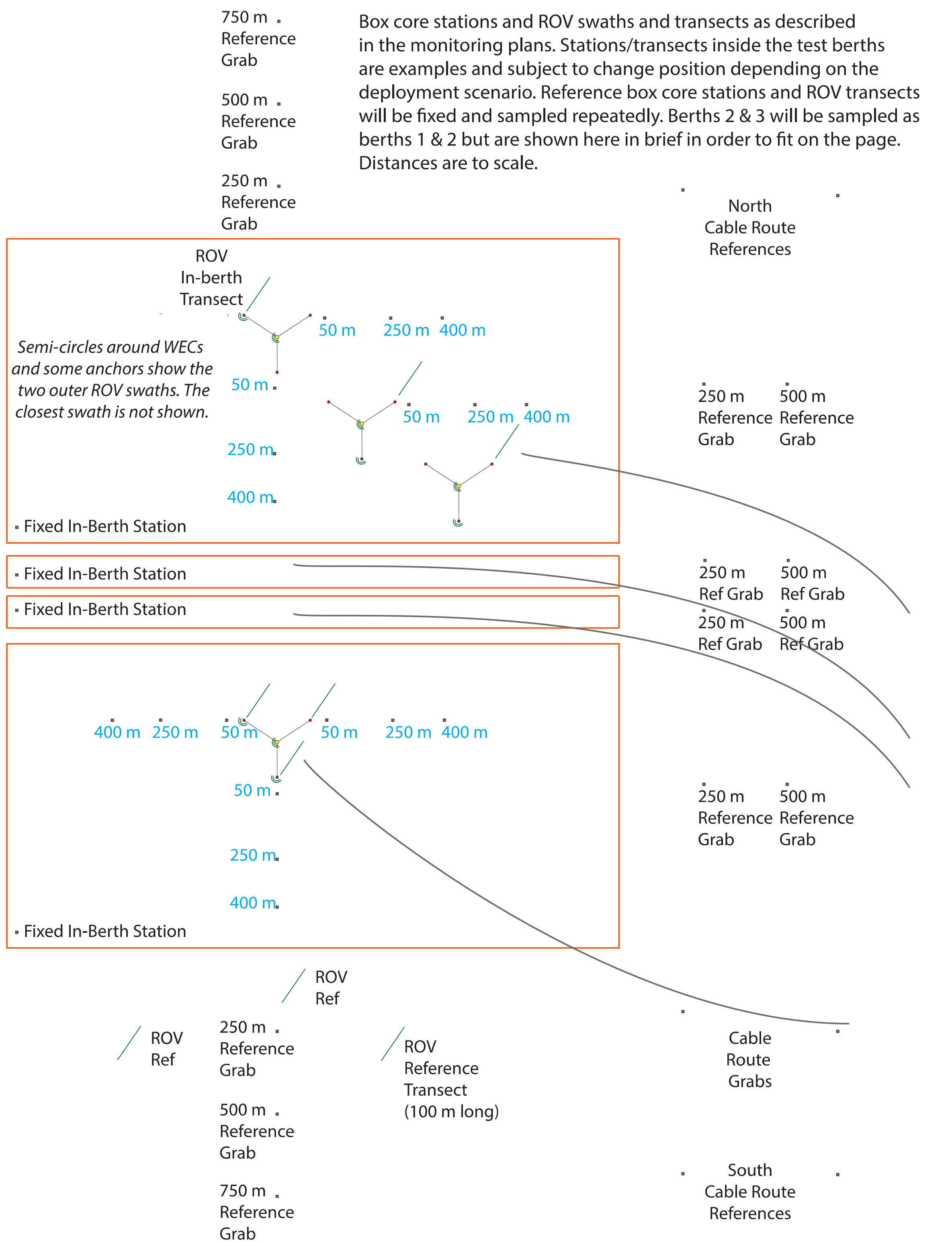

Figure 1. Benthic and organism interaction monitoring schematic. Within berth station distances are relative to the project component. Reference grab distances are relative to the site boundaries.

H-2

Monitoring Plan – Organism Interactions

MONITORING PLAN – ORGANISM INTERACTIONS

CONTACT: DAN HELLIN, OPERATIONS & LOGISTICS MANAGER, PACWAVE, P: 541-737-5452, DAN.HELLIN@OREGONSTATE.EDU

PRINCIPLE INVESTIGATOR: SARAH HENKEL, ASSISTANT PROFESSOR, HATFIELD MARINE SCIENCE AND DIRECTOR OF ENVIRONMENTAL RESEARCH, OSU, 541-867-0316, SARAH.HENKEL@OREGONSTATE.EDU (NOTE: STAFF CHANGES MAY OCCUR, BUT OSU FACULTY MEMBERS WILL LEAD THIS STUDY)

1. INTRODUCTION/OVERVIEW

1.1 Resources of Interest

The resources of interest are the demersal and water column organisms in and around the Project area, which is located south of Yaquina Bay on the central Oregon coast. The entire Project area is within designated critical habitat for green sturgeon and is Essential Fish Habitat (EFH) for groundfish, coastal pelagics, Pacific salmon, and highly migratory species. Benthic sampling around both PacWave South (formerly known as Pacific Marine Energy Center South Energy Test Site [PMEC-SETS] and PacWave North (formerly known as Pacific Marine Energy Center North Energy Test Site [PMEC-NETS]) indicate substrate composition on the mid to inner shelf along this section of the Oregon coast consists of medium to coarse sand with larger grain sizes found with increasing depth (Henkel 2014), switching again to smaller grain sizes on the western boundary of the PacWave South Project Site. Thus, while the habitat in the Project area is EFH, it also is highly common and abundant on the Oregon central coast. The groundfish assemblages in this area are typical for sedimentary (sand and/or mud) areas on the Oregon mid to inner shelf. Comparisons of beam trawl collections from PacWave North, and surveyed areas off Reedsport and north of Coos Bay showed that benthic species assemblages differed more by depth than they do by collection location. This indicates that the PacWave South area is likely not a unique area for benthic fish species in Oregon.

Additional resources of interest include fishery limiting species such as overfished, sensitive, threatened, endangered, or strategy species. ODFW identified Dungeness crab, salmonids, rockfish and forage fish as species groups of interest to ODFW management.

1.2 Potential Effects/Issue Summary

The subsea cables, subsea connectors, and anchors would result in both temporary and long-term alterations of benthic habitat in the Project area. Temporary disturbances may be recurring at various intervals over the 25-year term of the project if anchors and other bottom components are removed and re-installed for different devices under test.

The WECs and mooring lines in the water column may serve as fish attractants as they will provide shelter and colonization structures as have been observed on other structures in the sea (Claudet and Pelletier 2004, Wilhelmsson et al. 2006, Seaman 2007, Langhamer and Wilhelmsson 2009, Langhamer et al. 2009), particularly providing habitat for structure-oriented fishes, such as rockfish (Danner et al. 1994, Love and Yoklavich 2006). Components higher in the water column or near the surface may particularly attract juvenile fishes. Recruitment production of midwater habitat at oil platforms was 3.7 times as much as on natural reefs, possibly due to increased settlement opportunity (Claisse et al. 2014) and settlement stimulus provided by high vertical profile platform structure (Love et al. 2006). Similarly, most of the fish present at wind farms offshore Europe (i.e., Atlantic cod, pouting) are juveniles (Reubens et al. 2014). These effects may be limited to a small number of species as at the Lillgrund wind farm where no major effects on demersal fish diversity and abundance were detected as compared to reference areas (Bergström et al. 2013), although some common species were detected in higher densities near the foundations. A research question remains whether fish will just be re-distributed from nearby areas or if the increased habitat will result in increased local productivity (Pickering and Whitmarsh 1997, Brickhill et al. 2005). For some species groups, there is the potential for a negative effect on local populations if there is enhanced predation or fishing pressure due to the aggregation effect (Wilhelmsson 2012).

In addition to fishes, some benthic invertebrates may be attracted by the conversion of habitat or be affected by reduced fishing effort and/or changes in predation. Rock crabs may be attracted to structure as observed around oil platforms in southern California, although the effect varies by species. Using baited traps immediately underneath oil platforms versus 200 m away in soft sediment, for *Cancer antennarius* and *C. anthonyi* there was a positive effect of the platform on abundance, while for *C. productus* and *Loxorhynchus grandis*, there was no effect of location (Page et al. 1999). In regards to sex ratios, the proportion of male rock crabs at the reference stations was not different than 0.50, while the proportion of males trapped under the platform was 0.34 for *C. antennarius* and 0.10 for *C. productus*, indicating fewer males of these species utilizing the platform-associated habitat. Page et al. (1999) also tagged 780 crabs at the platforms. Recapture rates were low (0.9 – 3.1 %) for all species at the platforms, while local fishermen working up to 8 km away from the platforms returned 2.9 % of the *C. anthonyi* tags. This suggests that while rock crabs may be attracted to the structures, they still maintain large foraging/home ranges. Additionally, structure does not seem to be a barrier to crabs as remotely operated vehicle (ROV) surveys of a pair of 25.4 cm diameter, 46 km long gas pipelines crossing Georgia Straight (Vancouver Island Pipeline) taken at three intervals over the first 10 year period following construction showed box crab and red rock crab actively crossing the pipes, and crustaceans such as prawns and shrimp appeared to be strongly attracted to the habitat created by the pipe in soft sediment (Glaholt 2008).

Adult Dungeness crabs are opportunistic, carnivorous feeders that primarily consume bivalves, fish, and shrimp as well as other small invertebrates by excavating prey from the sediment (Rasmuson 2013; Gotshall 2005). As such, they may be attracted to areas of sediment disturbance and/or structure that could provide feeding opportunities. During video reconnaissance at the 76 cm diameter, 1.5 km long Bazan Bay pipeline in Canada, Dungeness crab were observed feeding on epiphytic algae growing on the pipe exterior, actively crossing the pipe, buried in substrate immediately adjacent to the pipe, as well as in sediments up to the outer limit of the 15 m sample transect length perpendicular to the pipeline (Glaholt 2008). While we are not aware of studies that have directly tested Dungeness crab attraction to structure relative to soft-sediment habitats in the NE Pacific, a number of tagging studies have been carried out in the region to assess Dungeness crab movement patterns. These studies can be used to assess the potential for crabs to range in and out of the Project Site. The smallest estimates of movement are reported from Fritz Cove, Alaska. Estimated movement ranged from 2.13 to 7.24 km for males and 0.38 to 4.23 km for females, although no female crabs left the bay, which necessarily limited their potential range (Stone and O'Clair 2001, 2002). In British Columbia, Smith & Jamieson (1991) estimated that after one year of random dispersal, in the absence of geographical boundaries, 95% of males and females would be within radii of 9.5 and 13.9 km, respectively, of the point where they were one year previous. In a California study of females 54% of recovered crabs had moved more than 2 km away of the original release sites (~1 year later) while one crab was recovered 80 km away (with other recoveries at various distances in between; Diamond and Hankin 1985). In Oregon, Waldon (1958) conducted a tagging study of adult males and found crabs travelled an average of 15.3 km in an average of 80 days from the time of release to recapture with some distances exceeding 92 km. Similarly, Hildenbrand et al. (2011) found adult males tagged off Reedsport, Oregon, travelled an average of 18.6 km with a maximum of 90.7 km between release and recapture locations. It's important to note that distances observed in the mark-recapture studies represent minimum distances the crabs may have travelled, as the crabs may have made any number of movements between the times of release and recapture.

Besides the deployed structure itself, shell mounds are a feature of the sea floor around offshore oil platforms in California (Page et al. 1999) and wind turbines in Europe (Hiscock et al. 2002) where structures are colonized by fouling organisms, which then fall or are scraped off the devices as part of regular maintenance. In California, sea stars and *Pandalus* shrimp dominated shell mound megafauna, with rock crab and Dungeness crab observed on shell mounds around platforms (Goddard & Love 2010). Thus, if similar mounds form beneath WECs and their moorings at PacWave South there is the potential for other megafaunal invertebrates (in addition to Dungeness crabs) to show differing distributions or abundances compared to pre-installation conditions or reference areas. However, it is uncertain whether these features will develop at PacWave South as the duration of WEC deployment and thus potential for fouling community succession as well as the need for at-sea cleaning are unknown. A study of the fouling communities on the Ocean Sentinel anchors and surface floats marking them (neither of which were coated with anti-fouling paint) found very little biomass on the anchors (primarily small balanoid barnacles, percent cover ranging from 2 % to 80 %) while on the buoys at least 50% of the subsurface halves were covered with turf algae, gooseneck barnacles, and mussels (Mendoza thesis, in prep.)

2. NEED FOR INFORMATION

Available literature leads us to expect a new community will form on and to some degree around deployed structures (Claisse et al. 2014), but what that community will be composed of and how long it will take to form remains unknown. Published information is available to characterize fish assemblage and marine life that currently occupy waters of the Pacific Ocean off of Newport at similar depths as SETS (see section 3.3.3 of the PDEA). However, some gaps remain in terms of spatial and temporal trends or distribution of fish within the water column. The new community associated with WEC testing at PacWave South could have both positive and negative effects on existing local populations of marine species. The state maintains a high level of interest in how important resources and uses may be impacted, and considers it paramount that they are considered when the siting and authorizing of marine renewable energy projects is conducted (DLCD 2015).

Published literature indicates great variability in taxon- and age-specific responses of fishes to the deployment of differently designed artificial reefs (Hueckel et al. 1989, Bohnsack, et al. 1991, Baine 2001; Claudet and Pelletier 2004) as well as structures of offshore renewable energy devices (e.g. Wilhelmsson et al. 2006, Seaman 2007, Langhamer and Wilhelmsson 2009, Langhamer et al. 2009, Bergström et al. 2013). Thus, we expect that different WECs (and their associated mooring systems) deployed at PacWave South could have different levels of "attractiveness" to organisms in the vicinity. In addition, the time of year of WEC deployment may have an effect on the species attracted due to differences in migration or recruitment of fishes. An ROV survey conducted in September 2012 around the WetNZ device 25 days after WEC deployment at PacWave North did not show any fish around the WEC, the Ocean Sentinel, or any of the anchors, aside from the occasional flatfish disturbed from the sediment. The lack of observations using the ROV may be due to the season, the time of day the surveys were conducted, the length of time devices had been in the water, or due to the behavior of the species (avoiding the ROV). When we conducted an ROV inspection of the Ocean Sentinel anchors in May 2015, we observed juvenile rockfish schooling just above one of the anchors indicating ROV presence may not be driving whether or not fish are observed. Similarly, ROV observations of the 10-meter-diameter Ocean Power Technology anchor documented "large schools" of black rockfish as well as lingcod and potentially other fish as well as motile invertebrates (e.g. Dungeness crab, sea stars) associated with the structure (OPT 2014; OPT 2016). Conducting twice-yearly surveys of deployed structure multiple times after they are installed will help us determine if the difference in fish observed in September 2012 versus May 2015 was due to seasonal differences (e.g., timing of settlement of juveniles) or fish finding and being attracted to the structure after it had been deployed for some time.

The fouling communities on the Ocean Sentinel anchors and surface floats were documented after over 2 years of deployment at NETS, following removal in November 2015. The Ocean Sentinel surface floats had considerably more biomass than the anchors, including large gooseneck barnacles, mussels, and seaweed (Figure 1). The anchors out of the water showed very little accumulation of biomass (Figure 2): mostly Balanoid barnacles, a small number of chitons (molluscs), bryozoans, and a single anemone across all three anchors after over 2 years of deployment. There was evidence of anchor movement that may have affected development of the attached surface community. After 23 months installed in water depths similar to the proposed SETS project, in-water observations of the 10-meter-diameter Ocean Power Technology anchor documented an "established community" including attached invertebrates (e.g. plumose anemones) (OPT 2014; OPT 2016). The potential for ecologically significant shifts in community composition at PacWave South due to biofouling is unknown and there is potential for broader scale changes with longer-duration tests incorporating multiple anchors and mooring systems. However, this may be offset by the potential for more frequent removal of WECs, surface floats, and anchors, resulting in less time to support biomass accumulation.

Management interests in monitoring fishery (including crab) resources at SETS are primarily driven by ODFW's expressed need to understand how stocks interact with installed devices and if fishing activity potentially enhanced or constrained by facility installation could result in localized changes to abundances or distributions. ODFW may use information gathered from this study to inform fishery management decisions relating to use of the project area or nearby areas.

The use of video tools to observe organisms present in the project area has distinct advantages over other methods of assessment. While traditional survey methods of hook-and-line, trawling, and or crab pots allow for higher taxonomic resolution and biometric data on individuals (ex. sex, weight), they fail to provide either behavioral information of precise habitat utilization and/or actual interactions with the device. Capture methods also often result in the take (or killing) of the sampled organisms. Video techniques do allow for direct observations of the organisms in the habitat and provide better taxonomic resolution than hydroacoustic survey methods. Videos also provide a long-term archive of information that can be reviewed in the future to revisit existing research questions or investigate new questions. These video records additionally may be valuable in terms of identifying entangled gear and other debris and/or maintenance issues on the WECs and/or mooring systems before they become larger problems.

3. Goals/Objectives

The overall goal of this organism interaction monitoring plan is 1) to track changes to pelagic and demersal fish and invertebrates (particularly Dungeness crab) that might be (a) attracted to the installed components or (b) affected due to the potential for reduced fishing pressure, and 2) to track biofouling on the anchors/devices. The information will be provided by the licensee to ODFW for the agency's use in managing ocean and coastal resources.

3.1 Study Objective

The presence of Project components will introduce hard substrate previously unavailable in the project area. We expect these components to be colonized by fouling organisms over time, as well as to potentially attract mobile invertebrates and fish to the area. The objectives of the organism interaction monitoring are to assess differences in the timing, abundance, and size classes of fish and invertebrate species or species groups that colonize or associate with different types of project structures on the bottom and in the water column.

4. Data Collection and Analysis

4.1 Methods & Equipment

An ROV will be used for monitoring of biofouling, structure-oriented fish, and distribution of organisms surrounding installed components in the test berth area. The ROV will have forward and downward facing video cameras with live feed to the support vessel. The ROV also will be equipped with a Tritech Gemini multibeam imaging sonar to evaluate whether there are fish beyond the camera's visual field that may avoid the ROV. The ROV will have a pair of lasers at a fixed width to assist with sizing organisms. A single pre-installation (pre-WEC installation) survey will be conducted in the spring/early summer period before the first devices are deployed at PacWave South, as described in Section 4.2.1 below, to obtain pre-installation abundances of benthic and lower water column organisms at the test site as well as gain insight on visibility/detectability of seafloor organisms at the test site. Once WECs are deployed, sub-surface components and the surrounding seafloor will be surveyed using videographic observations from ROVs at the frequency described in Section 4.2.1, below. While on the vessel, the live video feeds will be watched in real time by a dedicated observer and notes will be taken regarding ocean and seafloor conditions and organisms seen. Any derelict gear observed while at sea will be reported as detailed in the Entanglement Mitigation Measure, and appropriate actions will be taken according to the terms of the Mitigation Measure. Additionally, any derelict gear observed during processing of the video in the lab will be compared to at-sea observations and any additional observations will be reported and acted upon per the terms of the Mitigation Measure. Each organismal community to be monitored is described in more detail below.

4.1.1 Structure-associated, water-column fishes

Each sub-surface component type (both WECs in the water column with associated moorings and anchors on the bottom) will be observed for mobile, water-column organisms associated with the structure. To accomplish this, the ROV will partially circle the subsurface components from decreasing distances towards the device to assess the number and species of fish visible in each swath. A similar approach was determined to be effective for assessing fish communities on submerged oil and gas platforms (Ajemian et al. 2015). We will drop the ROV in the water ~25 m away (using a range-finder on the surface) from the WEC (on the downstream side). The ROV will be flown to the first position: 10 m below the surface, 20 m away from the WEC, where it will be held stationary with the camera facing up-current for a 1 minute period [a modified stationary point count (SPC)]. After the stationary observation, the ROV will navigate along a continuous horizontal rove partially around the structure from near one mooring line to near the next. Then we will instruct the ROV to move closer (e.g., to ~10 m away), do a SPC followed by a semi-circular swath, then move ~1-2 m from the WEC to do a SPC followed by a semi-circular swath. At no point would we attempt to maneuver the ROV across or under the mooring lines. Thus, if a WEC is on a three point mooring, the semi-circular swaths would cover an arc of just under 120°, as illustrated in Figure 3. If the draft of the WEC under observation does not extend to 10 m below the surface, we will attempt to conduct the WEC observations as near to the base of the WEC/surface of the water as possible with the caveat that operations closer to the surface make navigation and station keeping for the SPCs more challenging. Then we will instruct the ROV to dive to a position ~20 m away from the expected position of an anchor, 1-2 m above the bottom. Then SPCs and semi-circular swaths will be conducted moving toward the anchor. We would then transit along the sea floor to the second anchor, conducing SPCs with semi-circular swaths as we approach.

This navigational task will be accomplished using a commercial AUV navigation system on the ROV combined with the open-source Robot Operating System (ROS) in an integration developed by the Hollinger lab at Oregon State University (Lawrance et al. 2016). In brief, the system allows for autonomous station keeping as well as traveling between known positions. In 2016 field trials, the ROV was able to reach and traverse between waypoints to within approximately 1 m with respect to the internal navigation determination. Once the position of the WEC is known (after deployment) we will develop dive plans for the ROV that will include the paths of the roves.

If multiple sub-surface components of the same type are deployed in a berth, we will attempt to sample at least two of the same type. For example, if a WEC is on a 3-point mooring (3 anchors), then we anticipate we likely will be able to survey the two anchors on the downstream side of the WEC, as it is preferable to maneuver the ROV against the prevailing current rather than go with the flow and potentially be swept into the object of interest. If multiple WECs are deployed within a berth the configuration of the array will affect how many of the individual WECs/anchors can be surveyed; however, our goal will be to get at least three observations of each WEC and anchor types.

Although we do not expect a high likelihood of observing mid-water fish in reference areas, as we are descending for the reference band transects (described below), we will pause at 10 m below surface and do an SPC (with multibeam imaging sonar) before continuing the descent to the seafloor.

4.1.2 Biofouling

Focal observations of major sub-surface components (e.g., WEC, anchor) will be made following the closest swath survey conducted on each component as described above. As practical, multiple (2-3) observations on different faces of the same component type will be made. If there are multiple components of the same type (e.g., anchors), at least two anchors (those on the down-current side of a WEC) will be observed in each berth as described above. Additional anchors may be observed as possible. During the focal inspection, the ROV operator will perform a slow pan of the structure of interest, primarily using the forward camera to observe the structure. During anchor observations, the downward camera will be used to observe scour and organisms in the sediment adjacent to the anchors.

4.1.3 Benthic fishes and invertebrates

The ROV will conduct band transect surveys within the individual test berths in use among the bottom-mounted components on the seafloor. We will conduct 3 transects each at least 100 m long within each berth. This will enable standardized abundance estimates of benthic fishes and invertebrates at and between the different bottom-mounted components.

Band transect surveys also will be conducted at pre-determined reference areas outside of the PacWave South Project Site to determine the density of benthic fishes and invertebrates that would be expected in the area in the absence of the installation. We will conduct 6 reference transects each at least 100 m long outside of the Project Site: two north and two south of the Project Site at depths that match the test berths as well as two inshore of the Project Site, which will necessarily be shallower.

Additionally, although the cables will be buried for nearly the entire length, one of the cable routes will be surveyed as part of each semi-annual ROV cruise. (Thus each of the five cables will be surveyed every 2.5 years.) This will include the unburied portions near the sub-sea connector as well as the buried route back towards shore. We will follow the expected route based on GPS coordinates as well as use all reasonably available tools to orient along the cable.

4.1.4 Video processing

Trained personnel will process collected videos in the laboratory. Videos from the forward-looking and downward-looking cameras will be viewed simultaneously on stacked monitors. The forward-looking versus the downward-looking cameras will be the quantification view depending on the type of observation, as described below. If time codes are recorded onto the audio track of the video footage, a time code wedge will be used to record the time (on the video) of each organism observation, which can be useful for re-finding species of interest on the footage during data analysis.

For the semi-circular swath observations, all organisms encountered on each rove, swath, and SPC will be identified to the lowest possible taxonomic level and enumerated. Because the start/stop time will be logged for each individual rove, swath, and SPC, we will be able to compare the numbers of individuals observed during each survey component. Fishes will be classified as juveniles, sub-adults, or adults (as appropriate for the species), based on size determined using the lasers. Crab and seastar sizes will be estimated using the lasers. We anticipate that with each view of the subsurface components (at different distances), we will count some organisms that had been observed and counted in the previous view. Thus, at each SPC and over the course of the encircling rove, we will determine the maxN (the maximum number of fish for a given species) within the field of view, a commonly used metric (e.g., Merritt et al. 2011; Cappo et al. 2004; Cappo et al. 2007; Harvey et al. 2007) and note observed behavior. (This metric is sometimes referred to as MinCount because it represents the minimum number of individuals for a particular species during a dive; Ellis and DeMartinie 1995, Watson et al. 2005, Willis et al. 2000). As feasible, we will use the distance travelled over the bottom to convert numbers of each species observed in the water column on the rove to standardized abundances. If we are not able to determine distance travelled, organism counts will be standardized by survey time using the start and stop time of each rove and SPC. As the ROV is transiting from the WEC to the anchors, any fish and/or schools of fish will be documented and reported. However, we do not intend to quantify densities of organisms detected in these “off transect” observations. Upon the approaches to the anchor, in addition to quantification of organisms, we will review the footage to look for evidence of scour. Since we will be conducting slow swaths at three distances, if we detect scour in close proximity to the anchors using this video tool, we will be able to delineate the extent at least relative to the three distances. If we detect scour at all visual survey distances and suspect the extent is broader, we anticipate it would then be detected by the within-berth band transects if they are conducted in the direction of the scour and, if very wide-spread, by sediment analysis of the box core grabs, which begin at 50 m away from the anchor.

For each of the Project component focal observations, the percent cover of fouling on the component will be determined. All organisms will be identified to the lowest possible taxonomic level. We anticipate for the initial observations, total percent cover or perhaps percent cover of film/invertebrates/algae will be the lowest possible taxonomic level. As the community develops, we may be able to distinguish general classes of fouling organisms (e.g., sponges, ascidians, barnacles, bryozoans, mussels), and the percent cover of each will be determined. As the community further matures, fouling species may be distinguished. Additionally, mobile organisms such as seastars, anemones, and crabs observed on the structures will be identified and sizes estimated using the lasers. A challenge to using video techniques for assessing biofouling can occur if you have many canopy-forming and sub-canopy species, making it difficult to observe, let alone identify, all the organisms on a surface. We do not anticipate this will be an issue for assessing biofouling on the anchors as they will be at ~70 m, well below the photic zone, and we did not observe or collect algae on the Ocean Sentinel anchors which were deployed for over two years in shallower waters. Canopy-forming invertebrates such as anemones or those with lots of interstitial spaces such as mussels can present similar challenges for quantifying smaller organisms. However, as described above, we did not observe these species on the Ocean Sentinel anchors at NETS. The extent of biofouling on anchors will vary based on anchor type, complexity of the structure, duration of installation, and height above the seafloor where the potential for abrasion is highest. We recognize that the WECs themselves could support growth of larger organisms (e.g., algae, gooseneck barnacles, mussels; Figure 1) as we collected from the Ocean Sentinel floats, although the algae on the floats was small turf algae, and the floats were not coated with anti-fouling paint.

For the band transects (pre-test, between device components, and reference transects) standard analysis procedures will be used (e.g., Tissot 2008). Along each transect, the substratum type will be classified (mud/sand/coarse sand/shell hash) and the presence of "litterfall" will be delineated, and all organisms larger than 5 cm will be identified and enumerated. (If we observe large aggregations of small individuals that cannot be enumerated, we will report their occurrence but will not attempt to quantify them.) Benthic epifauna, some endofauna taxa showing recognizable body parts above the sediment, and fish will be identified to the lowest possible taxonomic level and enumerated. We will use the distance travelled over the bottom to convert numbers of each species observed along the transect to standardized abundances. If we are not able to determine distance travelled, organism counts will be standardized by survey time using the start and stop time of each transect. Fishes will be classified as juveniles, sub-adults, or adults (as appropriate for the species), and crab and seastar sizes will be estimated using the lasers. When interesting behaviors are observed (e.g., crabs feeding on litterfall), they will be documented and reported. Again, this footage also may be used for quantification of the spatial extent of scour.

4.1.5 Sonar processing

The use of the multibeam imaging sonar will allow us to estimate the presence of fish that may disperse beyond the field of view before the ROV gets close enough to see them on the optical camera. A suite of metrics may be used to quantify variability of pelagic nekton biomass detected by the multibeam sonar including density, aggregation, center of mass, and dispersion, which have been used to describe a wide range of aquatic organism distribution attributes (Urmy et al. 2012). These metrics, as appropriate, will be compared among structure types. Acoustic images will be analyzed as described below in 4.4.2, and compared to optical information to determine if fish may be avoiding the ROV. However, acoustic images will likely be insufficient in detail to identify species.

4.2 Schedule & Frequency

4.2.1 Within Site

A single pre-installation ROV survey (pre-WEC installation) will be conducted as early as technically feasible (e.g. ocean conditions conducive to effective monitoring) without jeopardizing human safety, property and the environment in the spring (mid-March to mid-June) prior to our first anticipated testing client. During this survey, we will carry out the survey described in section 4.1.3 – the seafloor band transects. For this survey, we will survey transects at 6 locations outside of the Project Site (the Reference transects) as well as 6 transects randomly placed inside the Project Site. Before diving for each set of transects, we will pause at 10 m below the surface to do a SPC, as described at the end of 4.1.1 above.

Seasonal ROV surveys will be conducted twice per year targeting spring (mid-March to mid-June) and fall seasons (late August to late October) with a minimum of 3 months between data gathering events that meet the objectives of this plan. Spring surveys will be conducted as early in the season as technically feasible to minimize risk of entanglement as described in mitigation measure 3. This schedule likely will result in any new installation being surveyed within three months of deployment (as we anticipate summer deployments that would be observed by the fall survey). During those semi-annual surveys, all test berths with WECs installed in them will be surveyed. If multiple structures of the same type are installed in a single berth (e.g., > 3 anchors of the same type) a subset of those structures may be observed on each survey. Semi-annual surveys will continue for at least three years of deployed WECs and anchors.

After three years of semi-annual surveys, if no devices are under test, any hardware remaining in the water will be surveyed once every three years. If survey results indicate consistent and predictable species associations over time (i.e., no significant differences observed in species diversity, density/ maxN, or total number of fish observed in spring versus fall on the multiple WEC, anchor or mooring types/configurations), then for the next 7 years ROV surveys for the purposes of organism interaction monitoring will be conducted annually when WECs are present. After 10 years of ROV surveys, the licensee will consult with the AMC regarding the frequency/need of continued organism interaction ROV surveys. This timeline is based on documented observations where colonization of an artificial reef showed fluctuations in species abundance within the first two years, but after two years most of the species that dominated or characterized the reef after five years had already settled (Hiscock et al. 2010). Of course, the situation at PacWave South may differ since the same structures may not be in place for a continuous three years, so the “stabilization” of species recruitment observed by Hiscock et al. after two years may not be observed at PacWave South.

4.2.2 Cable Route

For biological purposes, one of the cable routes will be surveyed as part of each ROV cruise, including the “pre-WEC installation” survey. Thus, with five cables, each one will be surveyed once after the first 2.5 years of semi-annual sampling and each will be surveyed at least a second and possibly a third time by the end of the 10 years of ROV surveys. This schedule is based on the assumption that all seafloor cables will be entirely and continuously buried, and does not preclude additional observations that may or may not occur for maintenance purposes. If installation or post-construction survey of the cables indicates unburied segments, the licensee will consult with the AMC regarding the appropriate frequency of organism interaction ROV surveys.

4.3 Constraints & Limitations

A constraint in developing this monitoring plan is the variability associated with the Project as a test center. To overcome that, we have written this study to be applicable to deployments of various size, number, and location of device components, the distance between them, and the number and type of mooring hardware associated with the Project components of interest. The major constraints of any ocean-going field project are weather conditions and vessel availability. However, we are confident we can successfully conduct surveys sometime in the mid-March to June window and again in the August to October window.

The ability to implement ROV surveys is subject to weather and safety constraints. OSU will notify the AMC within 10 days of the close of each seasonal window (end of June/October) if it seems likely we will not be able to complete the sampling within that window to discuss whether sampling should be attempted in the next month or deferred until the following season. Furthermore, any inability to perform this study within the time period or spatial extent described here would be communicated to members of the AMC within 10 days from the date determined by OSU that it is unable to complete the tasks identified in this plan, and a contingency plan would be developed and submitted to the AMC within 30 days after notification.

4.4 Analysis

4.4.1 Analysis of video observations

For the SPCs and semi-circular swath surveys, the maxN of different species as well as total number of fish observed and overall diversity will be compared along distances from the structure and among structure types. Within species, we will investigate if different size classes are present associated with the WEC (at 10 m below the surface) versus at the anchors (1-2 m above bottom) or at varying distances away from the structures and/or among structure types.

For the focal observations, percent cover or density (as appropriate) of different biofouling organisms (as identifiable) will be determined and compared among structure types (using either faces of the structure or multiples of the same structure type as replicates). The diversity of fouling organisms also will be compared among structure types. If structures are left in place over long periods of time (perhaps anchors that are re-used) we will (eventually) develop histograms to display the arrival, growth, and succession of major colonizing species.

For the band transects, data will be analyzed as described in Hemery and Henkel (2016). In short, multivariate analysis will be conducted to assess the similarities and/or differences in the organisms along position on transect (distance from a structure), within versus outside the site, and in association with any particular substratum type. We also will conduct univariate analyses on total diversity and abundance against these factors. For particular fish species and Dungeness crabs, we will investigate if different densities and/or size classes are present by comparing size and density distributions before versus after installation of project components, in varying distances away from the structures, among structure types, or within versus outside of the Project Site. Berth-specific visual surveys will allow us to determine if different structures are differentially attractive (versus a baited capture survey where we might catch organisms in one berth that were utilizing habitat in another berth). We also will compare detections of fish using the imaging sonar on the band transects within the Project Site to the reference ROV band transects conducted outside the Project Site.

Visual surveys also allow for behavioral observations, rather than just whether organisms are captured more inside or outside of a particular area (which can be influenced by attraction to bait). For example, with visual surveys we can assess whether crabs are burying near an anchor, using it as additional shelter, or if they are foraging on the organisms growing on the anchors. We will be able to observe whether the density of buried crabs changes in conjunction with sediment changes (if changes in sediment are observed) with increasing distance away from an anchor or inside versus outside the project area. We also will determine and report the ratio of Dungeness crab to rock crab at varying distances away from the structures and/or among structure types.

4.4.2 Analysis of sonar observations

The number of targets in the acoustic images will be compared among structure types, and we will attempt to assign the acoustic targets to a species group. The use of the multibeam imaging sonar will allow us to estimate the presence of fish that may disperse beyond the field of view before the ROV gets close enough to see them on the optical camera. We will compare and report the number of targets (individual fish) or aggregations (schools of fish) detected acoustically using the sonar with the numbers of fish/schools of fish detected visually using the cameras and determine the percent of acoustically-detected targets that were not detected using the visual tools.

5. Results

For the semi-circular swath surveys, we will summarize findings including the total number of fish observed and the relative abundances of different fish species at different distances for the floating (WECs) and bottom (anchor) structures. By comparing the relative abundance of fish across the different distances away from the floating structures, we will be able to describe the spatial pattern of any fish attraction effect and how far it extends. Comparisons among WEC/anchor types will inform us if differently shaped/sized components have different levels of attractiveness or attract different species. A species list including number of individuals and life stages of each species observed during each survey, as well as over time, will be provided.

The results of the focal observations for biofouling will include graphical representation of percent cover and/or density (as appropriate for the organism type) on different components. A species list including number of individuals and life stages of each species observed during each survey, as well as over time, will be provided.

For the band transects, we will report the densities of organisms along the in-berth transects as compared to the reference transects. We will report the densities of organisms as a function of distance away from structures. We will report the results of all multivariate and univariate analyses described above. Again, if we observe large aggregations of small individuals that cannot be enumerated, we will report their occurrence. A species list including number of individuals and life stages of each species observed during each survey, as well as over time, will be provided.

6. Reporting

Once the activities under this plan commence, they will be reported annually in OSU's Annual Report, which will be filed with FERC and provided to the AMC. The annual reporting will include the components described below; it will also identify any relevant new information considered in the findings or future monitoring.

6.1 Monitoring Summary

OSU will summarize all activities undertaken in implementing the monitoring plan, including a table with monitoring dates and locations if appropriate. In the unlikely event that OSU must deviate from this plan for reasons outside of its control (e.g., delayed sampling due to adverse weather conditions that pose risk to human safety) it will describe any deviations from the monitoring plan as reported to the AMC and discuss implications of any such deviations.

6.2 Results & Conclusions

The AMC will discuss the monitoring results and any significant findings or conclusions. The AMC will be given the opportunity to provide feedback on the study results prior to any official filing, and if they exist, OSU will describe any disagreements over characterization of results in its final report.

6.3 Future Monitoring

OSU will describe in each Annual Report monitoring activities that are planned for the next reporting period. OSU will provide any proposed modifications to the monitoring plan and rationale for the changes to the AMC.

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Figures


Figure 1. Photo quadrats taken from the Ocean Sentinel surface floats after over two years of deployment. The photo on the left is the quadrat that had the least percent cover and the photo on the right had the most percent cover of all 6 quadrates (2 on each of the 3 floats).


Figure 2. Photo quadrats taken from the Ocean Sentinel anchors after over two years of deployment. The photo on the left is a side of the anchor and the photo on the right is the top of the same anchor.

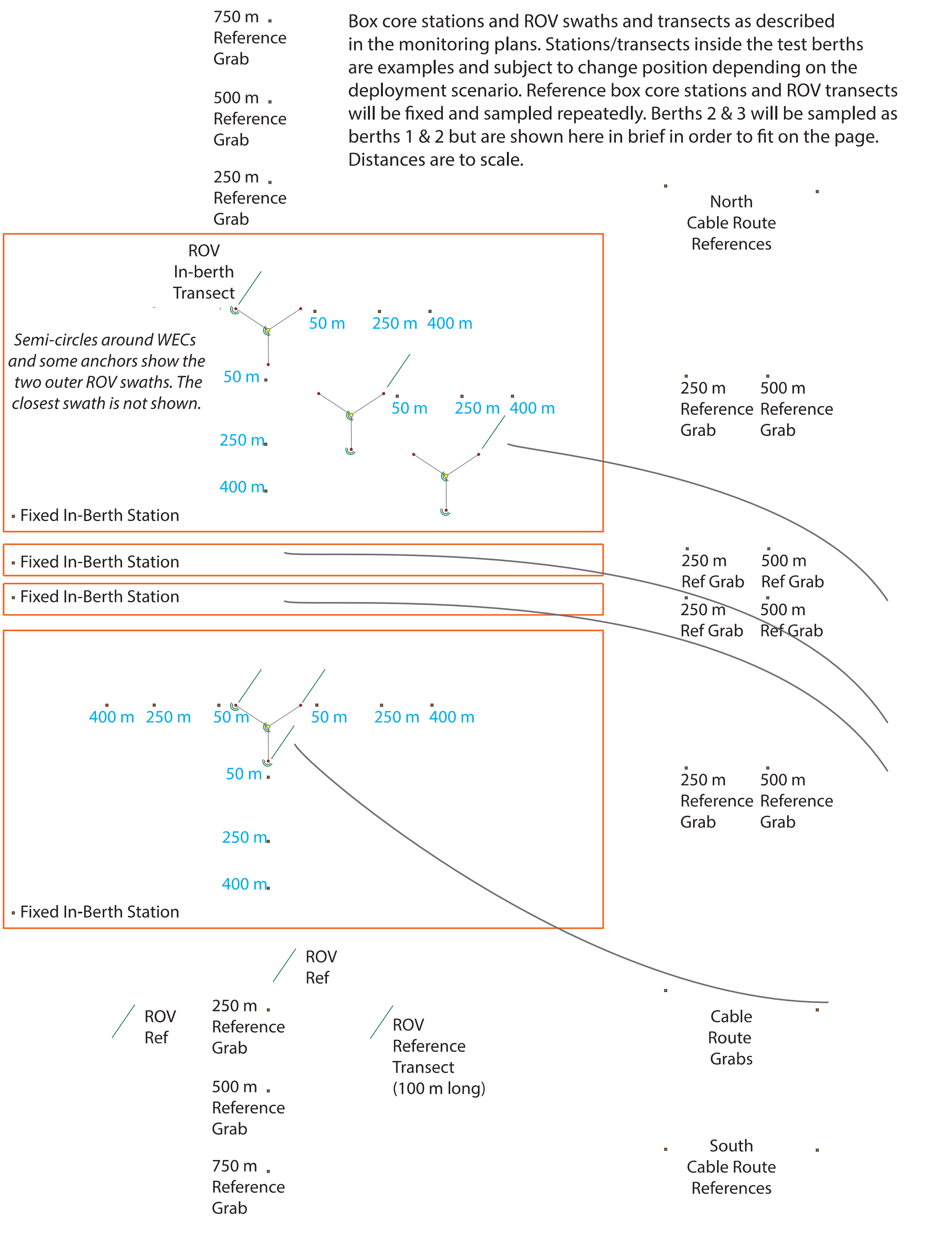

Figure 3. Benthic and organism interaction monitoring schematic. Within berth station distances are relative to the project component . Reference grab distances are relative to the site boundaries.

H-3
Monitoring Plan – Acoustics

MONITORING PLAN - ACOUSTICS

CONTACT: DAN HELLIN, OPERATIONS & LOGISTICS MANAGER, PACWAVE
P: 541-737-5452 DAN.HELLIN@OREGONSTATE.EDU

PRINCIPLE INVESTIGATOR: DR. JOSEPH HAXEL, ASSISTANT PROFESSOR, 541-867-0282 HATFIELD MARINE SCIENCE CENTER, JOE.HAXEL@NOAA.GOV (NOTE: STAFF CHANGES MAY OCCUR, BUT OSU FACULTY MEMBERS WILL LEAD THIS STUDY)

1. INTRODUCTION/OVERVIEW

1.1. Resource(s) of Interest/Existing Environment

Ambient sound in the marine environment originates from both natural and anthropogenic sources, such as commercial and recreational vessel traffic, wave action, marine life, and atmospheric sound. Sound in the ocean may affect marine species in a variety of ways, ranging from no effect to acute lethal effects. Responses to sound can be highly variable depending on the acoustic characteristics of the sound (e.g., frequency, amplitude, and duration), non-acoustic characteristics of the sound source (e.g., stationary or moving), environmental factors that affect sound transmission, the sensitivity of an animal's hearing, the behavioral or motivational state at the time of exposure, and past exposure to the sound which may have caused habituation or sensitization (NRC National Research Council 2003). A key component for assessing effects from sound exposure is rooted in determining whether animals can detect and are sensitive to sound generated above ambient levels. Further complications arise as marine animals may detect sounds above and below existing regulatory guidance threshold levels that fail to elicit a response, either behavioral or physiological.

The PacWave South (formerly known as Pacific Marine Energy Center South Energy Test Site [PMEC-SETS]) Project area and surrounding region experience considerable vessel traffic related noise from the Port of Newport, which is home to the west coast's largest commercial fishing fleet as well as a seasonally active sport fishing community. In addition, the commercial towlanes for tug and other vessel operations pass close to the site. Energetic weather conditions (surf, wind, rain) and acoustically active marine mammals also make significant contributions to ambient noise levels. In 2010, Haxel *et al.* (2013) collected passive acoustic data to characterize low frequency ambient conditions up to 840 Hz at PacWave North (formerly known as Pacific Marine Energy Center North Energy Test Site [PMEC-NETS]), which is located approximately 8 nm NNE of the PacWave South area. Despite the measured maximum value of 152 dB, less than 1% of the SPL_{RMS} measurements surpassed the 117 dB level, meaning that less than 1% of the measurements were between 117 dB and 152 dB (Haxel et al. 2013). In 2015, Haxel (2016) collected baseline ambient noise levels over an approximately 6 week period in the southern region of the SETS area for site characterization. SPL_{RMS} from 7 Hz – 13 kHz was used to generate a cumulative distribution function (CDF) of noise levels where the 50th percentile (101 dB_{RMS} re:1 µPa) was representative of a "typical" background sound level at SETS. Baseline monitoring recorded minimum SPL_{RMS} levels for this time period of 83 dB_{RMS} re:1 µPa, while local vessels generated the maximum RMS sound pressure level (138 dB_{RMS} re:1 µPa) from a total of 61,380 SPL_{RMS} values. Despite the measured maximum value of 138 dB, less than 1% of the measurements surpassed the 116 dB level at SETS (Haxel 2016).

Ambient sound levels in the SETS Project area were also influenced by the three types of dominant acoustic sources experienced at NETS: environmental processes, anthropogenic activity, and marine mammal vocalizations.

1.2. Potential Effects/Issue Summary

Vessels used during Project construction, operations, and environmental monitoring would generate underwater sound, which could result in avoidance by marine mammals, fish, and seabirds (DOE 2012). However, these effects would be minor and temporary (i.e., hours) with exposure to the stressor limited to locations and times where marine life are in close proximity to the sound source. Furthermore, the types of vessel noise would be familiar to marine life in the area; similar to existing commercial, fishing, recreational, and research vessel activity, which have not been shown to have significant impacts on marine mammals, fish or seabirds.

During Project operations, sound is expected to be generated by the moving components of the WECs, mooring components (e.g., chain noise) and water flowing past and splashing against Project structures. The maximum sound pressure level (SPL) attributed to Columbia Power Technologies' 1/7-scale WEC was measured from 116 to 126 dB re: 1 µPa in the integrated bands from 60 Hz to 20 kHz at distances from 10 to 1,500 m from the SeaRay (Bassett et al. 2011). From this, the SPL was estimated at 145 dB re: 1 µPa at 1 m and 126 dB re: 1 µPa at 10 m (Thomson et al. 2012, as cited in NAVFAC 2014). In the EA prepared for the Hawaii Wave Energy Test Site, engineers conservatively assumed that a full-sized WEC would be 3–6 dB louder than the 1/7 scale version, and estimated that the maximum SPL for a WEC would be 148–151 dB re: 1 µPa at 1 m and 129–132 dB re: 1 µPa at 10 m (NAVFAC 2014). Cumulative sound over a 24 hour period generated by operating WECs is expected to be lower than the temporary (TTS) and permanent threshold shift (PTS) onset thresholds for injury level for low (LF) to mid-frequency (MF) cetaceans for non-impulse noise (178 & 179 dB re 1 μPa^2s for TTS and 198 & 199 dB re 1 μPa^2s for PTS) or Phocid (Pw) and Otariid (OW) pinnipeds (181 dB & 199 dB re 1 μPa^2s for TTS and 201 dB & 219 dB re 1 μPa^2s for PTS), but WEC operation might generate underwater sound exceeding the 120 dB_{RMS} re 1 µPa threshold for marine mammal behavioral disruption within a zone of influence (R_2) determined using a practical spreading loss model (NMFS 2012b) from an acoustic measurement made at a distance (R_1) from the WEC.

$$R_2 = R_1 * 10^{((dB_{R1} - 120dB)/15)}$$

While the Project is not expected to generate sound at levels that could cause injury to marine mammals, Project-related underwater sound has the potential to affect marine mammals by interfering with communication, prey and predator detection, and migration. The temporal and spatial scales of the acoustic disturbance depend on factors such as the amplitude, spectral characteristics and exposure duration of the sounds generated by the Project.

2. NEED FOR INFORMATION

There is limited information available on underwater sound generated by operating WECs. The acoustic monitoring proposed for this project will identify and characterize noise generated during WEC installation and operational WEC testing phases and allow for comparisons with regulatory thresholds. The information will be used to inform implementation of Mitigation Measure 7 and/or to modify this monitoring plan as necessary to ensure protection and conservation of marine resources from potential effects of Project-related sound.

3. GOALS/OBJECTIVES

The goal of monitoring is to provide information for use in decisions to change, add, increase or otherwise modify mitigation measures as necessary to mitigate for acoustic effects resulting from project operations. Acoustic monitoring will provide the data necessary for: 1) characterizing the level and signature of sound from various project components; and 2) allowing for comparison to established sound thresholds to minimize the potential for exceedance of TTS and PTS onset at any time and to determine the extent to which sound is in excess of the 120 dB_{RMS} threshold for harassment. The information will be used to inform implementation of Mitigation Measure 7 and/or to modify this monitoring plan as necessary to ensure protection and conservation of marine resources from potential effects of Project-related sound.

3.1 Study Objective

The objective of this study is to conduct both rapid assessment and long-term passive acoustic recordings to assess Project generated sound levels throughout the range of all likely environmental conditions and vessel activity to confirm regulatory sound exposure threshold criteria are not exceeded or determine if and when criteria are exceeded. Recordings will provide quantitative measurements outlining the acoustic stressor levels of Project activities within the statistical framework of ambient sound levels derived from long-term site characterization and pre-installation measurements of acoustic conditions at the SETS. The information will be used to inform implementation of Protection, Mitigation and Enhancement Measure 7 and/or to modify this monitoring plan as necessary to ensure protection and conservation of marine resources from potential effects of Project-related sound.

4. DATA COLLECTION AND ANALYSIS

Acoustic recordings and analysis will be conducted using moored autonomous underwater hydrophones (AUHs, Fig. 1) and acoustic drifting underwater hydrophones (ADUH, Fig. 2); data analysis will be conducted following NMFS guidance (NMFS 2016). The AUH and ADUH hydrophone systems will be configured to provide frequency content in the required 7 Hz – 20 kHz range most likely to impact living marine resources in the region. Additionally, available data although limited, indicates that sound from WEC devices would rarely occur above 20 kHz for WEC devices based on monitoring in the UK and Lake Washington (Bassett et al. 2011; Tougaard 2015) thus monitoring is limited to 20 kHz on the upper frequency range.

4.1 Methods, Equipment and Schedule

Drifting Hydrophones

For rapid measurements of post-installation WEC-generated noise levels, acoustic drifting underwater hydrophone (ADUH) recordings will be collected within at least a 100 m range of each newly installed device. These recordings will be performed as rapidly as possible, no later than 10 days after the WEC is operational. If further delays (due to weather, ship scheduling, personnel availability, etc.) look likely, OSU will inform NMFS of the logistical challenges and propose a revised schedule prior to reaching the end of the 10 day deployment window. The ADUH will be deployed up current or nearby the WEC target and allowed to drift in the prevailing ocean current for no less than 0.5 hr during each drift to enable the hydrophone sensor to equilibrate and stabilize, thus improving the quality of recordings. Drifting hydrophone monitoring will be conducted until a minimum of 1 hour of recording around each newly installed WEC/WEC array has been collected, and therefore may require multiple drifts. In the event that drifts are unable to capture recordings within a 100 m radius of the WEC, a practical spreading loss model (NMFS 2012b).

$$TL = 15\, log\left({}^{R_2}/_{R_1}\right)$$

will be used for estimates of received levels at ranges less than 100 m from each WEC. Maximum measured noise levels will be reported to NMFS no later than 3 business days after collection of ADUH recordings. Assessment of WEC source level/acoustic signature and relation between received sound levels and sea state/power generation state will require detailed analysis. An oral report will be made to NMFS within 45 days of survey completion describing the survey and presenting preliminary results. A written report will be provided within 90 days of survey completion. This free drifting hydrophone approach is limited to a subset of low energy environmental conditions and may not be representative of WEC generated noise levels at higher sea states.

Moored Hydrophones

To address measurements of WEC generated noise levels through a variety of environmental conditions, long-term recordings will be conducted using an array of moored hydrophone systems (Fig. 1, in accordance with NMFS (2012b) guidance) around the Project Site and a specialized seafloor mounted lander hydrophone system (described below) within each WEC berth.

Perimeter Array: Accurate timing inherent to the hydrophone acquisition systems and careful spatial configuration of the array around the perimeter of the Project Site will potentially enable detection and localization, or at least bearing information, for discrete WEC-generated signals, provided noise generated by WECs is of sufficient amplitude to reach the outer hydrophone sensors of the array. An array of four hydrophone lander systems surrounding the Project site will be deployed prior to the first WEC installation with hydrophone systems deployed at ~ 2 km spacing. This spacing is required to allow for adequate travel time differences in the propagating WEC generated signals for array based localization and/or bearing efforts. These calculations will not be performed until the entire array is recovered and redeployed every 6 months. The perimeter array will be maintained continuously for the first 5 years of the project, assuming at least two WEC tests have been conducted. The purpose of this component of the monitoring is to track how ocean noise and potentially WEC-generated noise vary with sea state, and it not likely to be used for mitigation actions. The array configuration will allow for identification of which berths are generating sound signals of interest. As stated above, an oral report will be made to NMFS within 45 days of the moored survey completion describing the survey and presenting preliminary results. Detailed results will be included in the SETS Annual Report.

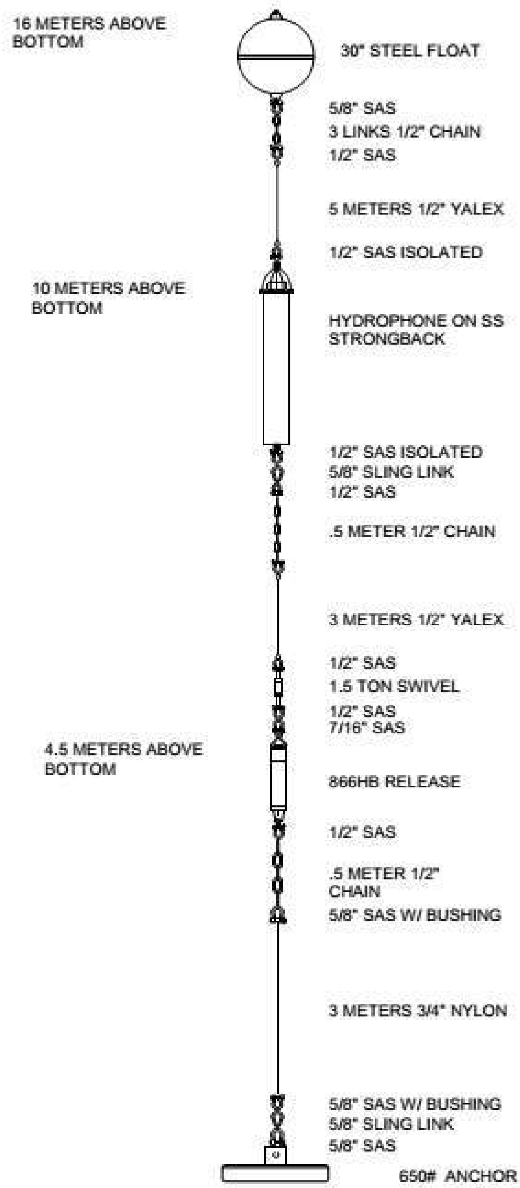

Figure 1 – Moored autonomous underwater hydrophone

Specialized Seafloor Lander Hydrophone System: Within each active berth, a specialized seafloor lander hydrophone system will be deployed at a target distance of 100 m from the outermost WEC. This hydrophone mooring will consist of a new NOAA/PMEL developed Real-time Acoustic Observing System II (RAOS II) including satellite and cell-phone (GSM) telemetry for active monitoring and reporting of sound from the project. The RAOS will be deployed within two weeks of a WEC installation (unless there is already one deployed in a berth), weather permitting, and remain operational for the remainder of the test at which time it will be recovered. The primary purpose of this component is to address management needs (Protection, Mitigation, and Enhancement Measure 7) for rapid reporting and identification of the berth in which the issue is occurring. Each RAOS system consists of a seafloor package and surface mooring spaced 10-30 m apart (Figure 3): 1) a surface buoy with satellite/GSM receive and transmission capabilities; and 2) a subsurface hydrophone lander mooring for acoustic recording and real-time data processing. The hydrophone lander instrument has a configurable onboard event detection system that will calculate SPL_{RMS} received levels. If an exceedance event occurs (SPL_{RMS} > 120 dB), the hydrophone system communicates with the surface buoy via acoustic modem and will be programmed to send diagnostic information via Iridium satellite to shore. This information will include time of the event, dB_{RMS} level, and importantly a small spectrogram surrounding the event to distinguish the sound source (e.g., passing vessel, WEC noise, surf noise). The RAOS system located within each berth will provide near real-time monitoring capabilities of project related noise as well as the ability to monitor data collection efforts and ensure data quality in a timely manner.

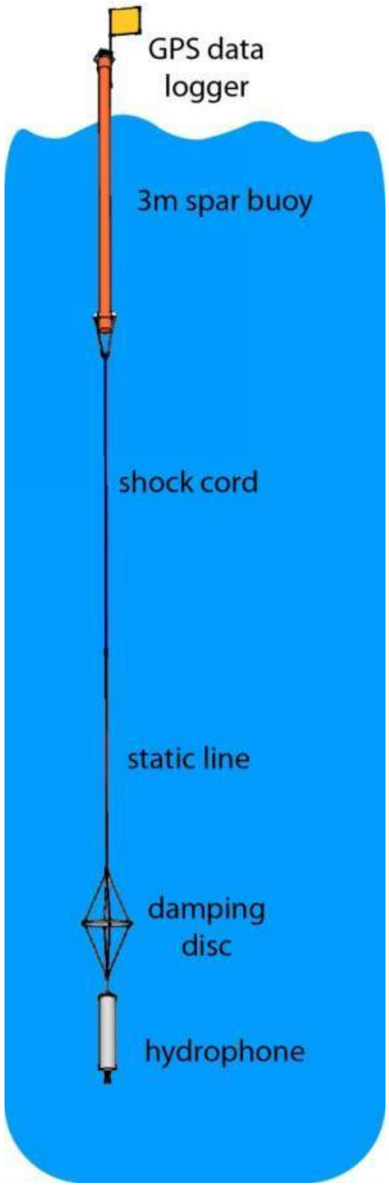

Figure 2 - Drifting autonomous underwater hydrophone

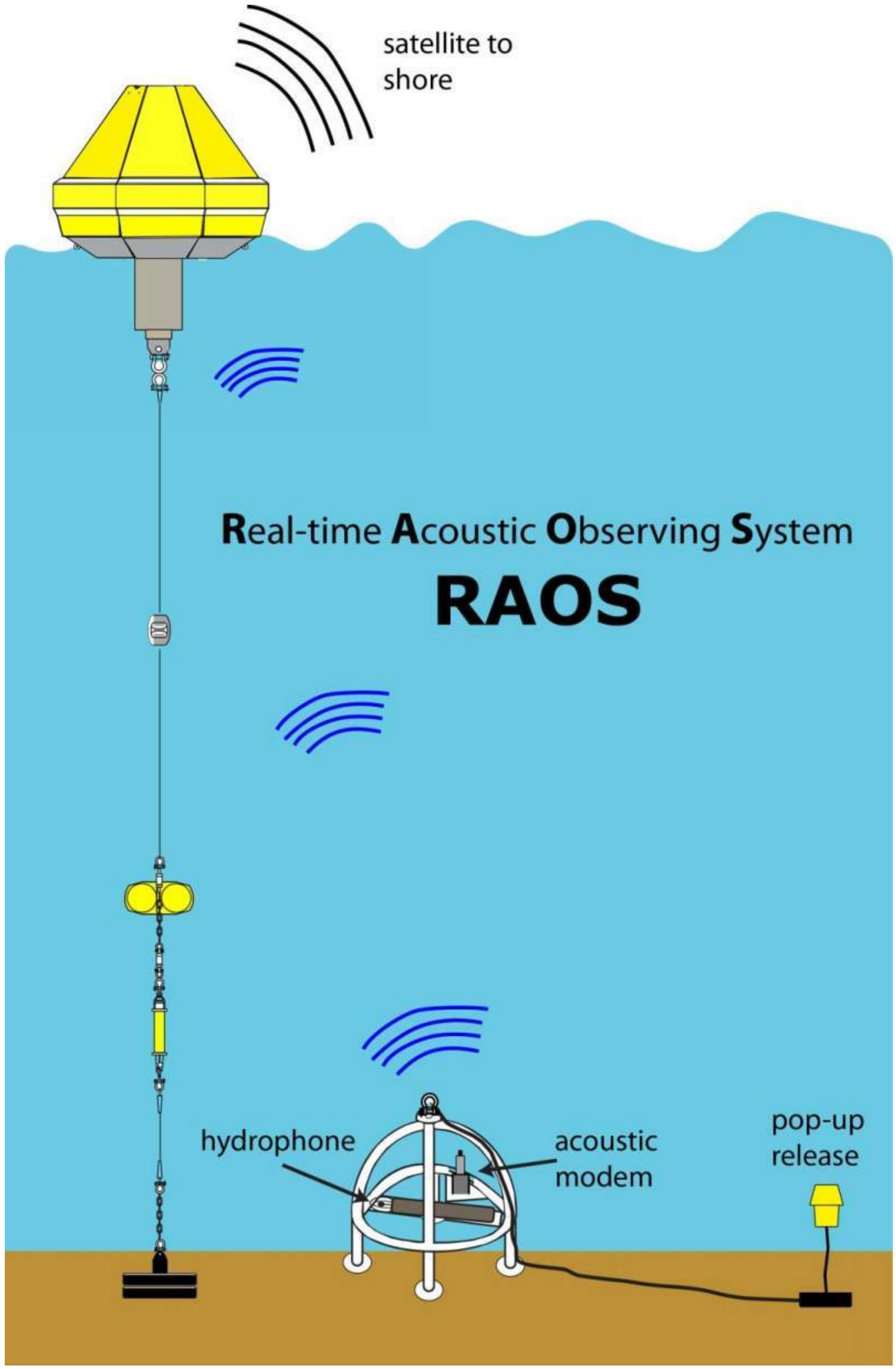

Figure 3. Real-time acoustic observing system to be deployed within each berth with a WEC under test.

Calibration

Hydrophone systems will be calibrated before and after deployments The hydrophone sensors for the project have not yet been decided on yet, but may include:

- HTI 92-WB -180 dB re: 1V/uPa
- ITC1032 -194 dB re:1V/uPa
- icListen HF -170 dB re: 1V/uPa

Despite the range in sensitivities, OSU controls the dynamic range through a pre-amplifier gain stage in our systems.

Flow-noise and Self-noise Minimization

Fixed and drifting platforms may experience flow-noise and self-noise that masks the propagating sound produced by WECs. At present, there are neither benchmark systems nor specific procedures that can be used to quantify flow-noise and self-noise in sound measurement systems suitable for measuring sound around WECs.

Sound measurement systems that produce high-amplitude flow-noise and/or self-noise will be unable to characterize WEC sound at some frequencies, which may lead to an over-estimate of WEC sound. Consequently, it is desirable to minimize flow-noise and self-noise to the extent possible.

The following methods will be used to help to minimize acoustic self-noise:

- Securing and/or eliminating any loose mechanical connections;
- Potting flexible mechanical joints (e.g., shackles) in a thick urethane compound to minimize sound produced by joint motion; and
- For drifting systems with a surface expression, reducing the surface area for wave impacts and pathways for water to drain off the surface expression in a way that produces a “splashing” noise on contact with the water surface.

Samples will be manually reviewed by visual inspection of the mean-square sound pressure spectral density level as a function of time (i.e., a spectrogram), visual inspection of hydrophone voltage as a function of time, and auditory review. Samples will be excluded from further analysis if any of the following apply:

- Hydrophone voltage saturates;
- A sample contains obvious non-WEC anthropogenic sound (e.g., vessel traffic);
- A sample contains obvious non-WEC biological sound (e.g., whale vocalization);
- A sample contains obvious self-noise (e.g., acoustic self-noise from hydrophone mooring, non-acoustic self-noise from the recording system);
- During a drifting platform measurement, the deployment vessel was within 100 m of the drifting platform or was operating systems that are likely to radiate noise

4.2 Constraints & Limitations

The greatest limitations to accomplishing the acoustic monitoring objectives include mooring survival and potential equipment failures. The close proximity of SETS to the Yaquina Bay port entrance and navigational corridor presented a significant challenge for maintaining the acoustic instrumentation during the Site Characterization Study. Since the SETS Project Site is located in the southern portion of the initial Site Characterization study area (farther from the port entrance), and the site will be well marked and well publicized the AUH and RAOS hydrophone deployment for this monitoring is likely to encounter less interference with other at sea activities and achieve much higher survivability. Deploying more than the minimum amount of instrumentation outlined above could further mitigate these constraints; however, due to the technical nature of the equipment, the increase in costs for deploying and maintaining more instrumentation is prohibitive.

The real-time reporting and tracking capability of the RAOS hydrophone system will alert OSU staff of any equipment failures or data loss. If these are experienced this information will be passed along to NMFS within 48 hours. OSU will recover/repair/redeploy a failed RAOS system as soon as possible (depending on weather, vessels, parts, labor, etc.), and in the meantime carry out ADUH drifter recordings to continue monitoring efforts under consultation with NMFS. Weather conditions may also limit our ability to conduct ADUH recordings within a 100 m radius of the WEC(s); in the event that drifts are unable to capture recordings within the target range, a NMFS approved practical transmission loss model (NMFS 2012b) will be used for estimates of received levels at 100 m from the source.

Inability to perform this study within the time period or spatial extent described here would be communicated to members of the Adaptive Management Committee (AMC) within 10 days from the date determined by OSU that it is unable to complete the tasks identified in this plan, and a contingency plan developed and submitted to the AMC within 30 days after notification.

4.3 Analysis

Data will be analyzed following NMFS guidance (2016) for acoustic stressors. Broadband (7 Hz – 20 kHz) sound pressure levels (SPL_{rms}) will be derived from 30 second rms averages of acoustic recordings during operational testing of WEC devices to ensure compliance with NMFS sound exposure thresholds for behavioral disruption. Marine mammal auditory functions will be applied after sound field measurements have been obtained (i.e., post-processing,; auditory weighting functions should be applied beforehand), with the total spectrum of WEC sound preserved for later analysis (i.e., if weighting functions are updated or if there is interest in additional species, then data can still be used). Sound exposure levels will be compiled over a period of 24-h to apply the TTS and PTS onset auditory acoustic thresholds expressed as the SEL_{cum} metric. Cumulative sound takes into account both received level and duration of exposure (ANSI 2013). To determine if received sounds can be attributable to a WEC (as opposed to other sources), the spectrogram will be compared against known sound sources (e.g. vessels, wind, rain, waves, biological sources). If the signature does not match known sources and oscillates with the same frequency as the waves, it is likely attributable to a WEC. The spectrogram received from a RAOS unit following an event will be assessed as described above and compared to the recordings made by the drifting hydrophones to determine if the event triggering noise was WEC-generated. Additionally, spectral estimates from recordings made during Project activities in a variety of acoustic conditions will be compared with the percentile based cumulative distribution of ambient sound levels to quantitatively describe the contribution of WEC project related sounds to background levels.

5. Results

Results of our analysis will be presented graphically as a time series plot of SPL_{rms} measurements, and the calculated cumulative sound exposure levels (SEL_{cum} metric) from 24 hour periods throughout the recording duration. Similarly, long-term spectrograms will be generated to show the temporal and spectral characteristics of WEC generated sound output during operational testing. Furthermore, time averaged spectral estimates from operational WEC testing periods will be plotted with frequency based percentile curves of the cumulative distribution of spectral energy levels (as per NMFS 2012a) from ambient recordings to quantify the acoustic presence of the WEC(s) in the context of background levels.

6. Reporting

Once the monitoring activities under this plan commence, they will be reported annually in OSU's Annual Report, which will be filed with FERC and provided to the AMC. The annual reporting will include the components described below; it will also identify any new information considered in the findings or relevant to future monitoring. Maximum measured noise levels (highest 10-second SPL_{RMS}) will be reported to NMFS no later than 3 business days after collection of ADUH recordings and within 3 business days after a RAOS detected exceedance event attributed to the project. The assessment of WEC source level/acoustic signatures and relations between received sound levels and sea state/power generation state will require detailed analysis. NMFS will be notified within 45 days of survey completion describing the survey and presenting preliminary results. A written report will be provided within 90 days of survey completion.

6.1 Monitoring Summary

OSU will summarize all activities undertaken in implementing the monitoring plan, including a table with monitoring dates and locations if appropriate. OSU will describe any deviations from the monitoring plan (e.g., modified sampling frequency due to adverse weather conditions) and discuss implications of any such deviations. OSU will describe any changes to monitoring as a result of adaptive management or mitigation measures that were implemented during the course of the reporting period, if applicable.

6.2 Results & Conclusions

The AMC will discuss the monitoring results and any significant findings or conclusions, and whether or not the findings exceed thresholds and indicate the conditions under which the acoustic thresholds were exceeded as identified in Mitigation Measure 7. The AMC will be given the opportunity to provide feedback on the study results prior to any official filing, and if they exist, OSU will describe any disagreements over characterization of results in its final report.

6.3 Future Monitoring

OSU will describe in its Annual Report monitoring activities that are planned for the next reporting period. OSU will provide a list of any proposed modifications to the monitoring plan to the AMC, including any adaptive management criteria or response actions, and rationale for the changes.[1]

7. References

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NMFS. 2012a. Guidance Document: Data Collection Methods to Characterize Underwater Background Sound Relevant to Marine Mammals in Coastal Nearshore Waters and Rivers of Washington and Oregon. Memorandum from NMFS Northwest Region and Northwest Fisheries Science Center to Interested Parties.

NMFS. 2012b. Guidance Document: Sound Propagation Modeling to Characterize Pile Driving Sounds Relevant to Marine Mammals. Memorandum from NMFS Northwest Region and Northwest Fisheries Science Center to Interested Parties.

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Thomson J., B. Polagye, C. Bassett (2012) Noise Measurements of Columbia Power Technologies 1/7 Scale Prototype (SeaRay). Report prepared by Northwest National Marine Renewable Energy Center, University of Washington for Columbia Power Technologies, Inc. 7 pp.

[1] See Adaptive Management Framework for provisions related to modifying monitoring plans and adaptive management criteria and response actions.

Tougaard, J. 2015. Underwater Noise from a Wave Energy Converter Is Unlikely to Affect Marine Mammals. PLoSONE 10(7): e0132391. doi:10.1371/journal.pone.0132391. http://tethys.pnnl.gov/publications/underwater-noise-wave-energy-converter-unlikely-affect-marine-mammals.

H-4
Monitoring Plan – Electromagnetic Field

MONITORING PLAN-ELECTROMAGNETIC FIELD

CONTACT: DAN HELLIN, OPERATIONS & LOGSITICS MANAGER, PACWAVE
P: 541-737-5452 DAN.HELLIN@OREGONSTATE.EDU

PRINCIPLE INVESTIGATOR: TBD

1. INTRODUCTION/OVERVIEW

1.1 Resource(s) of Interest/Existing Conditions

Ambient, natural electromagnetic fields (EMF) in the ocean come from three sources: the geomagnetic field of the earth, electric fields induced by the movement of charged objects (e.g., currents/waves, organisms) through a magnetic field, and bioelectric fields produced by organisms (Slater et al. 2010a, Normandeau Associates et al. 2011, Gill et al. 2014). EMF includes both the electric field (E-field, measured as the voltage gradient in V/m) and the magnetic field (B-field, measured in tesla [T] or gauss [G]; 10,000G=1T; Slater et al. 2010a) (Table 1).

Wave, tidal, and current motion of seawater, an electrolyte, through the Earth's magnetic field induces electric and magnetic fields (Slater et al. 2010a). Local geomagnetic fields (off Reedsport, OR) are estimated at 52.2 microteslas (µT) [~52,000 nanoteslas (nT)] (Slater et al. 2010a). The earth's magnetic field off Reedsport, OR is estimated at 52.2 microteslas (µT) [~52,000 nanoteslas (nT)] and is largely vertical (Slater et al. 2010a). EMF in the ocean at the Reedsport site was modeled by incorporating the influence of ocean conditions (e.g., currents, waves) on the earth's magnetic field. Based on the wave climate at the Reedsport site, at surface (where effects are likely the strongest), electric fields are expected to range from 6 to 216 µV/m, and would be observed between 0.04 and 0.3 Hertz (Hz), with maximum induced magnetic fields due to wave motion ranging from 0.02 to 0.54 nT. Because of the similar levels of the earth's magnetic field, wave climate, tidal motion, and coastal currents at Reedsport and the Project area, we expect that EMF modeled at Reedsport will be similar to that in the Project area.

1.2 Potential Effects/Issue Summary

Project-generated EMF

EMF transmissions would be generated by the WECs, the umbilical cables (connecting the WECs to the subsea connectors), the hubs and subsea connectors, and the subsea cables to the shore. Each test berth could accommodate a WEC or array of WECs with a maximum capacity, based on cable specifications, of 8 MW (although not all 4 berths could be at capacity at any one time); the capacity of the umbilical cables would correspond with the WECs. The subsea cables would be three-conductor (3C), AC cables, with approximately 70 mm^2 copper conductors bundled together into a typical 3C submarine power cable configuration with a total diameter of approximately 10 cm (4"). Each of these cables is estimated to have a rated capacity of up to 36 kV. From the offshore test site, the majority of the cables would be buried 1-2 m (3-6 ft) below the seafloor, except within the footprint of the test site (in order to provide access to connect WECs and/or hubs to the subsea connectors) or in places with hard substrate. From the 10-m isobath (approximately 1 km offshore), the cables would run under the beach through HDD conduits to an onshore landing point where they would transition to terrestrial cables and connect to the Utility Connection and Monitoring Facility (UCMF). All the power cables (i.e., subsea cables, umbilicals) would be shielded and armored, and would not emit any electric fields directly; however, electric fields could be induced by the movement of fish and currents through the magnetic fields produced by the cable.

As a general rule, the higher the power output from a WEC, the higher the electrical current transmitted through AC cables and hence the stronger the emitted magnetic field and iE-field (Gill 2016). It is also notable, however, that there is remarkable consistency among the modeled attenuation of AC magnetic fields among 10 different cables (most of them associated with large offshore wind farms) (Figure 1) (Normandeau et al. 2011). These cables likely carried much larger currents than the proposed Project cables at full build out, all of them were unburied cables, and they all still showed an exponential decline that reached near ambient levels by around 2 m from the cable. Existing information (based on modeling of EMF at 10 different cables) all showed similar and consistent exponential declines that reached ambient conditions by around 2 m from the cable, and we can expect this to be similar at the Project site (Normandeau et al. 2011). Based on field validation, models have been shown to be accurate for estimating EMF emissions from subsea cables (CMACs 2003, Kavet et al. 2016, Gill 2016). From the offshore test site, the majority of the cables would be buried 1–2 m (3–6 ft) below the seafloor, except within the footprint of the test site. Burial of the cable at a depth of 1 m will reduce the magnetic field at the seabed by around 80 percent (Normandeau et al. 2011). Therefore, it is likely that EMF generated by the Project cables will be similar or less than other cables that have been modeled, and that EMF generated by power cables above ambient levels would not extend much beyond a couple 1-2 of meters. Physical burial of most of the Project cables will additionally minimize any likelihood of exposure (Figure 2).

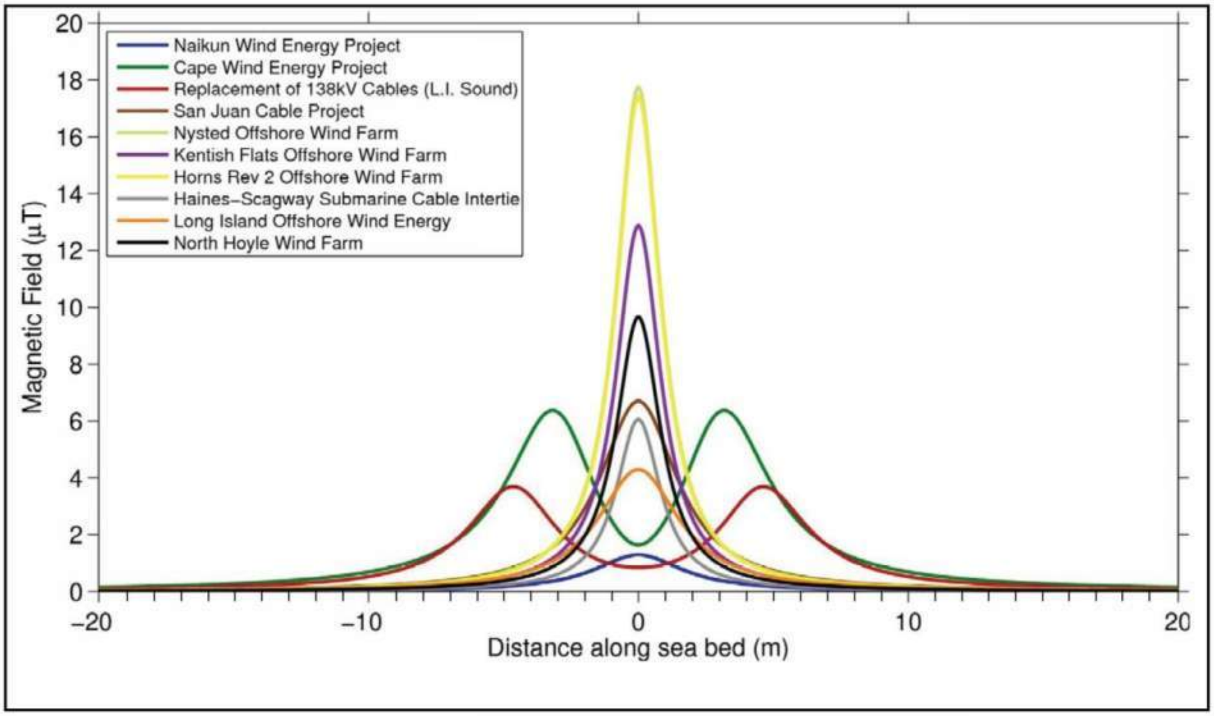

Figure 1. Modeled AC magnetic field profiles across the seabed surface for 10 submarine cables systems (Normandeau Associates et al. 2011). Cable voltages range from 33 kV (e.g., Cape Wind) to over 100 kV (e.g., Naikun Wind Energy, Nysted Offshore Wind Farm).

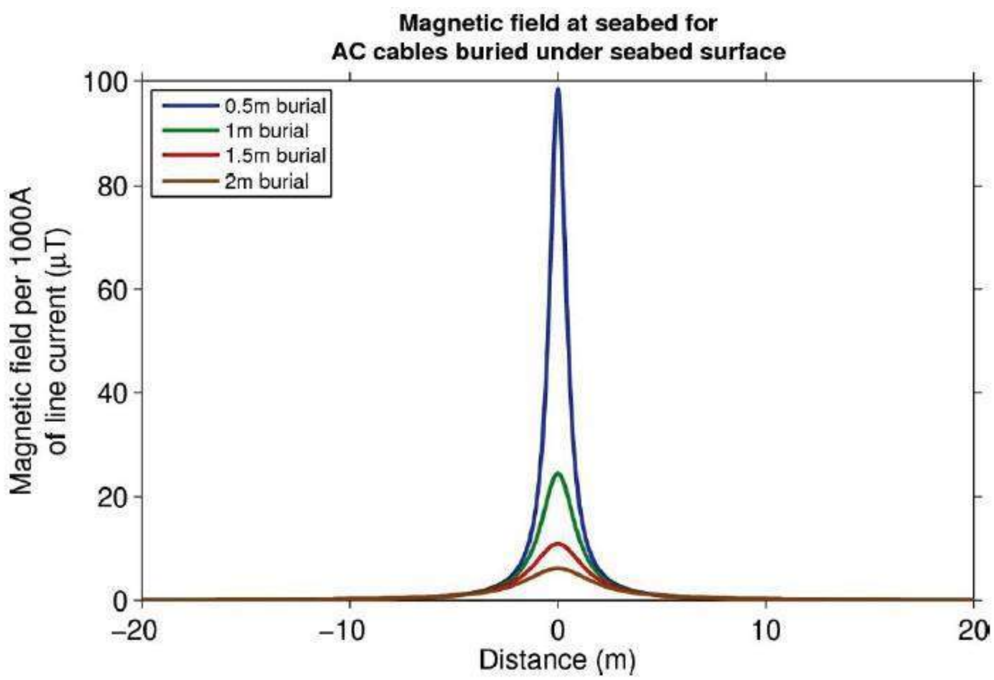

Figure 2. Modeled magnetic field profiles at the seabed for a buried AC cable (0.5, 1.0, 1.5 and 2 m burial depth) (Normandeau Associates et al. 2011).

Ability of animals to detect EMF

Electric field detection occurs by fishes with specialized electroreceptors that include electroreceptive elasmobranchs (e.g., sharks, skates, and rays) and holocephalans (e.g., ratfish), and electrosensitive agnatha (e.g., lamprey), acipenseriformes (e.g., sturgeon), and some teleost fish (Normandeau Associates et al. 2011, Gill et al. 2014). Electroreception is used to detect bioelectric fields emitted by prey, detection of mates, and potentially to detect predators, as well as for short and long term movements or migration (Normandeau Associates et al. 2011, Gill et al. 2014). Elasmobranchs and holocephalans are the most electroreceptive marine animals because of specialized electroreceptive organs, the Ampullae of Lorenzini, which can detect very weak electric fields as low as <5–20 nV/m (Fisher and Slater 2010, Normandeau Associates et al. 2011, Gill et al. 2014). Elasmobranchs are reported to be repelled by strong anthropogenic electric fields (Gill et al. 2014). Electroreceptive teleost fish have a minimum sensitivity level of about 0.01 mV/m (Normandeau Associates et al. 2011) and may respond to strong electric fields 6–15 V/m (Gill et al. 2014).

Some animals use geomagnetic fields to orient during migration; animals that are considered to be capable of this include cetaceans, sea turtles, certain fishes and crustaceans, and mollusks (Gill et al. 2014). Species in the Project area that may be capable of detecting magnetic fields include Dungeness crab, salmonids, sturgeon, and leatherback sea turtles (Normandeau Associates et al. 2011). Fish, in particular salmonids and scombrids (e.g., tuna), have a magnetite receptor system and respond to magnetic fields in the 10–12 µT range (Normandeau Associates et al. 2011). Eulachon behavior (e.g., orientation or migration) may potentially be affected by EMF; however, there are no specific studies conducted on their sensitivities (Normandeau Associates et al. 2011).

Information regarding animal responses to EMF in the laboratory

In the laboratory, juvenile salmon, when subjected to the magnetic field intensity and inclination angles similar to those found at the latitudinal extremes of their ocean distribution (northern and southern intensity used in laboratory experiments of 555.5 µT and 444.6 µT), change their orientation (e.g., direction of swimming) and subjecting fish to unnatural pairings of field intensity and inclination resulted in more random orientation (Putman et al. 2014). Loggerhead and green sea turtles are sensitive to B-fields as low as 0.005-29 µT (Normandeau Associates et al. 2011). Dungeness crab *(Metacarcinus magister*), as well as Atlantic halibut (*Hippoglossus hippoglossus*) and American lobster (*Homarus americanus*) have been examined in the laboratory, and only subtle changes in behavior were observed for relatively high thresholds of B-field from ~0.05 mT background to 1.0–1.2 mT direct current (DC) considered an upper bound of an anthropogenic source that might be encountered based on reviewed literature (Woodruff et al. 2013).

Information regarding animal responses to EMF sources in the field

Multiple projects on the U.S. west coast have evaluated or are evaluating EMF at subsea cables and biotic interactions, indicating very minor, limited interactions. In particular, BOEM has evaluated effects of EMF from power cables by conducting in-situ studies of powered and unpowered cables using SCUBA and ROV surveys (Love et al. 2015, 2016). Results from three years of surveys concluded:

1) Researchers did not observe any significant differences in the fish communities living around energized and unenergized cables and natural habitats;

2) They found no compelling evidence that the EMF produced by the energized power cables in this study were either attracting or repelling fish or macro invertebrates;

3) EMF strength dissipated relatively quickly with distance from the cable and approached background levels at about one meter from the cable; and

4) Cable burial would not appear necessary strictly for biological reasons.

While evaluations of marine animal interactions with subsea cables have provided understanding that EMF produced by WECs and their subsea cables could be in the magnitude of the sensitivity ranges of many marine animals, the ability to detect EMF does not necessarily translate to an effect or an impact on individuals, populations, or ecosystems (Normandeau et al. 2011, Gill et al. 2014). Most effects are assumed to be minor and limited to a close distance (meters), with the exception of elasmobranchs that are considered to be the most vulnerable because of their high sensitivity and use of EMF for important behaviors (e.g., prey detection) (Normandeau et al. 2011, Gill et al. 2014). However, to date, there is no evidence that suggests that EMF at the levels expected from WECs and their subsea cables would have a negative or positive effect on any species (Gill 2016, Love et al. 2016).

Potential for exposure to EMF emissions at PacWave South

EMF emissions from the Project are expected to be minor and limited to the immediate vicinity of the cable. However, there is higher uncertainty about EMF emissions from WECs, which has not been measured. While there is uncertainty about whether electro- and magneto-sensitive species would be capable of detecting EMF emissions from the Project, as well as the type and degree of these species' responses to EMF, the proportion of a given population that might be exposed to site-specific EMF generated by the Project is expected to be low for most of these species due to factors such as migratory range and available habitat. For example, exposure to Project-related EMF is unlikely for both leatherback sea turtles and highly migratory species like salmon and green sturgeon due to the very small spatial scale of the Project footprint relative to the area within which these species migrate and feed. While Project-related EMF is expected to be minor and spatially limited, there is some concern about the uncertainty associated with levels of EMF transmission from the Project and potential for detection by special status species.

2. Need for Information

Because the cables would be shielded and the majority of the subsea cables would be buried, there is little uncertainty related to EMF transmission given our understanding of existing cables and the capability to model EMF. However, there is some uncertainty in applying these results to WECs at PacWave South because specific EMF characteristics of WEC types are not known.

3. Goals/Objectives

The overall goal of this study is to manage uncertainties associated with EMF produced by WECs and increase understanding about the magnitude and extent of WEC levels of EMF relative to ambient[1] EMF background levels. The information will be used to inform implementation of Mitigation Measure 1 and/or to modify this monitoring plan as necessary to ensure protection and conservation of marine resources from potential effects of WEC-related EMF.

3.1 Study Objective

The objective of this study is to evaluate the EMF levels produced by the WECs by using existing models to estimate the expected electrical/magnetic output of the WECs and validating the model estimates using field measurements. The information will be used to inform implementation of Mitigation Measure 1 and/or to modify this monitoring plan as necessary to ensure protection and conservation of marine resources from potential effects of Project-related EMF.

4. Data Collection and Analysis

Once the WEC device(s) are scheduled to be deployed at a berth at PacWave South, OSU will conduct modeling based on existing approaches (e.g., such as described in Slater et al. 2010c, 2010d, CMACs 2003, Pommerenck et al. 2014, Kavet et al. 2016) to estimate the anticipated EMF output associated with the WEC(s). The model(s) will estimate if EMF from the WEC(s) is likely to exceed biologically relevant levels (e.g., 3 milliteslas (mT), Woodruff et al. 2012, Normandeau et al. 2011, Gill 2016, or newer data as determined by the Adaptive Management Committee) at a distance of 10 meters from WEC(s). Input to the models will include the estimated power generation data from energized WECs, and anticipated ranges in sea state and currents. Results from pre-deployment modeling performed by OSU would be provided to the Adaptive Management Committee (AMC) at least 45 days prior to deployment.

Within 45 days after the first WEC(s) become operational at PacWave South, OSU will conduct a field survey to measure EMF at the WEC(s) while they are in an energized state to provide field data to validate the models. These surveys will be conducted as close as possible to the location in the water column where EMF from the WEC is predicted to be the highest (e.g., near sea surface, mid-water) likely by boat or with divers and/or ROVs, AUVs, or by drifting or dropping (e.g., stationary) a magnetometer. The specific survey equipment, locations and timing, will be determined once models have been conducted and based on expected EMF output, in accordance with the relevant standards and protocols (see section 4.1 below for examples). The field methodology will include measurements near to WECs and at a distance away (as informed by model results) in order to determine when EMF transmissions decay to ambient conditions.

[1] This study plan refers to comparing the EMF emissions from WECs to ambient or background levels as a first step to determine whether the project is emitting EMF that is measurable. EMF emissions that exceed ambient levels are not considered biologically relevant unless they exceed 3 milliteslas (mT) (Woodruff et al. 2012, Normandeau et al. 2011, Gill 2016, or newer data).

Reference measurements will be taken at similar depth (~70m), over similar sediment type and at the same time as Project area measurements and will serve as a measure of ambient conditions. Measurement of ambient EMF will provide critical data to validate or calibrate modeled expectations as necessary and to support future distinctions between ambient and WEC-related EMF. Reference measurements will be paired with all other field measurements being conducted during the first energized test (i.e., within 45 days after the first WEC(s) become operational OSU will measure EMF at the WEC(s) while they are in an energized state).

OSU will also record power performance data from the Project during these surveys, as well as other inputs to the models including sea state. Because the surveys will likely be conducted during relatively low sea states (for safety of personnel and equipment) OSU will use the survey results and power performance data as inputs to models to estimate EMF emissions of the Project at full power (during higher sea states).

4.1. Methods & Equipment

Technology to measure EMF is considered “under development” (e.g., “off-the-shelf” monitoring devices are not available). Regardless, measurements of EMF fields around WECs initially will be conducted using available equipment such as a general EMF1390 electromagnetic field tester as used by BOEM in their studies of the Las Flores Canyon submarine power cables (Love et al. 2015, Love et al. 2016), or other standard equipment used by BOEM or other EMF researchers to take underwater measurements of EMF (e.g., as described in Slater and Schultz 2010, Gill et al. 2009, Kavet et al. 2016). The magnetometer would be able to measure EMF at biologically meaningful levels (e.g., mT). Induced electric fields can be reliably modeled from measured magnetic fields (Pommerenck et al. 2014); therefore, standardized equipment such as gauss meters will be used at a minimum to measure magnetic fields, and induced electric fields will be modeled.

4.2. Schedule & Frequency

Predictions of ambient EMF levels and EMF emissions from PacWave South will be modeled once the devices are scheduled to be deployed and will be provided to the AMC as stated above. As soon as possible (i.e., within 45 days) following deployment and energizing of a WEC(s) at PacWave South field measurements would be conducted as described above and weather permitting. Field results will be used to validate model predictions (e.g., determine if EMF from the Project is likely to exceed biologically relevant levels at a distance of 10 meters from WEC devices). Field measurements will be taken as described in this monitoring plan for the first 8 WECs tested at the Project. If field monitoring from the first 8 WEC tests indicate that EMF does not exceed biologically relevant levels, modeled at a distance of 10 meters from WECs, then field monitoring will only be conducted when the licensee plans to deploy WECs with a rated capacity that is 30% greater than previously studied or plans to operate more WECs per berth than previously studied (EMF emissions will be related to the WEC’s rated capacity, therefore, 30% greater rated capacity or a WEC array is considered a reasonable increase to conduct field validation based on demonstrated model accuracy). The licensee’s obligation to conduct field measurements shall cease if it can be demonstrated that 80% of field measurements from the first 8 WEC tests do not exceed model predictions by more than 20%. If field measurements from the first 8 WEC tests exceed model predictions by more than 20%, the model will be refined to reflect knowledge gained during field measurements and field measurements will continue as described above.

4.3. Constraints & Limitations

The major constraints of any ocean-going field project are weather conditions and the availability of suitable vessels. Additional constraints include the costs and availability of equipment and staff, as well as practical limitations (e.g., sea state). Another field constraint (noted by previous researchers [e.g., Slater, Schultz]) include ability to take EMF measurements in proximity to project components. At PacWave North on a "flat calm day" measurements of the WET-NZ WEC only able to be obtained approximately 45 m from the WEC; OSU will make every attempt to measure EMF as close as safely possible to Project components. As a contingency for equipment failure or loss, a second magnetometer would be available as a backup. Any inability to perform this study within the time period or spatial extent described here would be communicated to members of the AMC within 10 days from the date determined by OSU that it is unable to complete the tasks identified in this plan, and a contingency plan developed and submitted to the AMC within 30 days after notification.

4.4 Analysis

A general EMF model approach (such as described in Slater et al. 2010c, 2010d, CMACs 2003, Pommerenck et al. 2014, Kavet et al. 2016, Thomsen et al. 2015) will be used to predict EMF from the WECs, and calculate if EMF from the WECs is likely to exceed biologically relevant levelsat a distance of 10 meters from WECs. These models would be validated by using field measurements as described above. Results from ongoing EMF studies, including BOEM's evaluations of oil platform cables (energized and unenergized) off Southern California, and the Trans Bay Cable in San Francisco Bay, and the MaRVEN Project (Thomsen et al. 2015) will also inform the approach to modeling and field data collection.

5. Results

Model results will be provided graphically to show the decrease in magnetic and induced electric fields with distance from the cable, and if EMF from the Project exceeds biologically relevant levels within a distance of 10 meters from WECs. These predictions will be validated using field measurements; studies to date using similar approaches (e.g., CMACs 2003, Kavet et al. 2016) indicate field measurements have validated model results. However, if field measurements indicate models are not providing accurate predictions, models will be recalibrated. Field measurements will be provided along with model results. Model results for anticipated high sea states will be provided. Preliminary results will be provided to the AMC within 90 days. Final results will be provided in the Annual Report.

6. Reporting

Once the activities under this plan commence, they will be reported annually in OSU's Annual Report, which will be filed with FERC and provided to the AMC. The annual reporting will include the components described below; it will also identify any relevant new information considered in the findings or future monitoring. For initial deployment, preliminary results will be provided to the

AMC within 90 days. Results from pre-deployment modeling performed by OSU will be provided to the AMC at least 45 days prior to deployment.

6.1. Monitoring Summary

OSU will summarize all activities undertaken in implementing the monitoring plan, including a table with monitoring dates and locations if appropriate. OSU will describe any deviations from the monitoring plan (e.g., modified sampling frequency due to adverse weather conditions) and discuss implications of any such deviations. OSU will describe any changes to monitoring as a result of adaptive management or mitigation measures that were implemented during the course of the reporting period, if applicable.

6.2. Results & Conclusions

The AMC will discuss the monitoring results and any significant findings or conclusions, and whether or not the findings exceed thresholds identified in Mitigation Measure 1. The AMC will be given the opportunity to provide feedback on the study results prior to any official filing, and if they exist, OSU will describe any disagreements over characterization of results in its final report.

6.3. Future Monitoring

OSU will describe in its Annual Report monitoring activities that are planned for the next reporting period. OSU will provide a list of any proposed modifications to the monitoring plan to the AMC, including any adaptive management criteria or response actions, and rationale for the changes.

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Unit Definitions and Conversion

Current		
Ampere	A	1 A
Milliampere	mA	0.001 A
Microampere	µA	0.000001 A
Current density mA/m^2		
Voltage		
Volt	V	1 V
Kilovolt	kV	1000 V
Millivolt	mV	0.001 V
Microvolt	µV	0.000001 V
Nanovolt	nV	0.000000001 V
Electric Field		
V/m	volt/m	
mV/m	0.001 V/m	
V/cm	100 V/m	
mV/cm	0.001 V/cm	
µV/cm	0.000001 V/cm	
nV/cm	0.000000001 V/cm	
Magnetic Flux Density (B) - aka Magnetic Field[1]		
Tesla	T	1 $Weber/m^2$
Millitesla	mT	0.001 T
Microtesla	µT	0.000001 T = 10 mG
Nanotesla	nT	0.000000001 T
Gauss	G	
Milligauss	mG	0.001 G= 0.1 µT

Table 1. Unit Definitions and Conversions (Normandeau Associates et al. 2011).

APPENDIX I
Protection, Mitigation, and Enhancement Measures

PROTECTION, MITIGATION AND ENHANCEMENT MEASURES

OSU proposes that the following Protection, Mitigation and Enhancement (PM&E) measures be incorporated into the license for the construction and operation of the PacWave South (formerly known as Pacific Marine Energy Center South Energy Test Site [PMEC-SETS]) in order to facilitate the safe and compliant deployment of Wave Energy Converters (WECs) and to minimize impacts on the environment. Each of these measures and their manner of implementation were developed in close coordination with federal and state agencies and stakeholders. These PM&E measures are grouped into three categories, as follows:

<u>Measures 1-5</u>: ***PM&E measures that are implemented pursuant to the Adaptive Management Framework (Appendix J) in conjunction with a group of key agency stakeholders.*** These measures address potential Project impacts where there is uncertainty regarding whether impacts will occur and how to address them, and where a number of agency stakeholders have authority or interest regarding potentially affected resources, thus requiring a formal structure within which adaptive management decisions will be made. Monitoring plan implementation requirements are also included in this category because the Adaptive Management Committee (AMC) has authority to review and revise these monitoring plans pursuant to the Adaptive Management Framework.

<u>Measures 6-9</u>: ***PM&E Measures that are implemented adaptively in consultation with a specific agency or agencies that have regulatory authority over the resources that may be affected.*** These measures address potential Project impacts where there is uncertainty regarding whether impacts will occur and how to address them, but where there is a primary agency with authority over the potentially affected resources and therefore a multi-agency decision making structure is not necessary or appropriate. Each of these measures include adaptive management concepts through direct consultation with, and approval of, the named agency, as provided in the specific measures.

<u>Measures 10-20</u>: ***Prescriptive PM&E measures that are not expected to change or require adaptation for the term of the license.*** These measures include both best management practices and measures specifically crafted to address potential or likely Project impacts where there is greater certainty regarding how to avoid, minimize or mitigate for any impact that may occur

The basis for the incorporation of each of these PM&E Measures in this license application are further discussed in the Environmental Analysis (Section 3.0).

PM&E Measures

The following Measures (1-5) are subject to the provisions of the Adaptive Management Framework attached as Appendix J.

1. MITIGATION FOR POTENTIAL IMPACTS OF ELECTROMAGNETIC FIELDS ON MARINE RESOURCES

The licensee shall take the following measures to minimize and mitigate for potential impacts of electromagnetic fields on marine resources:

(1) Subsea Cables and Electrical Infrastructure. The licensee shall bury subsea cables to a depth of 1-2 meters, and utilize shielding on subsea cables, umbilicals, and other electrical infrastructure (including, to the extent feasible, hubs and subsea connectors) to minimize electromagnetic field (EMF) emissions, to the maximum extent practicable.

(2) EMF Monitoring Plan. The licensee shall implement the EMF Monitoring Plan attached in Appendix H. This monitoring plan may be modified in accordance with the Adaptive Management Framework attached as Appendix J.

(3) Verifying Model Results. If, after eight (8) different WECs have been tested, EMF measurements validate modeled predictions (meaning that 80% of field measurements from the eight (8) different WECs tested do not exceed model predictions by more than 20%), then no additional field measurements will be taken except as explicitly set forth below. If field measurements exceed model predictions by more than 20%, the model will be refined to reflect knowledge gained during field measurements and field measurements will continue pursuant to the EMF Monitoring Plan until such standard has been met.

Once the model has been validated as provided above, new field measurements verifying model results would only be conducted for the following scenarios:

- WECs with greater power generation capabilities (rated capacity that is 30% greater than previously studied);
- more WECs per berth than previously measured are operational; or
- where field monitoring is required under Section 4, below, to ensure mitigation actions are successful.

(4) EMF Exceedance. If the results of field measurements or validated and reliable modeling results indicate levels in excess of biologically relevant levels (e.g., 3 milliteslas (mT), Woodruff et al. 2012, Normandeau et al. 2011 or newer data, as determined by the AMC) at a distance equal to or greater than 10 m from WECs, the licensee shall notify the AMC forty-eight (48) hours after determining than an exceedance has occurred and shall implement or shall instruct the relevant WEC testing client to implement the following mitigation actions:

- Within sixty (60) days, investigate the source of the exceedance and, based on the results, implement one of the following, to the extent practicable:
    - Install additional shielding of project components; or
    - Make repairs to Project component(s) to address the exceedance.

- Conduct subsequent field monitoring as appropriate within sixty (60) days and notify the AMC within fourteen (14) days following field measurements, to verify that the excess EMF levels associated with the test have been abated.

If, after taking the steps above, levels cannot be mitigated to below the identified threshold, the licensee shall provide or shall instruct the relevant WEC testing client to provide to the AMC within thirty (30) days a draft plan[1] to implement the following mitigation actions:

- Address the potential adverse effect of the levels produced by taking one or more of the following additional mitigation actions or other measures agreed on by the licensee and the AMC:
    - Delay subsequent deployment of additional WEC(s) of the specific model that generated EMF above thresholds until resolution of the issue is achieved;
    - Investigate interactions of the EMF generated by the WEC(s) at issue and species that are sensitive to EMF; or
    - Relocate, remove or cease testing one or more WECs until appropriate measures to ensure levels are below the mitigation threshold can be taken and are successful.
- Ensure that the identified action is carried out; and
- Conduct subsequent field monitoring and analysis as appropriate within sixty (60) days to verify that the excess EMF levels associated with the test have been abated and inform the AMC within fifteen (15) days following completion of analysis.

The Licensee shall submit the draft plan to the AMC for approval pursuant to the AMF attached at Appendix J and, upon approval, shall implement or instruct the WEC testing client to implement the plan.

2. MITIGATION FOR BENTHIC HABITAT IMPACTS FROM ANCHORS, WECS, AND OTHER EQUIPMENT DURING OPERATION, MAINTENANCE AND MONITORING ACTIVITIES

The licensee shall take the following measures to minimize and mitigate for potential impacts to benthic habitat from anchors, WECs, and other equipment during operation, maintenance and monitoring activities:

(1) Anchors. Recognizing that WEC testing clients may require installation of WEC-specific mooring systems, the licensee shall minimize installation-removal cycles by encouraging WEC testing clients to reuse anchors already in place where practicable.

(2) Benthic Sediments Monitoring Plan. The licensee shall implement the Benthic Sediments Monitoring Plan attached in Appendix H. This monitoring plan may be modified in accordance

[1] The draft plan shall include a proposed implementation timeline and monitoring provisions to confirm whether the measures were effective. Upon approval of a plan by the AMC pursuant to the AMF attached as Appendix J, the licensee shall ensure that the plan is implemented in accordance with the approved plan and timeline. In no circumstances shall implementation of the plan be undertaken at a time that would jeopardize human safety, property or the environment.

with the Adaptive Management Framework attached as Appendix J. If monitoring results indicate that WEC anchors or project components on the seafloor have a statistically significant adverse impact (changes beyond the range of seasonal/inter-annual variability) on macrofaunal species composition or abundance at the nearest monitored location outside any individual test berth site (as detailed in 3d below), the licensee shall provide to the AMC within thirty (30) days a draft plan[2] to implement one of the following mitigation actions:

- Limit use of specific anchor types in future installations;
- Modify and manage deployment frequency or location to allow for recovery of macrofauna;
- Use permanent anchoring systems (e.g., for the life of the project); or
- Conduct additional monitoring as described below.

The Licensee shall submit the plan to the AMC for approval pursuant to the AMF attached at Appendix J, and, upon approval, shall implement or instruct the WEC testing client to implement the plan.

(3) Project Site Box Coring. Once the Licensee has conducted five (5) years of post-installation project site box coring sampling under the Benthic Sediments Monitoring Plan with at least nine (9) anchors in place, and upon completion of any subsequent five-year implementation periods as described below, the licensee will modify monitoring efforts as follows:

a) If no statistically significant differences in sediment characteristics (percent silt-clay, median grain size) are observed within or at reference stations outside of test berths, as compared to either pre-installation conditions or reference stations, the licensee shall not be required to conduct further box core surveys.

b) If statistically significant differences are detected in the sediment characteristics within the berths, but no statistically significant differences are detected in macrofaunal characteristics (abundances or diversity) within the berths and no statistically significant differences in sediment characteristics or macrofaunal characteristics are detected at the reference stations outside of the project area, then the licensee shall document project-related changes to sediment characteristics and shall not be required to conduct further box core surveys.

c) If statistically significant differences in macrofaunal characteristics are detected within the berths, but no changes in sediment or macrofaunal characteristics are detected at reference stations outside of the project area, then the licensee shall continue to conduct project-site box core sampling as described in the Benthic Sediments Monitoring Plan for another five years and repeat the assessment set forth in these sections (1) through (4). If, at the end of

[2] The draft plan shall include a proposed implementation timeline and monitoring provisions to confirm whether the measures were effective. Upon approval of a plan by the AMC pursuant to the AMF attached as Appendix J, the licensee shall ensure that the plan is implemented in accordance with the approved plan and timeline. In no circumstances shall implementation of the plan be undertaken at a time that would jeopardize human safety, property or the environment.

the license term, and the licensee proposes to surrender the license, previously occupied berths will be sampled to assess post-decommissioning recovery.

d) If statistically significant differences in both sediment and macrofaunal characteristics are detected at locations outside of any individual test berth that are beyond the range of seasonal/inter-annual variability expected based on six (6) years of surveys at PacWave North[3] (formerly known as Pacific Marine Energy Center North Energy Test Site [PMEC-NETS]) and two (2) years of site characterization surveys at PacWave South, the licensee shall develop a revised Benthic Sediments Monitoring Plan for the AMC's approval, which may include sampling additional box core stations further away from the project to find the edge of the effect.

(4) Cable Route Box Coring. Once the licensee has conducted the initial two seasons of post-installation cable route box coring surveys under the Benthic Sediments Monitoring Plan, the licensee will modify monitoring efforts as follows:

a) If no statistically significant differences in sediment characteristics are observed in the post-installation survey as compared to the pre-installation survey in the same season, the licensee shall not be required to conduct further box core sampling of the cable routes.

b) If statistically significant differences are detected in the sediment characteristics but no differences are detected in macrofaunal characteristics (abundances or diversity), cable route[4] sampling will continue as described for two more seasons to assess whether sediment characteristics will return to pre-installation conditions and/or if there are detectable changes to macrofaunal characteristics over time. If, after the additional two seasons of cable route sampling, there are still no detectable changes to macrofaunal characteristics, the licensee shall not be required to conduct further box core sampling of the cable routes.

c) If statistically significant differences in both sediment and macrofaunal characteristics are detected in the transect closest to the cable route but not along the reference transects, sampling will continue for two more seasons to assess whether these changes spread beyond the cable corridor to the references transects. If, after the additional two seasons or cable corridor sampling, changes are still limited to the cable corridor, the licensee shall not be required to conduct further box core sampling of the cable routes.

d) If statistically significant differences in both sediment and macrofaunal characteristics are detected in the cable route and the reference transects (either initially or after any additional sampling seasons as described above), that are beyond the range of expected seasonal/inter-annual variability (previous determined through six (6) years of surveys at PacWave North and two (2) years of site characterization surveys at PacWave South), the licensee shall develop a

[3] PacWave North is an existing wave energy test facility developed by OSU in 2012. The facility, which is north of the proposed PacWave South site, is not grid connected and is not part of the PacWave South license application.

[4] As defined in Figure A-12 of License Application.

revised Benthic Sediments Monitoring Plan for AMC approval which may include sampling additional box core stations further away from the cable routes to find the edge of the effect.

(5) Vessel Anchoring Plan. For any Project vessels that may anchor at the project site, the licensee will develop an anchoring plan or protocol for such activity that:

- Avoids anchoring in known rocky reef or hard substrate habitats to the maximum extent practicable; and
- Minimizes the use of anchors within the project area wherever practicable by combining onsite activities.

3. MITIGATION FOR MARINE SPECIES ENTANGLEMENT OR COLLISION

The licensee shall implement the following measures to minimize the risk to marine species from entanglement of fishing gear on Project components that may increase the risk of marine species entanglement or collision:

(1) Design and Maintenance. The licensee shall direct the WEC testing clients to design and maintain cables and moorings in configurations that minimize the potential for marine mammal or sea turtle entrapment or entanglement (e.g., cable and lines should remain under tension) to the extent practicable.

(2) Opportunistic Observations. The licensee shall make opportunistic visual observations from the water surface in the portions of the test site which are being visited to conduct operations, maintenance, or environmental monitoring work and shall review any underwater visual monitoring conducted for other purposes to detect entangled fishing gear that has the potential to increase the risk of marine species entanglement. The licensee will ensure that surface observations will occur during all visits to the project test site, and at least once per quarter each year for the duration of the license.

(3) Surface Surveys. Annually, following the peak storm season and period of maximum activity for the Dungeness crab fishery, the licensee shall conduct surface surveys of active WEC berths during the spring season (mid-March through mid-June), or the earliest possible time after that period that avoids jeopardizing human safety, property or the environment.

(4) Subsurface Surveys. Subsurface surveys of moorings and anchor systems using ROV or other appropriate techniques with approval by NMFS will be conducted annually for the first 10 years after WECs are first deployed, as early as technically feasible (i.e., ocean conditions conducive to effective monitoring) without jeopardizing human safety, property and the environment, during the spring (mid-March through mid-June) as described in the Organism Interaction Monitoring Plan. The licensee will include a description of the timing and any significant delays in conducting such surveys in its Annual Report.

(5) Entangled Fishing Gear Identified.

a. If monitoring shows that fishing gear has become entangled or collected on any Project structure, but is not likely to pose a threat to navigational safety or marine species, the

Licensee will notify NMFS, FWS and ODFW within seven (7) days of detection, and shall remove the fishing gear during recovery of WECs or at the next scheduled mooring maintenance period. Until such time as the gear is removed or confirmed absent, the licensee shall observe such gear during subsequent underwater surveys to determine whether the gear must be reclassified as posing a threat requiring removal under subsection (b), below.

b. If monitoring shows that fishing derelict gear has become entangled or collected on any Project structure and no organisms are caught within it, but it poses a risk of entanglement to marine species or to navigational safety, the Licensee will notify NMFS, FWS and ODFW within seven (7) days of detection, and shall remove the fishing gear as soon as practicable while avoiding jeopardizing human safety, property or the environment. The Licensee shall notify NMFS, FWS and ODFW within seven (7) days of removal that the fishing gear has been removed.

c. If monitoring shows that fishing gear has become entangled or collected on any Project structure and marine mammals or sea turtles are observed entangled, injured or impinged, the licensee will immediately follow the Reporting Protocol for Injured or Stranded Marine Mammals (listed below) and give NMFS, FWS and ODFW all available information on the incident. If any other marine species is entangled or entrapped in fishing gear or marine debris, the licensee will report the incident to NMFS, FWS and ODFW as soon as practicable but no later than 48 hours from the observation and consult with the appropriate agency regarding whether gear removal is required and will remove the gear if necessary at the earliest time that avoids jeopardizing human safety, property or the environment.

For purposes of this section, any nets or free-floating line from any source and at any depth will be considered to pose a threat or risk of marine species entanglement and will be removed in accordance with subsection (b), above. Free-floating line is defined to mean line either attached or detached from fishing gear not tightly wrapped around facility or testing equipment. Other fishing gear including pots without free-floating line will not be considered to pose a threat or risk to marine species entanglement, but observations will be documented, reported and resurveyed in accordance with subsection (a), above.

(6) Development of Monitoring Plan. If separate sets of fishing gear are observed entangled or collected on Project structures on four separate site visits in any 12 consecutive months, the licensee shall develop a plan to monitor for entangled fishing gear more frequently, or using different timing, at mooring or cable types or Project locations that appear prone to accumulating fishing gear and will remove such gear in accordance with section 5, above. Upon obtaining the AMC's concurrence, the licensee shall implement the monitoring plan, and shall do so in a manner that does not jeopardize human safety, property or the environment.

(7) Return/Recycle. The licensee will make every effort, to return recovered fishing gear to the owner if identification is possible, and will be responsible for storing the gear and contacting the owner to retrieve it. The licensee will request owner information from ODFW for gear with tags or other

identification markers. In the event that an owner cannot be identified or attempts to return gear are unsuccessful, it may be recycled at Newport's International Terminal, or another suitable location.

(8) Strandings. For any observed Project-related marine mammal or sea turtle strandings, entanglements, impingements, injuries or mortalities, the licensee shall follow the following protocols:

- Live marine mammals or sea turtles observed swimming but appearing debilitated or injured: Capability to respond to free swimming animals is very limited and relocation is a major issue. In addition, medical treatment facilities for marine mammals and sea turtles are for the most part non-existent in Oregon. Therefore, it's recommended that the sighting be recorded as part of the monitoring report and provide the information to the Stranding Network. The data should include: 1) any photos or videos, if possible 2) species or common name of the animal involved; 3) date of observation; 4) location (lat/long in decimal degrees); 5) description of injuries or unusual behavior observed.
- Live marine mammals or sea turtles observed entangled in fishing gear or marine debris: The marine mammal disentanglement network in Oregon is based at Hatfield Marine Science Center in Newport, OR. Contact with the West Coast Stranding Network should be made immediately if an entanglement is observed and, if possible the reporting vessel should remain on scene while contact is made. Report should include the following information: 1) species or common name of animal involved; 2) location (lat/long in decimal degrees); 3) whether the animal is anchored by the gear or swimming with the gear in tow; 4) a description of the entangling gear (line size, line color, size number and color of floats if attached, presence or absence of pots or webbing; 5) if animal is towing gear, give direction of travel and current speed; 6) local weather conditions (sea state, wind speed and direction); 7) whether the vessel can stand by until someone is able to get there. The disentanglement network will determine whether or not a response can be mounted immediately and will advise the reporting vessel on next steps.
- Dead protected species found entangled or otherwise impinged at the project: These should be reported as part of the monitoring report to NMFS and ODFW, giving all available information on the case. The report should include the following information: 1) species or common name of animal involved; 2) location (lat/long in decimal degrees); 3) whether the animal was found on a project device or anchoring system; 4) a description of injuries or entanglement observed; 5) if fishing gear or other debris was involved, give a description of the gear (line size, line color, size number and color of floats if attached, presence or absence of pots or webbing); 6) photographs if possible and fill out a Level A Data sheet. Guidance on how to fill out the Level A Data sheet is found in "The Examiner's Guide to the Marine Mammal Stranding Report Level A Data". In the event fishing gear is involved, the presence of protected species entangled in the gear should be included in the report initiating gear removal planning and coordination.

4. MITIGATION FOR ORGANISM INTERACTION

The licensee will implement the Organism Interaction Monitoring Plan attached in Appendix H and will provide the resulting data to the AMC. This monitoring plan may be modified in accordance with the Adaptive Management Framework attached as Appendix J. No other mitigation actions associated with Organism Interaction are proposed.

5. MITIGATION FOR IMPACTS OF SOUND FROM WECS AND THEIR MOORING SYSTEMS ON MARINE RESOURCES

The licensee shall implement the Acoustic Monitoring Plan attached in Appendix H, including quantifying sound levels using field measurements and validated sound propagation models. This monitoring plan may be modified in accordance with the Adaptive Management Framework attached as Appendix J. For as long as WEC or mooring systems remains deployed, the licensee will continue in-situ monitoring and notify NMFS whether exceedances attributable to the WEC/mooring system are detected. Other specific mitigation actions for potential impacts of Project-related sound are provided in Measures 6 and 7.

The following Measures (6-9) are subject to on-going coordination with the specific resource agencies as noted below in each measure.

6. MITIGATION FOR POTENTIAL IMPACTS OF DYNAMIC POSITIONING VESSEL ACTIVITIES ON MARINE RESOURCES

The licensee shall take the following measures to ensure sound produced by Dynamic Positioning Vessels (DPVs) does not injure marine mammals and to mitigate for marine mammal exposure to sound in excess of NMFS's published harassment threshold(s) (120 dB re: 1 µPa):

(1) The licensee will avoid the use of DPVs or other equipment that may exceed NMFS's published threshold for injury to the maximum extent practicable during Phase B gray whale migration (April 1-June 15). If these construction activities are proposed during this migration period, the licensee will consult with ODFW regarding the timing of such activities including cable-laying in state waters.

(2) The licensee, with technical assistance from NMFS, will establish and carry out the following actions and protocols necessary to maintain an appropriate acoustic zone of influence in accordance with NMFS's published harassment threshold(s) (120 dB re: 1 µPa) during DPV operations to minimize behavioral disturbance and protect marine resources, which may be modified by agreement of the licensee and NMFS:

- The licensee will post qualified marine mammal observers during daylight hours;
- The licensee will conduct dynamic positioning ("DP") activities during daylight hours when feasible to ensure observations may be carried out;
- DP for cable laying may occur during all hours; however, DP start up for cable laying will only occur during daylight hours; and
- The licensee will carry out the following ramp-up procedures, which may be modified by agreement of the licensee and NMFS:

- ○ DP vessel operators shall be required to ramp up upon initial operations;
- ○ During DPV operations, except those associated with cable laying, the licensee shall reduce DP thruster power to the maximum extent practicable if a marine mammal approaches or enters the acoustic zone of influence except under circumstances when human, environmental health or the integrity of the project are compromised; and
- ○ The licensee shall not increase power until the zone is clear of marine mammals for a minimum of thirty (30) minutes.

(3) The licensee will implement such additional measures as may be imposed pursuant to a Marine Mammal Protection Act authorization.

7. MITIGATION FOR IMPACTS OF SOUND FROM WECS AND THEIR MOORING SYSTEMS ON MARINE RESOURCES

The licensee shall take the following measures to minimize and mitigate for WECs and their moorings systems that produces sound in excess of NMFS's published harassment threshold(s) (120 dB re: 1 µPa):

(1) Equipment. The licensee will require WEC testing client(s) to keep their equipment in good working order to minimize sound due to faulty or poorly maintained equipment.

(2) Persistent Sound Not Associated with High Seas State. If acoustic monitoring results indicate that sound from one or more WECs and their mooring systems at a Project berth persistently[5] exceeds NMFS's published harassment threshold(s), modeled at a distance of 100 meters from the source[6], then the licensee shall notify NMFS and:

- Instruct the relevant WEC testing client to diagnose and make repairs or modifications to WEC(s) or mooring systems so that they operate as intended as quickly as possible, but no longer than sixty (60) days unless agreed upon by the licensee and NMFS; and
- Continue in-situ monitoring and notify NMFS of any exceedances of NMFS's published harassment threshold(s). The licensee will also notify NMFS whether exceedances attributable to the WEC/mooring system are detected in the fourteen (14) days after implementation of the repairs to verify that the WEC and mooring systems are no longer producing noise over threshold levels.

If the subsequent monitoring results indicate that noise has been abated, monitoring will continue as detailed in the Acoustic Monitoring Plan.

[5] "Persistently" is defined as exceedances recurring for 4 or more consecutive days that are not during high sea states, where "high seas state" is defined as conditions that meet the National Oceanic and Atmospheric Administration's small craft advisory definition.

[6] Distance derived using NMFS guidance practical spreading model and a WEC sound source level of 151 dB_{rms} @ 1 m (Basset et al. 2011, NAVFAC 2014) as cited in the PacWave South Draft Biological Assessment.

If the sound level has not been abated below NMFS's published harassment threshold(s), the licensee shall instruct the relevant WEC testing client to provide to NMFS within thirty (30) days a draft plan[7] to implement one of the following mitigation actions, or other actions agreed upon by the licensee and NMFS, to reduce sound levels below the threshold. The mitigation action will be carried out within thirty (30) days of NMFS's approval unless NMFS has approved an alternate timeframe.

- Perform additional or alternative methods of monitoring to identify the specific source and cause of the sound to provide specific information as to the timing, duration and magnitude of the project-related sound and compare to ambient levels, and inform the development of specific actions necessary to reduce sound below threshold;
- Modify the operation of the WEC or mooring system components producing the sound (e.g., modify controls to change the motion of the WEC); or
- Perform necessary repairs or modifications to minimize sound levels. Subsequent monitoring would be conducted to verify that the sound level associated with the test has been abated.

After completing the necessary actions, the licensee will continue in-situ monitoring and notify NMFS whether exceedances attributable to the WEC/mooring system are detected in the fourteen (14) days after the expected solution is implemented to verify that the noise associated with the test is no longer over threshold levels.

If, after taking the steps above, persistent sound levels from the operation of the project cannot be mitigated to below NMFS's published threshold(s) for harassment, measured or modeled at 100 meters from any WEC or mooring system, the licensee, with technical assistance from NMFS, will:

- Require the testing client to cease operating the WEC, if possible, if doing so will temporarily halt the sound threshold exceedances;
- Work with the testing client, NMFS and subject matter experts to determine whether actions can be taken to reduce the sound produced by the WEC or mooring system that is in excess of the threshold; and
- Implement the actions identified above to reduce sound produced by the WEC or mooring system or, if no such actions can be identified, either (i) cease testing the WEC at the Project or (ii) obtain approvals under the MMPA and ESA, as appropriate, to continue testing the WEC at the Project.

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[7] The draft plan shall include a proposed implementation timeline and monitoring provisions to confirm whether the measures were effective. Upon approval of a plan by the NMFS, the licensee shall ensure that the plan is implemented in accordance with the approved plan. The mitigation action will be carried out within 30 days unless NMFS has approved an alternate timeframe. In no circumstances shall implementation of the plan be undertaken at a time that would jeopardize human safety, property or the environment.

Upon re-initiation of operations or redeployment of the WEC and/or mooring system, the licensee will continue in-situ monitoring and notify NMFS whether exceedances attributable to the WEC/mooring system are detected in the fourteen (14) days after the expected solution is implemented to verify that the noise associated with the test is no longer over threshold levels.

(3) Temporary Sounds Associated with High Seas States. If acoustic monitoring indicates that sound pressure levels attributable to operations of any WEC or mooring system are above 120 dB_{rms} non-impulsive or 160 dB_{rms} impulsive sound, modeled at a distance of 117 meters, and are temporary[8] and associated only with high sea states (i.e., intermittent), the licensee shall determine whether the sound threshold exceedance occurs again during the next high sea state based on in-situ monitoring. If the exceedance occurs again, the licensee shall notify NMFS and:

- Instruct the WEC testing client to investigate system monitors or power output components in order to diagnose and make repairs or modifications so that it operates as intended as quickly as possible, but no longer than sixty (60) days unless agreed upon by the licensee and NMFS; and
- Continue in-situ monitoring and notify NMFS whether exceedances attributable to the WEC/mooring system are detected (i) in the fourteen (14) days after the expected solution and (ii) during the next high sea state, to verify that the noise associated with the test is no longer over threshold levels.

If, after taking the steps above, sound levels from the WEC or mooring system during high sea states cannot be mitigated to below 120 dB_{rms} non-impulsive or 160 dB_{rms} impulsive, modeled at 117 meters, the licensee, with technical assistance from NMFS, will:

- Work with the WEC testing client, NMFS and subject matter experts to evaluate the likelihood of additional exceedances during high sea states based on the planned WEC removal schedule and the potential adverse impacts of such exceedances on marine resources; and
- Either (i) with NMFS's approval, leave the WEC in place until it is removed as scheduled, (ii) remove the WEC or mooring system responsible for sound exceedances during the soonest feasible window for such an action, or (iii) obtain approvals under the MMPA and ESA, as appropriate, to continue testing the WEC at the Project.

(4) Reporting and Evaluation. To ensure that the mitigation measures detailed above are providing the mitigation necessary, the licensee will:

- Provide an annual report in accordance with the Acoustic Monitoring Plan that includes the following:
  - Analysis of monitoring results including comparison to ambient conditions and identified thresholds;

[8] "Temporary" means occurring only during high seas states, where "high seas state" is defined as conditions that meet the National Oceanic and Atmospheric Administration's small craft advisory definition.

- Level, duration and timing of any WEC or mooring-related exceedance of identified thresholds;
- Mitigation measures carried out and documentation of actions taken including date, time and WEC or structures; and
- Evaluation of whether acoustic monitoring techniques are sufficient to adequately assess potential effects of varying operational states.

The licensee will provide the draft annual report to NMFS at least thirty (30) days prior to submitting it to FERC and will indicate in its submittal how comments from NMFS were addressed, provided such comments are received at least ten (10) days prior to submission of the draft report.

8. MITIGATION FOR PINNIPED HAULOUT ON WECS AND MARINE PROJECT STRUCTURES

The licensee and its agents shall make opportunistic visual observations of pinnipeds in the portions of the test site which are being visited to conduct operations, maintenance, or environmental monitoring work and shall report any observed pinniped haulout activity to NMFS within seven (7) days of such observation.

If pinnipeds are identified on one or more of the WECs or project structures, the licensee will ensure that the following NMFS haulout protocols are followed during any attempt to access the device or structure, and shall provide a summary of protocols employed to NMFS within fifteen (15) days of having used any such deterrent measures:

- If pinnipeds are present on one of the project structures and do not leave the structure upon approach up to 100 yards and the pinnipeds are non-ESA listed species, the licensee or its assigns or agents may proceed to deter the pinniped from project structures so long as such measures do not result in the death or serious injury of the animal (pursuant to Section 101(a)(4)(A) of the Marine Mammal Protection Act). Any efforts to deter pinnipeds must take into consideration possible impacts on other species that may be in the area. The licensee shall ensure authorized visitors to the project follow the most up to date NOAA guidance on deterring pinnipeds, current at the time of the occurrence.
- If ESA-listed pinnipeds are present on project structures, no intentional deterrence activities may be undertaken; however, the licensee or its assigns or agents may proceed to approach the project structure as originally planned. If the pinnipeds leave the project structure as a result of normal vessel approach, all work may continue as planned. If the pinnipeds do not leave the project structure upon approach, only work that can be carried out without injuring pinnipeds or endangering human safety may go forward.
- If the licensee needs to perform emergency maintenance that requires immediate attention (e.g., closing an opened hatch, repairing a failed mooring or electrical fault) and deterrence of an ESA-listed species is necessary, the licensee will request assistance from the NMFS Regional Stranding Coordinator, Protected Resources Division, 206-526-4747. The licensee will provide an account of the incident to the appropriate staff at NMFS and ODFW as soon as possible but not later than fifteen (15) days following the event.

9. MITIGATION FOR BIRDS AND BATS

The licensee shall implement the Environmental Measures section as described in Bird and Bat Conservation Strategy attached as Appendix B to the APEA, in coordination with USFWS and ODFW.

The following Measures (10-20) will be implemented by the licensee as described herein without further coordination with resource agencies.

10. MITIGATION FOR OPERATIONS AND MAINTENANCE

The license shall employ periodic, routine inspection and maintenance methods to ensure structural integrity of Project components. Methods are described in the Operation and Maintenance Plan, provided in Appendix F. Operations and maintenance activities will not cause injury or harassment of marine mammals without any necessary authorization under the MMPA.

11. MITIGATION FOR IMPACTS TO BENTHIC HABITAT FROM CABLE LAYING AND ASSOCIATED CONSTRUCTION ACTIVITIES

The licensee shall take the following measures to minimize and mitigate for potential impacts to benthic habitat from cable laying and associated construction activities:

(1) Installation Method. The licensee will use horizontal directional drilling (HDD) to install the cable conduits under the nearshore and intertidal habitat (to approximately the 10-m isobath) to minimize substrate disturbance.

(2) Burying Cables. The licensee will bury cables at a depth of 1-2 meters (so as to ensure continuous burial in accordance with implementation requirements of Territorial Sea Plan Part 4) to the maximum extent practicable, to minimize the amount of habitat conversion (soft bottom to hard structure) from laying exposed cable on the seafloor. In areas where a cable cannot be buried or persistently becomes unburied, that portion of the cable will be on the seafloor and will be protected by split pipe, concrete mattresses, or other cable protection systems.

(3) Cable Routes. The licensee will develop cable routes that avoid crossing areas with rocky reef and hard substrate to the maximum extent practicable to protect sensitive habitat features.

(4) Best Practices. The licensee will follow best practices during cable installation, operation, and removal activities to avoid or minimize potential effects to sediment, including minimizing the time that the seafloor is disturbed and sediment is dispersed and the associated effects by completing cable laying and other construction activities during appropriate construction windows and within one construction season to the extent practicable.

12. MITIGATION FOR WATER RESOURCES

- Follow industry standards and guidelines[9] for antifouling applications (e.g., TBT-free) on Project

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[9] Industry standards are sometimes published in written documents (e.g., the International Cable Protection Committee's cable recommendations available at https://www.iscpc.org/publications/recommendations/) or in manufacturer guidelines (e.g., for a vessel anchor, providing the recommended ratio of water depth to anchor line

structures such as marker buoys, subsurface floats, subsea connectors, and WECs.

- Develop and implement an Emergency Response and Recovery Plan with spill prevention, response actions and control protocols, as well as provisions for recording types and amounts of hazardous fluids contained in WECs and other Project components.
- Require all vessel operators to comply with an Emergency Response and Recovery Plan for installation and maintenance of Project facilities.
- Prepare waste management, hazardous material, and spill prevention plans, as appropriate, for onshore Project facilities.
- Minimize storage and staging of WECs outside of existing docks, ports or other marine industrial facilities.
- Project components in the estuarine environment should not bottom out so as to prevent nearshore/estuarine habitat effects.
- Require that all Project chartered or contracted vessels comply with all current federal and state laws and regulations regarding aquatic invasive species management.
- Develop and implement an HDD Contingency Plan to minimize the potential for inadvertent return of drilling fluids, provide timely detection, and address potential releases by describing monitoring, containment, response and notification procedures to be implemented by the contractor.

13. MITIGATION FOR VESSEL TRAFFIC

- The licensee shall require vessels in transit to/from the Project site to avoid close contact with marine mammals and sea turtles and adhere to NMFS "Be Whale Wise" guidelines to minimize potential vessel impacts to marine mammals.

14. MITIGATION FOR GEOLOGIC AND SOIL RESOURCES

- Use horizontal directional drilling (HDD) to install the transmission cable conduits under the nearshore and intertidal habitat (out to approximately the 10-m isobath) to minimize substrate disturbance.
- Use HDD to install the terrestrial cables in up to five bores, from the beach manholes at the Driftwood Beach State Recreation Site to the UCMF property, and from the UCMF to the Highway 101 grid connection point, to minimize habitat and substrate disturbance.
- Minimize the time that the seafloor is disturbed and sediment is dispersed.
- Develop and implement Erosion and Sediment Control Plans, where appropriate, to minimize effects of ground disturbing activities associated with installation of the terrestrial cables and/or other terrestrial construction.
- Project components in the estuarine environment should not bottom out so as to prevent nearshore/estuarine habitat effects.

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paid out). These standards are sometimes required as a condition of insurance or warranty. In other cases, industry standards represent unpublished best practices commonly implemented by a particular industry and that evolve over time.

- To the extent possible, minimize frequency of anchor installation/removal cycles and reuse installed anchors.

15. MITIGATION FOR AQUATIC RESOURCES AND THREATENED AND ENDANGERED SPECIES

- Bury subsea transmission cables, at a depth of 1-2 meters, and utilize shielding on subsea cables and other electrical infrastructure (including, to the extent feasible, umbilicals and subsea connectors) to minimize electromagnetic field (EMF) emissions, to the maximum extent practicable.
- Require vessels in transit to/from the Project site to avoid close contact with marine mammals and sea turtles and adhere to NMFS “Be Whale Wise” guidelines to minimize potential vessel impacts to marine mammals.
- Minimize construction activities during key gray whale migration periods, to the extent possible.
- Comply with current regulations that require marine mammal observers for vessel based activity (e.g., sub-bottom profiling).
- Design and maintain cables and moorings in configurations to minimize the potential for marine mammal entrapment or entanglement.

16. MITIGATION FOR TERRESTRIAL RESOURCES

- Minimize or avoid terrestrial activities in sensitive ecological areas (e.g., jurisdictional wetlands and nesting areas for listed avian species).
- Use HDD to install the cable conduits under the beach and sand dune habitat.
- Use HDD to install the terrestrial cable conduits in directly from the Driftwood site to the UCMF, and from the UCMF to the Highway 101 grid connection point, to minimize effects to wetlands, streams, and terrestrial habitat.
- Prior to construction, conduct a survey of wetlands and rare plants in areas where ground disturbing activities would occur to identify and avoid potential impacts as practicable.
- Employ environmental measures during installation, operation, and removal to avoid or minimize potential effects to sediment and soils. For example:
    - Minimize disruption of terrestrial geology and soils by maintaining buffers around wetlands to the degree practicable,
    - Develop and implement Erosion and Sediment Control Plans, and maintain natural surface drainage patterns.
    - Develop and implement stormwater runoff containment such as low-impact development design at terrestrial facilities to maintain existing drainage patterns, protect Project-adjacent habitat, and prevent contamination of streams. Develop a stormwater plan that meets all federal and state legal requirements during site design of the UCMF and associated facilities prior to any construction activities at the site.
- Avoid to the extent practicable, disturbance of snags and of wildlife or legacy trees including live or dead trees that provide benefit to wildlife. If unavoidable, additional pre-construction species specific surveys may be necessary to minimize effects.
- Avoid to the extent practicable, disturbance of forested wetlands.

- Avoid to the extent practicable, disturbance of wetlands and adjacent areas that may provide habitat for turtles, amphibians, and other semi-aquatic wildlife.
- Avoid to the extent practicable, disturbance of riparian wetlands where restoration of natural hydrology may be unsuccessful within a short timeframe. Natural hydrology should be restored after construction is complete, and may require a restoration plan with monitoring until successful restoration can be determined.
- Minimize disturbance of streams that support fish, or are connected to fish-bearing streams. Unavoidable work within or adjacent to fish-bearing streams may be subject to in-water work windows. If terrestrial activities directly or indirectly affect any stream used by anadromous fish or fish listed as threatened or endangered under the federal Endangered Species Act, OSU would consult with NMFS/FWS staff to avoid and minimize any potential effects to listed species.
- Avoid to the extent practicable, disturbance of seaside hoary elfin butterfly habitat within and in the vicinity of Driftwood Beach State Recreation Site. Where unavoidable, species-specific surveys may be necessary on properties outside of Driftwood Beach State Recreation Site but within the construction footprint to determine the extent of occupied habitat and associated mitigation[10].
- Develop a revegetation plan, in consultation with NMFS, ODFW, and appropriate agencies, using native species to the extent practicable for areas disturbed during construction. This plan will include the minimization measures identified in letters commenting on the DLA filed with FERC by NMFS (dated July 18, 2018) and ODFW (dated July 20, 2018) as appropriate.
- Develop measures that will limit the introduction or spread of invasive species, to be included in each construction plan.

17. MITIGATION FOR RECREATION, OCEAN USE, AND LAND USE

- Mark Project structures with appropriate navigation aids, as required by the USCG.
- Avoid, to the extent practicable, anchoring in areas known to contain hard substrate or rocky reef habitats as identified by available seafloor mapping.
- Conduct outreach to inform mariners of Project structures or activities to be avoided in the area (e.g., Notice to Mariners, flyers posted at marinas and docks).
- Install subsurface floats at sufficient depth to avoid potential vessel strike.
- Work cooperatively with commercial and recreational fishing entities and interests to avoid and minimize potential space-use conflicts with commercial and recreational interests during construction and operation.
- Bury subsea transmission cables 1 to 2 m deep where feasible to minimize interactions with fishing gear and anchors.
- Use HDD to install the terrestrial cables conduits directly from the Driftwood Beach State Recreation Site to the UCMF, and from the UCMF to the Highway 101 grid connection point, thus minimizing effects to adjacent landowners and traffic along Highway 101.

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[10] Survey protocol to be consistent with the U.S. Forest Service Interagency Special Status/Sensitive Species Program protocol for Seaside Hoary Elfin (<https://www.fs.fed.us/r6/sfpnw/issssp/planning-documents/species-guides.shtml>. Accessed November 28, 2018).

- If acceptable to OPRD, develop and install interpretive display describing PacWave South. OSU would work with OPRD to develop a plan regarding the interpretive display.
- Comply with all state and local permitting requirements for all construction work.
- Use construction fencing to isolate work areas from park lands.
- Although non-project related vehicular access to the Driftwood Beach State Recreation Site would be prohibited during construction, OSU would arrange the construction work area to maintain pedestrian public beach access, to the extent safe and practicable and with concurrence of OPRD. OSU would coordinate with the OPRD to mitigate impacts to public access and use of Driftwood Beach State Recreation Site.
- Construction work areas or staging areas should be sited on other disturbed areas if possible.

18. MITIGATION FOR CULTURAL RESOURCES

- Contract with a marine archaeologist to review the results of the marine survey to determine the potential presence of archeological resources.
- Conduct a Phase 1 archaeological survey of the terrestrial areas to be disturbed. Depending on results of the Phase 1 survey, reviewed in consultation with the SHPO, a Phase 2 survey may be required, which would likely include in-field analysis (e.g., shovel test pits on a grid) of potential sites to determine National Register Eligibility.
- Consult with local, state, and tribal organizations with regards to any excavation or digging to limit land disturbance and prevent impacts to any cultural or tribal resources (known or discovered).
- Develop and implement an Unanticipated Cultural Resource Discovery Plan that provides for procedures to follow in the event that cultural resources are encountered during construction of the terrestrial components of the Project. For example, immediately cease activities and contact the appropriate authorities (i.e., the SHPO and/or the Tribal Historic Preservation Office) if any historical, cultural, and/or archeological resources are encountered during construction of the Project.

19. FIVE YEAR REVIEWS

Beginning five years and six months after deployment of the first WEC device at the Project, and recurring every five years thereafter, the licensee shall file with FERC a Five Year Report and provide copies to BOEM, NMFS, USFWS, and ODFW. The Five Year Report shall contain: (1) a review of all WEC deployments and associated Project activities from the prior five years (not including the most recent six months), including a description of the types and number of WEC devices deployed, frequency and duration of WEC deployments, monitoring activities and results, and any adaptive management criteria or response actions that were applied or modified; and (2) a description of WEC deployment activities that are planned or that are reasonably foreseeable in the next five years including, to the extent known, the types and number of WEC devices likely to be deployed, and the likely duration of such deployments. The purpose of the Five Year Plan is to allow each agency to evaluate past and proposed future Project operations to confirm that Project effects are consistent with each agency's prior regulatory review.

20. FISH OR WILDLIFE EMERGENCY

In the event of an emergency in which fish or wildlife are being killed, harmed or endangered by project facilities or operations in a manner that was not anticipated, OSU will notify agencies with regulatory authority as soon as possible and take action to promptly minimize the impacts of the emergency, including implementing any guidance pursuant to agency legal authorities. Within 48 hours after the emergency, OSU will notify the agencies regarding the results of actions taken to minimize impacts to fish or wildlife and will consult with the agencies regarding whether additional actions are necessary to comply with federal, state or local law. Nothing in this provision shall prevent OSU from taking immediate actions to protect life and property, stabilize an incident, or minimize potential damage.

APPENDIX J
Adaptive Management Framework

ADAPTIVE MANAGEMENT FRAMEWORK

1. ADAPTIVE MANAGEMENT COMMITTEE

1.1 The purpose of the Adaptive Management Committee (AMC or Committee) is to inform Oregon State University's (OSU) implementation of certain monitoring and mitigation measures as provided herein pursuant to the Federal Energy Regulatory Commission (FERC) license for PacWave South (the Project; formerly known as Pacific Marine Energy Center South Energy Test Site[PMEC-SETS]) (FERC No. 14616), including monitoring of the facility and wave energy converters (WECs) at the facility. Specifically, in accordance with the provisions herein, the AMC will evaluate monitoring plan results and make changes to monitoring plans pursuant to Mitigation Measures 1, 2, 3, 4 and 5. In addition, the AMC will make decisions regarding whether to adopt additional or modify existing mitigation measures under Mitigation Measures 1, 2 and 3 to bring effects within the criteria identified in those Mitigation Measures. Other Mitigation Measures will be managed in accordance with their terms in coordination with the specified resource agency involved, as appropriate, and will not be managed by the AMC. Emergencies involving fish or wildlife are addressed in accordance with Mitigation Measure 19. This Adaptive Management Framework (AMF) is additive to existing regulatory and statutory authorities; it is not intended as the sole forum in which those authorities are exercised, and it does not preclude any AMC member's ability to exercise their authorities.

1.2 The AMC's responsibilities are as follows:[1]

1.2.1 Monitoring Plan Changes. The AMC will evaluate monitoring plan results and any relevant new information[2] to make any warranted changes to the monitoring plans under Mitigation Measures 1, 2, 3, 4, and 5. Changes may include modifications to monitoring design, methods, duration, goals, cessation of monitoring, or additional monitoring. OSU would be responsible for ensuring that the changes are carried out.

1.2.2 Mitigation Measures. The AMC will evaluate monitoring plan results and any relevant new information to determine whether the monitoring results indicate that mitigation should be implemented under Mitigation Measures 1, 2 or 3 as provided in those measures. The AMC will consider whether the information indicates that detected effects: (a) are attributable to the Project facility, WEC assemblies (WEC, mooring lines, anchors, floats, etc.) being tested, or the manner in which the facility or deployed test equipment is installed, operated or removed; and (b) meet criteria provided in the relevant Mitigation Measure for taking an action. If the AMC affirms (a) and (b) above, it will then evaluate and

[1] This section 1.2 is a list of all AMC responsibilities. The process for how the AMC makes decisions is provided in Section 4.

[2] Monitoring results will be distributed in accordance with the reporting provisions in each monitoring plan. Relevant new information may be provided by OSU or any member of the AMC for the group's consideration; however, neither OSU nor AMC members are obliged to seek information beyond the monitoring results.

approve/disapprove proposed plans provided by the licensee or WEC testing client to mitigate for the identified effect and monitor to ensure the mitigation is effective. In the event the AMC disapproves a plan, the licensee may either revise and resubmit the proposed plan for AMC approval or disapproval, or initiate dispute resolution.

2 COMMITTEE MEMBERSHIP AND PARTICIPATION

2.1 The AMC is comprised of a representative from each of the following entities: OSU, National Marine Fisheries Service, U.S. Fish and Wildlife Service, Bureau of Ocean Energy Management and Oregon Department of Fish and Widlife. The Committee, by unanimous agreement of its members, may grant any other entity membership on the Committee. All members of the AMC, including new members, agree to follow the provisions of this AMF.

2.2 Each AMC member will designate a primary representative to the Committee within 30 days after issuance of the Project license, and may also designate an alternate representative who may act on the primary representative's behalf. A member may change their representative or alternate representative at any time thereafter. Designations or changes to representatives or alternates will be made by notice to other AMC members in accordance with Section 6, and shall include name, title, mailing address, email address and telephone number. Failure to designate a representative will not prevent the Committee from convening or conducting the functions identified in Section 1.2 above.

2.3 Each AMC member representative may send staff with expertise or experience in a particular issue to attend and participate in meetings to advise the representative (or alternate).

2.4 Committee members agree to support Committee actions with which they agreed when subsequently commenting or making other submissions or statements regarding the Project to the FERC and in other forums. In addition, each state and federal agency representative will coordinate internally, and intends that actions it supports or approves through the Committee process will meet the requirements of that agency's statutory and regulatory authorities. Nothing in this AMF or in the Committee's decisions pre-determine the outcome of an agency's statutory or regulatory reviews, nor does it preclude any AMC member's ability to exercise existing regulatory and statutory authorities. In addition, nothing in this paragraph is intended to restrict Committee members from taking a different position than previously taken when new information indicates that a prior agreement is no longer consistent with law, regulation or the best available science.

2.5 An AMC member may withdraw from the Committee at any time, for any reason, by providing prior written notice to other members in accordance with Section 6. Withdrawal may be temporary, and the withdrawing entity may rejoin the Committee as a full member at any time by providing prior written notice to other members under the provisions in Section 6.

3 Meeting Provisions

To ensure effective communication, AMC members will follow the communication protocols described herein. The AMC may elect to modify these protocols in certain situations, as appropriate. All timeframes in this AMF refer to calendar days.

3.1 Frequency and Duration. The Committee will convene at least once annually for the term of the Project license, or more frequently as needed to perform the actions set forth in Section 1.2 above. Meeting frequency and duration will be determined based on milestone events associated with the monitoring plans (e.g., following OSU's issuance of monitoring results); or as the need arises based on new information warranting AMC discussion.

3.1.1 Meetings may be held in-person or via conference calls and/or webinars as needed, as the Committee deems appropriate. Meetings at which the Committee will employ the decision-making process described in Section 4 will be scheduled at least thirty (30) days in advance. OSU will distribute an agenda at least fourteen (14) days in advance of each scheduled meeting for review and feedback from Committee members.

3.2 Meeting Materials. Meeting materials will be developed to inform and guide meeting discussions. While it is anticipated that OSU will be responsible for developing meeting materials, any AMC member can provide meeting materials, per the provisions of this section.

3.2.1 Meeting materials will be distributed at least fourteen (14) days in advance of each scheduled meeting. Any materials subject to Committee decision-making (as described in Section 4) will be distributed at least thirty (30) days in advance.

3.3 Meeting Summaries. Meetings will be documented by summarizing topics discussed and action items. Meeting summaries will be distributed within fourteen (14) days of the meeting. Members may propose changes to meeting summaries within twenty-one (21) days of receipt (response period). OSU will share the revised meeting summary with the AMC within fourteen (14) days after the response period.

3.4 Miscellaneous. OSU will arrange, administer and chair all meetings, unless otherwise agreed. OSU will bear all costs associated with conducting meetings. Each AMC member will bear its own cost of attending.

4 Committee Deliberations & Decisions

4.1 Decisions. The AMC will deliberate and make decisions consistent with its responsibilities under Section 1.2. OSU will implement any action where a decision has been made by the Committee, subject to the requirements of the Project license (such as filing for FERC approval) and any necessary regulatory approvals. The AMC decision-making under this AMF relates only to this AMC process; it is not intended as the sole forum in which members' existing statutory and regulatory authorities are exercised, and does not preclude members' ability to exercise their authorities.

4.2 Decision Making Process.

4.2.1 The Committee will make decisions by consensus, which is achieved when the representative (or alternate) of each member present at a duly-noticed meeting pursuant to Section 3.1.1 casts a supportive or neutral vote, or abstains from the decision. Members may vote in person, over the phone, or by proxy.[3] AMC members will use best efforts to reach consensus decisions or resolve disputes through the processes prescribed in this AMF; however, nothing in this AMF prevents any member from seeking remedy in whatever forum(s) are available to them (e.g., filing an appropriate document with FERC, recommending that FERC reinitiate consultation, etc.). If the Committee cannot reach a consensus decision, any AMC member may initiate the dispute resolution process described in Section 5.

4.2.2 Any materials subject to Committee decision-making will be distributed at least thirty (30) days in advance of the Committee discussion or vote, as described in Section 3.

4.2.3 Unless otherwise noted, OSU will file with FERC the monitoring information, any plans, requests for approval, or other required actions on which the Committee has reached a consensus decision within twenty-one (21) days of the Committee decision. OSU will include documentation of consultation with Committee members.

5 DISPUTE RESOLUTION

5.1 Disputes. If the Committee does not reach a consensus decision, any member may initiate dispute resolution.

5.2 Procedures. Committee members agree to devote such time and attention to dispute resolution as necessary and reasonable to attempt to resolve the dispute at the earliest possible time, and each member will cooperate in good faith to promptly schedule, attend and participate in dispute resolution. Each member will promptly implement all final agreements reached, consistent with its applicable statutory and regulatory responsibilities.

5.2.1 *Initiation Notice*: A member initiating dispute resolution will provide notice to other members within fourteen (14) days of the Committee vote on the matter. This notice should describe the matter(s) in dispute, the member's position and basis for disagreement, any proposed relief or resolution, and any supporting documentation. Each member that wishes to participate in dispute resolution must provide notice to other members within fourteen (14) days of receiving the notice initiating dispute resolution. All notices must be provided in accordance with Section 6.

5.2.2 *Informal Meetings*: The members involved in attempting to resolve the dispute (Disputing Members) must hold informal meetings to resolve the dispute. If the Disputing Members are unable to resolve the dispute after one informal meeting, a second informal meeting

[3] The member representative (or alternate) must identify its proxy by notice to other Committee members prior to the vote.

will be held at the management level to seek resolution. Both meetings will occur commencing within thirty (30) days and concluding within sixty (60) days after the notice initiating dispute resolution.[4] The member who initiated the dispute is responsible for coordinating all meetings under this Section 5.2.2 and will make good faith efforts to coordinate a meeting time and location that is satisfactory to all Disputing Members.

5.2.3 *Mediation*: If the parties are unable to resolve the dispute through the informal meetings described in Section 5.2.2 above, the Disputing Members may, by unanimous consent, agree to mediation. The Disputing Members will choose a mediator within thirty (30) days of the conclusion of informal meetings under Section 5.2.2. Mediation will only occur if the Disputing Members unanimously agree on the allocation of costs and choice of mediator. The mediation process will be concluded no later than sixty (60) days after the mediator is selected. The above time periods may be adjusted upon mutual agreement of all Disputing Members.

5.2.4 *Dispute Resolution Notice*: OSU will give notice to all AMC members and FERC of the results within twenty-one (21) days of conclusion of the dispute resolution process, in accordance with Section 6. Plans changed during resolution of the dispute will be circulated to the AMC to confirm with the non-disputing members that the revised plan remains consistent with elements present in the initial plan with which they previously agreed. Disputing parties who don't agree with OSU's characterization of issues and resolution may file their position with FERC under independent cover.

5.3 <u>Commission Filings</u>. If OSU is required to make a FERC filing relating to an issue that was not successfully resolved through Committee vote or this dispute resolution process, OSU will make the required filing and will include an explanation of the lack of agreement, including a summary of any dissenting opinions, to ensure the issue is fully communicated and documented in the administrative record. Any Disputing Member may file comments and other documents with FERC regarding the disagreement, or oppose or seek modification of OSU's filing. Members who did not participate in dispute resolution regarding a plan provided to the AMC by the licensee or WEC testing client as described in Section 1.2.2 may not later oppose or seek modification of that plan.

5.4 <u>Effect of Dispute Resolution on Other Proceedings</u>. The dispute resolution process in this Section 5 does not preclude any AMC member from timely filing and pursuing an action for administrative or judicial relief of any FERC order, compliance matter, or other regulatory action related to the Project license.

5.5 <u>Remedies</u>. Following conclusion of dispute resolution, a Disputing Member that is not satisfied with the outcome of dispute resolution may exercise any appropriate remedy, including filing comments with FERC and seeking to amend or modify the Project license or other appropriate relief.

[4] These timeframes may be adjusted by mutual agreement of all Disputing Members.

6 NOTICE

Any notice required to be given to AMC members will be in writing. When sent by email, such notice will be effective upon the date the email is sent. Certified mail will be effective upon the date it is verified to have been received. First-class mail or comparable method of distribution shall be effective seven (7) days after the date on which it is first mailed or otherwise distributed. Notice will also be filed with FERC, as applicable. For large electronic documents, notice is only effective as provided above so long as the recipient has adequate technology to receive and view the document.

For purposes of notice, OSU will maintain an updated list of AMC member representatives (and any alternates) provided pursuant to Section 2.2, including their contact information, and shall provide this list to AMC members at least annually and upon request. AMC members shall provide notice of any change in the authorized representatives.

APPENDIX K
Habitat Mitigation Plan Developed for ODFW

HABITAT MITIGATION PLAN

CONTACT: DAN HELLIN, OPERATIONS & LOGISTICS MANAGER, PACWAVE, OSU
P: 541-737-5452 DAN.HELLIN@OREGONSTATE.EDU

1. INTRODUCTION

Oregon State University (OSU) is developing PacWave South (Project; formerly known as the Pacific Marine Energy Center South Energy Test Site [PMEC-SETS]). PacWave South would serve as the primary grid-connected ocean test facility for wave energy converters (WECs) in the United States. While the majority of PacWave South's equipment would be located offshore, the terrestrial portion of the Project would include a cable landing site, terrestrial cables, and a utility connection and monitoring facility (UCMF). The terrestrial portion of the Project area (Figures 1) includes the cable landing at the Driftwood Beach State Recreation Site (Driftwood), where the subsea cables would transition to terrestrial cables. These terrestrial cables would run in conduits to the southeast, under the southern portion of Driftwood. The cable conduits would then run under small sections of six private properties located on either side of Highway 101, and then to the OSU-owned parcel east of the highway. The total distance of the terrestrial cables would be about 0.5 miles, and all the cables would be installed by horizontal directional drilling (HDD), which is an underground boring technique. The grid connection to Central Lincoln People's Utility District's (CLPUD) distribution system would be installed by HDD and run in conduit from the UCMF to a grid connection point with the CLPUD overhead distribution lines along Highway 101 adjacent to the UCMF site.

This HMP describes the habitat in the project area, the anticipated temporary and permanent impacts, and mitigation to address these limited impacts. This HMP addresses habitat within the final route for the terrestrial cables, which has changed since the prior draft of the HMP. Specifically, OSU would now plan to install the terrestrial cables by HDD rather than trenching in order to avoid most impacts to habitat, particularly wetlands. As part of OSU's collaborative approach to the regulatory process, OSU has developed and revised this HMP to address recommendations from Oregon Department of Fish & Wildlife (ODFW) regarding Oregon's Habitat Mitigation Policy (Oregon Administrative Rules 635-415) for onshore habitat impacts. This plan is based on the Habitat Characterization Report[1] dated August 1, 2017 and authored by HDR, which has been previously provided to ODFW and is incorporated herein by reference.

Figure 1 shows the current FERC Project Boundary, which includes habitat features such as wetlands, dunes, beaches, potential roosting habitat for bats, disturbed/shore pine forest, and unpaved maintained and landscaped areas. OSU has carefully routed its cable to ensure minimum impacts to the fewest habitat features. As a result, there is potential for impacts to roosting habitat for bats (due to construction equipment noise and lighting), disturbed/shore pine forest (due to UCMF construction), and unpaved, maintained, and landscaped areas (due to HDD) by the Project. Most impacts to the terrestrial portion of the Project area would be temporary and limited to disturbance associated with cable installation and HDD operations. The permanent impacts would be the loss of approximately 1.4 acres of Habitat Category

[1] The Habitat Characterization Report and other studies encompassed a larger area than is shown in Figure 1.

4 Disturbed/Shore Pine Forest on the private land parcel for the UCMF and improved access road. In addition, a small area (less than 0.04 acres) of Habitat Category 6 Roads and Existing Rights-of-way would be permanently impacted in the vicinity of the CLPUD utility pole on Highway 101 and along the edges of NW Wenger Lane. These impacts would be mitigated as described in Section 3 of this document.

This Habitat Mitigation Plan is based on the current design of the Project. As final construction plans become available after OSU files the Final Licensing Application (FLA), OSU would provide the construction plans to the appropriate agencies and modify this HMP, if needed, in consultation with ODFW.

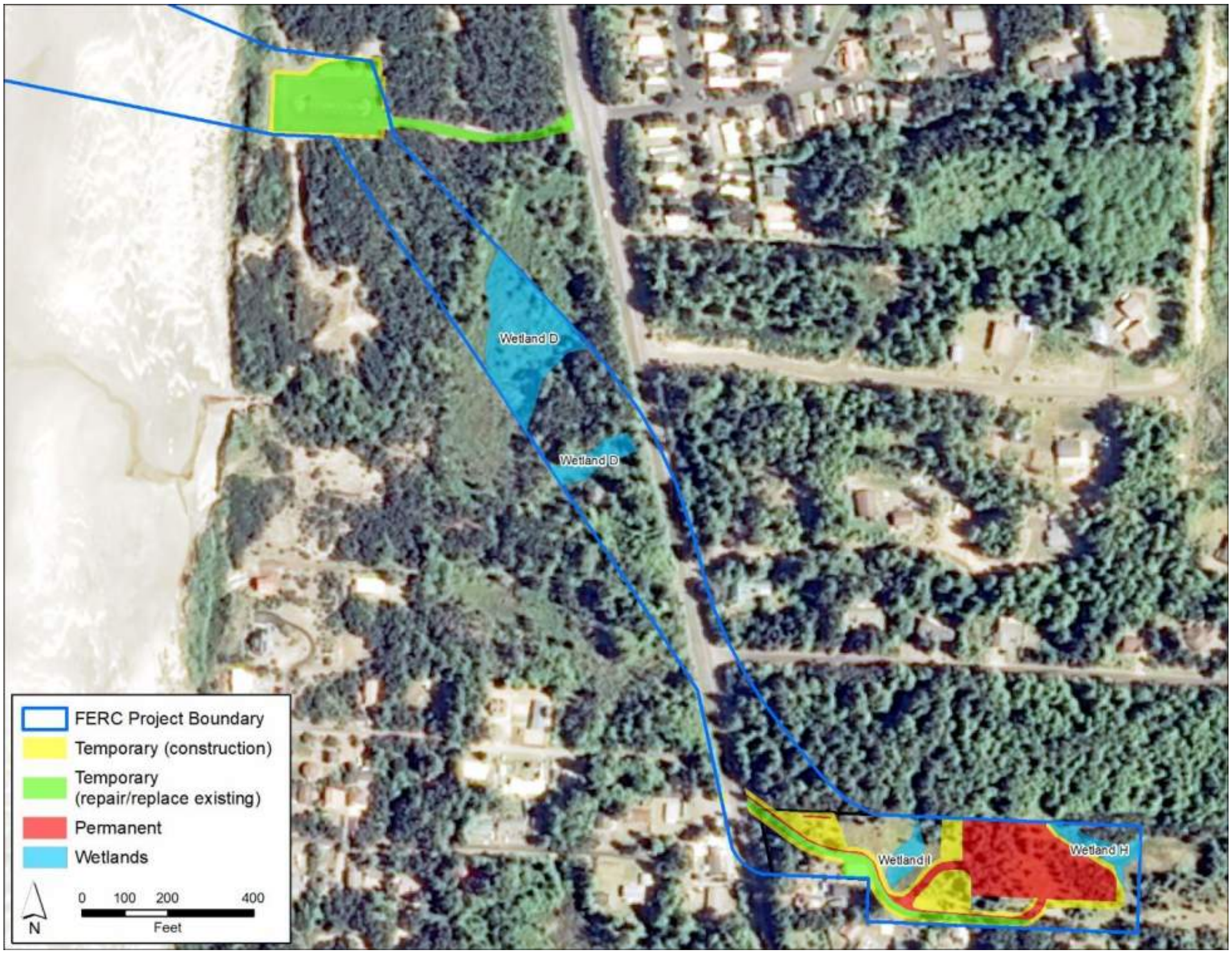

Figure 1. FERC Project Boundary, wetlands and areas of temporary and permanent impact.

2. Discussion

Described below are the habitat types within the Project boundary and the Project's temporary and permanent impacts to onshore fish and wildlife habitat.

A. *The proposed development; alternatives; affected species and habitat; and nature, extent, and duration of expected impacts. OAR 635-415-0020(8)(a), incorporating OAR 635-415-0020(4)(a)-(d) by reference.*

The Proposed Development

PacWave South is a marine and terrestrial facility that would connect an ocean test facility for WECs to the Central Lincoln People's Utility District's (CLPUD) grid. The marine portion of the Project would be located in the Pacific Ocean, approximately six nautical miles off the coast of Newport, Oregon, on the Outer Continental Shelf. The marine portion would include a two square nautical mile area where WECs can be deployed in four berths and an additional two square nautical mile cable corridor where four subsea transmission cables and an auxiliary cable would run to shore. Between the 10-m isobath offshore and the Driftwood parking lot, HDD would be used to install five separate conduits and cables beneath the dunes, beach and seafloor, out to a distance of about 0.6 nautical miles.

The subsea cables would come ashore at the Driftwood parking lot through the HDD conduits to a series of beach manholes, or splice vaults, where the subsea cables would transition to terrestrial cables. This is also where proposed HDD drilling operations and equipment would be located during construction. It is anticipated that there would be five beach manholes, which are vaults made of precast concrete. While known as "beach" manholes, these vaults would be installed under the Driftwood parking lot. The underground vaults would each be approximately 10 x 10 x 10 feet. Access to the vaults would be via a standard manhole cover, similar to those used to access underground utilities (sewer, power, and telephone).

From the Driftwood parking lot, the cables would run in underground conduits to the southeast, under the southern portion of Driftwood. The HDD cable conduits would run under small sections of six private properties located on either side of Highway 101, and then to the OSU-owned parcel east of the highway. The total distance of the terrestrial cables would be about 0.5 miles. The grid connection to CLPUD's distribution system would run from the UCMF to a CLPUD utility pole carrying overhead distribution lines along Highway 101 adjacent to the UCMF site and would either be installed by HDD. The specifications of the terrestrial cables are dependent on the cable design and coordination with CLPUD to ensure compatibility with existing infrastructure (e.g., copper versus aluminum conductors).

The terrestrial cables would be installed by boring from the Driftwood parking lot to a series of pull boxes located on the UCMF property on the east side of Highway 101, and boring from the UCMF site back to the pull boxes.

Power monitoring, conditioning, utility equipment, and other electrical operations would be performed at the onshore UCMF, located on the private property parcel 0.3 miles south of Driftwood. The current plans for the UCMF include three single-story buildings. One building would accommodate the power conditioning and monitoring equipment for each of four potential test clients and would be approximately 11,250 ft^2. A second, 4,800 ft^2 building would include the PacWave South switch gear, utility equipment, and general storage. The third building would be the Project's data, control and communications center and would contain monitoring, communications, data storage and Supervisory Control and Data Acquisition (SCADA) systems. This building would be approximately 4,250 ft^2. The existing gravel lane (NW

Wenger Lane) would be paved to accommodate semi-truck access to the UCMF. The improved road would be approximately 20 ft wide and 800 ft long and would run from Highway 101 to the UCMF compound. The UCMF compound would include the three buildings and a parking/laydown area large enough to allow truck access (approximately 80 feet by 200 ft). The entire area of the UCMF compound would be approximately 1.2 acres and would be fenced and covered by security cameras and necessary lighting to meet building code standards.

Areas of disturbance would be limited to the HDD operations at Driftwood (e.g., noise, equipment) and the construction activities at the UCMF property, and the grid connection at CLPUD's overhead transmission line along Highway 101. Use of HDD to install the terrestrial transmission cables between Driftwood and the UCMF and from the UCMF to Highway 101 would avoid impacts between the sites.

Alternatives

This Habitat Mitigation Plan reflects the outcome of OSU's alternatives analysis for construction and placement of the Project. OSU considered alternatives as to the methods to install the cables and the routes the cables would take. OSU selected the cable installation method of boring (HDD) because this method is the most feasible alternative that causes the least impact, as opposed to running cable above ground or other alternative routes discussed in the Draft License Application. This Habitat Mitigation Plan discusses in detail below the potential impacts from boring. The direct cable route from Driftwood to the UCMF site reflects OSU's consideration of route and placement alternatives, and demonstrates efforts to minimize habitat impacts, particularly to streams, wetlands and shore areas. In addition to the chosen direct route, OSU analyzed cable routes on both the east and west sides of Highway 101. In consultation with agencies and other stakeholders, along with its own environmental and engineering analysis, OSU determined the direct route from Driftwood to the UCMF site would have the least impact on the surrounding environment. OSU's adoption of the selected route and method reflects its commitment to minimizing impacts to onshore fish and wildlife habitat.

Affected Species and Habitat

The affected area is the described terrestrial Project area and the immediately adjacent area that could be affected by terrestrial cable installation and construction of manholes and the UCMF. While fish-bearing streams, wetlands, beaches, dunes, and forested areas occur in the Project area, the proposed HDD route would either avoid or minimize effects to these habitat types. The Project could potentially affect sensitive and listed species associated with these habitat types, including juvenile and adult coho salmon (Oregon coast ESU), northern spotted owl, and western snowy plovers.

Nature, Extent, and Duration of Expected Impacts

Temporary Impacts – The nature, extent, and duration of impacts from Project construction would predominately be temporary, minimal, and confined to the areas described above in the Proposed Development. The anticipated temporary impacts of construction would last approximately 6-8 months, and may temporarily impact forested areas, unpaved maintained and landscaped areas, and paved and dirt roads, rights-of-way, houses, other paved areas. There are a number of areas that would actually require repairs or improvements, such as the Driftwood parking lot, which would be largely removed during construction, but would be replaced with a new, identical parking lot. Impacts would be avoided or minimized whenever possible, and mitigation would be implemented immediately after construction is complete.

The terrestrial cables are proposed to be installed by boring under the ground using HDD, to avoid direct impacts to sensitive beach, dune, wetland, and fish-bearing stream habitats in the Project area. However, directional bore operations have a potential to accidentally release drilling fluids, which is the inadvertent return (of drilling fluids, which could enter sensitive habitats and waterways. The directional boring procedure uses a slurry of a fine clay material, such as bentonite, as a drilling fluid, which is non-toxic but if discharged to waterways can temporarily affect benthic invertebrates, aquatic plants, fish, and smother fish eggs. The depth of HDD operations would be such that the engineers determine there is a low risk of inadvertent return of drilling fluid. Inadvertent return is considered highly unlikely; however, if it occurred, it could result in effects to beach, dune and aquatic habitat. An HDD Contingency Plan would be developed to minimize the potential for inadvertent return of drilling fluid, provide timely detection, and address potential drilling fluid release by describing monitoring, containment, response and notification procedures to be implemented by the contractor. The plan would be based on the Federal Energy Regulatory Commission's *Guidance for Horizontal Directional Drill Monitoring, Inadvertent Return Response, and Contingency Plan*. The discussion below identifies locations where boring would take place and, thus, minimize potential for inadvertent returns.

Snags, fallen trees, and trees with openings can provide maternity roosting habitat for special-status bats such as California myotis (*Myotis californicus*), fringed myotis (*Myotis thysanodes*), long-legged myotis (*Myotis volans*), hoary bat (*Lasiurus cinereus*), Townsend's big-eared bat (*Corynorhinus townsendii*), and silver-haired bat (*Lasionycteris noctivagans*). In April 2019, H. T. Harvey & Associates conducted a bat habitat survey that identified no suitable Townsend's big-eared bat maternity roost habitat within 400 feet of any of the construction areas (i.e., Driftwood or the UCMF) and no suitable maternity roost habitat for other bat species within 250 feet of Driftwood. Some potential maternity roost habitat was identified adjacent to the UCMF property.

Construction activities (e.g., lighting used for nighttime construction or construction equipment that generates high frequency sound) could disturb a roost to the point that adult female bats at a maternity roost, either pregnant or raising young, could abandon the roost and possibly their young. These impacts, and mitigation for them, are described in the Bird and Bat Conservation Strategy.

Permanent Impacts – The Project would include permanent removal or modification of approximately 1.4 acres of Habitat Category 4 Disturbed/Shore Pine Forest for the UCMF compound and improved access road, but impacts would be mitigated, as discussed below. In addition, a small area (less than 0.04 acres) of Habitat Category 6 Roads and Existing Rights-of-way would be permanently impacted in the vicinity of the CLPUD utility pole on Highway 101 and along the edges of NW Wenger Lane. The anticipated impacts of habitat removal or modification would last for the Project's 25-year operation and while the UCMF and improved access road exist.

Habitat Categories and Mitigation Goals. OAR 635-415-0025.

OAR 635-415-0025 describes six habitat categories and mitigation goals. Table 1 lists the categories, their mitigation goals and strategies, and the Project habitat found within each category. Table 2 indicates the potential for temporary and permanent habitat impacts for each habitat category in the terrestrial portion of the Project area (Figure 1).

Table 1. Habitat categories and mitigation goals and strategies in the Project Area.

Habitat Category	Characteristics	Mitigation Goal	Mitigation Strategy	Habitat Type in Project Area
1	Irreplaceable, essential habitat and limited on a physiographic province or site-specific basis	No loss of habitat quantity or quality	Avoidance	None
2	Essential habitat and limited on a physiographic province or site-specific basis	No net loss of habitat quantity or quality, and provide a net benefit of habitat quality or quantity	Avoidance or in-kind, in-proximity habitat mitigation	Fish bearing streams, wetlands, and habitat important for rare species
3	Essential habitat or important habitat that is limited on a physiographic province or site-specific basis	No net loss of habitat quantity or quality	Avoidance or in-kind, in-proximity habitat mitigation	Older forested areas, wetlands, and dune habitat
4	Important habitat	No net loss in habitat quantity or quality	Avoidance or in-kind or out-of-kind in-proximity or off-proximity habitat mitigation	Beaches, degraded wetlands, and recently disturbed forests.
5	Habitat having high potential to become essential or important habitat	Net benefit in habitat quantity or quality	Avoidance or mitigation that contributes to essential or important habitat	Landscaped or maintained areas
6	Habitat that has low potential to become essential or important habitat	Minimize impacts	Actions that minimize direct habitat loss and avoidance of impacts to off-site habitat	Roads and existing rights-of-way, houses, and other paved areas.

Table 2. Potential temporary and permanent impacts in the onshore portion of the Project Area.[2]

Feature name	Feature characteristics	Potential for Temporary Impacts	Potential for Permanent Impacts
Habitat Category 2			
Buckley and Friday Creeks	Perennial, fish-bearing streams	No	No
Wetland D	Riparian-forested depressional scrub-shrub emergent wetland, potential habitat for amphibians, supports hydrology of fish-bearing Friday and Buckley creeks	No	No
Roost habitat for bats	Maternity roosting habitat for bats. This habitat type (snags, fallen trees, etc.) is only Habitat Category 2 if there are bats roosting. If no bats are roosting, this area is Habitat Category 4 like surrounding forest type.	Yes	No
Beach habitat for western snowy plovers	Potential roosting, foraging, and nesting habitat for western snowy plover. The beach is only Habitat Category 2 if there are western snowy plovers that occur within 300 feet of construction activities. If no western snowy plovers are on the beach, this beach habitat is Habitat Category 4.	No	No
Habitat Category 3			
Wetland H	Scrub-shrub emergent wetland on north side of NW Wenger Lane	No	No
Wetland I	Emergent wetland on north side of NW Wenger Lane	No	No
Dunes	Dunes adjacent to Driftwood parking lot	No	No
Habitat Category 4			
Disturbed/Shore Pine Forest	Disturbed forest with few or no large trees and shore pine forests within the UCMF property	Yes (<1.1 acres)	Yes (<1.4 acres)
Beach habitat	Foraging and stopover habitat for multiple species	No	No
Habitat Category 5			
Unpaved maintained and landscaped areas	Unpaved maintained and landscaped areas adjacent to Driftwood parking lot and restroom access, and area adjacent to CLPUD's utility pole on Hwy 101	Yes (<0.2 acres)	No
Habitat Category 6			
Paved and dirt roads, rights-of-way, houses, other paved areas	Driftwood access road, parking lot and restroom area, existing NW Wenger Lane and old utility shed on UCMF property	Yes (<1.2 acres)	Yes (<0.04 acres)

[2] The assessment of potential impacts and acreages of impact throughout this HMP are based on current construction footprints. Final determination of temporary and permanent impacts and acreages would be provided when final construction plans are available after the FLA is filed.

The following is a description of the habitat features within each habitat category that are present within the Project area, and the avoidance, minimization, and mitigation measures are described in Section 3.

Category 1.

The Project does not contain Category 1 habitat.

Category 2.

Category 2 habitat within the Project area includes Buckley Creek and Friday Creek, potential bat maternity roosts, beach habitat if western snowy plover nests are found within 300 feet of the construction activities, and areas where kinnikinnick (a host plant for the seaside hoary elfin butterfly) was documented.

Streams – Friday Creek is a perennial, fish-bearing stream, connected to Buckley Creek south of the Driftwood parking lot, which is known to support coastal cutthroat trout, is historic habitat for federally threatened coho salmon (Oregon coast ESU), and provides habitat for other aquatic and semi-aquatic organisms. Buckley Creek flows into the Pacific Ocean south of Driftwood, and provides habitat for cutthroat trout, possibly lamprey, and other aquatic species, with extensive wetland complexes. The cables would be installed by HDD under the creeks.

Construction impacts at Driftwood would occur in the parking lot away from Buckley Creek and Friday Creek; impacts would be avoided by using HDD to bore under Buckley Creek south of Driftwood. Friday Creek would not be crossed by the cable route. Therefore, no temporary or permanent impacts to Buckley or Friday Creek are anticipated.

Wetlands – Wetland D (1.39 acres within the Project area) is an extensive wetland system surrounding Buckley Creek. The cables would run from Driftwood, and under the wetland area surrounding Buckley Creek. Wetland D would therefore be avoided during HDD cable installation and no temporary or permanent impacts to these wetlands are anticipated.

Roost habitat for bats[3] – Potential impacts on bat roosts and bats during cable installation would be minimized, as described in the Bird and Bat Conservation Strategy, by conducting pre-construction surveys of potential roost habitat and implementing avoidance and minimization measures if necessary (see Section 3.C). While temporary disturbance of bat roosts may occur during cable installation, removal of bat roost habitat is not anticipated, and therefore no permanent loss of bat roosts is expected to occur.

Beach Habitat for Western Snowy Plovers[4]– Driftwood Beach contains nesting and foraging habitat for the state and federally threatened western snowy plover. As described in the Draft Biological Assessment,

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[3]This area is only considered Habitat Category 2 if being used by bats for roosting, which cannot be determined without surveys. If not being used as bat roosts, then this area would be considered Habitat Category 4.

[4] This area is only considered Habitat Category 2 if western snowy plovers are found to be nesting or foraging there, which cannot be determined without surveys. If no western snowy plovers occur within 300 ft of HDD construction activities or equipment, then the area would be considered Habitat Category 4. All heavy-duty equipment activities would occur at least 164 feet (50 m) from potentially suitable habitat, consistent with the Habitat Conservation Plan http://www.oregon.gov/oprd/PLANS/docs/masterplans/osmp_hcp/final_hcp_eia_08_2010/wsp-hcp_08182010-web.pdf

effects on plovers would be avoided or minimized by using HDD to drill from the onshore cable landing within the Driftwood parking lot (see Section 3.D) under the beach and beneath the seafloor. No HDD construction equipment or activities are anticipated to occur on the beach, and inadvertent return of drilling fluids, if any, would be remediated in accordance with the contingency plan. All heavy-duty equipment activities in the Driftwood parking lot would occur at least 164 feet (50 meters)[4] from any potentially suitable habitat and are expected to last for approximately 6-8 months. Temporary or permanent impacts on beach nesting or foraging habitat are unlikely to occur. Mitigation for impacts on western snowy plovers are described in the Bird and Bat Conservation Strategy.

Category 3.

Category 3 habitat within the project area includes two wetlands (Wetlands H and I), and dune habitat.

Wetlands – Wetlands H (0.21 acres) and I (0.15 acres) are located just east and west of the proposed UCMF compound. Wetland H would be avoided entirely by the Project, so no temporary or permanent impacts from the Project would occur. The cables from the pull boxes to the UCMF, and potentially the cable out to the CLPUD distribution system on Highway 101, would run under Wetland I but the cables would be installed by HDD, so no temporary or permanent impacts to this wetland are anticipated.

Dune Habitat – There is approximately 0.5 acres of dune habitat adjacent to the Driftwood parking lot. No equipment, activities, or personnel are planned within this habitat, and HDD would be used to install the cable conduits under the beach and dune habitat (see Section 3.E). As noted above, a contingency plan would be developed to address the unlikely inadvertent return of drilling fluids to beach and dune habitat. No temporary or permanent impacts to dune habitat would be expected to occur.

Category 4.

Category 4 habitat within the study area includes areas of disturbed forest.

Disturbed/Shore Pine Forest – There are approximately 3.5 acres around the proposed UCMF facility of recently disturbed forested areas with few or no large trees and shore pine forest, which provide limited habitat. This bat habitat survey did not identify any potential bat maternity roosts as there were no snags or trees with roosting habitat characteristics. Approximately 1.1 acres of the disturbed/shore pine forest on the UCMF property would be disturbed temporarily during construction activities (i.e., construction buffers around the UCMF compound, Wenger Lane widening and UCMF pull boxes), and approximately 1.4 acres of disturbed forest would be removed during access road improvements, UCMF compound construction and cable pull box installation on the private parcel. Temporary and permanent impacts would be mitigated by developing a revegetation plan and using native species, including kinnikinnick where appropriate, in adjacent areas along the north side of NW Wenger Lane (see Section 3.F).

Beach habitat – There is beach habitat west of the Driftwood parking lot. No equipment, activities, or personnel are planned within this habitat, and HDD would be used to install the cable under the beach and dune habitat (see Section 3.E). As noted above, a contingency plan would be developed to address the unlikely inadvertent return of drilling fluids to beach and dune habitat. No temporary or permanent impacts to dune habitat would be expected to occur.

Category 5.

Category 5 habitat within the study area includes unpaved, maintained and landscaped areas adjacent to the Driftwood parking lot and restroom area, plus an area by the utility pole on Highway 101 where the Project would connect to CLPUD's distribution system. Less than 0.2 acres of unpaved, maintained and landscaped areas around the parking lot, restroom access and utility pole, would be temporarily disturbed during cable installation. Temporary impacts would be mitigated by developing a revegetation plan using native species for areas disturbed during construction (see Section 3.F).

Category 6.

Category 6 habitat includes the Driftwood parking lot and other paved areas. The Driftwood parking lot would be used for the HDD rig and construction equipment, which includes temporary impacts associated with the beach manhole construction and improvements/repairs to the parking lot pavement. Construction activities would avoid disturbance to vegetated areas or construction of new paved areas. Along the cable route, no new paved areas would be created because the cable would be bored underground using HDD. Less than 0.04 acres of paved areas and rights-of-way alongside NW Wenger Lane and at the CLPUD utility pole on Highway 101 would be permanently impacted due to the widening of the lane and the connection point to CLPUD's distribution system.

B. Map of the development action and mitigation actions. OAR 635-415-0020(8)(c).

The terrestrial portion of the Project subject to this mitigation plan would encompass approximately 4.2 acres near Driftwood and at the UCMF site (see Figure 1). The Project is located in Lincoln County at approximately 44.462° -124.077° in the following township/range/sections:

- NW ¼ of Township 13S, Range 11W, Section 7
- SW ¼ of Township 13S, Range 11W, Section 6
- SE ¼ of Township 13S, Range 12W, Section 1.

C. Monitoring for mitigation measures. OAR 635-415-0020(8)(e)-(f).

The relevant monitoring and success criteria for each habitat category would be developed in the revegetation plan to align with planned construction activities. As construction details continue to develop, this plan would be updated, if needed, to reflect any different impacts on habitat quality and quantity. Mitigation measures, a monitoring schedule, and associated plans (e.g., revegetation, contingency) would also be addressed, as needed, during planning and construction, and following construction. See Table 1 in Section A for the habitat mitigation goals for each habitat category.

Category 2, 3, and 4 Streams and Wetlands – The streams and wetlands are not expected to be impacted, resulting in no long-term loss of habitat quantity or quality.

Category 2 Beach Habitat for Western Snowy Plovers – Temporary or permanent impacts on beach nesting or foraging habitat are unlikely to occur. Mitigation for impacts to western snowy plovers is described in the Bird and Bat Conservation Strategy.

Category 2 Bat Maternity Roost Habitat – Any impacts to bat maternity roost habitat are expected to be temporary. The results of pre-construction surveys for bat roosts, and associated minimization measures employed (if any), would be provided in a report to FERC, USFWS, and ODFW.

Category 3 Dune Habitat – No temporary or permanent impacts on dunes are expected to occur; therefore, there would be no net short-term or long-term loss of habitat quantity or quality.

Category 4 Disturbed/Shore Pine Forest – Some loss of habitat quantity or quality for this habitat type is expected. Temporary and permanent impacts would be mitigated by developing a revegetation plan and planting native species in adjacent areas along the north side of NW Wenger Lane.

Category 5 and 6 – Temporary impacts would be mitigated by developing a revegetation plan using native species for vegetated areas disturbed during construction, which would provide a net benefit to Category 5 habitat. For Category 6 habitat, habitat loss would be minimized by limiting construction of new paved areas and working within previously disturbed/paved areas whenever possible.

D. Other Considerations. OAR 635-415-0020(8)(g).

This HMP would be effective throughout the Project life or the duration of the Project impacts, whichever is longer. As discussed above, OSU would monitor the Project under this mitigation plan and arrange for long-term habitat protection and management of the Project, as appropriate.

3. **AVOIDANCE, MINIMIZATION, AND MITIGATION MEASURES.** OAR 635-415-0020(8)(b), incorporating OAR 635-415-0025 by reference.

Below are avoidance, minimization, and mitigation measures to address the impacts associated with terrestrial Project construction specific to onshore fish and wildlife habitat. Many avoidance and minimization measures have already been developed in existing draft permitting documents, including the Protection, Mitigation and Enhancement Measures (PMEs), and Bird and Bat Conservation Strategy (BBCS), both of which were developed in coordination with ODFW and federal resource agencies, and each of which is included as part of OSU's application for a license from the Federal Energy Regulatory Commission. These measures are also evaluated in OSU's Applicant Prepared Environmental Assessment (APEA) and Draft Biological Assessment (BA) that are submitted in support of the license application.

A. Stream and Wetland Minimization Measures (Habitat Categories 2, 3, and 4)

PME 16: MITIGATION FOR TERRESTRIAL RESOURCES

- Minimize or avoid terrestrial activities in sensitive ecological areas (e.g., jurisdictional wetlands and nesting areas for listed avian species).
- Employ environmental measures during installation, operation, and removal to avoid or minimize potential effects to sediment and soils. For example:
    - Minimize disruption of terrestrial geology and soils by maintaining buffers around wetlands to the degree practicable,

    - Develop and implement an Erosion and Sediment Control Plan, and maintain natural surface drainage patterns.
    - Develop and implement stormwater runoff containment at terrestrial facilities to maintain existing drainage patterns, protect Project-adjacent habitat, and prevent contamination of streams. Develop a stormwater plan that meets all federal and state legal requirements during site design of the UCMF and associated facilities prior to any construction activities at the site.
- Avoid to the extent practicable, disturbance of forested wetlands.
- Avoid to the extent practicable, disturbance of wetlands and adjacent areas that may provide habitat for turtles, amphibians, and other semi-aquatic wildlife.
- Avoid to the extent practicable, disturbance of riparian wetlands where restoration of natural hydrology may be unsuccessful within a short timeframe. Natural hydrology should be restored after construction is complete and may require a restoration plan with monitoring until successful restoration can be determined.
- Minimize disturbance of streams that support fish, or are connected to fish-bearing streams. If terrestrial activities directly or indirectly affect any stream used by anadromous fish or fish listed as threatened or endangered under the federal Endangered Species Act, coordinate with NMFS staff to avoid and minimize any potential effects to listed species.
- Develop a revegetation plan, in coordination with NMFS, ODFW, and appropriate agencies, using native species to the extent practicable for areas disturbed during construction. This plan would include minimization measures identified in letters commenting on the DLA filed with FERC by NMFS (dated July 18, 2018) and ODFW (dated July 20, 2018) as appropriate.
- Develop measures that would limit the introduction or spread of invasive species, to be included in a construction plan.

B. Bat Roosts (Habitat Category 2)

PME 16: MITIGATION FOR TERRESTRIAL RESOURCES

- Avoid to the extent practicable, disturbance of snags and of wildlife or legacy trees including live or dead trees that provide benefit to wildlife. If unavoidable, additional pre-construction species specific surveys may be necessary to minimize effects.
- BBCS: procedures to determine if potential roosts are occupied, and to avoid or minimize impacts, as appropriate.

C. Beach Habitat (Habitat Category 2 or 4)

PME 16: MITIGATION FOR TERRESTRIAL RESOURCES

- Use HDD to install the transmission cable conduits under the beach and dune habitat.

D. Dune (Habitat Category 3)

PME 16: MITIGATION FOR TERRESTRIAL RESOURCES

- Use HDD to install the transmission cable conduits under the beach and dune habitat.

E. Disturbed/ Shore Pine Forest (Habitat Category 4), Unpaved Maintained and Landscaped Areas (Habitat Category 5), and Paved and Dirt Roads, and Existing Rights-of-way, Houses, and Other Paved Areas (Habitat Category 6)

PME 16: MITIGATION FOR TERRESTRIAL RESOURCES

- Develop a revegetation plan, in coordination with NMFS, ODFW, and appropriate agencies, using native species to the extent practicable for areas disturbed during construction. This plan would include minimization measures identified in letters commenting on the DLA filed with FERC by NMFS (dated July 18, 2018) and ODFW (dated July 20, 2018) as appropriate.
- Develop measures that would limit the introduction or spread of invasive species, to be included in each construction plan.

Permanent impacts would be mitigated by developing a revegetation plan and using native species, including kinnikinnick where appropriate, to establish forest habitat in adjacent areas along the north side of NW Wenger Lane. The revegetation plan would consider mitigation, as appropriate, including transplanting or relocating kinnikinnick plants prior to construction, replanting with kinnikinnick after construction, and removal of encroaching disturbed/shore pine forest to enhance kinnikinnick growth and survival.

4. REFERENCES

Oregon State University Biological Assessment, Federal Energy Regulatory Commission (Project No. 14616)

Oregon State University Preliminary Draft Environmental Assessment, Federal Energy Regulatory Commission (Project No. 14616)

APPENDIX L
Consultation

APPENDIX L-1
Comment Response Matrix

PMEC-SETS (FERC Project No. 14616)

Draft License Application Comment Response Table

No.	Page	Agency Comment	OSU Response
Federal Energy Regulatory Commission (7/18/18)			
FERC 1	A-1	Per section 4.41 of the Commission regulations, please provide the Project boundary data in a geo-referenced electronic format.	The Project boundary data has been provided in a geo-referenced electronic format with the license application e-filing receipt on CD as required by the Federal Regulatory Commission (FERC) regulations.
FERC 2	B-1	Aquatic Resources ... NMFS cannot complete section 7 consultation with the Commission and issue an Incidental Take Permit for listed marine mammals until an Incidental Harassment Authorization has been issued. Based on the analysis in the draft APEA and draft biological assessment, the Project may adversely affect and also subject marine mammals to harassment. Section 1.3.8, Marine Mammal Protection Act, of the draft APEA states that Oregon State University (OSU) expects to apply for a marine mammal harassment authorization for the Project. In the final license application, please provide a schedule for working with NMFS to satisfy the requirements of the MMPA.	OSU held a conference call with NMFS regional and marine mammal staff on September 7, 2018, to discuss whether an Incidental Harassment Authorization (IHA) under the Marine Mammal Protection Act (MMPA) would be needed for construction or operation of the Project. OSU subsequently provided copies of the draft ESA biological assessment and PDEA to NMFS's marine mammal permitting staff for review, and staff provided preliminary feedback that no IHA was likely required. On April 10, 2019, OSU requested a determination in writing that the Project's construction and operation was not expected to result in "take" under the MMPA. Subsequently, NMFS issued the letter on May 30, 2019, attached as Appendix N to the FLA which concludes that neither construction nor operation of the Project is expected to result in take of marine mammals and that no IHA is therefore required. Therefore, no authorization is required pursuant to the MMPA.
FERC 3	B-1	Terrestrial Resources Please provide additional details in the final APEA of proposed measures to revegetate disturbed areas and proposed measures to minimize the spread of invasive plant species, including use of herbicides.	In the DLA and Preliminary Draft Environmental Assessment (PDEA), OSU proposed to develop a revegetation plan using native species to the extent possible for areas disturbed during construction. As specified in the Applicant Prepared Environmental Assessment (APEA) and noted below in this matrix, OSU will include the minimization measures identified by NMFS and ODFW (letters commenting on the DLA dated 7/18/18 and 7/20/18, respectively) in development of the revegetation/restoration plan, which will be developed in consultation with NMFS, ODFW, and appropriate agencies. OSU

No.	Page	Agency Comment	OSU Response
			plans to develop the plan 6 to 12 months prior to the start of Project construction.
FERC 4	B-1	Please revise this Section 3.3.4 to include a discussion of potential effects to the western pond turtle.	OSU has analyzed existing literature and the best available information since the DLA on the western pond turtle. Western pond turtles inhabit a range of lentic and lotic habitats including sloughs, streams, large rivers, reservoirs, marshes, but are most common in stagnant or slow-moving waters (Rosenberg et al. 2009). Wetlands and streams exist in the Project area; however, this species is most abundant in the Willamette, Umpqua, Rogue and Klamath River drainages, none of which extend into Lincoln County or the Project area. Further, its distribution does not include Lincoln County (NatureServe 2018). In addition, OSU is now proposing to use HDD to install the entire terrestrial cable, avoiding disturbance to surface waters. Collectively, this information suggests the western pond turtle would not occur in the Project area, and that the Project proposal would have no impact on the species or its habitat even if it did occur there. Therefore, OSU removed reference to this species in the APEA.
FERC 5	B-1	Please provide additional details in the final APEA on survey methods and potential mitigation measures for the elfin.	As noted in the PDEA, Protection, Mitigation and Enhancement (PM&E) measures (Appendix I), and Habitat Mitigation Plan (HMP) (Appendix K), OSU has committed to avoiding, to the extent practicable, disturbance of seaside hoary elfin butterfly habitat within and in the vicinity of Driftwood Beach State Recreation Site. Where unavoidable, species-specific surveys may be necessary on properties outside of Driftwood Beach State Recreation Site, but within the construction footprint, to determine the extent of occupied habitat and associated mitigation. For information on survey protocols, see Interagency Special Status/Sensitive Species Program (ISSSSP) 2005 as specified in Section 4.5 (Environmental measures) of the FLA. While the Applicant recognizes the hoary elfin butterfly is a "strategy species" in the Oregon Conservation Strategy, the

No.	Page	Agency Comment	OSU Response
			Applicant does not have a statutory or regulatory obligation to take any specific actions regarding the butterfly. The butterfly prefers kinnikinnick, which is located in the Project Area, and as appropriate, the Habitat Mitigation Plan addresses kinnikinnick as a component of identified habitat areas.
FERC 6	B-2	In the final APEA, please include a table that outlines the amount of each (terrestrial) habitat type that would be affected by each Project component, including whether effects would be permanent or temporary.	OSU has provided the requested information in Section 3.3.4 (Terrestrial Resources) of the APEA and the HMP (Appendix K of the APEA).
FERC 7	B-2	Recreational Resources ... a portion of the Driftwood Beach State Recreation Site is subject to the requirements of 6(f)(3) of the Land and Water Conservation Fund Act. Please provide a description of this regulation in the final APEA.	This information has been included in Section 3.3.6 (Recreation, Ocean Use and Land Use) of the APEA.
FERC 8	B-2	... provide additional information in the final APEA about how the interpretive display would be developed, including; what coordination would occur with OPRD regarding the content of the interpretive material; what type of structure, or sign, would be used to display the interpretive material; and, where it would be installed within the parking lot area.	The APEA, and license application, has been revised to note that OSU would work with Oregon Parks and Recreation Department (OPRD) to develop a plan regarding the interpretive display.
FERC 9	B-2	... describe how construction activities would be planned and managed to mitigate impacts to public access and use of the Driftwood Beach State Recreation Site, including: (1) the proposed starting and end dates for construction activities within the recreation site; (2) any anticipated timing of partial, or complete, closures of the recreation site, including which portions of the site would be closed, and for how long; (3) how construction activities would be coordinated with OPRD; (4) what safety measures, aside from using construction fencing, would be enacted to protect recreational users visiting the site; (5) how public	OSU will work with OPRD to develop a plan to mitigate impacts to public access and use of Driftwood Beach State Recreation Site. The agreement will include agreed measures to minimize and mitigate for reductions in public access and will include protocols for coordination with OPRD prior to, during and following each phase of construction: 1. The planned start date for construction (Phase I – HDD operations and beach manhole and conduit installation) at Driftwood Beach State Recreation Site is planned for spring of 2020. This phase of the Project would last approximately 6-8 months. A second phase (Phase II – cable pull and in-water construction) would likely occur

No.	Page	Agency Comment	OSU Response
		access would be maintained throughout the duration of construction activities at the site; and (6) how the site will be restored to its original condition, aside from the newly installed manhole facilities, following the completion of construction activities.	in spring of 2021 and would last approximately 45-60 days. 2. It is anticipated the Driftwood Beach State Recreation Site would need to be closed to vehicular traffic for both Phase I and Phase II. It is possible there could be an option for limited pedestrian access, but OSU would work with OPRD to determine access feasibility and to ensure public safety. 3. In addition to construction fencing, OSU proposes to use signage to inform the public that access to Driftwood Beach State Recreation Site will be affected during the construction phases. Prior to construction, notifications about the work would be posted at the site to alert users. If possible, notice of the construction activities would be posted on the OPRD website. 4. OSU would arrange the construction work area to maintain pedestrian public beach access during construction, to the extent safe and practicable and with concurrence of OPRD. OSU work with OPRD to identify any additional, practicable steps that can be taken to mitigate impacts to public access and use of Driftwood Beach State Recreation Site. 5. Upon completion of construction work, all disturbed facilities would be returned to original or better condition, including grading and repaving of the parking lot and any disturbed sections of the entrance road. It should be noted that there are six Oregon Parks and Recreation Department facilities offering beach access, parking and restrooms within a ten mile radius of the Driftwood Beach State Recreation Site, including: Seal Rock (2.3 miles north); Governor

No.	Page	Agency Comment	OSU Response
			Patterson (4.1 miles south); Brian Booth/Ona Beach (4.3 miles north); Lost Creek (6.0 miles north); Beachside (6.3 miles south); and South Beach (9.9 miles north).
FERC 10	B-3	Cultural Resources ... provide all of the requisite reports (for both the marine and terrestrial aspects of your APE [Area of Potential Effect]) in your final license application, along with all comments you have received on them, including how you adopted all specific comments in the revised reports, or provide reasons why you did not adopt a particular comment. Contingent upon the findings in the reports, and your stated anticipations that the proposed Project would not have an effect on historic properties, seek written concurrence from the Oregon SHPO on this finding with a statement that they concur that the proposed Project would not have an effect on historic properties. Please provide written concurrence from the Oregon SHPO in your final license application, as well.	As described in Section 3.3.7 (Cultural Resources) of the APEA, the terrestrial cultural resources study has been completed and SHPO has concurred with the findings of this study. The letter of concurrence and the report was filed with FERC as privileged on August 28, 2018. Since that time, OSU is now proposing to use HDD to install the entire terrestrial cable, thus reducing the terrestrial portion of the APE from what was presented in the PDEA and original terrestrial cultural resources report, though all potential impacts were fully covered by the surveys conducted for the terrestrial cultural resources study. Geotechnical sampling was completed in 2018 and 2019, and this information has been incorporated into the Archeological Assessment of Submerged Cultural Resources report (Appendix O) OSU has completed the Archeological Assessment of Submerged Cultural Resources report. OSU will submit final Section 106 consultation materials to SHPO for concurrence on a finding of effect regarding the undertaking’s potential to effect historic properties. After SHPO’s concurrence is received, copies of all materials, including SHPO’s written concurrence, will be filed with FERC. This is anticipated to be conducted in Q3 2019.
FERC 11	B-3	Exhibit A Figures A-8 and A-9 show the depth of water to be 260 feet. However, in the text of Exhibit A (Project description – page A-1) the maximum depth is mentioned to be 78 meters = 255ft. In Exhibit F drawing also the maximum depth is shown as 255ft. Please	In Exhibit A of the FLA, OSU has updated the Figures and clarified that the water depths at PacWave South range up to 79 meters (260 feet), which has been made consistent throughout the license application.

No.	Page	Agency Comment	OSU Response
		correct this inconsistency in the final license application.	
National Marine Fisheries Service (7/18/18)			
NMFS 1	13-17	NMFS provided tables of affected marine species	OSU compared the tables NMFS provided of affected marine species to those in the PDEA and Draft BA. The North Pacific right whale was identified by NMFS as an ESA-listed species that may occur within the Project area, which was not included by OSU in the DLA documents. OSU included information regarding the North Pacific right whale in the APEA and Draft BA. NMFS also identified brown rockfish as a species with designated Essential Fish Habitat (EFH) affected by the Project, which OSU had not included in the DLA documents. OSU included this information in Table 7-1 of the Draft BA, along with an "activity" column, that NMFS also provided, to make the information consistent and more robust. Although NMFS did not include the Guadalupe fur seal as a marine species that may occur within the Project area, this species was included in the Marine Mammal Commission's 2014 letter dated August 4, 2014, so OSU included it in the PDEA, but no further analysis was conducted on the species because the likelihood of Guadalupe fur seals being in the Project area is extremely low, based on at sea observations and stranding information (Lambourn et al. 2012).
NMFS 2	34-35	Marine species affected by the Project – Species in the Spotlight Initiative	NMFS identified four species found within the Project area that are highlighted under the Species in the Spotlight Initiative including the 1) Central California Coast coho Evolutionarily Significant Unit (ESU), 2) Sacramento River winter-run Chinook ESU, 3) southern resident killer whale Distinct Population Segment (DPS), and 4) Pacific leatherback sea turtle. OSU has

No.	Page	Agency Comment	OSU Response
			incorporated this information in the Draft BA (Appendix A of the APEA).
NMFS 3	36-95	**SECTION 10(j) PRELIMINARY RECOMMENDED TERMS AND CONDITIONS** Preliminary recommended terms and conditions, A through M	NMFS' preliminary recommended terms and conditions are consistent with the PM&E measures proposed by OSU, which were developed as part of the CWG collaborative process with NMFS and other stakeholders. These PM&E measures can be found as an Appendix of the Final License Application's APEA.
NMFS 4	95	**ADDITIONAL PROTECTION, MITIGATION, AND ENHANCEMENT MEASURES** N. Work Area Isolation & Fish Salvage - NMFS provided a BMP that the licensee shall include for surface streams that are being impacted from the construction of the terrestrial cables and Utility Connection Management Facility.	As stated in Exhibit A, Section 1.4.3 (Terrestrial cables) of the FLA and throughout the FLA documents, the terrestrial cable would no longer be buried alongside Hwy 101 (where surface streams exist), but would now be installed using HDD directly from Driftwood to the Utility Connection and Monitoring Facility (UCMF). The use of HDD is a Best Management Practice (BMP) that would avoid impacts to surface streams. Therefore, NMFS's proposed BMPs for surface stream work are no longer necessary or applicable.
NMFS 5	99	O. Stormwater Management - NMFS provided stormwater management practices for the licensee to include for all new impervious surfaces associated with the construction of the Utility Connection Management Facility.	OSU would develop an appropriate stormwater plan that complies with NMFS's requirements, during site design of the UCMF and associated facilities prior to any construction activities at the site.
NMFS 6	102	P. Trenching/HDD Onshore Operations - NMFS provided minimization practices for all trenching and/or HDD operation activities on utility line stream crossings associated with the onshore terrestrial portion of the Project	As stated in Exhibit A, Section 1.4.3 (Terrestrial cables) of the FLA and elsewhere in the FLA documents, the terrestrial cable would no longer be buried next to the road, but would now be installed using HDD directly from Driftwood to the UCMF. OSU would develop appropriate minimization practices for all HDD operation activities during onshore construction in consultation with NMFS.

No.	Page	Agency Comment	OSU Response
NMFS 7	105	Q. Revegetation Plan - NMFS provided minimization measures for the development of a revegetation plan for areas disturbed during on-shore construction	In the PDEA, OSU proposed to develop a revegetation plan using native species to the extent possible for areas disturbed during construction. As specified in the APEA, OSU will include the minimization measures identified by NMFS and ODFW in development of the revegetation/restoration plan, which will be developed in consultation with NMFS, ODFW, and appropriate agencies. OSU plans to develop the plan 6 to 12 months prior to the start of Project construction.
NMFS 8	106	R. Decommissioning Plan – NMFS provided components of a removal and decommissioning plan to restore the Project site to natural characteristics to the extent practicable and minimize long term Project impacts to marine habitat and avoid extending the risk of entanglement with Project structures.	In the PDEA, OSU proposed to develop a removal and decommissioning plan for the Project. OSU would develop the Removal and Decommissioning Plan for the overall facility as the license term nears its end in consultation with NMFS and other agencies.
U.S. Fish and Wildlife Service (7/24/2018)			
USFWS 1	2	<u>FISH PASSAGE</u> <u>Terms and Conditions</u> Construction and proposed modifications to be made Driftwood Beach State Recreation Site (DBSRS) have the potential to impact Friday Creek, Buckley Creek, Twombly Creek, and two other unnamed streams. Activities and impacts to these waterways were not previously discussed and mitigation measures have not been vetted. These creeks support cutthroat trout (*Oncorhynchus clarkiz*). Pursuant to section lOG) of the FPA (16 U.S.C. 791 et seq.) and to carry out the purposes of the Fish and Wildlife Coordination Act (16 U.S.C. 661 et seq.), the Service recommends that any construction activities follow the east side of the Highway 101. We recommend any construction activities conducted use a horizontal directional drill under the streams.	As stated in Exhibit A, Section 1.4.3 (Terrestrial cables) of the FLA and elsewhere in the FLA documents, the terrestrial cable would no longer be buried next to the road, but would now be installed using HDD directly from Driftwood to the UCMF, consistent with the agreed upon measures to use HDD as a BMP that would avoid impacts to surface streams.

No.	Page	Agency Comment	OSU Response
USFWS 2	2	The Service also recommends that stormwater drainage be managed in accordance with the USACE, the Environmental Protection Agency, and the State of Oregon Department of Environmental Quality.	OSU would develop a stormwater plan that meets all federal and state legal requirements during site design of the UCMF and associated facilities prior to any construction activities at the site.
USFWS 3	2	WEC deployment and recovery as part of the Project may increase vessel traffic in Yaquina Bay. Increased vessel traffic has the potential to decrease water quality and promote invasive species. To protect sensitive areas in the estuary such as eel grass and fish nurseries the Service recommends restricting use in Yaquina Bay estuary to staying within navigation channels and specifically designated areas for vessel use such as existing permitted docks and dredged areas.	In response to this comment, OSU specified in Section 2.2.3.4 (Estuarine Activities) of the APEA that it would stay within navigation channels and areas for vessel use in Yaquina Bay.
USFWS 4	3	THREATENED AND ENDANGERED SPECIES CONSULTATION In the draft biological assessment you determined that the proposed Project, "may affect, is likely to adversely affect'' the marbled murrelet and the short-tailed albatross. The information for these species appears to support a determination of "may affect, is not likely to adversely affect''. Please review your rationale and ensure these determinations are correct.	OSU reviewed the analysis for marbled murrelet and the short-tailed albatross and revised the determination to "may affect, is not likely to adversely affect''. Our analysis indicated that 1) for short-tailed albatross, Project effects are likely to be discountable (due to the rarity of albatross in the Project area) and insignificant (collision with above-surface structures of WECs, and fouling of feathers and toxic effects from accidental release of oil/toxic substances is unlikely), and 2) for marbled murrelet, Project effects are likely to be discountable (in marine habitat due to distance offshore, and in terrestrial habitat due to lack of habitat in the Project area) and insignificant (potential for effects from Project-related sound, collision and entanglement, fouling from accidental release of toxic substances, and lighting is very low and/or short-term).
USFWS 5	3	The Service recommends the applicant consult with both the Service and the Oregon Department of Fish and Wildlife (ODFW) for the latest information regarding nesting western snowy plovers. Additionally, western snowy plover information and publications can	OSU has consulted with the relevant agencies regarding western snowy plovers and has included the latest information in the APEA and BBCS.

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		be found at https://www.fws.gov/arcata/es/birds/wsp/plover.html.	
USFWS 6	3	BATS AND MIGRATORY BIRDS The Bird and Bat Conservation Strategy (BBCS) contains additional mitigation measures such as noise buffers and shielding not previously discussed with the Service. To address these unvetted mitigation measures regarding bats, the Service recommends coordination with the Service and ODFW regarding the use of noise buffers and shielding as means to minimize effects on roosting bats. Additionally, some mitigation measures are subject to on-going coordination with specific resource agencies noted in each measure with some exceptions. Listed on page 24 of the BBCS mitigation measure beginning, "If construction work must occur within the noise buffer zones ... " includes terms not previously discussed with the Service. The Service recommends this measure be modified to include coordination with the Service and ODFW.	OSU has worked directly with USFWS and ODFW to revise the BBCS and address these concerns since the filing of the DLA. All parties have agreed to the revised BBCS as reflected in the FLA, Appendix B.
USFWS 7	3	GENERAL COMMENTS Lighting The Service encourages all pertinent items including WECs and onshore ancillary buildings and equipment install lighting that meets the minimum U.S. Coast Guard and National Oceanic and Atmospheric Administration (NOAA) requirements, are not white in color, and which flash or repeat at intervals (not constantly lit) to avoid and reduce seabirds and coastal migratory birds from being attracted to the site.	As specified in Exhibit A, Section 1.4.4 (Utility Connection and Monitoring Facility) of the FLA and elsewhere in the FLA documents, the entire area of the UCMF will be approximately 1.2 acres and would be fenced and covered by security cameras and necessary lighting to meet building code standards. OSU has committed to undertaking the following mitigation measures to avoid and minimize impacts to seabirds and migratory birds, as described in Section 2.2.4 (Proposed Environmental Measures) of the PDEA, Exhibit D, Section 4.5 (Environmental measures) of the DLA, and elsewhere in the DLA documents: • Use low-intensity flashing lights and bird-friendly wavelengths on the Project structures to minimize

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			seabird attraction and follow the specifications for Project lighting developed in consultation with the FWS and U.S. Coast Guard. • Minimize lighting (e.g., use low intensity, bird-friendly wavelengths, shielded lighting not providing upward-point light or light directed at the sea surface) used at night by service and support vessels to reduce the potential for seabird attraction. HDD operations in the parking lot will occur during daylight hours, but if lighting is required at night it will be appropriately shielded and directed to minimize artificial light reaching western snowy plover nesting habitat at night. Animal proof litter receptacles and related signage and coordination will be provided to minimize potential attraction of predators.
USFWS 8	3	Regarding construction activities, the Service recommends, to the maximum extent practicable, limit construction activities to the time between dawn and dusk to avoid the illumination of adjacent habitat areas. If construction activity time restrictions are not possible, use down shielding or directional lighting to avoid light trespass into bird habitat (i.e., use a 'Cobra' style light rather than an omnidirectional light system to direct light down to the roadbed). To the maximum extent practicable, while allowing for the public safety, low intensity energy saving lighting (e.g. low pressure sodium lamps) will be used. Minimize illumination of lighting on associated construction or operation structures by using motion sensors or heat sensors. Bright white light such as metal halide, halogen, fluorescent, mercury vapor and incandescent lamps should not be used.	See response above (USFWS 7).

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USFWS 9	4	... if lighting the Utility Connection and Monitoring Facility (UCMF) is required at night, it should be appropriately shielded and directed to minimize artificial light attraction and prevent potential injury or mortality to seabirds.	See response above (USFWS 7).
National Park Service (7/20/2018)			
NPS 1	1	**Land and Water Conservation Fund (LWCF) Act** ...the impacts at Driftwood Beach would require an LWCF conversion. ...In order for a conversion to be approved, replacement property of current fair market value and of reasonably equivalent usefulness and location must be provided.	OSU has been working directly with ORPD (and NPS, through OPRD) to facilitate the LWFC process and its requirements.
Oregon Parks and Recreation Department (7/20/18)			
OPRD 1	2	... As previously discussed with the applicant, the Driftwood property potentially impacted by this proposed Project was acquired with assistance of the federal Land and Water Conservation Fund (LWCF) administered by the National Park Service (NPS), and is subject to requirements of Section 6(f)(3) of the Land and Water Conservation Fund (LWCF) Act. The activities proposed by the applicant will constitute a "conversion of use" under Chapter 8 of the LWCF State Assistance Program Manual. Replacement land must be provided to OPRD to compensate for the converted property. The proponent must bear all costs associated with providing the replacement property and processing the conversion. As yet, no replacement lands have been identified. Approval of a LWCF conversion requires action on the part of the Oregon Parks and Recreation Commission (OPRC), as well as NPS.	OSU has been working directly with ORPD (and NPS, through OPRD) to facilitate the LWFC process and its requirements.

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OPRD 2	2	... OPRD manages the Driftwood property as at State Highway Rest Area under an agreement with the Oregon Department of Transportation (ODOT). ODOT must be notified at least three months in advance of closures lasting more than 90 days. Additionally, coordination needs to occur with ODOT to ensure adequate advance signage exists for motorists regarding temporary park closure(s) along with any permits required by ODOT (e.g., right of way permits for signage on the state highway).	OSU has been in communications with ODOT regarding various aspects of the Project and will continue to coordinate with them as necessary during the licensing and construction phases of the Project.
OPRD 3	3	... Given the rarity of the species (seaside hoary elfin), complete avoidance of the host plant, kinnikinick (*Arctostaphylos uva-ursi*), will be necessary for any land-based activities on state park property.	As noted in the PDEA, PM&E measures (Appendix I), and HMP (Appendix K), OSU has committed to avoiding, to the extent practicable, disturbance of seaside hoary elfin butterfly habitat within and in the vicinity of Driftwood Beach State Recreation Site. The current construction footprint has the Project well within the parking lot boundary of Driftwood, therefore interaction with kinnikinnick will be unlikely. Where unavoidable, disturbance to kinnikinnick outside of Driftwood Beach State Recreation Site, but within the construction footprint will be mitigated, as described in the HMP and PM&Es.
OPRD 4	3	Additionally, state and federally listed western snowy plovers (*Charadrius nivosus nivosus*) have nested for the past two breeding seasons (2017-2018) on the beach immediately adjacent to and in close proximity to Driftwood. In 2017, five nests were located in the vicinity and there have been four nests near Driftwood so far this year (2018). Additionally, plovers have been documented on the central coast during winter window surveys coordinated by USFWS, including at South Beach State Park every winter from 2015-2018 and at Bayshore in 2017. This spring, plovers initiated nesting at South Beach at least three times with one nest successfully hatching earlier this month (July 2018). If	The buffer has been revised from 150 feet (46 meters) to 164 feet (50 meters) for all activities in Section 2.2.4 (Proposed Environmental Measures) of the APEA, Exhibit D, Section 4.5 (Environmental measures) of the FLA, and elsewhere in the FLA documents.

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		nests or adult plovers are detected during breeding season (March 15-September 15) in the vicinity of Driftwood, protective measures should be implemented in coordination with USFWS, OPRD, and ODFW. The stated buffer of 50 meters "consistent with the Habitat Conservation Plan" was not designed for application to "heavy duty equipment activities" rather, to protect active nests from recreation-related disturbance (e.g., pedestrians) recreating on the ocean shore. Therefore, since all Project related activities are non-recreational in nature, they should occur at least 50 meters from plover habitat and be approved through consultation with USFWS.	
OPRD 5	3	Several fish bearing streams flow through Driftwood, including Friday Creek and the associated wetland system. OPRD supports ODFW's recommendation to drill (rather than trench) under sensitive resources, including fish-bearing streams and wetlands including all of those running through OPRD property. Work should occur during ODFW established in-water work windows. OPRD Stewardship staff should be involved in the development of any upland or riparian restoration and monitoring plans (including the associated erosion and sediment control plan) that occur on or have the potential to impact OPRD property. Restoration of the cable corridor running through Driftwood must occur in accordance with ODFW recommendations in consultation with OPRD Stewardship staff.	As stated in Exhibit A, Section 1.4.3 (Terrestrial cables) of the FLA and elsewhere in the FLA documents, the terrestrial cable would no longer be buried next to the road, but would now be installed using HDD directly from Driftwood to the UCMF, consistent with the agreed upon measures to use HDD as a BMP that would avoid impacts to surface streams. Therefore, OPRD's proposed BMPs for surface stream work are no longer necessary or applicable. OSU anticipates that it will work closely with OPRD with regard to these issues as the two parties negotiate construction access and plans. In addition, OSU anticipates coordinating directly with ORPD pursuant to its Ocean Shores Permit and/or easement requirements on OPRD resource issues and looks forward to that collaboration.
OPRD 6	3	Given the scenic quality of the coastal landscape and seascape at coastal parks, visualizations may need to be conducted from potentially impacted viewpoints depending on the heights of the proposed wave energy devices being used at the facility. Please refer to the	Visual impacts were evaluated in Section 3.3.8 Aesthetic Resources of the PDEA and included the following: *Portions of the Project potentially visible from shore would include the parts of the WECs that would be above the water surface*

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		visual resource protection standards established in the Oregon Territorial Sea Plan along with suggested Project review criteria for more information.	*during clear days and navigational lighting during clear nights. OPT's PB150, an example of a point absorber WEC, would extend about 30 feet above the water. For a person standing on shore, 5.6 nautical miles from the Reedsport OPT Wave Park, OPT determined that a PowerBuoy would appear to be 0.6 mm, at arm's length (Reedsport OPT Wave Park, LLC 2010). This is comparable to viewing from the closest location from shore, which is approximately 6 nautical miles. An oscillating water column WEC would be a larger structure than a point absorber (estimated to extend about 35 feet above the water surface), but would similarly appear very small when viewed from shore. Lights and navigation aids would be visible at some distance, but are necessary for maritime safety. The range of visibility would vary depending on time of day and weather conditions.* OSU reviewed the visual resource protection standards established in the Oregon Territorial Sea Plan and the suggested Project review criteria. Due to the distance from shore and small scale of the Project, the level of change to the characteristic seascape would be very low.
OPRD 7	4	*Cultural resources* Please refer to the information submitted by the State Historic Preservation Office regarding data needs (e.g., side-scan sonar and sub-bottom profile data) and requests to help avoid landforms where cultural remains may exist both offshore below federal and state waters, along the cable route and onshore (SHPO Case # 14-0893). Before commencing any work, SHPO approval must be attained and appropriate consultation with potentially affected tribes must occur.	OSU is aware of the data needs from SHPO and Section 106 consultation compliance requirements. In 2018, the marine route survey collected side-scan sonar and sub-bottom profile data and this analysis is incorporated into Section 3.3.7 (Cultural resources) of the APEA and also as an appendix. Geotechnical sampling was completed in 2018 and 2019, and this information has been incorporated into the Archeological Assessment of Submerged Cultural Resources report (Appendix O) OSU has completed the Archeological Assessment of Submerged Cultural Resources report. OSU will submit final Section 106

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			consultation materials to SHPO for concurrence on a finding of effect regarding the undertaking's potential to effect historic properties. After SHPO's concurrence is received, copies of all materials, including SHPO's written concurrence, will be filed with FERC. This is anticipated to be conducted in Q3 2019.
OPRD 8	4	*Ocean Shore Permitting* Under ORS 390.640 and ORS 390.715, any person conducting an ocean shore alteration, or placing any pipeline, cable line, or other conduit over, across or under the state recreation area or submerged lands adjoining the Ocean Shore, must submit an "Ocean Shore Alteration Permit" application to OPRD. Documents prepared by the applicant describe cable routes and a landing location, all of which will require a permit from OPRD to cross under the Ocean Shore. No application has been received at this time.	An "Ocean Shore Alteration Permit" application will be submitted to OPRD in 2019.
OPRD 9	4	OPRD will have to be consulted if the applicant needs to perform any activities on the Ocean Shore. For example, if an emergency staging area on the beach is necessary or if vehicles are required on the beach for any reason a permit is required. Both response to WECs outside of operational boundaries and HDD contingency plans will rely on beach access for containment response and monitoring. If necessary, access will likely rely on existing vehicle access points such as Quail Street, approximately 1.32 miles north of the Driftwood Beach State Recreation Site. Western snowy plovers have nested for the past two breeding seasons (2017-2018) adjacent to Driftwood but also to the north and south including near the Quail Street	A "Motor Vehicle on the Ocean Shore" application will be submitted to OPRD in 2019.

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		beach access. Any vehicles accessing the beach need to discuss access options with OPRD to get updated information about areas to avoid. Prior to any work being conducted on the beach, OPRD would require, at a minimum, a “Motor Vehicle on the Ocean Shore” permit and consultation with staff to address these and other issues.	
OPRD 10	4	*Ocean Shore Safety* As the managers of the ocean shore as a recreation area, OPRD should be involved when the applicant develops the proposed Emergency Response and Recovery Plan(s), especially as it relates to potential marine debris. Modeling that helps predict probable landfall locations of Project generated marine debris at various times of the year would be helpful. Impact analysis should include potential resource concerns associated with landfall of Project related marine debris and associated removal efforts, particularly for sensitive areas such as rocky intertidal habitat and western snowy plover nesting areas. Any potential impact to ocean shore resources, recreational use of the beach and the safety of visitors should be considered in development of these plans. Funding to cover any costs incurred for emergency recovery efforts, including those developed by individual technology developers eventually testing at PMEC-SETS, should also be clarified.	In the Emergency Response and Recovery Plan (Appendix G of the DLA), OPRD is identified as a key agency to notify and coordinate in the event a wave energy converter (WEC) makes landfall or appears that it might make landfall. The initial response to a WEC outside its operation boundaries is to attempt to get it under tow and taken to a safe location. Predicting where a loose device may make landfall is difficult. Previous experience and work conducted by the University of Washington has shown that, in the highly unlikely event that a device becomes loose, landfall is likely to occur north of PacWave South along the Oregon shoreline. The specifics of any response plan will depend on the type of shoreline where the device comes to rest. Testing clients will be required to sign a contract with PacWave ensuring that sufficient funds are available to cover emergency response and recovery efforts.
OPRD 11	4	Concurrence with ODFW recommendations Oregon Parks and Recreation Department supports Oregon Department of Fish and Wildlife’s 10(j) recommendations regarding proposed plans and measures and which should be included as enforceable conditions of the FERC license. This recommendation is	The footprint of construction disturbance has been added to Section 3.3.4 (Terrestrial Resources) of the APEA and is also included in the HMP, which provides enough detail to analyze for potential effects. The construction methods are described in the APEA and the construction plans will be developed by contractors

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		consistent with discussions that occurred during the CWG process. Additionally, OPRD concurs with ODFW that onshore habitat impacts cannot be fully analyzed for the Habitat Mitigation Plan (HMP) until finalized and detailed construction plans and associated information are provided. OPRD will rely on this assessment and recommendations from ODFW in the development of permits and property documents to protect state park and ocean shore resources.	prior to Project commencement. ODFW comments are addressed below.
OPRD 12	5	*Ongoing coordination* ... OPRD needs to be included in ongoing discussions and adaptive management for resources on, or potential impacts to, natural, cultural, and recreational resources on state park property and the Ocean Shore State Recreation Area during the entire life of the Project, both during and post-construction. A few examples of areas of interest to OPRD that may require adaptive management and should involve ongoing consultation with OPRD staff include: Removal and Decommissioning Plan, Bird and Bat Conservation Plan, Operations and Maintenance Plan, Construction Plan, Emergency Response Plan (including plans for inadvertent fluid release/HDD contingencies), Terrestrial Restoration Plans etc. OPRD would also like to receive the Annual Report provided to the AMC and participate in any sub-committee meetings that address any topics related to state park or ocean shore resources.	The FLA reflects proposed PM&E measures that were the subject of numerous years of evaluation (the Collaborative Working Group [CWG] formed in 2014), discussion and negotiation among the parties who were members of the CWG. The CWG included OSU, federal and state agencies and other stakeholders, including OPRD, as well as five other state agencies and the governor's office. The CWG reached agreement regarding specific measures that OSU would implement to protect, mitigate and enhance the resources referenced in OPRD's comments, including measures that would be managed pursuant to the Adaptive Management Framework. The CWG did not identify the plans listed by OPRD as appropriate for adaptive management, and the Adaptive Management Framework was not written to address those plans and explicitly does not include them. However, OSU anticipates that it will work closely with OPRD with regard to these issues as the two parties negotiate construction access and plans. In addition, OSU anticipates coordinating directly with ORPD pursuant to its Ocean Shores Permit and/or easement requirements on OPRD resource issues and looks forward to that collaboration.
Oregon Department of Fish and Wildlife (7/20/18)			
ODFW 1	16	Preliminary 10(j) Recommendation 2: Bird and Bat Conservation Strategy	The references have been added to the BBCS.

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		The licensee shall implement the Bird and Bat Conservation Strategy (BBCS) included as PDEA Appendix B, and PM&E number 9: Mitigation for Birds and Bats, with the following modifications: A. BBCS tables 2, 3 and 4 footnotes cite 2016 updates to the Oregon Nearshore Strategy (ONS) and sensitive species list but neither are in the reference section. The licensee shall add the 2016 ONS and sensitive species list updates to the reference list.	
ODFW 2	16	B. As agreed to by the US Fish and Wildlife Service (USFWS), ODFW and the applicant during development of the BBCS, to minimize potential effects of the Project on bats, the licensee shall avoid construction activities near bat maternity roosts during the maternity season, or implement buffer zones for terrestrial construction activities. Without ODFW's review, the applicant added an alternative measure that if construction work must occur within the noise buffer zones during the maternity season, engineering controls will be implemented. The licensee shall remove from consideration the option to implement engineering controls until such time as USFWS and ODFW have reviewed and agreed to include such measures.	OSU has worked directly with USFWS and ODFW to revise the BBCS and address these concerns since the filing of the DLA. All parties have agreed to the revised BBCS as reflected in the FLA, Appendix B.
ODFW 3	16	C. PM&E measures 6-9 are subject to on-going coordination with the specific resource agencies noted in each measure. PM&E measure 9, mitigation for birds and bats, does not identify any such agencies, and shall be modified to include USFWS and ODFW as consulting agencies for birds and bats.	OSU revised the referenced text to add USFWS and ODFW.
ODFW 4	17	Preliminary 10(j) Recommendation 3: Electromagnetic Field Monitoring Plan	OSU had included this language on shielding, as noted by ODFW, in the DLA documents in the APEA and Draft BA documents. Adding this language in the EMF monitoring plan is not

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		The licensee shall implement the Electromagnetic Field (EMF) Monitoring Plan included as PDEA Appendix H-4, with the following modifications: A. The EMF plan states that the cable will be buried except within the footprint of the test site or in places with hard substrate, and all power cables would be shielded and armored and would not emit any electric fields directly. The licensee shall add, in accordance with PM&Es 1 and 15, that OSU shall utilize shielding on subsea cables, umbilical cables and other electrical infrastructure (including, to the extent feasible, hubs and subsea connectors) to minimize EMF emissions to the maximum extent practicable.	applicable, as this specific plan is focused on monitoring and evaluating EMF.
ODFW 5	18	B. The definition of what is considered “biologically relevant” is critical to the analysis of EMF measurements and modeling results, and is currently based on a small amount of data indicating species response to EMF. The licensee shall add to the EMF Monitoring Plan and to PM&E number 1(4) that the definition of what is considered “biologically relevant” may be modified during the license term if future best available science indicates it is appropriate to do so, as determined by the adaptive management committee.	The EMF Monitoring Plan (Appendix H) and PM&E measures indicate biologically relevant is based on what has been published and that “newer data” will be taken into account. However, it does not specify the process by which it will be accomplished. OSU has further specified that “biologically relevant” will be determined by the adaptive management committee.
ODFW 6	20	Preliminary 10(j) Recommendation 4: Acoustic Monitoring Plan and Mitig**ation** The licensee shall implement the Acoustic Monitoring Plan included as PDEA Appendix H-3, and mitigation measures related to acoustic impacts including PM&Es 5, 6, and 7, with the following modifications: A. Results of acoustic site-characterization studies were contaminated by “self-noise” from the hydrophone	The study plan was modified to address this concern.

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		mooring system. Add to the monitoring plan methods to reduce or address "self-noise" and maximize successful collection of acoustic data during any sea state to fulfil stated objectives of the monitoring plan.	
ODFW 7	20, 23, 24	B. The license shall require that the licensee schedule Project construction activities in the territorial sea outside of the phase b gray whale migration. ... ODFW remains concerned that cable laying may occur within the nearshore area used by mother calf pairs during the phase b migration and recommends that the license require avoidance of this sensitive timeframe for cable laying activities. ... ODFW does not consider it acceptable to characterize adverse effects on this state-listed species as unavoidable unless every possible measure has been taken to avoid adverse effects. More could be done to avoid at least the most sensitive timeframe, phase b.	As specified in Section 2.2.4 (Proposed Environmental Measures) of the PDEA, and Exhibit D, Section 4.5 (Environmental Measures) of the DLA, OSU has proposed to avoid the use of vessels for installation of the offshore cable to the maximum extent practicable during Phase B gray whale migration (April 1-June 15). To the extent these construction activities during this migration period are proposed, the licensee will consult with ODFW regarding the timing of such activities including cable-laying in state waters. It is important to note that this PM&E measure was the subject of in-depth discussions with CWG members, and all members agreed with this language as part of the final CWG work product. In addition to ODFW, members who agreed with this measure included NMFS, the federal agency with expertise in and regulatory authority regarding gray whales. NMFS's preliminary 10(j) recommendations are consistent with OSU's proposed PM&E measure, which should not be modified.
ODFW 8	20	C. The licensee shall require WEC testing clients to prepare contingency plans and stock replacement parts to prepare to remedy acoustic exceedance events and expedite the timeline proposed by the applicant.	In the PM&E measures (Appendix I of PDEA), OSU included measures to minimize and mitigate for WECs and their mooring systems in the event a WEC produces sound in excess of NMFS's published harassment threshold. The proposal presented in this comment oversimplifies what would be a complex engineering and design issue. First and foremost, it is not possible to anticipate in advance which parts may be the cause of any acoustic exceedance so that those parts may be stocked. Moreover, an exceedance may be caused by the design of a particular part, so having an exact replacement may not solve any acoustic issue. Even if WEC clients could anticipate which parts might cause acoustic exceedances, creating and storing replacements on site would be unreasonably costly and

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			inefficient. The purpose of the monitoring and coordinated response effort developed by the CWG is to identify and address an acoustic exceedance of any kind and, in a timely but organized manner, develop the necessary information to accurately diagnose and address any such exceedance. The proposed solution presented in this comment is highly impracticable, unduly costly, and ultimately unlikely to result in any change in the timeline required for engineers and other experts to identify acoustic sources and develop a solution that addresses the specific cause of any exceedance.
ODFW 9	28	Preliminary 10(j) Recommendation 5: Onshore Habitat Mitigation Plan ODFW and the applicant have drafted a Habitat Mitigation Plan (HMP) pursuant to Oregon's habitat mitigation policy (OAR 635-415), wherein all habitats within the onshore portions of the Project area have been categorized by quality and value to wildlife. The licensee shall modify the HMP included as PDEA Appendix K, as follows: A. Upon delivery of construction and operation footprints and construction methods for specific segments of the onshore Project components, the licensee shall work with ODFW to complete the analysis of affected habitat type and quality.	The Applicant has prepared an HMP (Appendix K) and consulted with ODFW consistent with ODFW's requests and state policy. The Licensee has developed a final construction and operational footprint and has revised the HMP to reflect that footprint. In addition, the Applicant has revised the HMP in response to ODFW's various comments, as noted herein. The Applicant proposes that the license include a requirement to implement the HMP submitted with this FLA, without modification.
ODFW 10	28, 30	B. Clarify that although OSU added consideration of kinnikinnick habitat for the seaside hoary elfin butterfly to the HMP, plants and terrestrial invertebrates are not within the Oregon Fish and Wildlife Commission's (OFWC) jurisdiction and so are not subject to the habitat mitigation policy. Recommended conservation actions for the seaside hoary elfin are provided in the Oregon Conservation Strategy.	As discussed above, kinnikinnick is a preferred plant for the seaside hoary elfin butterfly, an Oregon Conservation Strategy species. Kinnikinnick is addressed where appropriate in the HMP (Appendix K) as a component of certain identified habitat areas. Avoidance, minimization and mitigation for kinnikinnick disturbance as provided in the PM&E measures and the HMP is expected to provide sufficient mitigation for any loss of kinnikinnick habitat for the hoary elfin butterfly.

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		... ODFW recommends that mitigation for impacts on this very rare butterfly species could be addressed by the HMP with clarification that conservation actions for the seaside hoary elfin are provided in the Oregon Conservation Strategy, and not pursuant to the habitat mitigation policy.	As stated in the PM&Es and HMP, where unavoidable, species-specific surveys may be necessary on properties outside of Driftwood Beach State Recreation Site, but within the construction footprint, to determine the extent of occupied habitat and associated mitigation. For information on survey protocols, see Interagency Special Status/Sensitive Species Program (ISSSSP) 2005 as specified in Section 4.5 (Environmental Measures) of the FLA.
ODFW 11	28, 30	C. Upon completion of the analysis, additional mitigation of Project impacts on onshore habitat may be necessary. ... In it's PDEA, the applicant states it has developed a HMP to address recommendations by ODFW regarding Oregon's Habitat Mitigation Policy for onshore habitat impacts; this document does not represent any environmental measures in addition to those proposed. ODFW disagrees with this characterization and has maintained with the applicant throughout this assessment of onshore habitat that additional mitigation may be necessary, a determination that cannot be made until construction plans and associated information are provided and ODFW completes its habitat analysis in accordance with OAR 635-415.	OSU has provided supporting data, studies, and drafts of the HMP for ODFW review, including a revised HMP that reflects the final Project footprint and construction details in sufficient detail to ascertain potential habitat impacts. OSU has also revised the HMP in response to ODFW's various comments, as noted herein. OSU proposes that the license include a requirement to implement the HMP submitted with this FLA, without modification.
ODFW 12	28	D. Any impacts on Category 2 habitat (e.g. streams, wetlands, bat maternity roosts, and western snowy plover nests) must be mitigated for to meet the net benefit standard required by policy. If these habitats can't be avoided, temporary and permanent impacts must be mitigated to the net benefit of the affected species.	OSU's proposal for construction of the Project would avoid most or all impacts to Category 2 habitat. The proposed HDD route avoids referenced potential impacts to streams and wetlands. Any impacts that cannot be avoided would be minor, temporary impacts to bat roost habitat (if found on site) that would last during construction only. The habitat is anticipated to revert to its pre-construction condition, or it will be improved by OSU as provided in the HMP. Under ODFW's statutes and regulations,

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			OSU does not have an obligation to provide further compensatory mitigation, and as a practical matter, additional mitigation, beyond that proposed in the HMP, is not possible.
ODFW 13	29	Once modified in consultation with ODFW and approved by ODFW, the final HMP shall be implemented by the license.	As discussed above, OSU proposes that the license include a requirement to implement the HMP submitted with this FLA, without modification.
ODFW 14	31	ODFW does not concur with all habitat categorizations provided in the Habitat Characterization Report (PDEA Appendix C), which were the work of OSU and their consultants. Information contained in the Habitat Characterization Report was provided as reference material to provide the results of habitat surveys performed in the Project area vicinity. In the Habitat Characterization Report, the applicant states that a draft summary report was submitted to ODFW August 2, 2017, and ODFW provided comments on August 22, 2017 (HC 6). To clarify, ODFW was not asked to and did not provide comments on the report, but did provide a table of habitat categorization we would agree to, and that table served as a starting point for the HCP. ODFW acknowledges and appreciates the applicants efforts to survey onshore habitat (reported in the Habitat Characterization Report, PDEA Appendix C), and to use survey results to responsibly site onshore facilities. ODFW and the applicant have reached agreement on preliminary habitat categorizations described in the draft HMP (PDEA Appendix K). However, preliminary assessment of potential impacts and approximate acreages of impact are estimated throughout this report and final determination of temporary and permanent impacts and exact acreages will be provided after final construction plans are available. Per PM&E measure 16, the applicant will minimize or avoid	OSU has modified its Project proposal to avoid the vast majority of habitat impacts by using HDD to install the terrestrial cable. The HMP meets state policy and is reasonable and consistent with OSU's obligations under the Federal Power Act. ODFW acknowledges that it agrees with the habitat characterization that was provided in the draft HMP attached to the DLA. As discussed above, OSU proposes that the license include a requirement to implement the HMP submitted with this FLA, without modification.

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		terrestrial activities in sensitive ecological areas (e.g., jurisdictional wetlands and nesting areas for listed avian species). The HMP and any necessary mitigation measures shall be deemed final when approved by ODFW as consistent with state policy. The final HMP and any necessary mitigation measures shall be implemented by the applicant and required by the FERC license.	
ODFW 15	32	Preliminary 10(j) Recommendation 6: Fish Streams In its PDEA, the applicant asserts that impacts to Friday Creek will be avoided by boring under the streambed, and if feasible, other streams will be bored under as well. ODFW recommends boring under all fish-bearing streams including Friday Creek and stream 4, which is connected to Friday Creek. If the Project must trench through stream 4, the licensee shall use in-water work windows (IWWW) prescribed by ODFW to minimize impacts on fish, and consult ODFW regarding the need for fish salvage. ... The recommended work window for coastal streams is July 1 to September 15.	As stated in Exhibit A, Section 1.4.3 (Terrestrial Cables) of the FLA and elsewhere in the FLA documents, the terrestrial cable would no longer be buried next to the highway, but would now be installed using HDD directly between Driftwood and the UCMF, consistent with the agreed upon measures to use HDD as a BMP that would avoid impacts to surface streams. Therefore, ODFW's proposed BMPs for surface stream work are no longer necessary or applicable.
ODFW 16	32	Streambank restoration shall be conducted in accordance with the restoration and monitoring plan to be completed before construction begins. The licensee shall propose a schedule for development and implementation of a riparian restoration and monitoring plan and shall consult ODFW for a list of critical components.	OSU proposes to develop a revegetation plan using native species to the extent possible for areas disturbed during construction. As specified in the APEA, OSU will include the minimization measures identified by NMFS and ODFW in development of the revegetation/restoration plan, which will be developed in consultation with NMFS, ODFW, and appropriate agencies. OSU plans to develop the plan 6 to 12 months prior to the start of Project construction.
ODFW 17	35	Preliminary 10(j) Recommendation 7: Estuarine Resources	OSU agrees with these measures, which were proposed on pp 2-11, 2-23, 2-29, 3-27, and 3-30 to 3-31 of the PDEA and are carried forward in the APEA.

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		To minimize impacts on estuarine habitat and species, the licensee shall: A. Fabricate Project components at existing permitted land-based facilities, allowing all coatings and paints to fully cure prior to deployment into the estuary B. Restrict use of the estuary to commercial dockage that has been designed, permitted and is used for dockage, where the docks have been and continue to be dredged.	
ODFW 18	35	The licensee shall clarify whether references to Newport Harbor refer to Yaquina Bay or a specific location within the estuary.	Such references have been revised to the Port of Newport, as referenced correctly elsewhere in the DLA documents.
ODFW 19	40	Preliminary 10(j) Recommendation 8: Invasive Species ... Per PM&E 16, mitigation for terrestrial resources, the applicant shall develop measures that will limit the introduction or spread of invasive species, to be included in each construction plan. If aquatic invasive species are found on or inside a watercraft, the owner or operator must provide ODFW with an accurate history as to where the watercraft has been during the last six months. Information shall include; (1) All waterbody(s) in which the watercraft has been moored or operated; (2) The length of time that the watercraft has been out of water; (3) All locations where the watercraft has been stored; and (4) If previously inspected, the agency and individual which conducted the inspection.	Protection against the spread of invasive species is governed by state and federal laws. OSU proposes that all Project chartered, or contracted vessels comply with federal and state laws and regulations regarding aquatic invasive species management in order to minimize spread of invasive species during Project construction.
ODFW 20	42	Preliminary 10(j) Recommendation 9: Adaptive Management	The AMF states, "[I]n accordance with the provisions herein, the AMC will evaluate monitoring plan results and make changes to monitoring plans pursuant to Mitigation Measures 1, 2, 3, 4 and

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		Proposed PM&E measures that are implemented pursuant to the Adaptive Management Framework (AMF) address potential Project impacts where there is uncertainty and where a number of agency stakeholders have authority or interest. They include EMF, benthic monitoring, entanglement, organism interaction monitoring, and acoustic monitoring. As described on AMF page 1, the Adaptive Management Committee (AMC) will evaluate monitoring plan results, make changes to monitoring plans, and make decisions regarding whether to adopt additional or modify existing mitigation measures 1, 2 and 3. The licensee shall rectify this statement in the AMF and be clear that the AMC will evaluate and make changes and decisions regarding all five measures subject to the AMF.	5. In addition, the AMC will make decisions regarding whether to adopt additional or modify existing mitigation measures under Mitigation Measures 1, 2 and 3 to bring effects within the criteria identified in those Mitigation Measures. Other Mitigation Measures will be managed in accordance with their terms in coordination with the specified resource agency involved, as appropriate, and will not be managed by the AMC. Emergencies involving fish or wildlife are addressed in accordance with Mitigation Measure 19." The AMC will have the ability to evaluate and make changes to all five monitoring plans; however, only Mitigation Measures 1 through 3 include *mitigation* measures (compared to Mitigation Measures 4 and 5, which include monitoring but no related mitigation measures), therefore, the reference to the AMC making decisions regarding mitigation measures is properly limited to Mitigation Measures 1, 2 and 3. In the final AMC, OSU has made edits to ensure that language is consistent and clear.
ODFW 21	43	Preliminary 10(j) Recommendation 10: Revegetation and Restoration Plans The licensee shall develop, in consultation with ODFW, Revegetation and Restoration Plan(s) to include: ODFW Preliminary Recommendations and Comments Pacific Marine Energy Center – South Energy Test Site (FERC No. P-14616-000) 43 A. Methods and schedule for implementation, monitoring, and reporting. B. Completion timeframes, success criteria, and secondary mitigation measures including reseeding, soil amendment, supplemental irrigation or other water management to ensure establishment of native vegetation.	In the DLA and PDEA, OSU proposed to develop a revegetation plan using native species to the extent possible for areas disturbed during construction. As specified in the APEA, OSU will include the minimization measures identified by NMFS and ODFW in development of the revegetation/restoration plan, which will be developed in consultation with NMFS, ODFW, and appropriate agencies. OSU plans to develop the plan approximately 6 months prior to the start of Project construction.

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		C. Methods to address soil compaction and erosion control, and to restore natural drainage patterns. D. Short-term soil stabilization measures, if necessary. E. Noxious weed control measures and monitoring of noxious weed control and revegetation efforts for three years post construction, two times per year (spring and fall) and every third year thereafter to determine success. F. Mitigation areas, if necessary, with mitigation goals to be met by revegetation. G. Seed and plant with native vegetation, per PM&E 16, in consultation with ODFW to maximize benefit to fish and wildlife. H. H. Compliance with measures described in the HMP, pursuant to the Habitat Mitigation Policy.	
ODFW 22	45	Preliminary 10(j) Recommendation 11: Horizontal Directional Drill Contingency Plan ... The licensee shall develop a draft HDD Contingency Plan for review no later than at such time as the FLA is submitted, and shall append the draft plan to the draft EA for review in the context of other Project plans and procedures. The licensee shall include in this draft plan: A. Description of HDD locations, maps, coordinates and spatial dimensions, including marine HDD beneath the beach and any terrestrial HDD. B. Description of HDD laydown area location (Driftwood), manhole spacing (20 feet apart), and drill site preparation and set up. C. Description of HDD target depth beneath dunes and beach habitat, diameter of the HDD hole, and approximate dimensions (distance, width, depth) of the HDD cable corridor. D. HDD methods (drill and leave).	OSU proposes to develop and implement an HDD Contingency Plan to minimize the potential for inadvertent return of drilling fluids, provide timely detection, and address potential releases by describing monitoring, containment, response and notification procedures to be implemented by the contractor. The HDD Contingency Plan (or other supporting documents) will include, but not limited to, the components requested by ODFW, along with FERC's published guidelines. OSU proposes to develop this plan after the FLA is submitted (but prior to construction), upon engagement of an HDD contractor who would be expected to contribute to the plan's development.

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		E. Schedule and timing (one month per borehole, 6-8 months in total). F. Construction best operating procedures designed to minimize the potential for inadvertent return of drilling fluids. G. Description of anticipated support services such as marine vessels or divers. H. Inspection procedures to facilitate timely detection of inadvertent return, if any. I. Monitoring (e.g. drill mud pressure and volume), containment, response recovery and clean-up of inadvertent release, and notification procedures, including notification of ODFW. J. Emergency response equipment to be stored on-site during HDD operations. K. Map of potential vehicle beach access points and description of consultation procedures with OPRD. L. Map of environmentally sensitive sites (e.g. western snowy plover potential habitat, seaside hoary elfin potential habitat, streams, wetlands, dune habitat). M. Identify approved locations for spoil piles on previously disturbed, paved, areas selected to avoid impacts on habitat. N. Identify procedures and approved disposal sites for spoils and drilling mud. O. Describe demobilization procedures. The licensee shall incorporate comments on the draft plan and finalize the plan for submittal to FERC. Upon Commission approval, the licensee shall implement the final HDD plan. If modifications to the approved plan are necessary, the licensee shall revise the plan in	

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		consultation with parties who commented on the draft plan.	
ODFW 23	49	Preliminary 10(j) Recommendation 12: Decommissioning ... The applicant proposes to develop a Removal and Decommissioning Plan for the overall facility as the license term nears its end and will implement it with decommissioning of the overall Project. The license shall require full removal of all anchors and adequate insurance to do so. In the event the Project is decommissioned for any reason, the licensee shall develop a decommissioning plan and the plan shall include: A. Proposed decommissioning schedule. B. Description of removal and containment methods. C. Description of site clearance activities. D. Plans for transporting and recycling, reusing, or disposing of the removed Project components, including removal of all anchors and equipment from the water at the time of decommissioning and destination location of appropriate land-based permitted disposal or storage facility. E. Description of those resources, conditions, and activities that could be affected by or could affect the proposed decommissioning activities. F. Results of any recent habitat or biological surveys conducted in the vicinity of the structure. G. Mitigation measures to protect sensitive biological resources during removal activities or subsequently restore habitat features. H. Description of methods that will be used to survey the area after removal to determine any effects on marine life or habitat.	OSU proposes to develop the Removal and Decommissioning Plan for the overall facility as the license term nears its end in consultation with ODFW and other agencies. The plan will be developed consistent with FERC policies and requirements in effect at that time.

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		I. Description of how the applicant will restore the site to the natural condition that existed prior to the development of the Project area. J. Plans to conduct post decommissioning underwater visual surveys to demonstrate that all equipment has been removed and habitat has been returned to its pre-installation state. K. Plans to provide a report of post-decommissioning survey results. The licensee shall develop the decommissioning plan in consultation with ODFW. The licensee shall provide a draft decommissioning plan to ODFW for a minimum of 30 days for review and comment. The licensee shall revise the draft plan in accordance with agency recommendations prior to submitting the draft plan to FERC. The licensee shall include documentation of agency consultation and specific identification of how agency comments and recommendations are accommodated by the decommissioning plan. Upon approval by FERC, the licensee shall implement the plan. After removal of all Project components that will be removed but before the end of the license term, surveys for post-decommissioning habitat recovery should be conducted to ensure that habitat within the entire Project area (e.g. offshore deployment area, nearshore cable corridor, onshore facilities) has been restored and no further mitigation is required. The licensee shall provide a draft report to the agencies documenting the successful removal of all equipment, any equipment decommissioned on site or planed for reuse and any necessary approvals to do so, and	

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		sufficient restoration of affected areas or additional mitigation planned to achieve complete restoration.	
ODFW 24	53	Preliminary 10(a) Recommendation 1: Navigation Plan and Surface Markers The applicant proposes to mark some Project equipment, to the extent possible. For example a surface buoy would mark the subsea connector, and marker buoys may be in place between WEC deployments if anchors are not removed at the same time as the WECs. ODFW recommends that the applicant be required, by license article, to successfully and continuously mark all at-sea equipment that lacks a surface expression. Per PM&E measure 17, the licensee shall mark Project structures with appropriate navigation aids as required by the US Coast Guard (USCG). According to the Navigation Safety Risk Assessment (PDEA Appendix E) marking may include daymarks, lighting, radar reflectors, and automatic identification system equipment, and will monitor position of equipment and effectiveness and operation of navigational markers. At minimum, the surface marker buoy type shall be approved by USCG, and shall be sufficient to ensure continuous marking and compliance with the license.	PM&E measure 17 was developed in collaboration with the CWG, including ODFW and USCG, which reached consensus on its contents. As the measure indicates, OSU will comply with all USCG requirements for marking surface equipment. Furthermore, discussions with the CWG only included marking of the four corners of the site with surface floats. OSU is not committing to marking all Project components with surface floats for both technical and environmental reasons (e.g. risk of entanglement).
ODFW 25	56	Preliminary 10(a) Recommendation 2: Operations and Maintenance Plan ... As disclosed by the Operations and Maintenance (O&M) Plan, included as PDEA Appendix F, clients who are testing at PMEC-SETS will be required to develop their own O&M plans which will need to be approved by OSU. The FERC license shall also require that clients must include in their plans applicable elements of the	OSU is committed to the terms identified in the O&M plan, which is restated by ODFW in its comments, and includes a requirement for testing clients to develop their own O&M plans to be approved by OSU. These client specific plans may or may not include all the requirements OSU has imposed on itself for the Project as a whole based on the fact that OSU and its clients may be responsible for different aspects of said O&M plans. As requested by ODFW, OSU will also provide a list of those parties

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		Project's O&M plan. The license shall require that each client's O&M plan include: A. Quarterly inspections from the surface of all components at PMEC-SETS, subsurface ROV survey of all Project components at least every 3 years, seafloor ROV survey at each cable every 2.5 years, monthly UCMF inspection, and weekly supervisory control and data acquisition (SCADA) diagnostic of PMEC-SETS. B. Subsea connectors will be inspected when WECs are connected or disconnected and on a schedule determined by the manufacturer (eg every 5 years). C. Environmental monitoring instruments may require periodic cleaning to remove excessive bio-fouling, which would likely be done at sea. Cables and manholes do not require routine maintenance. During O&M activities, OSU will carry out any obligations it may have under the PM&Es and pursuant to the Project license. Reports will be produced following each inspection and maintenance procedure in accordance with PMEC-SETS operating procedures. The licensee shall provide a notification chart describing all parties who receive O&M reports, and shall include such materials with the annual reports.	who receive the O&M reports as part of the plan itself, and will include all nonproprietary materials with the annual reports.
ODFW 26	58	Preliminary Comment 1: Project Description The applicant should provide construction methods and Project footprints for construction and operation as soon as possible, and no later than at such time as the FLA is submitted. ODFW requires information about what specifically OSU is proposing to do (e.g. boring or trenching the terrestrial cable route) and where	As stated in Exhibit A, Section 1.4.3 (Terrestrial Cables) of the FLA and elsewhere in the FLA documents, the terrestrial cable would no longer be buried alongside Highway 101, but would now be installed from the Driftwood Beach State Recreation Site to the UCMF site using HDD. The use of HDD represents a BMP to minimize and avoid impacts to the terrestrial environment, including wetlands, streams, and other habitat. The footprint of

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		activities will occur (e.g. final marine cable corridor area) to complete the analysis of potential impacts and provide final recommendations to FERC. In addition, the applicant should clarify and make consistent all aspects of the Project description throughout the license application and environmental assessment, including all appendices. Issues needing clarification or consistency include:	construction disturbance has been added to the APEA. The construction methods are described in the APEA and the construction plans will be developed by contractors prior to Project commencement.
ODFW 26a		A. Subsea cable approximate area (2 square nautical miles) and length (8.3 nautical miles) is provided in some documents and not in others.	This information was presented clearly and consistently, and in the appropriate places (i.e., Exhibit A of the DLA, the PDEA, and Draft BA).
ODFW 26b		B. Minimum width of subsea corridor is 60-400 meters, provide maximum and actual anticipated width.	This information was presented clearly and consistently in the Project Description in the DLA documents, which includes the following: The industry best practice for minimum spacing between buried subsea cables is 1.5 times the water depth. The eastern edge of the Project site is in approximately 65 m of water, and the HDD conduits would be located in approximately 10 m of water. Accordingly, the minimum spacing between each cable at the edge of the Project site would be at least 100 m (i.e., 65 m x 1.5 = 97.5 m), and the minimum spacing between each cable at the HDD conduit would be approximately 15 m, resulting in a cable corridor that converges from at least 400 m at the offshore test site to 60 m at the nearshore HDD conduits. The seafloor does not shelve evenly, so the cable corridor would not widen at a constant rate between the Project site and the HDD conduits (as illustrated in Figure A-12).
ODFW 26c		C. Four subsea connectors each having a footprint of about 30 square feet. Habitat modifications would be permanent for the subsea connectors (about 120 square feet total) and long-term for WEC anchors (up to 5 years or longer).	This information was presented clearly and consistently in the DLA documents. In the PDEA, OSU indicated that there would be a direct disturbance associated with the installation of the four subsea connectors *(*each with a footprint of approximately 30 ft^2). Collectively, this would equate to a footprint of 120 square feet

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			for the 4 subsea connectors. In the FLA documents, OSU clarified that the habitat modifications related to the presence of the subsea connectors would be long-term. OSU did note in the DLA that the disturbance process will repeat itself on a periodic basis over the Project license term as subsea connectors are retrieved and deployed. OSU also indicated in the DLA documents that there would be long-term loss of unconsolidated sand habitat within the footprint of the WEC anchors.
ODFW 26d		D. Five terrestrial cables would run in underground conduits, extending .2 miles on Driftwood to Highway 101, .3 miles south on Highway 101, and .2 miles on private property to the UCMF, for a total distance of 0.7 miles. Rectify discrepancies in BBCS, PDEA, and throughout the application documents to avoid confusion.	As stated in Exhibit A, Section 1.4.3 (Terrestrial cables) of the FLA and elsewhere in the FLA documents, the terrestrial cable would no longer be buried next to Hwy 101 but would now be installed using HDD. From the beach manholes at the Driftwood Beach State Recreation Site, where the subsea cables would transition to terrestrial cables, the cables would be installed in up to five HDD bores to the UCMF property. From the beach manholes, the cables would run to the southeast, under the southern portion of Driftwood Beach State Recreation Site. The HDD cable conduits would run under small sections of six private properties located on either side of Highway 101, and then to the OSU owned parcel east of the highway. From the UCMF, a cable would also be buried by HDD west to, and under, Highway 101 to the grid connection point with the CLPUD overhead transmission line along west side of the road. The total distance of the terrestrial cables would be about 0.5 miles.
ODFW 26e		E. Describe terrestrial cable construction plans including methods and cable corridor width (e.g. 20 feet) and depth. Clarify whether cables will be laid in separate conduits in one bundle, or will multiple boreholes or trench lines be necessary. To minimize disturbance, ODFW recommends a single line (one conduit containing all terrestrial cables).	As stated in Exhibit A, Section 1.4.3 (Terrestrial Cables) of the FLA and elsewhere in the FLA documents, the terrestrial cable would no longer be buried next to the road but would now be installed using HDD. In Section 1.4.3 of the FLA Project Description, OSU specified that the final specifications of the terrestrial transmission cables are dependent on the final subsea cable design and coordination with Central Lincoln People's Utility

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			District (CLPUD) to ensure compatibility with existing infrastructure.
ODFW 26f		F. Clarify whether the terrestrial cable goes to the UCMF then back down Wenger Lane to Highway 101, and if there will be additional trenching or power pole installation to achieve grid connection. Include this information in the total disturbance area for impact assessment, whether grid connection activities are performed by OSU as part of the action or by CLPUD as an interrelated or interdependent action.	As specified in Section 1.4.4 of the DLA Project description and as depicted in Exhibit G, the grid connection to CLPUD's distribution system would run from the UCMF to CLPUD's distribution lines on the west side of Highway 101. The distance from Highway 101 to the UCMF is 600 feet and this area is considered during the impact assessment. OSU specifies that the lines would be underground. OSU would be responsible for installing the conduits along the route, then CLPUD would pull the wires through the conduits and complete the installation. It is expected that three 4-inch diameter conduits, and a bare copper ground wire would be required. Potential impacts associated with the terrestrial cable were included under the Section 3.3.4 of the PDEA.
ODFW 26g		G. Clarify intentions to close or maintain public access to park facilities at Driftwood during construction.	It is anticipated the Driftwood Beach State Recreation Site would need to be closed to vehicular traffic during construction. It is possible there could be an option for limited pedestrian access, and OSU would work with OPRD to determine access feasibility and to ensure public safety. The specific steps in this plan are provided in the response to FERC 9. It should be noted that there are six Oregon Parks and Recreation Department facilities offering beach access, parking and restrooms within a ten mile radius of the Driftwood Beach State Recreation Site, including: Seal Rock (2.3 miles north); Governor Patterson (4.1 miles south); Brian Booth/Ona Beach (4.3 miles north); Lost Creek (6.0 miles north); Beachside (6.3 miles south); and South Beach (9.9 miles north).
ODFW 26h		H. Describe how UCMF construction and operation will impact terrestrial resources.	Potential impacts from construction, operation, and maintenance of the UCMF were described and analyzed in the PDEA's impacts

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			analysis related to terrestrial resources (Section 3.3.4.2) and in the HMP. Also see response to ODFW 26k below.
ODFW 26i		I. Clarify the area proposed for new paving and expand discussion of the UCMF and include any paving activity planned for Wenger Lane or other areas. Per the PDEA, access to the UCMF would be via a paved 30-ft-wide spur road approximately 100 feet long. From review of the application for a Lincoln County Conditional Use Permit, ODFW understands that the applicant is proposing to install asphalt paving of a section of Wenger Lane approximately 20 feet wide by 700 feet long (Lincoln County Department of Planning and Development, 2018). Installation of impervious surfaces (e.g. paving dirt roads, new rooftops, paved parking area) to an area with significant precipitation could result in storm water runoff or changes to absorption rates which may alter wetland, waterbody, and upland habitat.	OSU has updated Section 2.2.1.3 (Power Transmission and Grid Interconnection) of the APEA and related sections of FLA documents to describe its proposal to pave a section of Wenger Lane approximately 20 feet wide by 800 feet long and a parking/laydown area that is approximately 80 feet by 200 feet. OSU has committed, in Section 2.2.4 of the APEA and elsewhere in the FLA documents, to developing an appropriate stormwater plan during site design of the UCMF and associated facilities prior to any construction activities at the site.
ODFW 26j		J. Parking and laydown area would be approximately 130 feet by 140 feet and large enough for semi-truck access. The entire area for the road, parking, and UCMF would be 2 acres and would be fenced and covered by security cameras and lighting. As ODFW commented to Lincoln County for the Conditional Use Permit, lighting shall be shielded or directed downward away from trees to minimize impacts on nocturnal species (Lincoln County Department of Planning and Development, 2018).	OSU will comply with the terms of the Conditional Use Permit.
ODFW 26k		K. Describe the intended use of the UCMF site (power conditioning, monitoring, energy and data storage, and maintenance/supply area are all indoors). As ODFW recommended to Lincoln County for the	In Exhibit A, Section 1.4.4 (Utility Connection and Monitoring Facility) of the FLA, and elsewhere in the FLA documents, the intended use of the UCMF site is described. The UCMF will be used for power monitoring, conditioning, utility equipment and

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		Conditional Use Permit, intended uses should not be permitted to include outdoor storage, workshop facilities, equipment build out or repair, or storage or cleaning of marine equipment (Lincoln County Department of Planning and Development, 2018). Such activities could elevate concerns related to potential degradation of habitat quality from noise, pollutants, or other sources.	other electrical operations would be performed at the onshore UCMF. The current plans for the UCMF include three, single-story buildings. One building would accommodate the power conditioning and monitoring equipment for each of four potential test clients. A second building would include PacWave South switch gear, utility equipment and general storage. The third building would be the Project's data, control, and communications center and would contain monitoring, communications, data storage, and supervisory control and data acquisition (SCADA) systems. The building would also contain operational support infrastructure such as restrooms and a maintenance/supply area. The UCMF would be located off of Highway 101, a major U.S. highway, which generates noise and pollutants. In response to a request from Lincoln County Planning, OSU provided additional information on transformer sound levels and expected attenuation and the County concluded that operational noise would not be an issue. As noted in Section 2.2.4 (Proposed Environmental Measures) of the PDEA, OSU will prepare waste management, hazardous material, and spill prevention plans, as appropriate, for onshore Project facilities. Additionally, as stated in the same section, if lighting is required at the UCMF at night, it will be appropriately shielded and directed to minimize artificial light attraction. To the maximum extent practicable, while allowing for the public safety, low intensity energy saving lighting (e.g., low pressure sodium lamps) will be used, and bright white light will be minimized. Therefore, impacts associated with the operation of the UCMF would be negligible and were not analyzed in the license application.
ODFW 26l		**L.** Clarify whether WEC deployment would be expected to take no more than seven days to install one mooring system and WEC (see PDEA page 2-	Based on OSU's experience at the nearby PacWave North site, it is anticipated that it could take up to seven days to install the mooring system for a single WEC, and an additional one to two

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		25) or if it would take one to two days to deploy a single WEC and up to seven days to deploy a small array of WECs (see PDEA page 2-27).	days to attach the WEC to the mooring. If an array was installed, which consisted of a number of WECs on individual mooring systems, this process would need to be repeated for each device. It is likely faster to install a simpler mooring system as compared to a more complex one. For example, a single point mooring would likely take a shorter time to install than a 3-point, six anchor mooring system. Deployment activity would not necessarily be continuous as weather and unforeseen issues could interfere with operations. However, actual at-sea activities are not expected to take more than nine days to install one mooring system and WEC.
ODFW 26m		M. Describe intended outreach throughout the PDEA and DLA documents. In the Navigation Safety and Risk Assessment (PDEA Appendix E), OSU states it would conduct additional outreach to inform mariners traveling in the vicinity of Project structures of activities to be avoided, and in PM&E measure 17, the applicant proposes to conduct outreach to mariners about the structures or activities to be avoided (e.g., Notice to Mariners, flyers posted at marinas and docks).	OSU has described its proposed outreach to mariners regarding structures and activities to be avoided in the Project area. This information is included in the Navigation Safety and Risk Assessment (Appendix E of PDEA), is further described in the PDEA, and included as a commitment in OSU's proposed PM&E measures (Appendix I of PDEA).
ODFW 27	62	Preliminary Comment 2: Grid-Connection and System Upgrades ... The applicant should submit a plan for future grid infrastructure, which describes the extent of new infrastructure to be added for the Project and the potential affects to fish and wildlife or habitat. If the applicant will eventually need additional trench lines or poles to support transmission of energy produced by the Project, then potential future impacts on fish and wildlife and habitat must be considered as part of the	The proposed Project was fully described in Exhibit A of the PDEA and elsewhere in the DLA documents. At this time, there is sufficient grid capacity to accommodate the Project, but OSU would continue to coordinate with both CLPUD and BPA to determine whether upgrades would be necessary to achieve the planned 20 MW of generating capacity as the facility approaches maximum capacity. If infrastructure upgrades are determined to be necessary in the future to directly accommodate the generating capacity of the Project, such upgrades may be subject

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		action or as interdependent or interrelated actions in ODFW's analysis of the Project.	to FERC approval and any required federal and state environmental review.
ODFW 28	62	Preliminary Comment 3: Anchors The applicant should clarify the frequency with which anchor installation or recovery might occur and provide an anticipated maximum frequency of anchor installations. Anchor installation and removal is discussed in the analysis but is inconsistent. Examples of installation/removal frequency discussion include: A. Even under the full build-out scenario, anchor installation/removal is not expected of occur more than once a year at PMEC-SETS. B. Anchor deployment and recovery would be infrequent, for a given WEC not likely more than once a year. C. Although it is highly uncertain, WEC mooring system turnover could affect 2 berths per year. Habitat modifications would be long-term for WEC anchors (up to 5 years or longer).	Each individual WEC or array test is expected to last between one and five years. Anchor and mooring system installation would occur prior to the start of a test and removal would occur once a test was complete. Such operations are extremely costly, so it is highly unlikely that a test client would plan to make adjustments to their anchor placement once a test was underway. Therefore, disturbance due to anchor installation and removal operations within a berth should only occur occasionally (e.g. once a year, and perhaps only once ever several years). However, as testing operations in each berth are independent of the activities in the other berths, it is possible that in any one year, anchor installation or removal operations might occur in more than one berth. This information has been made consistent throughout the license application.
ODFW 29	63	...To reduce disturbance to the seafloor, OSU will reuse anchors wherever possible. There would be long-term loss of sand habitat within the anchor footprint, OSU estimates as much as 2 acres at full build out, however this doesn't take into account anchors that are left on site for reuse.	The estimate provided by OSU considers the maximum anchors that may be needed on site, whether newly installed or from a previous installation.
ODFW 30	63	ODFW encourages actions that minimize disturbance to the seafloor, including reuse of fully functional anchors. However, to successfully minimize disturbance and avoid delayed anchor removal or abandonment of Project or test equipment, the applicant should: A. Document by signed agreement the intent of individual test clients to remove anchors when the test concludes, or for OSU to take over	A. OSU will maintain a contract with testing clients that will outline berth use terms and conditions. As stated throughout the license application, OSU intends to reuse anchors where possible, but will not make it a condition of the berth use. OSU may or may not remove the anchor after a test concludes. B. OSU will remove all anchors at the end of the license if it does not seek and receive a license extension.

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		responsibility of anchor removal. Any costs of removal not covered by clients will be paid by OSU. B. Remove all anchors at the end of license. C. Mark anchors left in between tests with continuous surface marking. D. Discuss anchor recovery methods and back up plans for all potential anchor types. E. Clarify whether OSU will require test clients to remove any anchors prior to subsequent test that will not be reused or might they let anchors accumulate until final facility decommissioning. All anchors will be removed at conclusion of active testing activity or by the end of the license period. F. Plan well in advance for anchor installation or removal, especially if multiple vessels would be needed at one time. G. Not install anchoring and mooring systems with percussive pile driving or drilling, and avoid any activities creating a comparable noise level to pile driving activity either during installation or operation of the Project. Document this commitment consistently throughout the analysis.	C. To avoid increased risk of entanglement and to maintain operational safety, OSU will mark the four corners of the site with surface buoys, but may not mark anchors left between tests. D. See section2.2.3.2 of the PDEA. E. All anchors will be removed at the conclusion of active testing or by the end of the license period, if OSU does not seek and receive a license extension. F. OSU will be responsible for all operational activities at the site and intends to plan these activities accordingly. G. OSU has identified the types of anchors that will likely be used at PacWave South.
ODFW 31	64	... Per the PDEA and appendices, suction caisson anchors can be easily removed, installation of the anchoring and mooring system for this Project will not involve percussive pile driving or drilling, and neither installation nor operation of the Project will involve any activities creating a comparable noise level to pile driving activity. The applicant should document throughout the analysis that no pile-driving or installation procedure with comparable noise level will be used at PMEC-SETS.	OSU agrees with ODFW, as stated in the PDEA and appendices, that installation of the anchoring and mooring system for this Project will not involve percussive pile driving or drilling, and neither installation nor operation of the Project will involve any activities creating a comparable noise level to pile driving activity. OSU has made this statement clearly in the appropriate places and is not making changes throughout the document.

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ODFW 32	65	The number of vessels needed for anchor installation and removal will depend on the quantity and size of anchors being deployed, but typically requires two to four specialized work vessels (e.g. tugs, barges). The applicant should consider in its analysis that vessel availability is a regular limitation for marine operations off of Oregon, and describe a realistic anchor installation and recovery scenario that does not assume timely availability of required vessels. Anchor installation/removal activities rely on specific weather windows so the timeframes within which anchor removal or installation could occur are also limited, which may further complicate successful timely removal of equipment and anchors.	OSU believes installation/removal timing has been accurately characterized in the DLA. For example, the following information was included in the PDEA and updated in the APEA: "While the number of vessels needed for anchor installation or removal would depend on the quantity and size of anchors being deployed, these activities typically require two to four vessels (specialized work vessels, tugs, barges, and smaller crafts). Based on OSU's experience at the nearby PacWave North, it is anticipated that it would take up to seven days to install the mooring system for a single WEC, and an additional one to two days to attach the WEC to the mooring. If an array was installed, which consisted of a number of WECs on individual mooring systems, this process would need to be repeated for each device. This time would not necessarily be continuous because weather could delay the start-to-finish completion, but actual at-sea activities would not be expected to take more than nine days to install one mooring system and WEC."
ODFW 33	66	It is likely that Project components will become buried to varying degrees and once anchors are partially sanded in they can become extremely difficult to remove. The longer anchors stay in, likely the harder and more costly recovery will be. The applicant should expand the analysis to provide some certainty that equipment will be recoverable.	OSU has committed to removing all anchors at end of license, if OSU does not seek and receive a license extension.
ODFW 34	67	Preliminary Comment 4: Scour and Sediment Transport Site characterization reports reviewed by the CWG included a sediment map with a key of sediment types shown from the initial marine survey, which indicated mud and fine sand in the Project area. However, this map was not included with the PDEA. The applicant will perform marine geophysical and geotechnical surveys (see comment 5 below) and should provide results, including a map of sediment types within the Project	OSU has provided the results of the geophysical and geotechnical surveys in the license application, along with the Marine Survey report attached as an appendix. A revised sediment map is also included in section 3.3.1 of the APEA.

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		area, as soon as possible and no later than at such time as the FLA is submitted.	
ODFW 35	67	... Suspended sediment resulting from cable laying, subsea connection installation and anchor installation/removal is expected to last for minutes or tens of minutes. However, it is important to note that these estimates of sediment settlement rates are based on a brief disturbance event whereas the more frequent activity at PMEC-SETS may induce ongoing disturbance for days (eg anchor installation) weeks (cable installation) or months (WEC operation).	OSU included duration of disturbance activities in its analysis. As noted, in each instance of disturbance, whether from initial Project construction (cable laying) or O&M (subsea connection installation and anchor installation/removal), the duration of suspended sediment occurring is expected to last for minutes or tens of minutes.
ODFW 36	68	... The applicant should consider in the analysis that, based on pre-removal and post-decommissioning sonar and ROV video surveys conducted by OPT around seafloor equipment installed approximately 2.5 nautical miles off of Reedsport Oregon (OPT 2016b): A. After 13 months installed, the scar left by a sunken sub-surface float was still visible, had persisted for 13 months post-removal (October 2013 to November 2014), and was approximately 30 feet long. B. After 23 months installed, the anchor had partially settled into the soft sediment, and scour and deposition were visible in the sediment against the anchor. The hole left by the anchor was approximately 3-4 feet deep and easily identified on the sonar, documenting pit persistence for approximately 6-8 weeks between anchor removal and post-removal survey. The full duration of persistence is unknown as additional survey would be necessary to identify if and when sediment scar healing occurred.	ODFW's comment refers to a video that was made available to ODFW, but that has not been made available publicly or to OSU or its contractors. In any event, it is important to note that sediment approximately 2.5 nautical miles off of Reedsport, Oregon is significantly smaller grain size compared to sediment in the Project area, which is more energetic such that anchor-related features are expected to recover faster. OSU believes the analysis in the APEA considers the potential for post-removal impacts in the Project location, and no further analysis is necessary or appropriate. Furthermore, OSU has proposed a monitoring plan to study potential changes to benthos and address those changes as appropriate pursuant to the Adaptive Management Framework.

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ODFW 37	69	Preliminary Comment 5: Marine Geological Surveys ... ODFW anticipates that final marine surveys will be presented in the FLA and that information will include maps of the seafloor sediment type at the proposed deployment area and along the marine cable corridor. ODFW strongly recommends avoidance of any rocky habitat identified by surveys.	The 2018 marine route surveys are included in Section 3.3.1 (Geological Resources) of the APEA and appended. OSU has provided the results of the geophysical and geotechnical surveys in the license application, along with the Marine Survey report attached as an appendix. A revised sediment map is also included in the APEA. As specified in Section 2.2.4 (Proposed Environmental Measures) of the DLA, OSU has developed cable routes that avoid crossing areas with rocky reef and hard substrate to the maximum extent practicable to protect sensitive habitat features.
ODFW 38	69	Preliminary Comment 6: Marine Mammal Surveys Results displayed in the marine mammal site characterization report are from October 2013 to September 2015. Data analysis is in progress, and at this stage of analysis OSU can only make inferences towards trends in the observational data. Analyzing occurrence and distribution by combining acoustic surveys from 2014 with all visual surveys will result in a more robust data set for identifying trends and habitat use patterns. ODFW is concerned that no results are reported 2.5 years following completion of survey activities. It is essential to have these results in the FLA so ODFW can consider what is known about marine mammal use of the Project area in our final recommendations.	The 2014 acoustic survey data studied harbor porpoise. Calambokidis and Barlow (1987) document the largest concentrations of this species in summer and early fall; therefore, the digital monitoring devices were deployed mid-May to mid-October. The study showed echolocation and feeding sound detections were higher at the reef site than the offshore PacWave South test site, but harbor porpoise were detected at the offshore site almost daily during the summer months. There was a gradual increase of detections from May to June and peak detections between the summer and fall. There were more “buzz positive minutes”, which is indicative of feeding, at the offshore site at night and morning and more at the inshore reef station in day and evening. Interestingly, harbor porpoise were rarely present at both sites at the same time, suggesting that they may move between the sites. The results presented in the Site Characterization Report (Appendix C of the PDEA) are the only results available for the ship-based observations, and have been edited accordingly.
ODFW 39	70	Preliminary Comment 7: Entanglement Hazards The applicant should justify the need for 300 meters of unburied subsea cable in water depths less than 80 meters. The applicant should propose measures to	As specified in Exhibit A, Section 1.4.2 (Subsea Cables) of the DLA and elsewhere in the DLA documents, within the Project site, the umbilical cables and a segment (approximately 300 m) of the

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		ensure continuous marking of potential at-sea hazards (e.g. subsea connectors not in use) and perform outreach to fishery participants to increase awareness of marked and unmarked at-sea hazards and any changes in equipment status (deployed on station, off station, decommissioned). The applicant should minimize the extent of unburied seafloor cables and structures to minimize conflicts and safety hazards with fishery participants. The applicant should perform marine geological surveys (see comment 5 above) to identify and avoid rocky substrate to achieve complete and continuous burial in the cable corridor between the WEC deployment area and the HDD entrance at the 10-m isobath.	subsea cables would remain unburied to allow for access during WEC deployment, WEC removal, and maintenance activities. The Project site marker buoys would identify the area in which marine hazards may occur. Additional markings may themselves pose a navigational hazard or environmental risk (e.g. entanglement), therefore, additional markings within the site may not be appropriate. OSU has completed the marine surveys as suggested.
ODFW 40	70	According to the applicants analysis, whales are not known to collide or entangle with taut moorings, which would be used at PMEC-SETS. According to proposed PM&E measure 3, mitigation for marine species entanglement or collision, the applicant shall direct the WEC testing clients to design and maintain cables and moorings in configurations that minimize the potential for marine mammal or sea turtle entrapment or entanglement (e.g., cable and lines should remain under tension) to the extent practicable. ODFW concurs that taut configurations present the lowest relative risk of entanglement (Harnois et al, 2015) and recommends that the applicant should require all clients to design and maintain cables and moorings to minimize entrapment or entanglement.	ODFW correctly sites that PM&E measure 3 provides that OSU will direct WEC testing clients to design and maintain cables and moorings in configurations that minimize the potential for entrapment or entanglement.
ODFW 41	71	According to the applicant's analysis, there are few examples of marine megafauna entangled in moorings or cables of any kind. However, a tidal energy site in the Bay of Fundy, Canada, has been associated with	The two Projects (a tidal energy site in Canada and a seafloor cable in Hawaii) do not present conditions similar to PacWave South, and inclusion of these examples in the APEA would not be relevant for the following reasons:

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		entrapment and mortality of humpback whales (James, 2013), and whale entanglements with seafloor cables do occur (National Marine Sanctuaries, 2017).	1) Entrapment and mortality of humpback whales occurred due to interaction with a tidal barrage, which utilizes a barrier across a tidal area to create energy. As stated in the cited study: "Tidal barrages in particular have the potential to trap marine life. At one tidal energy site, Annapolis Royal Generating Station in the Bay of Fundy, Canada, two humpback whales (*Megaptera novaeangliae*) became trapped. The first was trapped in the upper part of the river for several days in 2004 after swimming through the sluice gates. In 2007 the body of an immature humpback whale was discovered, the post mortem suggested that the whale had followed the fish through the sluice gates and also became trapped (Nova Scotia Power, 2012)." This Project will include no barrages and no devices with relevant characteristics similar to a tidal barrage. 2) The seafloor cable cited in the comment has a diameter of 5/8 inch, far smaller than any of the subsea cables in the PacWave South Project. According to NMS (2017), "Sunday's assessments by the response team revealed that the gear was heavy-gauge (~ 5/8") electrical cable. The team used cable cutters to cut both cables leading to the whale's mouth. It is estimated that around 500 feet of cable was removed from the animal with little gear remaining. The cable had already embedded itself too deeply at the back of the whale's mouth to pull out remaining gear. However, this represents a significant improvement and the animal illustrated this in its movements and behaviors afterwards. The source of the gear, which is a PVC-insulated electrical-type cable, is still unknown." The cables used at this Project would be approximately 4 inches in diameter and heavy (approximately 7-8 lbs/ft); therefore, would not likely form loops or cause entanglement.

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ODFW 42	72	Another significant hazard for some animals may be tethers between devices such as mooring cables, chains, guy-lines, or power cables, which marine mammals must be able to detect in order to avoid (DLCD, 2015). Models have predicted significant encounter rates between marine mammals and MRE devices; these are expected to increase when water is more turbid, such as during storms (Wilson et al. 2007). Avoidance becomes more complicated when several cables are used per device or multiple devices are present (DLCD, 2015), or at night or in turbid environments where structures may be visually undetectable and provide little or no opportunity for a behavioral response (Wilson et al, 2007).	Section 3.3.3.2 (Environmental Impacts Related to Aquatic Resources) of the PDEA and Section 5.2.2 (Risk of Collision or Entanglement) in the Draft BA provided a comprehensive analysis on the effects or risk of collision/entanglement to marine mammals. OSU has included newer published information in our analysis (e.g., Benjamins et al. 2014, Harnois et al. 2015). These newer references indicate low risk of entanglement, especially for taut moorings. As noted in the PDEA, OSU has proposed multiple measures to minimize the risk of entanglement to marine mammals and will direct the WEC testing clients to design and maintain cables and moorings in configurations that minimize the potential for marine mammal entrapment or entanglement.
ODFW 43	72	The applicant should expand its analysis to describe feeding strategy of whale species potentially present in the vicinity of the Project area including the cable corridor. For example, gray whales are bottom-feeders, and roll on their sides swimming slowly along the seafloor sucking sediment and benthic amphipods through coarse baleen plates (NOAA, 2013; Weller, 2010). This feeding activity suspends sediment in the water column creating long trails of “mud plumes” that can be seen in the water column or from the surface (Weller, 2010). Seafloor foraging activity may increase an individual’s risk of entanglement in Project equipment exposed on the seafloor.	OSU added information about the feeding behavior and pit depths for gray whales in Section 3.3.3 (Aquatic Resources; Marine Mammals) of the APEA. Our analysis indicates that gray whales scour substrate for feeding at much shallower depths (10-15 cm) than the depth of cable burial (1-2 m).
ODFW 44	72	... The applicant should add throughout the analysis, whenever discussing potential species entanglement that mooring lines and umbilical cables would be designed to avoid looping.	OSU has included this language in the appropriate places in the license application documents and has made this analysis clear throughout the APEA (e.g., Section 3.3.5.2 of the PDEA [Environmental Impacts Related to Threatened and Endangered Species, Critical Habitat, and Essential Fish Habitat]).

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ODFW 45	73	... PM&E measure 6 establishes that cables and lines should remain under tension. For consistency with what the CWG agreed to in 2017, the applicant should add “with no easy forming loops”.	OSU has already included language regarding the need to avoid looping in the appropriate sections of license application documents and it is not necessary to further repeat.
ODFW 46	74	Although fish screening techniques are not well established for the marine environment, ODFW and other state and federal agencies are adept at creating solutions to achieve fish protection objectives using methods appropriate for the species and the environment. For example, NMFS and Maine Department of Marine Resources submitted a condition that would require the TideWorks Hydroelectric Project, FERC numbers 13656-000 and 13656-001, to install screens around a proposed tidal turbine unit (FERC, 2012b). The agencies’ condition stated that the screen must (1) have a clear opening of one-inch or less; (2) maintain an approach velocity of two feet per second or less; and (3) be demonstrated to be effective (FERC, 2012b).	The example provided by ODFW bears no relationship to the proposed Project. The TideWorks Project proposed to deploy a hydrokinetic, vertical shaft turbine in the tidal waters of the Sasanoa River, Maine. The turbine was proposed to extend 6 feet below the water surface in water depths that would range from approximately 6 to 19 feet; therefore, the turbine would extend across the entire water column at low tide. Additionally, Tideworks proposed to install the turbine 40 feet from the shoreline, which was identified as important migratory and foraging habitat for fish. In contrast, PacWave South, and associated WECs, would be located approximately 6 nautical miles off the coast of Oregon where water depths range from 65 to 79 m (~210 to 260 ft). The WECs would likely be deployed 50 to 200 m or more apart from each other within the 2 square nautical miles (1,695 acres) test site. Scale drawings of WECs are provided in Figure A-8 and A-9 in the DLA. Unlike tidal turbines, WECs do not have underwater turbine blades and consequently there is no comparable mechanism of effect for WECs. Screens of the type described by ODFW here are not necessary or feasible in the ocean environment for a Project of this type, and there is no legitimate argument for considering them here. NMFS, the agency with regulatory authority for fisheries resources at the Project site, has not proposed screening of WECs, but did ask about the amount of water used for ballasting in a full scale WEC (see NMFS 15, below.).

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ODFW 47	75	Preliminary Comment 8: Marine Fish Entrainment ... The applicant should expand their analysis to include: A. Ballast needs of any WEC types to be considered in this analysis. B. Velocity with which in-ballast would occur for any WEC types to be considered in this analysis. C. Volume of water needed to “trim” ballast for any WEC types to be considered in this analysis, and frequency with which “trimming” may be necessary. D. Discussion of any continuous or fluctuating ballast systems, which should be avoided. E. Discussion of any power generating systems that are open to the water column, which would be avoided.	OSU respectfully disagrees that the analysis needs to be expanded. OSU has conducted the analysis already and addressed these concerns in Section 5.1.1 of the Draft BA. As discussed with the CWG, the NMFS screening criteria are specifically designed to address entrainment of fry and juvenile salmonids in water diversions, at locations where fish have to pass in order to rear or complete their outmigration. Our analysis indicates that WECs are: 1) using ballast for the purpose of maintaining the proper position in the water column when on site and operational; 2) ballast water quantity used for trimming will be very low and ballasting would occur infrequently (e.g., not continuously); and 3) juvenile salmonids in the ocean would be unlikely to encounter ballast intakes due to the small relative size of the Project.
ODFW 48	77	Preliminary Comment 9: Marine Species Attraction ... The applicant should clarify why, if pelagic fish may be attracted, would Project structures be unlikely to act as FADs. ODFW disagrees with the applicant’s conclusions that fish attraction is unlikely, and requests that the analysis be revised to conclude that uncertainty about fish attraction to MRE remains, but fish attraction to structure off of Oregon is well documented and should be analyzed.	Project structures have the potential to result in both a FAD effect and a reef effect; marine ecologists generally distinguish between these two phenomena, although this distinction is not always clear-cut, either in the literature or ecologically. Briefly, a FAD effect refers to the development of a behaviorally-mediated aggregation of fishes in response to surface or mid-water structure, usually of anthropogenic origin. A reef effect, in contrast, refers to the development of a similar aggregation, but oriented to structure at or near the bottom. The depth of water and the vertical continuity (or lack) of that structure complicates any distinction between these phenomena. Arguably, the distinction may be most closely related to the ecology of the species in question, with pelagic species more likely to orient to surface or mid-water structure and benthic or benthopelagic species to bottom and near-bottom structure. Regarding FAD effects, OSU is aware of no reports, published or even anecdotal, that artificial surface or mid-water structures

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			develop or retain an associated pelagic fish community in these latitudes, from San Francisco Bay northwards. FAD effects, in other words, are a tropical or sub-tropical phenomenon: although temperate or cold-water pelagic fishes may encounter surface structure and even, briefly, orient to them, they do not appear to form lasting (hours to days) aggregations in the vicinity (meters to tens of meters) of such structure. In contrast, artificial reefs and the fish communities that assemble around them are well known in temperate waters (and colder); OSU agrees that non-pelagic fishes (e.g., *Sebastes* spp) are likely to associate with these structures at or near the bottom or temporarily as they transition from pelagic larval to demersal juvenile as fish attraction to structures off the coast of Oregon is well documented. In summary, pelagic fishes may visit but will not form a lasting presence and there is no expectation of a FAD effect; on the other hand, the parts of the structure near the bottom (substrate to 3-4 meters) are likely to result in a reef effect, attracting and holding the kind of fish community found at rocky reefs of a comparable depth and latitude. We expect a weak artificial reef effect because the gear in question is not expected to offer extensive, complex habitat structure. In addition, OSU has committed to the "Organism Interactions" study to evaluate potential interactions with structures.
ODFW 49	78	The applicant should discuss potential changes in predation further, including expanded analysis of potential attraction of elasmobranchs because these are apex predators that target prey including salmon, and in some cases are fishery limiting species. ODFW requests that the applicant provide any information currently available to assist in the analysis of potential Project effects.	OSU respectfully disagrees that apex predator populations are expected to change due to the Project. Sharks are not generally included amongst those species known or expected to associate with artificial reefs in temperate waters. While benthic sharks (e.g., sixgill sharks) in Project waters may encounter these structures, these benthic species are not thought to include salmonids as a significant part of their diet. Pelagic sharks, particularly the salmon shark, may of course consume salmonids,

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			but these are not expected to associate with the Project structure.
ODFW 50	79	Preliminary Comment 10: Oregon Endangered Species Act The Oregon Endangered Species Act (ORS 496.171 et. seq. & OAR 635-100) requires state agencies to protect and promote recovery of state listed species. In its PDEA, section 3.3.5 T&E species, the applicant discusses federally endangered (FE) and federally threatened (FT) species, but the PDEA does not discuss state endangered (SE) or state threatened (ST) species not federally listed (gray whale, brown pelican) or the north Pacific right whale which is both SE and FE. The applicant should add to the analysis: • Gray whale, SE, not federally listed • North Pacific right whale, SE, FE • California brown pelican, SE, not federally listed In the PDEA, text for federally listed species should consistently and correctly include state listing, including: • leatherback sea turtle FE and SE • Green sea turtle FT and SE • Loggerhead sea turtle FE and ST • Olive (Pacific) Ridley sea turtle FT and ST • Humpback, blue, fin, sei, and sperm whales FE and SE • Short-tailed albatross FE and SE	OSU provided analysis regarding the North Pacific right whale to the APEA. OSU provided state status in the PDEA in Table 3-16. Effects to these state listed species, including gray whale and pelican, were discussed Section 3.3.3 Aquatic Resources and 3.3.4 Terrestrial Resources, but not in Section 3.3.5 Threatened and Endangered Species. As noted in FERC's guideline for preparing environmental documents, the Threatened and Endangered Species section of the EA document is used for species listed under the (federal) ESA.
ODFW 51	80	... Feeding BIAs have been delineated for the Pacific coast feeding group (PCFG), a sub-population of ENP gray whales. Based on primary feeding areas for the resident population, PCFG feeding BIAs include a 199 square km area (Calambokidis et al, 2015) inshore of the proposed PMEC-SETS Project area (NOAA, no date	OSU added this information to the analysis to Section 3.3.3 Aquatic Resources of the APEA.

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		c). The PCFG Depot Bay feeding BIA includes the nearshore area off of Newport and terminates just north of Seal Rock (Calambokidis et al, 2015; NOAA, no date c). ODFW requests that the applicant add this information to its analysis.	
ODFW 52	81	... Based on high concentrations of feeding humpback whales, a 2,573 square km area encompassing Stonewall and Heceta Banks was identified as a feeding BIA and one of the most critical areas for humpback whales (Calambokidis et al, 2015). Based on comparison of PMEC-SETS coordinates, the online interactive BIA map and GIS shapefile data (https://cetsound.noaa.gov/important) and figure 4.5(b) from Calambokidis et al, 2015, the humpback whale Stonewall and Heceta Bank feeding BIA encompasses the proposed Project area and extends to a large area to the west and southwest of the proposed Project area. Individual whales remain loyal to preferred feeding areas and may frequently use or transit through the Project area to access the Stonewall and Heceta Banks BIA. The applicant should add this information to their analysis and should provide a map with BIA spatial data overlaid by all marine Project components (e.g. cable corridor, WEC deployment area, vessel transit corridor, etc.).	OSU added this information to the analysis to Section 3.3.3 Aquatic Resources of the APEA.
ODFW 53	82	*Western snowy plover*: As reported by the applicant in their PDEA and appendices, western snowy plover nesting was observed in 2017 to the north and south of the Driftwood. The applicant should also consider in their analysis that western snowy plover nesting was observed during the past two breeding seasons (2017-2018) on the beach immediately adjacent to and in close proximity to Driftwood. OSU also reports that no	OSU added this information to Section 3.3.5 (Threatened and Endangered Species; Western Snowy Plover) in the APEA.

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		plovers were reported during winter surveys conducted at South Beach State Park in 1991-1994, 2001-2003, and in 2007. However, updated survey reports indicate that plovers have been documented on the central coast during winter window surveys coordinated by USFWS, including at South Beach State park during multiple recent years (USFWS, 2018).	
ODFW 54	82	The applicant proposes to conduct multiple HDDs from Driftwood under the beach and if HDD activity is initiated within the western snowy plover nesting season, nest surveys and noise monitoring will be conducted. The applicant considers noise significant if it increases from background by more than 10dBA, and considers the anticipated HDD noise level within potential snowy plover habitat unlikely to exceed this value. The applicant should explain how they reached this conclusion, while their analysis also includes that surf noise is approximately 60 dBA and HDD is approximately 92dBA at 50' and 76 dBA at 300'. Noise predictions for HDD in potential habitat already exceeds 60 + 10 = 70 dBA levels of what might be considered significant according to the applicant's analysis.	76 dBA at 300 feet was predicted from HDD at plover habitat. The 60 dBA figure is from a published measurement of 0.4 m surf (Bolin and Åbom 2010), a surf height substantially lower than what we expect at the Project site (see below, and the original analysis for further details). Furthermore, multiple factors combine to reduce HDD noise at plover habitat and increase background noise above the undeflected/masked baseline of 70 dBA: The following factors reduce HDD noise at plover habitat • distance (accounts for reduction from 92 dBA at 50 feet to 76 dBA at 300 feet, with further reductions with greater distance from source) • elevation (40 feet, difference between source and plover habitat, see Harmelink and Hajek 1973) • deflection (dune vegetation, see Huddart 1990, van Renterghem et al. 2012, 2015) • absorption (dune vegetation, see Fang and Ling 2003) • acoustic shadows (temperature differential between the ground and near-ground atmosphere during the time of day that drilling would occur, see West et al. 1989) The following factors increase background noise above a baseline surf (1 m height) estimate of 70 dBA:

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			• surf greater than 1 m height (average annual wave height at PMEC-NETS estimated at 2.0 m, surf-generated noise scales roughly with the square of the wave height (Deane 2000); see also Bolin and Åbom 2010, Tollefsen and Byrne 2011; and data from NDBC, Station 46098; also Bascom 1986) • wind speed, local average nearly 10 knots, see Wenz 1962 • wind direction, prevailing winds are onshore, see Tanaka and Shiraishi 2008, Oshima and Li 2013 These factors contribute to reducing the HDD noise at the location western snowy plovers may be nesting, and in combination lead to the conclusion that the drilling will not add 10+ dBA above background. Regarding nesting surveys, as stated in the DLA: If HDD is initiated within the western snowy plover nesting season (March 15 to September 15), prior to operation of the HDD, surveys of suitable nesting habitat will be conducted. If nests are detected, measures specified in the BBCS will be implemented, including noise monitoring and implementation of engineering controls, if appropriate (e.g., install temporary noise barriers such as berms, stockpiles, dumpsters, bins, and/or engineered acoustical barriers).
ODFW 55	83	Based on review of the DLA application package, including the PDEA and appendices, ODFW is uncertain what level of public access is proposed to occur at Driftwood, and is concerned that beach and dune habitat within the park may be negatively affected if public use is not addressed appropriately. The applicant should clarify if public beach access and parking will be maintained during construction (see PDEA page 3-168 & PM&E 17), or significantly restricted (see PDEA page	OSU will work with OPRD to develop a plan to mitigate impacts to public access and use of Driftwood Beach State Recreation Site. The agreement will include agreed measures to minimize and mitigate for reductions in public access and will include protocols for coordination with OPRD prior to, during and following each phase of construction: 1. The planned start date for construction (Phase I – HDD operations and beach manhole and conduit installation) at Driftwood Beach State Recreation Site is planned for spring

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		3-171), or if the public beach access, restrooms, parking, and picnic facilities would be closed during construction (see PDEA appendix A page 5-65). ODFW anticipates that this issue will be addressed by the applicant in consultation with OPRD, but recommends that the analysis clarify the anticipated level of public access so we may determine habitat concerns, if any.	of 2020. This phase of the Project would last approximately 6-7 months. A second phase (Phase II – cable pull and in-water construction) would likely occur in spring of 2021 and would last approximately 45-60 days. 2. It is anticipated the Driftwood Beach State Recreation Site would need to be closed to vehicular traffic for both Phase I and Phase II. It is possible there could be an option for limited pedestrian access, but OSU would work with OPRD to determine access feasibility and to ensure public safety. 3. In addition to construction fencing, OSU proposes to use signage to inform the public that access to Driftwood Beach State Recreation Site will be affected during the construction phases. Prior to construction, notifications about the work would be posted at the site to alert users. If possible, notice of the construction activities would be posted on the OPRD website. 4. OSU would arrange the construction work area to maintain pedestrian public beach access during construction, to the extent safe and practicable and with concurrence of OPRD. OSU would work with OPRD to identify any additional, practicable steps that can be taken to mitigate impacts to public access and use of Driftwood Beach State Recreation Site. 5. Upon completion of construction work, all disturbed facilities would be returned to original or better condition, including grading and repaving of the parking lot and any disturbed sections of the entrance road. It should be noted that there are six Oregon Parks and Recreation Department facilities offering beach access, parking and restrooms within a ten mile radius of the Driftwood Beach State

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			Recreation Site, including: Seal Rock (2.3 miles north); Governor Patterson (4.1 miles south); Brian Booth/Ona Beach (4.3 miles north); Lost Creek (6.0 miles north); Beachside (6.3 miles south); and South Beach (9.9 miles north).
ODFW 56	83	In the draft HMP included as PDEA Appendix K, the applicant has included that "all heavy duty equipment activities in the Driftwood parking lot will occur at least 164 feet (50 m) from any potentially suitable habitat for western snowy plover, consistent with the Habitat Conservation Plan (HCP)". Prior to submittal of the DLA package, ODFW worked with the applicant to develop the HMP and had agreed to including a HCP mitigation measure establishing a buffer of 50 m for all activities, not only heavy duty equipment (ICF International, 2010). The applicant should revise the HMP to be consistent with protection measures established by the HCP and agreed to by ODFW.	The HMP states that "[a]ll activities in the Driftwood parking lot will occur at least 164 feet (50 meters) from any potentially suitable [beach] habitat [for western snowy plovers]." This commitment aligns with the Habitat Mitigation Plan.
ODFW 57	84	*Marbled murrelets*: ... The applicant should clarify that individual birds were observed during the site characterization survey to the west, north, and east of the Project area so it is reasonable to assume they could also occur within the PMEC-SETS boundary. The applicant should issue a correction throughout application documents that, following the OFWC June 7 2018 decision declining to uplist marbled murrelets, the species will remain listed as threatened by Oregon ESA.	The FLA documents were amended to include observations in Section 3.5.1 (Marbled Murrelet) of the Draft BA, and Section 3.3.5.1 (Marbled Murrelet) of the APEA.
ODFW 58	84	*Short-tailed albatross*: The Habitat Characterization Report, included as PDEA Appendix C, states the short-tailed albatross is listed as threatened by the State of Oregon, but should say endangered.	This change has been made on page 18 in the Habitat Characterization Report (Appendix C).
ODFW 59	85	Preliminary Comment 11: Onshore Habitat Survey	While the Applicant recognizes the hoary elfin butterfly is a "strategy species" in the Oregon Conservation Strategy, the

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		To determine if conservation actions are appropriate, the applicant should contract a specialist to assess and possibly survey kinnikinnick patches delineated within the Project area but outside of Driftwood to determine if habitat is suitable for, or occupied by, the seaside hoary elfin. Surveys should be conducted by experts, in the appropriate season, and preferably in accordance with procedures used on OPRD property (Ross, 2005).	Applicant does not have a statutory or regulatory obligation to take any specific actions regarding the butterfly. The butterfly prefers kinnikinnick, which is located in the Project Area, and as appropriate, the HMP addresses kinnikinnick as a component of identified habitat areas. As noted in the PDEA and Protection, Mitigation and Enhancement (PM&E) measures (Appendix I), OSU has committed to avoiding, to the extent practicable, disturbance of seaside hoary elfin butterfly habitat within and in the vicinity of Driftwood Beach State Recreation Site. Where unavoidable, disturbance to kinnikinnick outside of Driftwood Beach State Recreation Site, but within the construction footprint will be mitigated, as described in the Habitat Mitigation Plan.
ODFW 60	86	Preliminary Comment 12: Wetlands and Waterbodies ... The applicant should bore under sensitive wetlands surrounding fish-bearing streams to avoid disturbance, or if boring is not technically feasible, should consult ODFW regarding fish salvage and IWWW (see 10(j) recommendation 6).	As stated in Exhibit A, Section 1.4.3 (Terrestrial cables) of the FLA and elsewhere in the FLA documents, the terrestrial cable would no longer be buried next to Hwy 101, but would now be installed using HDD. The use of HDD is a BMP that would avoid impacts to surface streams.
ODFW 61	87	... Consistent with the final order of the Lincoln County Planning Commission for the Conditional Use Permit, the applicant should obtain a NPDES 1200-C construction stormwater permit from the Oregon Department of Environmental Quality (ODEQ; Lincoln County Planning Commission, 2018) if more than one acre of land is disturbed including temporary work areas.	OSU will obtain the necessary permits as dictated by the Conditional Use Permit.
ODFW 62	87	Also, the applicant should implement a method of post-construction stormwater management that complies with ODEQ requirements (Lincoln County Planning Commission, 2018) described in the Section 401 Water Quality Certification Post-Construction Stormwater	OSU will develop a plan that complies with ODEQ requirements prior to construction.

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		Management Plan Submission Guidelines (ODEQ, 2016).The applicant should provide a plan for stormwater management with their environmental analysis so that ODFW may determine if concerns for onsite and adjacent wetland, stream, and upland habitats are adequately addressed. The analysis should clearly describe how natural drainage will be restored and recharge of on-site wetlands will be accomplished.	
ODFW 63	87	If the applicant needs a Section 404 removal/fill permit from the US Corp of Engineers, the applicant should meet all Federal and State water quality standards required by the Clean Water Act in accordance with the water quality certification issued by the ODEQ under section 401 of the Clean Water Act, which requires post-construction stormwater plans.	OSU will comply with all Federal and State water quality standards required by the Clean Water Act.
ODFW 64	88	Preliminary Comment 13: Cumulative Effects Analysis According to PDEA section 3.2.1, the geographic scope of the analysis for cumulatively affected resources encompasses onshore facilities, the subsea cable area from shore to the edge of the territorial sea, and the offshore facility site. The applicant should add the subsea cable from the western edge of the territorial sea to the offshore facility site, as well as a discussion of any onshore developments (e.g. utility lines, culverts, residential, road improvements) with the potential to have cumulative effects.	The geographic scope has been revised to include the subsea cable from the western edge of the territorial sea to the offshore facility site. It includes the Driftwood Beach State Recreation Site the terrestrial HDD cable route and the UCMF location, which encompasses the area to be affected by onshore development.
ODFW 65	88	... Any use of NETS data as a proxy for PMEC-SETS should be accompanied by acknowledgment in the differences in site depth, nearby bathymetry (shoreline, headland, reefs), and proximity to shore, as well as the distance between the sites.	This acknowledgment is provided in the PDEA.

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ODFW 66	88	... The applicant should clarify what studies have been performed at NETS since equipment removal on November 6, 2015.	One box core survey was conducted at PMEC-NETS in April 2016.
ODFW 67	89	... The applicant should clarify the status of Camp Rilea as of the time of PMEC-SETS filing.	The APEA has been revised to provide this clarification.
ODFW 68	89	Preliminary Comment 14: Schedule to Develop and Implement Project Plans The applicant intends to develop and implement several plans not provided as part of the DLA, PDEA or appendices (e.g. HDD contingency plans, construction plans, revegetation plans, restoration plans, erosion control plans, others). The applicant should propose a schedule for development and implementation of these plans, so that ODFW can anticipate when information contained in these plans will be made available to support determination of potential impacts on fish and wildlife and habitat.	OSU will develop an HDD contingency plans, construction plans, revegetation plans, restoration plans, and erosion control plans prior to construction.
National Marine Fisheries Service (9/10/18 - Additional comments on the Draft BA)			
NMFS 1		What is the range in diameters for mooring lines?	As specified in the DLA documents the specific anchors and mooring configurations at PacWave South would depend on the particular WECs deployed. Mooring lines and umbilical cables would be under tension and would not form loops.
NMFS 2		Under Mitigation Measure #6 for DPV activity • should be plural for thresholds and should include harassment level • In NMFS preliminary 10(j)s, safety/exclusion zone has been changed to acoustic zone of influence. • remove shut down procedures since they are not being proposed and would not be practicable. • Start-up typically includes 30 minutes of pre-clearance of marine mammals not 15 minutes. This has been changed in NMFS preliminary 10(j)s based on headquarters comments.	The following changes have been made to Mitigation Measure #6 in Appendix I (Protection, Mitigation and Enhancement Measures) and throughout the license application: • Removed “threshold(s)” and replaced with “thresholds” and included the 120 dB harassment threshold. The harassment threshold of 120dB was also included in PM&E measure #7. • Changed the phrases “safety/exclusion zone” to “acoustic zone of influence” • Removed shut down/power down procedures

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		• In the BA, there is no mention of ramping up procedures and sound thresholds during that period. • In NMFS preliminary 10(j)s, under bullet #2, instead of "the licensee, with consultation with NMFS, will establish and carry out the following actions", this has been changed to "the licensee, with technical assistance from NMFS, will establish and carry out the following actions".	• Changed timing for start-up to 30 minutes rather than 15 minutes • Changed language of bullet #2 to "with technical assistance". This language was also incorporated in PM&E measure #7. Additionally, the ramping up procedures and sound thresholds were added to Section 2.4 (Proposed Environmental Measures) of the BA.
NMFS 3		Trenching surface waters: • If trenching to install the terrestrial power cable near surface streams, how much vegetation is being cleared? Will the area be revegetated?	As stated in Exhibit A, Section 1.4.3 (Terrestrial cables) of the FLA and throughout the FLA documents, the terrestrial cable would no longer be buried next to the road, but would now be installed using HDD. The use of HDD is a BMP that would avoid impacts associated with clearing. In the DLA and PDEA, OSU proposed to develop a revegetation plan using native species to the extent possible for areas disturbed during construction.
NMFS 4	2-27	Suction Piles: • 2-27: the sound being generated from suction piles is not described even though it states it is described in Section 5.2.1.	OSU added additional sound analysis for suction anchors in Section 3.3.3.2 of the APEA. The referenced Section 5.2.1 was revised to state Section 3.3.3.2 in the APEA.
NMFS 5		Cable Route: Does the 2 square nautical mile cable route include the cable corridor?	Yes.
NMFS 6	5-6	Suspended Sediment: • 5-6: "suspended sediment resulting from cable laying, subsea connector installation, and anchor installation/removal is expected to last for minutes or tens of minutes." Please clarify what tens of minutes means in this context.	This text summarized the full analysis, which was contained on p. 3-26 of the PDEA and stated: "Rough estimates of the settling velocity of grain sizes in the 200-600 µm diameter size range, the grain sizes at the (PacWave South) site, are 2.5 cm/s for 200 µm diameters and 8.5 cm/s for 600 µm diameters (Hallermeier 1981, Van Rijn 1984, both from Soulsby 1997). These are slightly conservative as they are based on ideal conditions where there is no water current or additional turbulence from construction activity or hindered settling. However, for a practical example, if these sediment grains were suspended 10 m into the water

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			column as a result of the construction activities, it would take the 200 µm and 600 µm sediments approximately 6.5 minutes and 2 minutes to settle out of suspension, respectively, given the settling velocities above." The settling velocities would be affected by ambient current speeds, the range of particle sizes that will be resuspended, and any impacts of hindered settling, these settling estimates may vary, but are anticipated to remain on the order of a factor of 1-3 times the zero-flow settling velocities (i.e., less than 20 minutes).
NMFS 7		Fish Salvage: • Where is fish salvage occurring and how large of an area is being isolated? What method is being used to isolate. How long will isolation occur? Will a bypass pipe be installed? When will isolation occur?	As stated in Exhibit A, Section 1.4.3 (Terrestrial Cables) of the FLA and elsewhere in the FLA documents, the terrestrial cable would no longer be buried next to the road, but would now be installed using HDD. The use of HDD is a BMP that would avoid impacts to surface streams
NMFS 8		Stormwater from increased impervious surface is not included or analyzed as an impact to fish in surface streams.	There would be no increase in impervious surface area other than the UCMF, access road, and parking area. OSU would develop an appropriate stormwater plan, that complies with ODEQ requirements, during site design of the UCMF and associated facilities prior to any construction activities at the site, thereby mitigating impacts.
NMFS 9	5-44	Acoustics: 5-44: To model WEC sound using a conservative source term of 151dB re: 1 µPa at 1 m, assuming a radius of 125 m would represent approximately 12 acres surrounded each WEC, in which noise would exceed 120dB. In the PME's the radius is described as 100m. Please clarify this.	As noted in the comment, in Section 5.1.2 of the Draft BA analysis, per NMFS's request, a conservative source term of 151 dB re: 1 µPa at 1 m was used. Implementing NMFS practical spreading model with the highest WEC sound source, sound levels would attenuate to 120 dB re: 1 µPa at 125 m. However, during the development of the acoustics monitoring plan (Appendix H), NMFS indicated that 117 m was the appropriate distance for measuring sound based on their estimate of area affected from a sound source of 151 dB re: 1 µPa at 1 m. The 100 meter radius referenced in the PM&E measures was the distance that the CWG determined was appropriate based on a more conservative level of affected area due to sound

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			exceedance, e.g., a smaller area where sound levels would be exceeded so more protective of marine resources, and more practical to measure.
NMFS 10		Acoustics • It would be helpful if the Project team included a Figure to visualize the size of WEC with the 12 acre acoustic zone of influence around each WEC, the Project coordinates, and the biological important areas (BIAs) for Humpback and Gray whales. If the zone of influence is that large, I would like to see how close that acoustic signature is to BIAs.	This figure was included in the revised Draft BA (Appendix of the APEA).
NMFS 11		11. Action Area • How was it determined that 3 m around each subsea cable was the furthest distance that sediment and benthic changes from installation are expected to be measurable?	A distance of 3 m around each subsea cable is the furthest distance that any physical disturbance to the sediment would be expected. Approximately 70 to 80 percent of the disturbed sediment, depending on the particle-size composition, would be expected to remain in the trench under limited water movement conditions, with 20 to 30 percent of suspended sediment traveling outside the footprint of the area directly impacted by the cable plow (DOE 2014). The majority of sediment disturbance is expected to occur in or adjacent to the trench, and, as noted in the Draft BA and PDEA, only represent trace amounts further from the trench. Therefore, OSU selected 3 meters from each subsea cable as the furthest distance from the cables that physical disturbance of the sediment would be likely to occur, and within which benthic changes from installation are expected to be measurable.
NMFS 12		Auxiliary Cable: In the Navigational Safety Risk Assessment report (p. 516) and page 32 of the BA, the following statement is made "The auxiliary cable will increase the monitoring capabilities at PMEC-SETS. Such cable connections allow for extended deployments of instruments with high data bandwidths or power requirements."	OSU has proposed a study plan that includes monitoring using Remote Operated Video (ROV) to evaluate derelict gear, and organisms associated with WECs and their moorings. The ROV monitoring requires reasonable water visibility and that the camera is within relatively close proximity to the moorings, WECs and anchors. The termination of the auxiliary cable, or "instrumentation node", will be remote from the WEC

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		In the past there have been conversations on the use of underwater video monitoring to detect species presence and detect if any derelict gear has accrued. The reason to not use underwater video monitoring was because of the amount of data that it collects and no way to store that amount of data. If the auxiliary cable increases monitoring capabilities in real-time and is connected to the on-shore UCMF, then please explain why underwater video monitoring is not feasible.	deployment areas (potentially several hundred feet away). Therefore, fixed video monitoring is not a feasible option to detect species presence or detect whether any derelict gear has accumulated.
NMFS 13		Under Mitigation Measure # 7: mitigation for impacts of sound from WECs and their mooring systems on marine resources. Prior to deployment, can the test client submit a draft plan to be approved by NMFS on mitigation actions that will be carried out if persistent sound not associated with High Seas State has not been abated after 74 days (60 days of diagnose and repairs, 14 days of monitoring after repair)? This could cut down the time it takes to carry out a mitigation action on a WEC that is exceeding sound thresholds.	In the PM&Es (Appendix I of PDEA), OSU included measures to minimize and mitigate for WECs and their mooring systems that produce sound in excess of NMFS's published harassment threshold. Such sounds are not anticipated, but if they occurred, could be the result of unanticipated equipment noise during high seas states. It is not feasible for WEC clients to develop mitigation actions prior to diagnosing the specific cause of any such exceedance, because such diagnosis is a necessary step in developing a draft plan to address the unanticipated noise.
NMFS 14		Anticipated scour depth disturbance from anchors: 5-8 in BA: "As a representative calculation, for a 10 m diameter gravity base anchor at the PMEC-SETS, this would amount to 0.64 m equilibrium scour depth at the upstream side of the anchor and up to 0.28 m of accretion in lee of the structure. Field observations of scour in sandy sediment have been reported at 0.5 to 1.0 m for a 10.5 m diameter obstruction (Bishop 1980, from Whitehouse 1998). A second calculation was made using the methods of Sumer and Fredsoe (2002); assuming a water depth of 60 m, a wave height of 10 m, a wave period of 15 second and a 10 m diameter	As indicated in Table 2-1 of the Draft BA, the maximum anchor size evaluated was 34-foot diameter gravity anchors (908 ft^2) per anchor, not a 34 *square foot* diameter, as stated in NMFS's comment. A 34-foot diameter is equal to 10.4 meters and is consistent with the referenced observations (Bishop 1980, from Whitehouse 1998). Application of the methods of Sumer and Fredsoe (2002), also estimated the maximum scour depth would be approximately 1 m, assuming a water depth of 60 m, a wave height of 10 m, a wave period of 15 second, and a 10 m diameter anchor.

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		anchor, the maximum scour depth was estimated at 1 m." • How do you think there will only be anticipated scour depths up to 1m when Sumer and Fredsoe found a 10.5 m in diameter obstruction created a max scour depth of 1 m. PMEC SETS is proposing a maximum size of a 34 sf diameter anchor. Please explain rationale further on the anticipated maximum scour depth of 1m.	
NMFS 15		Ballast intake size: 5-18 of BA: "One example is the Azura (formally WET-NZ) WEC that has deployed at PMEC-NETS and is currently deployed at the Navy Wave Energy Test Site (WETS) in Hawaii. Although not full scale, nor commercial in size, it can offer context for this issue." The BA goes into detail on how much water the ballast tank needs for Azura and the size of the ball valves. However, this is still not full scale. Is it possible to provide a ratio for Azura to extrapolate and determine a more accurate expected amount of water required and the size of the ballast tank opening for a full scale WEC?	The ratio to full scale is unknown for the Azura or any potential WEC client. This is due to the fact very few full-scale devices have been designed and constructed worldwide.
NMFS 16		Vegetation Removal for cable construction: 5-40 of BA: riparian vegetation will be removed for the 20-foot construction right-of-way. How much, what type of vegetation? Any trees? A revegetation plan will include a comprehensive monitoring plan, I have asked for this in our 10(j)s.	As stated in Exhibit A, Section 1.4.3 (Terrestrial Cables) of the FLA and throughout the FLA documents, the terrestrial cable would no longer be buried alongside Highway 101, but would now be installed from the Driftwood Beach State Recreation Site to the UCMF site using HDD, and from the UCMF to the CLPUD grid connection. The use of HDD represents a BMP to minimize and avoid impacts to the terrestrial environment, including wetlands, streams, and other habitat.

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			OSU will include the minimization measures identified by NMFS and ODFW in development of the revegetation/restoration plan, which would be developed in consultation with NMFS, ODFW, and appropriate agencies. OSU plans to develop the plan 6 to 12 months prior to start of Project construction.
NMFS 17		Acoustic Monitoring Plan: Page 2 Section 1.2: "The sound pressure level (SPL) for Columbia Power Technologies' 1/7-scale WEC was estimated at 151 dB re: 1 µPa at 1 m and 126 dB re: 1 µPa at 10 m (Basset et al. 2011). In the EA prepared for the Hawaii Wave Energy Test Site, engineers conservatively assumed that a full-sized WEC would be 3-6 dB louder than the 1/7 scale version, and estimated that the maximum SPL for a WEC would be 148-151 dB re: 1 µPa at 1 m and 129-132 dB re: 1 µPa at 10 m (NAVFAC 2014). If a full-size WEC is 3-6dB louder than the 1/7 scale WEC estimated at 151dB, then wouldn't the full scale WEC be 154-157 dB? Page 3 Section 4.1: Will the recording equipment be calibrated? How sensitive are the hydrophones in dB re 1 V/microPa?	In the DLA, the Draft BA indicated estimates of the Columbia Power Technologies' 1/7-scale WEC; however, there are data of actual measurements (Bassett et al. 2011) indicating that "Received sound pressure levels attributed to the WEC cycle from 116 to 126 dB re 1 µPa in the integrated bands from 60 Hz to 20 kHz at distances from 10 to 1500 m from the SeaRay." The same paper indicates "Masking by ship noise prevents rigorous extrapolation to estimate the WEC source level at the conventional 1 m reference." The WETS EA indicated that "Thomson et al. (2012) provide the spectrum of 1/7 scale WEC device in Puget Sound. The report shows sound energy peaks at 20, 100, 300, 700, and 1500 Hz. They reported a level of 126 db re: 1 µPa at 10 m from the device they measured. At close distances, such as 10 m, spherical spreading loss would be the more appropriate model of sound transmission loss, and is more conservative about the estimating the SPL. That is, in this case, it estimates the SPL at 1 m to be higher than using practical spreading loss. Using this approach, the SPL of the WEC device recorded by Thomson et al (2012) is estimated to be 145 dB re: 1 µPa at 1 m. The SPLs from the WEC systems are dependent on the conditions in which they are operating. Although no recordings of the sound of operation have been analyzed for the WEC devices for the deep water WETS, the maximum SPL is expected to be between 148 and 151 dB re: 1 µPa at 1m from the device. This judgment is based on the SPL that Thomson et al. (2012) report for their smaller scale device and adding 3 to 6 dB to the SPL

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			based on engineers' best judgment about the noise that will be generated by a device that is larger than the one assessed in Thomson et al." In response to hydrophone sensitivity, the hydrophone sensors for the Project have not yet been decided on yet. Possible sensors OSU has used and that are on the list for consideration include: a) HTI 92-WB -180 dB re 1V/uPa b) ITC1032 -194 dB re 1V/uPa c) icListen HF -170 dB re 1V/uPa Despite the range in sensitivities, OSU controls the dynamic range through a pre-amplifier gain stage in our systems.
NMFS 18		Eastern Pacific Right Whale- Endangered.: I have added this as a species that should be included as an affected marine resource. See NMFS preliminary 10(j)s for detailed information.	OSU added information regarding the North Pacific right whale in the APEA and Draft BA.
NMFS 19		Mitigation Measure # 12 Water Resources: • The BA states that the test clients will use commercial dockage that has been designed, permitted, and used for dockage. In NMFS preliminary 10(j)s I have added a bullet that reflects what is stated in the BA "*The licensee should restrict in-water moorage to existing permitted facilities where increased suspended sediment or direct shading will not affect sensitive eelgrass habitat within or adjacent to the permitted facility.*"	OSU would require test clients to use commercial dockage that has been designed, permitted, or used for dockage.
Natural Resource Defense Council, et al. (7/23/18)			
NRDC 1		The Project is a hub for national development of wave energy devices, is an academic research Project, and OSU has rushed the Project through a streamlined pilot Project process.	The Natural Resource Defense Council, et al. (hereinafter "NRDC") letter includes numerous significant errors in describing the proposed Project, and together these errors undermine NRDC's overall position and request for additional information

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			and study. First and foremost, the letter states: "The overall Project, as drafted, proposes various test locations along the coastline that would be the 'hubs' for the national development of wave energy devices." (p.3). In fact, the Project as proposed is a four-berth wave energy *test facility* that will not include additional locations and that will not serve as a "hub" for additional commercial energy Projects. The Project will allow owners of wave energy devices to test those devices in the Pacific Ocean for limited periods of time, and nothing more. The balance of NRDC's concerns regarding the Project should be viewed in light of the fundamental misunderstanding of the Project. In addition, NRDC refers to the Project in several places as a "research" or "academic" Project (pp. 3, 9). There is no question that, as a university, OSU has research facilities and has called on some of those resources to develop and implement the proposed Project. The proposed Project, however, is not a "research" or "academic" Project. OSU is proposing to obtain a FERC license to allow wave energy device developers to deploy and monitor the energy generated by those devices, and to transmit any energy that is generated to the grid. OSU is subject to the same licensing and permitting standards under the Federal Power Act and federal and state environmental statutes that a commercial development might be. While monitoring will be conducted to confirm that the Project's impacts are as anticipated, and that monitoring is expected to generate helpful environmental data, generating those data is not the purpose of the Project. NRDC's requests for additional Project-related research to buttress what NRDC believes is an academic research program should therefore be dismissed. Finally, OSU disagrees with NRDC's statement that the process was "rushed" because of OSU's desire to "move quickly." (pp. 1,

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			8). NRDC also mistakenly states that OSU pursued the “streamlined” permitting standards of a “pilot” Project (p. 9). In fact, OSU has undertaken a licensing approach that utilized FERC’s Alternative Licensing Process (ALP), which is a full regulatory process, not FERC’s pilot Project licensing process. This error demonstrates NRDC’s misunderstanding of the thoughtful, collaborative, stepwise approach that OSU has undertaken since 2013 to identify potential resource concerns and work diligently over the past five and a half years with agencies and stakeholders to determine the best approach to avoid, minimize, mitigate and monitor for those concerns – *all before an application has even been filed with FERC*. OSU has put significant time and effort into ensuring that every stakeholder voice has been heard and every impact has been considered and thoughtfully addressed.
NRDC 2	2, 7	PMEC-SETS must comply with the ESA, the CZMA, and the MMPA with regard to any impacts to SRKW and other protected species. In addition, FERC and OSU are obligated to ensure that the proposed activities are in compliance with all relevant state and local law, including the Oregon Coastal Management Plan.	OSU agrees that the Project must comply with the ESA, Coastal Zone Management Act (CZMA) and MMPA and relevant and applicable state and local law, and OSU has worked collaboratively with federal and state resource agencies over the past five and a half years to incorporate mitigation measures into its licensing proposal to meet or exceed those regulatory requirements. OSU has prepared a Draft BA for FERC’s use in consulting with NMFS and USFWS pursuant to ESA Section 7, which was included as Appendix A to the PDEA. In addition, OSU consulted with NMFS’s marine mammal permitting staff regarding whether specific phases of Project construction and operation would require authorizations under the MMPA. Subsequently, NMFS issued the letter attached as Appendix N to the FLA which concludes that neither construction nor operation of the Project is expected to result in take of marine mammals and that no IHA is therefore required. In addition, OSU has or is in the process of applying for various state authorizations, including the Clean Water Act 401 water quality certification and state

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			coastal zone consistency determination, among other things. A full list of applicable permits was provided in the DLA.
NRDC 3	2-3	FERC and OSU should take steps to ensure the proposed Project does not harm the SRKW, critical ecosystems and marine resources that sustain the state's livelihoods and economy. The Oregon Territorial Sea Plan requires all federal and state agencies to assess the reasonably foreseeable adverse effects of proposed actions that may affect the marine environment.	OSU has consulted extensively with NMFS, the federal agency with expertise and regulatory authority regarding Southern Resident killer whales (SRKW) and other marine mammals, in developing Project plans including monitoring programs and steps that will be taken should the Project have an impact that is not anticipated based on the thorough analysis conducted to date. More specifically, the Project includes design components to protect against adverse impacts to marine mammals including requirements related to mooring lines, as well as extensive measures to ensure that the Project does not have adverse impacts to marine mammals from sound generated during construction or operation, or from fishing gear that might be entangled with Project components. OSU prepared a Draft BA (Appendix A of the DLA) and the Project will be the subject of an Endangered Species Act Section 7 consultation between FERC and NMFS. In addition, as noted above, OSU has initiated discussions with NMFS regional and marine mammal staff to determine whether specific phases of Project construction and operation will require authorizations under the MMPA, and OSU has committed in the FLA to comply with any mitigation measures imposed by NMFS pursuant to any MMPA authorization.
NRDC 4	2, 8-9	OSU should implement intensive pre-approval site assessments modeled on international standards with a special focus on marine mammals, salmon, forage fish, and birds; post-licensing monitoring is not sufficient.	OSU has undertaken significant pre-approval site assessment studies, all of which were summarized in Appendix D of the DLA, including: 1) Benthic substrate and invertebrates, including 8 surveys conducted from August 2013 to June 2015; 2) Crab surveys, including 8 surveys from September 2013 to June 2015; 3) Marine mammals surveys, including 35 separate boat-based surveys from October 2013 to September 2015;

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			4) Seabird studies, including 44 strip transect surveys from May 2013 to October 2015; and 5) Acoustic studies, including an autonomous underwater hydrophone deployment at SETS from June to November 10, 2015. As noted in the PDEA, studies were also conducted at nearby PacWave North (referred to as PMEC-NETS in PDEA) (6.7 nm to the northwest) between 2010 and 2016, including fish/beam trawls, sediment and macrofauna, video, and bird and marine mammal observations. Additionally, OSU researched green sturgeon using lines of acoustic telemetry receivers at PMEC-SETS and PMEC-NETS between October 2015-January 2016, and April-October 2016. Collectively, the pre-application studies conducted above, together with analysis of literature and consultation with federal and state resource agencies and other stakeholders (none of whom have requested additional site assessment studies), comprised the foundation of the FLA's proposed Project design and PM&E measures. No additional site assessments are necessary or warranted.
NRDC 5	2, 4-5	OSU should conduct and analyze three years of monthly boat-based and aerial surveys of the SRKW and other imperiled marine species to establish a comprehensive data-rich baseline.	OSU followed BOEM's guidelines for site characterization, which recommend two annual cycles, conducting 35 separate boat-based, standard-line transect surveys marine mammal surveys from October 2013 to September 2015, during which time a total of 4 killer whales were observed (Henkel et al. 2016). In addition, killer whale vocalizations were detected on four different occasions in April and May 2014 by an acoustic lander deployed inshore of the WEC deployment area (Haxel 2016). OSU analyzed these data along with other acoustic surveys conducted by NMFS (Hansen et al. 2013) and aerial surveys and boat-based observation surveys conducted by BOEM (Adams et al. 2016) to

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			characterize SRKW in the Project area. On the basis of this baseline data, the PDEA (Section 3.3.5) and Draft BA (Section 3.3.1) concluded that killer whales could occur in the WEC deployment area, but likely in small numbers and at low frequency. Nevertheless, as explained above, the DLA included extensive monitoring and mitigation to ensure that the Project does not adversely impact marine mammals, including SRKW. These measures were developed in collaboration with federal and state resource agencies, including NMFS, over the past five and a half years. NMFS did not request additional studies to inform licensing or NMFS's analysis under the ESA or MMPA. Moreover, NMFS issued the letter attached as Appendix N to the FLA which concludes that neither construction nor operation of the Project is expected to result in take of marine mammals and that no IHA is therefore required. For these reasons, no additional survey work is warranted or reasonable.
NRDC 6	2, 8	OSU should incorporate the petitioned critical habitat expansion of the SRKW into site assessments and undertake thorough cumulative impacts analysis regarding ocean noise, entanglement, entrainment, and other disruptions to marine mammal foraging and migration patterns. Due to the sensitivity of the SRKW to marine noise, it is essential to calculate total noise to the whale along its entire range.	As NRDC acknowledges, critical habitat for SRKW has not been designated or proposed by NMFS in the vicinity of the proposed Project. Without such a rule, there is no regulatory description of the specific habitat functions and characteristics that a designation would be designed to protect, and it is not possible to conduct the specific critical habitat analysis suggested by NRDC. Nevertheless, as noted above, OSU and its partners in the CWG have thoroughly considered potential habitat-related impacts to marine mammals, including SRKW. OSU's Draft BA evaluates potential impacts to SRKW and other ESA-listed marine mammals in detail (Appendix A of the DLA), and includes the required analysis of potential cumulative impacts to ESA-listed species. Calculating the "total noise" that SRKW experience throughout their "entire range" would not assist FERC, federal and state resource agencies or the public in evaluating this proposed Project's potential impact on SRKW, nor is such a study technically feasible or related to the proposed Project. The DLA

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			included measures specifically designed to avoid, minimize, mitigate and monitor for possible impacts to marine mammals, particularly noise, to ensure that, as anticipated, the Project will have no adverse impact on SRKW or other cetaceans. These monitoring and mitigation measures were developed in close collaboration with NMFS and other resource agencies and are consistent with the most recent NMFS guidance regarding marine mammal acoustic thresholds.
NRDC 7	2	OSU should consult with marine scientists and experts to identify and integrate the most up-to-date survey data and modeling on predictive habitat and climate-induced shifts.	The CWG includes representatives from each of the federal and state fish, wildlife, coastal zone and water quality agencies, each of whom brought in agency technical experts as needed during the CWG's collaborative process. OSU consulted extensively with these technical experts over the past five and a half years through meetings, phone calls, and exchange of data and information. Based on recent findings, SRKW fecundity is highly correlated with the abundance of Chinook salmon, in particular the stocks from Fraser River, Puget Sound, and the Columbia River (Ward et al. 2009, Ford et al. 2016, Hansen et al. 2010, NOAA and WDFW 2018). Climate change is Projected to cause a decline in Chinook abundance (Munoz et al. 2014, Lacy et al. 2017). Viability models suggest that prey limitation is the most important factor affecting population growth for SRKW, and that in order to meet recovery targets through prey management, Chinook salmon abundance would have to be sustained near the highest levels since the 1970s (Lacy et al. 2017). PacWave South is not anticipated to have any effect to these important prey stocks for SRKW, and the APEA and BA have been revised to include this language on climate change.
NRDC 8	2	OSU should prioritize research programs based on the highest level of precautionary protections for SRKW and other marine mammals in accordance with Oregon's state planning Goal 19.	As noted above, the proposed Project is not an academic research Project. Rather, the purpose of this Project is to allow the testing of wave energy devices and the delivery of energy produced to the grid. Nevertheless, OSU shares NRDC's interest in

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			ensuring that the Project includes the highest level of protections for SRKW and other sensitive species. In fact, the DLA was based on significant pre-application research, analysis and collaboration with expert agencies, and includes proposed Project design elements and associated conditions to protect, mitigate and enhance marine mammals and other sensitive marine resources. For example, the DLA includes a monitoring package that would require acoustic monitoring to prevent acoustic harassment of marine mammals and the adjustment of devices should they approach levels believed to cause marine mammal harassment at certain distances. OSU will also regularly monitor and remove fishing gear to reduce the risk of marine mammal entanglement. As previously noted, these measures were developed in close collaboration with both NMFS and the state agencies charged with implementing Goal 19, and are sufficiently protective and precautionary.
NRDC 9	2	OSU should fund research on conservation strategies for the SRKW and threatened marine mammals, comparable to those already established for birds and bats.	The proposed Project is a wave energy test facility, not an academic research Project, and is expected to have no adverse effect on SRKW or other sensitive marine mammals. The DLA included a robust monitoring and mitigation program, and no additional research requirements are appropriate or necessary to protect, mitigate or enhance resources impacted by the proposed Project.
NRDC 10	2	OSU should develop a research budget for quantifying impacts to ecosystem services and minimizing negative impacts to marine mammals, birds, and fish equal to or greater than the budget for technology testing.	As noted above, OSU is proposing a grid-connected wave energy device testing facility, not a research Project. Nevertheless, the estimated cost for pre-installation environmental studies already completed, planned, or in progress is approximately $2 million. These studies included acoustic Doppler current profiling, wave modeling and far field effects analysis, underwater acoustics studies, water quality studies, aquatic species studies, marine mammal study, oceanographic/bathymetrical/benthic studies, and terrestrial resource studies. In addition, as part of this Project, OSU proposes to undertake certain measures

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			designed to gather environmental and operational data regarding the operation of the WECs. This information will be utilized to evaluate the effects of the Project and individual WECs and may result in modifications to the Project's operations. Due to the nature of the Project as a test site, many of the proposed monitoring plans are being applied to wave energy technology for the first time, making precise estimates for the overall cost of each plan extremely difficult. However, OSU estimates that the total annual cost to conduct the activities described in the proposed monitoring plans will be approximately $500,000 per year (see Section 4.5 of the DLA).
NRDC 11	2	OSU should conduct full tribal consultations to include traditional ecological knowledge in the pre-approval process.	OSU reached out to tribal representatives as part of the CWG and technical working group efforts that began over five years ago. In addition, OSU was designated by FERC as its non-federal representative for purposes of National Historic Preservation Act Section 106 consultation. OSU invited potentially affected Native American tribes to attend a field survey of the terrestrial portion of the Project area pursuant to Section 106 compliance. OSU prepared a Cultural Resources Terrestrial Study Report which was shared with participating tribes on February 19, 2018 and with the State Historic Preservation Officer on June 11, 2018. The SHPO concurred on July 6, 2018 that the terrestrial portion of the Project will likely have no effect on any significant archeological objects or sites. OSU has completed the Archeological Assessment of Submerged Cultural Resources report. OSU will submit final Section 106 consultation materials to SHPO for concurrence on a finding of effect regarding the undertaking's potential to effect historic properties.
NRDC 12	3, 9	As the proposed Project is intended to be an internationally recognized testing facility, the testing site should also be in compliance with EU environmental investigation standards [citing the Standard Investigation of the Impacts of Offshore Wind	EU offshore wind investigation standards do not apply within the U.S., nor would they be applicable to a wave energy testing facility. OSU is subject to FERC study requirements and conducted site assessment surveys to inform both the Federal Power Act and other federal and state environmental reviews. Critically, no

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		Turbines on the Marine Environment (StUK4) 2013]. To ensure these standards are met, research programs and funding of the PMEC-SETS should prioritize the sustainability of healthy ecosystems as part of its development and further testing of renewable energy generation technology; with the overriding objective to be Projects that do not harm marine food webs and processes. The development of the Project site should not be rushed and based on a minimum of 3 years of pre-siting baseline assessment of key species in accordance with EU environmental investigation standards.	federal or state agency has requested additional site characterization studies in response to issuance of the DLA. Although the cited standards are inapplicable here, it may be helpful to understand how they relate to OSU's robust baseline studies. StUK4 suggests two consecutive complete seasonal cycles (12 times per year) of aircraft transect surveys with a spacing of 3-10 km be conducted for purposes of site characterization, or baseline. With regard to the Project site, Adams et al. 2014 conducted surveys in summer, fall, and winter of 2011 and 2012, providing data for three seasons across two years. These surveys matched the StUK4 standards for flight speed, were closer to the water than StUK4 provides, and had transect spacing of 6 km. Results were described in the PDEA at page 3-52. In addition, the StUK4 calls for surveys of habitat use of harbor porpoises in the Project area using TPODS. At the Project site, Holdman (2016) and Holdman et al. (in press), conducted these surveys from May to October 2014 using DMONs, which are considered superior to TPODS because they record everything, rather than simply detecting "clicks." The results were described in the PDEA and Draft BA. Notably, StUK4 calls for two years of baseline studies, not three years as urged by NRDC. In addition, the OSU site assessment benthic surveys are effectively aligned with the StUK4 standards. OSU conducted 27 surveys (9 stations each survey) over 6 years at PacWave North. OSU consulted with federal and state resource agencies, which agreed that those surveys were sufficiently close geographically, and that there was no need for additional surveys that would cause significant additional fish mortality.

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			In addition to these robust baseline surveys, OSU is proposing to continue conducting box coring during the device testing phase.
NRDC 13	3	The PDEA is based on significantly outdated scientific data and did not account for recent research by NOAA on marine mammals and climate impacts to marine systems.	See response to NRDC 7 and 19.
NRDC 14	3	Recent scientific research has shown that many marine mammal species forage within the region that the PMEC-SETS is proposed to be developed [citing John Calambokidis et al, Biologically Important Areas for Selected Cetaceans Within U.S. Waters - West Coast Region, 39-41, Aquatic Mammals (2015)].	OSU's Draft BA (Appendix A) analyzes the potential effects of the Project on ESA-listed whales, including the SRKW and humpback whales. Gray whales in of the west coast are not ESA-listed; however, OSU evaluated the potential effects to this species in Section 3.3.3.2 of the PDEA. NMFS has identified Stonewall and Heceta Banks as a "Biologically Important Area" (BIA) for humpback whale feeding and the Depoe Bay as a BIA for gray whales, according to its Cetacean Density and Distribution Mapping Working Group (Calambokidis et al. 2015). The feeding BIA for gray whales occurs inshore of the proposed PacWave South Project area, but the Project area is located within the feeding BIA for humpback whales. This information has been incorporated into the FLA. No BIA was established for SRKW by Calambokidis et al. 2015.
NRDC 15	5	The Western Northern Population of gray whale is listed as "endangered" and its habitat should be considered in OSU's wave energy application decision. … FERC should consider the possible impacts of OSU's wave energy Project on the gray whale, and its migration patterns, in deciding whether to authorize the Project.	The western North Pacific gray whale is found off the coast of Russia, Korea, China, and Japan (Marine Mammal Commission 2018) and is not expected to occur in the Project area. However, OSU's PDEA analyzes the Project's potential to impact gray whales in Section 3.3.3.2 and concludes that the Project, as proposed after significant collaboration with NMFS, is not likely to adversely affect gray whales. Consistent with NRDC's comments, this Draft BA is being provided to FERC for the express purpose of informing its consultation with NMFS pursuant to Section 7 of the ESA regarding the Project's potential impacts to ESA-listed species and critical habitat, and that consultation must be completed prior to FERC authorizing the Project.

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NRDC 16	6	Since humpback whales are known to forage within areas near to the proposed wave energy development, FERC must consider whether the authorization of such conduct would negatively affect this stock.	OSU's Draft BA (Appendix A of the PDEA) analyzes the Project's potential to impact humpback whales starting on page 5-43 and concludes that the Project, as proposed after significant collaboration with NMFS, is not likely to adversely affect humpback whales. Consistent with NRDC's comments, this BA is being provided to FERC for the express purpose of informing its consultation with NMFS pursuant to Section 7 of the ESA regarding the Project's potential impacts to ESA-listed species and critical habitat, and that consultation must be completed prior to FERC authorizing the Project.
NRDC 17	7	FERC must ensure that the PMEC-SETS facility will not result in the unpermitted "take" of a protected marine mammal species and must obtain, if necessary, and appropriate MMPA incidental harassment or incidental take authorization from NMFS prior to licensing this facility.	As noted above, OSU discussed the potential need for MMPA authorizations with NMFS regional and marine mammal staff to determine whether specific phases of Project construction and operation would require authorizations under the MMPA. Subsequently, NMFS issued the letter attached as Appendix N to the FLA which concludes that neither construction nor operation of the Project is expected to result in take of marine mammals and that no IHA is therefore required.
NRDC 18	8	While the PDEA mentions unavoidable adverse impacts to gray whales, it does not discuss the 18 other marine mammals known to live in or pass through Oregon's waters. It is imperative that the PDEA incorporate marine mammal -- and Southern Resident killer whale -- conservation strategies, comparable to those already included for birds and bats [citing Appendix B to the PDEA].	The PDEA analyzed potential impacts to marine mammal species starting on page 3-144. In addition, marine mammals that are listed under the ESA were discussed in the Draft BA (Appendix A of the PDEA) starting on page 5-43. The DLA incorporated robust monitoring plans and mitigation measures, the purpose of which is to ensure the Project does not adversely affect marine mammals. In part as a result of these measures, NMFS has concluded that construction and operation of the Project is not expected to result in take of marine mammals and that no MMPA authorization is required.
NRDC 19	8-9	OSU's permitting application and site characterization frequently rely on outdated information that does not contemplate climate-related shifts, emerging data on fish stocks, and dynamic ocean management. For instance, OSU relies on NEPA scoping data and initial	See response to NRDC 7. The work cited (Hazen et al. 2017) does not apply to SRKW. The premise is that North Pacific Blue Whales that have been tracked by satellite telemetry can provide information in near real time

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		agency consultations from 2014, and its application cites documents from 2014 or earlier. Similarly, the PMEC-SETS application does not cite research from critical NOAA Fisheries models developed since 2010, even though survey data and modeling on predictive habitat and climate induced shifts have been produced since that time [citing Elliott L. Hazen, et al., Whale Watch: A Dynamic Management Tool for Predicting Blue Whale Density in the California Current, 54 J. Applied Ecology 1415 (2017)].	on whale distribution useful for year-round spatio-temporal overlap of blue whales with potentially harmful human activities, such as shipping. This approach would be unfeasible for SRKW, as it requires sufficient telemetry data.
NRDC 20	9	If approved, the PMEC-SETS research program should remain at the forefront of marine technology development, continually updating its precautionary protections for SRKW, in close consultation with NOAA Fisheries, Canada's Department of Fisheries and Oceans, Cascadia Research, the Marine Mammal Institute, and other marine scientists.	OSU has proposed a monitoring and mitigation package that was developed and would be implemented in close coordination with NMFS, the federal agency charged with regulating and protecting SRKW and other marine mammals and aquatic species. The monitoring and mitigation elements are subject to principles of adaptive management to allow consideration of new information that may be developed over time.
NRDC 22	9-10	It is imperative that OSU's APEA address previous analyses and concerns regarding the SRKW and wave energy, specifically those raised in the Snohomish Public Utility District proposal, the early proposal for the Makah Bay Offshore Wave Energy Pilot Project in the Olympic Coast National Marine Sanctuary, and the 2008 SRKW Recovery Plan.	With regard to SRKW, Snohomish PUD's Admiralty Inlet tidal Project raised concerns regarding sound exposure and blade strike; monitoring and mitigation plans were developed to address these impacts. OSU has developed an acoustic monitoring study (Appendix H3) to address sound exposure impacts, with mitigation measures provided in the PM&E measures (Appendix I). The potential for collision was analyzed in the PDEA at page 3-147, however, wave energy converter would not result in blade strike (there is no mechanism for this effect and is a well known difference between WECs and tidal turbines). The DLA analyzed the same potential for effects that NMFS considered in its biological opinion for the Makah Bay Offshore Wave Energy Pilot Project. NMFS's SRKW recovery plan indicates the following concerns regarding "alternative energy": "Buoys moored to capture wave

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			energy may generate sound or electromagnetic fields that have the potential to affect marine life. Some designs employ "open loop" technology that pumps sea water from the surrounding environment to drive internal turbines thus posing some risk of entrainment. Multiple anchored and connected buoys may also present an entanglement or collision risk." As noted in the PDEA "Many toothed whales have a well-developed ability to echolocate and avoid structures in the water (Akamatsu et al. 2005), and moorings for WECs would consist of large cables, which are likely to be detected at distances of tens of meters by echolocating toothed whales (Nielsen et al. 2012 cited in Benjamins et al. 2014). .... The Project mooring lines (up to 21 and 100 for the initial development and full build out, respectively; Table 3-15) and the umbilical cables (up to 6 and 20 for the initial development and full build out, respectively) are more substantial than those used for fishing or crab pot lines within which whales have become entangled. Also, the WECs are expected to create substantial tension on the mooring lines. Heavy mooring gear combined with relatively taut mooring lines has been shown to render the potential for entanglement negligible (Wursig and Gailey 2002). Entanglement is unlikely due to the moorings' size and mass regardless of the mooring configuration, though taut mooring systems represented lower relative risk than catenary mooring systems, particularly those using nylon (Benjamins et al. 2014, Harnois et al. 2015). The umbilical cables descending from the WECs to the seabed would also be substantially taut and relatively rigid. Therefore, it is likely the umbilical cables and mooring lines would act more as structures than as lines and entanglement would be unlikely to occur. In addition, the spacing of the WECs, approximately 50 to 200 m or more apart, would further minimize the potential for collision by providing ample space for marine mammals to pass

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			between the WECs and associated mooring lines and umbilical cables. As previously noted, OSU has committed to conducting monitoring and mitigation to address potential impacts from acoustics and entanglement. OSU has limited the types of devices that can be tested at the Project and is not proposing to test devices that pump seawater to drive turbines (e.g., "overtopping" devices).

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APPENDIX L-2
Consultation Letters

FEDERAL ENERGY REGULATORY COMMISSION
Washington, D. C. 20426
July 18, 2018

OFFICE OF ENERGY PROJECTS

Project No. 14616-000
Pacific Marine Energy Test Center-South
Energy Test Site
Oregon State University

Dr. Burke Hales
Oregon State University
104 CEOAS Administration Building
Corvallis, OR 97331

RE: Comments on Draft License Application for the PMEC-SETS Project

Dear Dr. Hales:

Thank you for providing us with a copy of the draft license application (DLA) that contains your draft Applicant Prepared Environmental Assessment (APEA) for the PMEC-SETS Project. We reviewed the application relative to the Alternative Licensing Process (ALP) regulations in 18 CFR §4.34 and the contents of the license application as outlined in 18 CFR §4.41.

Your DLA includes all of the applicable exhibits; however, we find that a deficiency (Appendix A) would need to be addressed in your final license application and additional analysis and information is needed in the DLA and APEA to analyze the environmental effects of your project (Appendix B).

If you have any questions, please call Jim Hastreiter at (503) 552-2760.

Sincerely,

Timothy Konnert, Chief
West Branch
Division of Hydropower Licensing

Enclosures: Appendix A-Deficiency
Appendix B-Additional Information

Appendix A

DEFICIENCY

Exhibit G

1. Per section 4.41 of the Commission regulations, please provide the project boundary data in a geo-referenced electronic format.

Appendix B

ADDITIONAL INFORMATION

Aquatic Resources

1. The Marine Mammal Protection Act (MMPA) prohibits, with certain exceptions, the "take" of marine mammals in U.S. waters and the high seas. Take authorization is granted by the National Marine Fisheries Service (NMFS) through either a letter of authorization or conditions contained in an incidental harassment authorization. In 1986, Congress amended both the MMPA, under the incidental take program, and the Endangered Species Act (ESA), to authorize incidental takings of depleted, endangered, or threatened marine mammals, provided the "taking" was small in number and had a negligible impact on marine mammals. With this relationship between the MMPA and ESA, NMFS cannot complete section 7 consultation with the Commission and issue an Incidental Take Permit for listed marine mammals until an Incidental Harassment Authorization has been issued.

   Based on the analysis in the draft APEA and draft biological assessment, the project may adversely affect and also subject marine mammals to harassment. Section 1.3.8, *Marine Mammal Protection Act*, of the draft APEA states that Oregon State University (OSU) expects to apply for a marine mammal harassment authorization for the project. In the final license application, please provide a schedule for working with NMFS to satisfy the requirements of the MMPA.

Terrestrial Resources

1. In Section 2.2.4, *Proposed Environmental Measures*, of the draft APEA, you propose to develop a revegetation plan and develop measures that would limit the introduction or spread of invasive species. Please provide additional details in the final APEA of proposed measures to revegetate disturbed areas and proposed measures to minimize the spread of invasive plant species, including use of herbicides.

2. In Section 2.2.4 of the draft APEA, you propose measures to protect the western pond turtle; however, this species is not discussed in Section 3.3.4, *Terrestrial Resources*, of the APEA. Please revise this section to include a discussion of potential effects to the western pond turtle.

3. In Section 2.2.4 of the draft APEA, you propose to conduct surveys for the seaside hoary elfin, a rare species of butterfly, in the event effects to elfin habitat are unavoidable. This would include properties outside of Driftwood Beach State

Recreation Site but within the construction footprint to determine the extent of occupied habitat and associated mitigation. Please provide additional details in the final APEA on survey methods and potential mitigation measures for the elfin.

4. In section 3.3.4.2, *Environmental Impacts Related to Terrestrial Resources*, of the APEA, you do not quantify the amount of different habitat types that would be affected by the project. In the final APEA, please include a table that outlines the amount of each habitat type that would be affected by each project component, including whether effects would be permanent or temporary.

<u>Recreational Resources</u>

1. Section 3.3.6.1, *Recreation, Ocean Use, and Land Use, Affected Environment*, of the draft APEA states that according to Oregon Parks and Recreation Department (OPRD), a portion of the Driftwood Beach State Recreation Site is subject to the requirements of 6(f)(3) of the Land and Water Conservation Fund Act. Please provide a description of this regulation in the final APEA.

2. Section 3.3.6.2, *Environmental Impacts Related to Recreation, Ocean Use, and Land Use*, of the draft APEA describes a plan to develop an interpretive display describing the PMEC-SETS Project, with the intention of installing it in the Driftwood Beach State Recreation Site parking lot. Please provide additional information in the final APEA about how the interpretive display would be developed, including; what coordination would occur with OPRD regarding the content of the interpretive material; what type of structure, or sign, would be used to display the interpretive material; and, where it would be installed within the parking lot area.

3. Section 3.3.6.2 of the draft APEA states that during construction of the terrestrial components of the project (i.e. HDD boring, installation of the underground cable, and construction of the "beach" manholes), access at the Driftwood Beach State Recreation Site would be significantly restricted, preventing access to much, if not all of the parking area. In section 2.2.4 OSU proposes to arrange construction work areas and maintain public beach access during construction, to the extent practicable, and, as feasible, locate construction staging and laydown areas outside of the recreation site to limit loss of parking space.

   In the final APEA, please describe how construction activities would be planned and managed to mitigate impacts to public access and use of the Driftwood Beach State Recreation Site, including: (1) the proposed starting and end dates for construction activities within the recreation site; (2) any anticipated timing of partial, or complete, closures of the recreation site, including which portions of the site would be closed, and for how long; (3) how construction activities would be coordinated with OPRD; (4) what safety measures, aside from using construction fencing, would be enacted to protect recreational users visiting the site; (5) how public access would be maintained throughout the duration of construction activities at the site; and (6) how the site will be restored to its original condition, aside from the newly installed manhole facilities, following the completion of construction activities.

Cultural Resources

1. In section 3.3.7, *Cultural Resources*, of the draft APEA, you state that OSU plans to conduct more focused and detailed geophysical and geotechnical surveys of the area of potential effects (APE) associated with the proposed test site and subsea cable routes for the proposed project, and these surveys are planned to be done in June and July 2018. You also state that a pedestrian survey of the terrestrial component of the proposed project's APE had been conducted in September 2017, and that the related survey report was submitted to the involved Indian tribes and agencies in February 2018 for comment, and that you plan to send a revised report (depending on comments from the tribes and agencies) to the Oregon SHPO for their review and comment. In all, you anticipate from the studies that the proposed project would not have an effect on historic properties.

   So we can have adequate information to assess the potential effects of your proposed project on historic properties within your defined APE, please provide all of the requisite reports (for both the marine and terrestrial aspects of your APE) in your final license application, along with all comments you have received on them, including how you adopted all specific comments in the revised reports, or provide reasons why you did not adopt a particular comment. Contingent upon the findings in the reports, and your stated anticipations that the proposed project would not have an effect on historic properties, seek written concurrence from the Oregon SHPO on this finding with a statement that they concur that the proposed project would not have an effect on historic properties. Please provide written concurrence from the Oregon SHPO in your final license application, as well.

Exhibit A

1. Figures A-8 and A-9 show the depth of water to be 260 feet. However, in the text of Exhibit A (project description – page A-1) the maximum depth is mentioned to be 78 meters = 255ft. In Exhibit F drawing also the maximum depth is shown as 255ft. Please correct this inconsistency in the final license application.

UNITED STATES OF AMERICA
FEDERAL ENERGY REGULATORY COMMISSION

Northwest National Marine Renewable Energy Center, Oregon State University	**) Pacific Marine Energy Center-) South Energy Test Site (PMEC-SETS) Project)**
Application for a Major Unconstructed Project	**) FERC Project No. 14616-000)**

NATIONAL MARINE FISHERIES SERVICE'S PRELIMINARY REVISED COMMENTS, AND RECOMMENDED TERMS AND CONDITIONS

I. INTRODUCTION

The U.S. Department of Commerce, National Marine Fisheries Service (NMFS) hereby submits its Preliminary Recommended Terms and Conditions for the Pacific Marine Energy Test Center- South Energy Test Site Project, FERC No. 14616, in response to the Federal Energy Regulatory Commission's (FERC or Commission) *Notice Soliciting Preliminary terms, conditions, and recommendations on the draft PDEA, and comments on the DLA* issued on April 20, 2018. NMFS is submitting this document to FERC, with an index to its Administrative Record (Appendix A), and will file its supporting Administrative Record within 45 days.

OSU formed an advisory team comprised of federal and state agencies involved in the Project as well as non-governmental organizations representing stakeholder interests, to collectively explore and identify key regulatory and environmental considerations. This advisory group is called the Collaborate Workgroup (CWG) NMFS has participated in negotiations within the CWG along with the following entities: Bureau of Ocean Energy Management (BOEM), Oregon Department of Fish and Wildlife (ODFW), U.S. Fish and

Wildlife Service (USFWS), Oregon Department of Land Conservation and Development (DLCD), Oregon Department of Environment Quality (ODEQ), Confederated Tribe of the Siletz Indians, U.S. Coast Guard (USCG), Port of Newport, Oregon Parks and Recreation Department (OPRD), Oregon Department of State Lands (ODSL), U.S. Environmental Protection Agency (EPA), U.S. Army Corps of Engineers (USACE), Department of Energy (DOE), and Oregon State University (OSU). The negotiations resulted in comprehensive Collaborate Workgroup products recently filed with FERC that include the following: bird and bat conservation strategy, terrestrial habitat characterization report, PMEC-SETS characterization report, navigation safety risk assessment, operations and management plan, emergency response and recovery plan, monitoring plans, protection, mitigation, and enhancement measures, adaptive management framework, and a habitat mitigation plan developed by ODFW. NMFS hereby submits its preliminary terms and conditions consistent with the Collaborative Workgroup products.

NMFS' preliminary recommended conditions are intended to address project effects, and meet NMFS' resource management goals and statutory obligations. NMFS is providing short summaries of the project description, affected marine resources, and project effects because there is no reason to duplicate the existing extensive record on file with FERC on these topics.

II. PROJECT DESCRIPTION

Oregon State University (OSU) is proposing to install and operate a grid-connected wave energy test facility for a 25 year license period that is designed to allow the testing of full-scale wave energy converters (WECs), with generation and transmittal of power to a grid connection point. The Project site includes a 2 square nautical mile (1,695 acres) WEC deployment area located in federal waters approximately 6 nautical miles off the coast of Newport, Oregon; and an approximately 2 square nautical mile cable corridor containing buried subsea cables from the test site to a terrestrial cable connection point at Driftwood Beach State Recreation Site in Seal Rock, Lincoln County, Oregon; and buried terrestrial cables running to the onshore Utility Connection and Monitoring Facility (UCMF) on a property east of Highway 101, located about 0.3 miles south of Driftwood Beach State Recreation Site. The portion of the ocean continental shelf (OCS) where the test site would be located is federal land administered by the Bureau of Ocean Energy Management (BOEM). The subsea cables would cross Oregon's territorial seas. The terrestrial components of the Project would be located on state, county, and privately owned lands.

The offshore test site is composed of four test berths that could collectively support up to 20 WECs, and associated moorings, anchors, subsea connectors, subsea power and communication cables, and onshore facilities. The Project could generate up to 20 megawatts (MW) that would travel through four individually buried subsea cables running from the test site to a terrestrial cable connection point at Driftwood Beach State Recreation Site in Seal Rock, Lincoln County, Oregon and then about 0.7 miles to the east and south to a newly built grid connection point with Central Lincoln People's Utility District (CLPUD). Water depths at PMEC-SETS range from 65 to 78 m (mean lower low water elevation). OSU would oversee and manage all activities, and clients deploying WECs at PMEC-SETS would be subject to test center protocols and procedures.

Figure 1. PMEC-SETS Project, Pacific Ocean, Oregon.

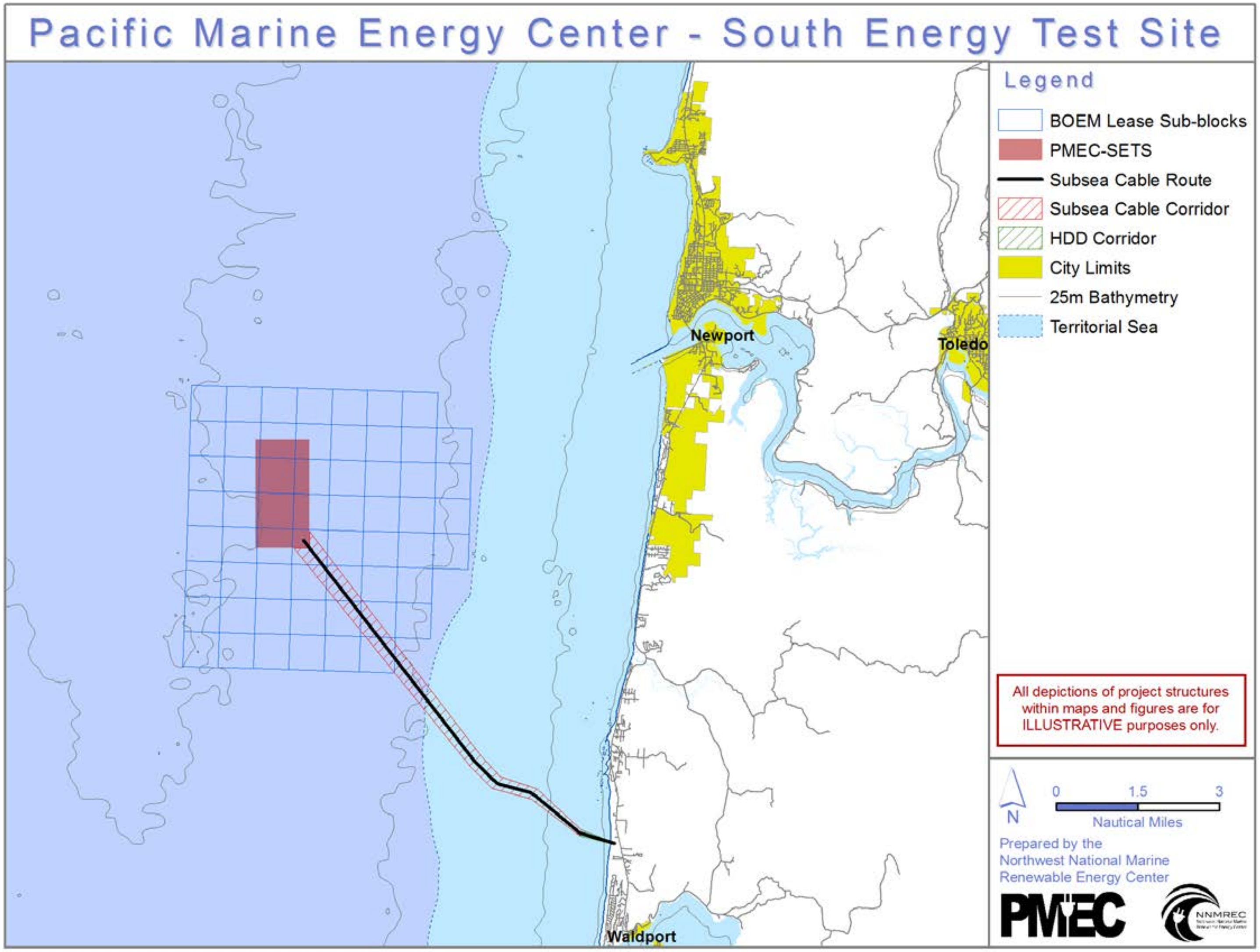
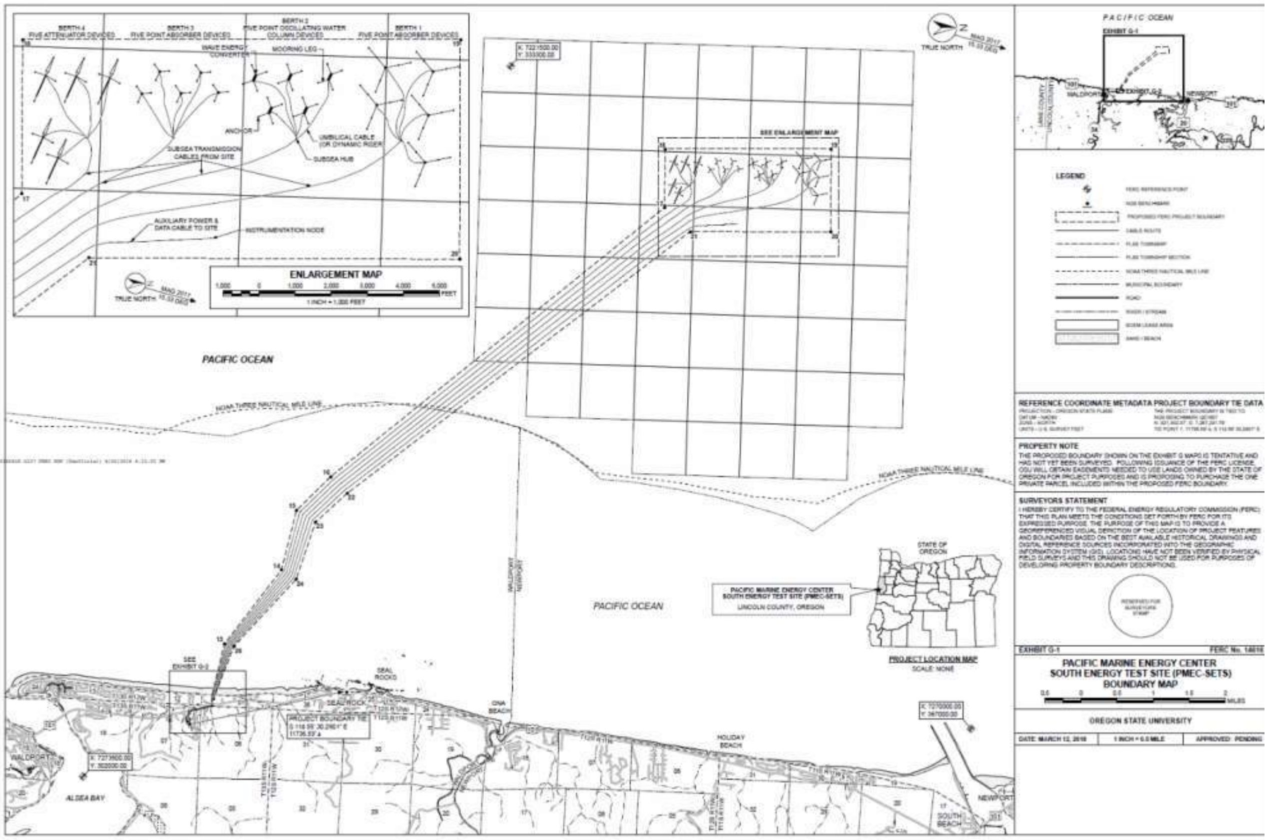


Figure 2. Boundary Map of the PMEC-SETS Project



III. Project Components

Primary Project components include WECs, marker buoys, anchors and mooring systems, support buoys and instrumentation, subsea connectors and hubs, subsea transmission and auxiliary cables, and an onshore control center to transfer power to the grid. The WECs, support buoys, anchors and mooring systems, and subsea connectors would be located in the test berths. From the subsea connectors, the subsea cables would transmit medium voltage alternating current (AC) power and data from the PMEC-SETS test berths to shore. Around the 10-m isobath (i.e., the 10-m [33-ft] depth contour), each subsea cable would enter a dedicated conduit, installed by horizontal directional drilling (HDD), running to an onshore cable landing point, or “beach manhole”. Each of the five beach manholes would consist of a 10 x 10 x 10 ft buried concrete vaults. Within the beach manholes, the subsea cables would be connected to terrestrial cables, which would connect to an onshore Utility Connection and Monitoring Facility (UCMF).

A. Wave Energy Converters (WECs)

The Project will deploy four WEC types based on the location of the test site (i.e. depth, wave resources, and proximity to ports). The WECS will be deployed either singly or in arrays but will not entrain or trap fish or other marine organisms into turbines or other components used for power generation. The WEC types to be deployed at the project will include point absorbers, attenuators, oscillating water columns (OWCs), and hybrid devices.

Point absorbers are floating or submerged structures with components at or near the ocean surface that capture energy from the motion of waves, which drives a generator. Point absorbers may be fully or partly submerged. They typically have a relatively small surface area compared to the wave length.

Attenuators are structures that respond to the curvature of the waves rather than the wave height. Attenuators may consist of a series of semi-submerged sections linked by hinged joints. As waves pass along the length of the WEC, the sections move relative to one another. The wave-induced motion of the sections is captured and used to drive a generator.

Oscillating Water Columns (OWCs) are structures that are partially submerged and hollow, open to the sea below the water line, enclosing a column of air on top of a column of water. Waves cause the water column to rise and fall, which in turn compresses and decompresses the air column. This air is allowed to flow to and from the atmosphere via a turbine, which usually has the ability to rotate regardless of the direction of the airflow.

Hybrid WEC types are WECs that utilize two or more of the above-listed WEC devices. For example, some WECs that are the relative size and shape of a point absorber may generate power through movements that resemble an attenuator. Another example is a class of WECs with moving masses that are internal to a hull with no external moving parts exposed to the ocean.

The Project will accommodate up to 20 WECs in total at one time however, OSU expects the number of WECs deployed would vary throughout the license term. There would likely be fewer WECs installed in the initial years of operation (about five years). WECs will be deployed 50-200 meters or more apart from each other within a test berth. Each WEC rate capacity would vary with an estimated range from 150kW to 2MW for a maximum installed capacity of 20 MW in total (cannot exceed 20 WEC devices).

The WECs and project structures will be properly illuminated and equipped with Automatic identification System (AIS) equipment and the site boundaries will be clearly marked on NOAA navigation charts.

B. Support Instrumentation

Anchoring systems at the Project site may include gravity based anchors, drag embedment anchors, suction anchors, plate anchors, or a combination of anchor types. These anchors will consist of steel, concrete, or a mixture of steel and concrete with all concrete having been fully cured prior to deployment. The estimated anchor footprint (maximum estimated area covered by the anchors) are based on an exclusive use of a large 34-ft diameter gravity anchor. The actual anchor footprint for the Project is expected to be considerably smaller than the estimated amount for the initial development (first 5 years) and full build out scenarios. Using the 34-ft diameter gravity anchor (908 ft^2 per anchor) as a maximum anchor footprint OSU estimated a maximum anchor footprint of 19,068 ft^2 (0.4 acres) for the initial development with a total of 21 anchors and 6 WECs. A maximum anchor footprint of 90,800 ft^2 (2 acres) was estimated for the full build out scenario with a total of 100 anchors and 20 WECs.

WEC devices use mooring systems that have a single or multi-point configuration. Mooring lines commonly consists of chain, steel wire, or synthetic material and often include buoys and/or subsurface floats. Buoys and subsurface floats will be treated with a TBT (tributyltin)-free anti-fouling paint prior to deployment to reduce biofouling.

Anchor installation and removal for a given WEC is not likely to occur more than once a year and OSU intends to reuse anchors when practicable to minimize seafloor disturbance.

C. Power Transmission and Grid Interconnection

Power generated by the WECs will be transferred via umbilical cables to a subsea connector located on the seafloor at each test berth. Electricity would be transmitted from the subsea connector through the subsea cable to shore. Because the WECs sit on or near the water surface, the umbilical cables will run from the WEC to the seafloor and be partially suspended in the water column. Umbilical cables will be attached to a subsurface float to create a lazy-S confirmation to maintain tension but allow the WECs to move with the wave action. There will be one umbilical cable per WEC device. If there is an array of WECs, all umbilical cables will connect to one subsea connector via a connection hub, at each test berth. The subsea connector located on the seafloor has no external moving parts and can be dry, oil, gel, or nitrogen filled as required. Subsea connectors typically have a built-in cathodic protection that controls the corrosion of the metal surface. The subsea connectors will be installed at the same time as the subsea cables to shore.

Four subsea cables will be installed, one for each test berth. One smaller, singular, auxiliary cable will connect the cables to each berth (one auxiliary cable/berth). The auxiliary cable increases real time monitoring capability and allows for extended deployment of monitoring instruments with high data bandwidths or power requirements. The subsea cables will be shielded and armored to produce lower magnetic fields outside the cable than unshielded cables (Normandeau *et. al.* 2011). The umbilical cables and a segment (approximately 300 meters) of the subsea cables would remain unburied to allow for access during WEC deployment, removal, and maintenance activities. The subsea cables would be buried to a target depth of 1–2 m from the offshore test site to the HDD conduits using a jet plow or similar technique for approximately 8.3 nautical miles. Although unlikely, in areas where burial is not feasible, the cables would be laid on the seabed and protected by split pipe, concrete mattresses, or other cable protection systems. The subsea cables would be buried to approximately the 10-m isobath, at which point each cable would enter an HDD (horizontal directional drilling) conduit passing under the beach into the parking lot at Driftwood Beach State Recreation Site. The cable corridor will converge from at least 400 meters at the offshore test site to 60 meters at the nearshore HDD conduits. The seafloor doesn’t shelve evenly, so the cable corridor does not widen at a constant rate between the Project site and the HDD conduits.

HDD would be used to install five separate conduits for four subsea transmission cables and one auxiliary cable at Driftwood Beach State Recreation Site approximately 50-100 ft beneath sand dunes and beach to approximately the 10-m isobaths, a distance of about 0.6 nautical miles. The cables will run through separate HDD conduits to individual onshore cable landing points (beach manholes), where the subsea cables will transition to terrestrial cables.

The terrestrial cables will run underground conduits for about 0.7 miles to reach the Utility Connection and Monitoring Facility (UCMF). The UCMF will consists of 3 buildings to accommodate the conditioning and monitoring of equipment, storage, and the Project's data control and communications center. The entire UCMF, spur road, and parking lot will be approximately 2 acres with 0.89 acres of new impervious surface.

IV. NMFS' STATUTORY AUTHORITY

NMFS is responsible for protecting and managing a variety of marine resources, including Pacific salmon, groundfish, halibut, sea turtles, and marine mammals, and their habitats, under the Endangered Species Act (as amended) (ESA) (16 USC §§1531 et seq.), the Federal Power Act (as amended) (FPA), National Environmental Policy Act (NEPA), the Magnuson-Stevens Fisheries Conservation and Management Act (as amended) (MSA) (16 USC §§1801 et seq.), the Reorganization Plan Number 4 of 1970, Pacific Northwest Electric Power Planning and Conservation Act, 16 USC 839 et seq.; the Pacific Salmon Treaty Act of 1985, 16 USC 3631- 3644; and other laws.

A. Endangered Species Act

The purpose of the ESA is to conserve endangered and threatened species and the ecosystems upon which they depend. To this end, the ESA provides for restrictions on the "take" of endangered and threatened species. Section 7 of the ESA, 16 USC §1536, establishes a policy that Federal agencies must seek to conserve listed species by using their authorities to carry out conservation programs for such species. Furthermore, a Federal agency must make sure that any action it authorizes, funds, or carries out is not likely to jeopardize the continued existence of any ESA-listed species. When listed species may be affected by a Federal action, the Federal agency must consult with NMFS. Issuance of a new project license by FERC is considered a Federal action that requires consultation under ESA Section 7.

B. Magnuson-Stevens Fisheries Conservation and Management Act

The 1996 amendments to the MSA set forth a number of mandates for NMFS, regional fishery management councils, and other Federal agencies to identify and protect important marine and anadromous fish habitats. The councils, with assistance from NMFS, are required to delineate essential fish habitat (EFH) for all managed species. Federal action agencies which fund, permit, or carry out activities that may adversely impact EFH are required to consult with NMFS regarding the potential effects of their actions on EFH, and to respond in writing to our recommendations. In addition, NMFS is required to comment on any State agency activities which would impact EFH.

C. Section 10(j) of the FPA

Under Section 10(j) of the FPA, licenses for hydroelectric projects must include conditions to protect, mitigate damages to, and enhance fish and wildlife resources, including related spawning grounds and habitat. These conditions are to be based on recommendations received from Federal and State fish and wildlife agencies. FERC is required to include such recommendations unless it finds that they are inconsistent with Part I of the FPA or other applicable law, and that alternative conditions must adequately address fish and wildlife issues. Before rejecting an agency recommendation, FERC must attempt to resolve the inconsistency, giving due weight to the agency's recommendations, expertise, and statutory authority. If FERC does not adopt a Section 10(j) recommendation, in whole or in part, it must publish findings that adoption of the recommendation is inconsistent with the purposes and requirements of Part 1 of the FPA or other applicable provisions of law, and that conditions selected by FERC adequately and equitably protect, mitigate damages to, and enhance fish and wildlife and their habitats.

D. Tribal Trust Responsibility

All executive agencies of the Federal Government have a fiduciary duty on behalf of the United States toward American Indian tribes, to be carried out in accordance with applicable treaties, statutes, judicial decisions, and executive and secretarial orders. NMFS strives to meet Tribal trust responsibilities in its licensing activities. Tribal trust resources are those natural resources, either on or off Indian lands, retained by, or reserved by or for Indian tribes through treaties, statutes, judicial decisions, and executive orders.

V. SCHEDULE FOR PROVIDING MODIFIED PRESCRIPTIONS

NMFS may submit modified prescriptions, conditions, and other recommendations within 60 days of the close of FERC's NEPA comment period, or in accordance with a schedule otherwise established by NMFS. If no further modified prescriptions, conditions, or other recommendations are submitted by NMFS within the specified schedule, the revised prescriptions shall become the final prescriptions.

VI. AFFECTED MARINE RESOURCES

The presence and location of Project features and operation of the Project adversely affects marine resources of the Pacific Ocean and ocean tributaries. The Project construction and operation affect our marine resources by altering habitat (suspended sediment, benthic disturbance, alter marine community & behavior, and water quality contamination), producing underwater sound, conducing electromagnetic fields, reducing water quality from construction effects on surface streams, creates risk of entanglement or collision with WEC structures and components, and vessel strikes due to increased vessel traffic to our marine resources. Among the affected marine species are described in Table 1, Table 2, and Table 3.

Table 1. ESA-listed species that may occur within the PMEC-SETS project area.

Common Name	**Scientific Name**	**Federal Status**	**Critical Habitat Designated**	**Critical Habitat in Project Area**
Lower Columbia River Evolutionary Significant Unit (ESU)	*Oncorhynchus tshawytscha*	Threatened	X	
Upper Columbia River spring-run ESU		Endangered	X	
Snake River spring/summer-run ESU		Threatened	X	
Snake River fall-run ESU		Threatened	X	
Upper Willamette River spring-run ESU		Threatened	X	
California Coastal spring-run ESU		Threatened	X	
Sacramento River winter-run ESU		Endangered	X	
Central Valley spring-run ESU		Threatened	X	
Lower Columbia River ESU	*O. kisutch*	Threatened	X	
Oregon Coast ESU		Threatened	X	
			X	
Southern Oregon/ Northern California Coast ESU		Threatened		
Central California Coast ESU		Endangered	X	
Lower Columbia River Distinct Population Segment (DPS)	*O. mykiss*	Threatened	X	
Middle Columbia River DPS		Threatened	X	
Upper Columbia River DPS		Threatened	X	
Snake River Basin DPS		Threatened	X	
Upper Willamette River DPS		Threatened	X	
Northern California Coastal DPS		Threatened	X	
California Central Valley DPS		Threatened	X	
South-Central California Coast DPS		Threatened	X	
Sockeye salmon				
Sockeye salmon Snake River ESU	*O. nerka*	Endangered	X	
Chum salmon				
Chum Salmon Columbia River ESU	*O. keta*	Threatened	X	
Other Marine Fish				

Common Name	Scientific Name	Federal Status	Critical Habitat Designated	Critical Habitat in Project Area
Green sturgeon Southern DPS	*Acipenser medirostris*	Threatened	X	X
Eulachon Southern DPS	*Thaleichthys pacificus*	Threatened	X	
Sea Turtles				
Leatherback sea turtle	*Dermochelys coriacea*	Endangered		X
Green sea turtle, East Pacific DPS	*Chelonia mydas*	Threatened		
Loggerhead sea turtle	*Caretta caretta*	Threatened		
Olive (Pacific) Ridley sea turtle Pacific DPS	*Lepidochelys olivacea*	Endangered		
Whales				
Killer whale Southern Resident DPS	*Orcinus orca*	Endangered	X	
Humpback whale, Central America DPS/Mexico DPS	*Megaptera novaeangliae*	Endangered / Threatened		
Blue whale	*Balaenoptera musculus*	Endangered		
Fin whale	*B. physalus*	Endangered		
Sei whale	*B. borealis*	Endangered		
Sperm whale	*Physeter macrocephalus*	Endangered		
North Pacific Right Whale	*Eubalaena japonica*	Endangered	X	

Table 2. MSA not listed species that may occur within the PMEC-SETS project area.

Common Name	Scientific Name
Pinnipeds	
California sea lion	*Zalophus californianus*
Harbor seal	*Phoca vitulina richardsi*
Northern elephant seal	*Mirounga angustirostris*
Northern fur seal	*Callorhinus ursinus*
Steller sea lion	*Eumetopias jubatus*

Common Name	Scientific Name
Cetaceans	
Baird's beaked whale	*Berardius bairdii*
Bottlenose dolphin	*Tursiops truncatus*
Cuvier's beaked whale	*Ziphius cavirostris*
Dall's porpoise	*Phocoenoides dalli*
Dwarf sperm whale	*Kogia sima*
Eastern North Pacific Gray Whale	*Eschrichtius robustus*
Harbor Porpoise	*Phocoena phocoena*
Mesoplodont beaked whale	*Mesoplodon spp.*
Minke whale	*Balaenoptera acutorostrata*
Northern right whale dolphin	*Lissodelphis borealis*
Pacific white-sided dolphin	*Lagenorhynchus oliquidens*
Pygmy sperm whale	*Kogia breviceps*
Risso's dolphin	*Grampus grisens*
Short-beaked common dolphin	*Delphinus delphis*
short-finned pilot whale	*Globicephala macrorhynchus*
striped dolphin	*Stenella coeruleoalba*

*Marine Mammal Commission. 2014. Response Memo to Bureau of Ocean Energy Management's March 2014 notice of an unsolicited lease request from NNMREC-OSU. April 23, 2014.

Table 3. Essential Fish Habitat (EFH) affected by the Project.

Common Name	Scientific Name	Lifestage	Activity
Groundfish			
Arrowtooth flounder	*Atheresthes stomias*	Eggs, Larvae, Adults	All
Big skate	*Raja binoculata*	Adults	All
Black rockfish	*Sebastes melanops*	Adults	All
		Juveniles	Feeding, Growth to Maturity
Blue rockfish	*S. mystinus*	Juveniles, Adults	All
		Larvae	Feeding
Bocaccio	*S. paucispinis*	Juveniles, Adults	Feeding, Growth to Maturity
Brown rockfish	*S. auriculatus*	Adults	All
		Juveniles	Feeding, Growth to Maturity
Butter sole	*Isopsetta isolepis*	Adults	
Cabezon	*Scorpaenichthys marmoratus*	Adults	
California skate	*R. inornata*	Eggs	Unknown
Chilipepper	*S. goodei*	Juveniles	Feeding, Growth to Maturity
Curlfin sole	*Pleuronichthys decurrens*	Adults	All
Darkblotched rockfish	*S. crameri*	Larvae, Juveniles, Adults	
English sole	*Parophrys vetulus*	Adults	All
		Juveniles	Feeding, Growth to Maturity

Common Name	**Scientific Name**	**Lifestage**	**Activity**
Flathead sole	*Hippoglossoides elassodon*	Adults	All
Greenstriped rockfish	*S. elongatus*	Adults	All
Kelp greenling	*Hexagrammos decagrammus*	Adults	All
		Larvae	
Lingcod	*Ophiodon elongatus*	Adults	All
		Larvae	Feeding
Longnose skate	*R. rhina*	Adults	All
		Juveniles	Growth to Maturity
		Eggs	
Pacific cod	*Gadus macrocephalus*	Adults	All
		Juveniles	
		Larvae	
Pacific hake	*Merluccius productus*	Adults	All
		Juveniles	
Pacific ocean perch	*S. alutus*	Adults	All
		Juveniles	
Pacific sanddab	*Citharichythys sordidus*	Adults	All
Petrale sole	*Eopsetta jordani*	Adults	All
Quillback rockfish	*S. maliger*	Adults	All
Redbanded rockfish	*S. babcocki*	Adults	All
Redstripe rockfish	*S. proriger*	Adults	All
Rex sole	*Glyptocephalus zachirus*	Adults	All
Rock sole	*Lepidopsetta bilineata*	Adults	All
Rosethorn rockfish	*S. helvomaculatus*	Adults	All
Rosy rockfish	*S. rosaceus*	Adults	All
rougheye rockfish	*S. aleutiamus*	Adults	All
		Juveniles	Feeding, Growth to Maturity
Sablefish	*Anoplopoma fimbria*	Juveniles, Adults	Growth to Maturity
		Larvae	Feeding
Sand sole	*Psettichthys melanostictus*	Adults	All
		Juveniles	Feeding, Growth to Maturity
Sharpchin rockfish	*S. zacentrus*	Adults	All
		Juveniles	Feeding, Growth to Maturity
Shortbelly rockfish	*S. jordani*	Adults	All
Shortraker rockfish	*S. borealis*	Adults	All
Shortspine thornyhead	*Sebastolobus alascanus*	Adults	All
Silvergray rockfish	*S. brevispinis*	Adults	All
Soupfin shark	*Galeorhinus galeus*	Adults	All
		Juveniles	Growth to Maturity
Spiny dogfish	*Squalus acanthias*	Adults	All
Splitnose rockfish	*S. diploproa*	Juveniles	Feeding

Common Name	Scientific Name	Lifestage	Activity
		Larvae	
Spotted ratfish	*Hydrolagus colliei*	Adults	All
		Juveniles	Growth to Maturity
Starry flounder	*Platichthys stellatus*	Adults	Growth to Maturity
		Juveniles	Feeding
Stripetail rockfish	*S. saxicola*	Adults	All
		Juveniles	Feeding, Growth to Maturity
Tiger rockfish	*S. nigrocinctus*	Adults	All
Vermilion rockfish	*S. miniatus*	Adults	All
Widow rockfish	*S. entomelas*	Adults	All
		Juveniles	Feeding, Growth to Maturity
Yelloweye rockfish	*S. ruberrimus*	Adults	All
Yellowtail rockfish	*S. flavidus*	Adults	All
Coastal Pelagic Species			
Northern anchovy	*Engraulis mordax*		
Pacific sardine	*Sardinops sagax*		
Pacific (chub) mackerel	*Scomber japonicus*		
Market squid	*Loligo opalescens*		
Jack mackerel	*Trachurus symmetricus*		
Pacific Salmon			
Coho Salmon	*Oncorhynchus kisutch*		
Chinook Salmon	*O. tshawytscha*		
Highly Migratory Species			
Common Thresher Shark	*Alopias vulpinus*		

*All refers to spawning, breeding, and feeding

A. Salmonids

Off the coast of Oregon ESA-listed Pacific salmon and steelhead species are known to occur as they enter the ocean as juveniles in the spring. Additionally, coho salmon are known to occur in surface streams in the vicinity of the terrestrial project area. Ocean dispersal and distribution varies widely among life stages, species and populations, and not all are likely to occur in the Project area. Salmon and steelhead that may occur in the action area originate from the Columbia River Basin, the Oregon coast, and the California coast.

In general, salmonids are low in abundance and exhibit a patchy distribution in U.S. West Coast waters when compared to other fishes, as evidenced by: 1) the low numbers of juvenile salmonids captured in directed pelagic surface/ subsurface research trawls relative to other nekton (Brodeur et al. 2004, Brodeur et al. 2005, Fisher et al. 2014, Peterson et al. 2010, Trudel et al. 2009); and by 2) low numbers of adult and subadult salmonids captured as bycatch in midwater trawls (e.g., commercial trawls for whiting, see Lomeli and Wakefield 2014). Juvenile salmonids are pelagic and typically surface-oriented, most often found in the upper 20 m of the water column (Emmett et al. 2004, Walker et al. 2007 Beamish et al. 2000). Their preferred prey types are also pelagic (e.g., copepods, euphausiids (*Euphausia pacifica* and *Thysanoessa spinifera*), and juveniles of northern anchovy (*Engraulis mordax*), Pacific herring (*Clupea pallasii*), sardines (*Sardinops sagax*), rockfishes (*Sebastes spp*.), and smelt (*Osmeridae*); Brodeur et al. 2005, Brodeur et al. 2007, Daly et al. 2009, Santora et al. 2012).

There are eight evolutionarily significant units (ESUs) of federally listed Chinook salmon that could occur in the Project area: Lower Columbia River, Upper Columbia River, Snake River spring/summer, Snake River fall-run, Upper Willamette River, California Coastal, Sacramento River winter-run, and Central Valley spring-run. Chinook salmon from these ESUs differ in their freshwater spawning and rearing locations, and differ somewhat in their marine distributions (Weitkamp 2010). Juvenile Chinook salmon tend to occur closer inshore than other juvenile salmonid species, generally within the 100 m isobath (Brodeur et al. 2004, Peterson et al. 2010). Juvenile Chinook salmon also tend to be more abundant off Washington in comparison to coastal waters of central and northern Oregon, likely reflecting more favorable habitat in Washington waters with a northwards migration after ocean entry (Bi et al. 2008, Peterson et al. 2010, Trudel et al. 2009).

There are four coho salmon ESUs that could occur in the Project area: the Lower Columbia River, the Oregon Coast, the Southern Oregon/Northern California Coast, and the Central California Coast ESU. Adult coho salmon tend to occur at shallower depths (< 40 m) than adult Chinook salmon (Walker et al. 2007).

There are nine listed DPSs of steelhead that may occur in the Project area: Lower Columbia River Distinct Population Segment (DPS), Middle Columbia River DPS, Upper Columbia River DPS, Snake River Basin DPS, Upper Willamette River DPS, Northern California Coastal DPS, California Central Valley DPS, and South-Central California Coast DPS. After rearing in freshwater streams for 1-4 years and migrating to the ocean in the spring, juvenile steelhead tend to move offshore quickly rather than use nearshore waters like other salmon. For example, Daly et al. (2014) captured tagged juvenile steelhead that migrated greater than 55km offshore of the Columbia River within 3 days. While at sea, steelhead are found in pelagic waters of the Gulf of Alaska principally within 10 m of the surface, though they sometimes travel to greater depths (Light et al. 1989).

Snake River ESU sockeye salmon enter the ocean and immediately begin migrating north, as no sockeye from the Columbia River have been caught south of the river’s mouth in 16 years of sampling in the Northern California Current (NMFS 2015). Therefore, it is unlikely that sockeye salmon would occur in the action area.

Columbia River ESU chum salmon juveniles may remain in the coastal area longer than other salmon before moving offshore to feed in pelagic ocean environments (Beamish et al. 2005). However, adult chum salmon are unlikely to occur in the Project area, because it is at the southern end of their range. Juveniles could occur in the Project area based on surveys along the Oregon coast (Brodeur et al. 2007, Fisher et al. 2007), but they generally migrate northward after ocean entry from the Columbia River (Beamish et al. 2005).

In addition to the salmonids listed above, coastal cutthroat trout (*Oncorhynchus clarki ssp*) are present within the Project area and may be affected by the construction and operation of the Project. Coastal cutthroat trout are not a federally listed species.

B. Other Marine Fishes

The Southern DPS of North American green sturgeon spend most of their lives in coastal marine waters, coastal bays, and estuaries along the Pacific coast. They spend about 15 years at sea before returning to spawn in their natal freshwater habitat, and spawn every 2 to 4 years thereafter (Moyle 2002). They spend summers in coastal waters typically <100 m deep along California, Oregon, and Washington, migrate north in the fall to as far as southeast Alaska, and then return in the spring (Erickson and Hightower 2007, Lindley et al. 2008). They occur on the bottom, although they can forage throughout the water column, feeding on benthic invertebrates and small fishes (Radtke 1966, Israel and Klimley 2006).

Models predict green sturgeon to have a high probability of presence in the Project area during all seasons (Huff et al. 2012) and occur at the same depths as the Project (Erickson and Hightower 2007, Huff et al. 2011). Close to the Project area, tagged green sturgeon spent longer durations in highly complex seafloor habitats (e.g., boulders) and tended to occur at depths of 20-60 m (Huff et al. 2011). Based on a tagging study near Reedsport, Oregon, green sturgeon most commonly occurred at depths of 50-70 m and were associated with flat, soft bottom habitat lacking high relief habitat (Payne et al. 2015), which is similar to the depth and habitat type of the Project site.

Tagged green sturgeon also occur at PMEC-SETS and PMEC-NETS, based on lines of 8 acoustic receivers placed at PMEC-NETS (1 line) and PMEC-SETS (2 lines) between October 2015 – January 2016, and April – October 2016 (Henkel 2017). Similar to Payne et al. (2015), most sturgeon moved through quickly (days) whereas others remained for longer periods (weeks or months) (Henkel 2017). Critical habitat is designated for nearshore waters to a depth of 60 fathoms (360 ft or 110 m) offshore Oregon for the southern DPS of the green sturgeon (50 CFR Part 226).

Southern DPS eulachon spend most of their life in the ocean and grow up to 12 inches in length and return to spawn at age 3 to 5 years (WDFW and ODFW 2001). Eulachon are typically found near the ocean bottom in waters of 20-150 m depth. In Oregon and Washington, eulachon are often captured as bycatch in the pink shrimp trawl fishery; in 2002–2010, the highest densities of eulachon were reported offshore of Astoria, Port Orford and Coos Bay, Oregon, with relatively lower densities off Newport in the Project area (Al-Humaidhi et al. 2012), suggesting that they could occur in the Project area but they are more likely to concentrate in other coastal Oregon waters.

C. Reptiles

Four sea turtles may occur in the Project area, leatherback sea turtle, loggerhead sea turtle, green sea turtle, and the olive ridley sea turtle.

Leatherback turtles occur along the Pacific coast of North America during summer and fall months, primarily feeding on cnidarians (jellyfish and siphonophores) but also on tunicates (pyrosomas and salps). Leatherback turtles are the most frequently observed sea turtle along the U.S. West Coast, however sightings have been infrequent and based on telemetry leatherbacks are typically farther offshore than the Project location (Benson *et al.*

2011). Benson et al (2011) used satellite tagging data to track leatherback turtle movements in the California Current, and noted forage areas off of Oregon and Washington in the continental shelf and slope habitat between the 200-2,000 m isobaths and particularly in waters adjacent to the Columbia River plume.

During the Oregon and Washington Marine Mammal and Seabird Survey, observers documented 16 leatherback turtles: five were located offshore of northern Oregon along the continental slope (Bruggeman et al. 1992). Climate change is likely to increase abundance and change the distribution of jellyfish, a major food source for leatherbacks (NMFS & FWS 2013). More specifically, during El Niño events the redistribution of their primary prey source (the jellyfish *Chrysaora fuscescens*) show a poleward and offshore re-distribution (NMFS 2010a). Critical habitat has been designated in the Pacific Ocean off areas of Washington, Oregon, and California (77 FR 4170). The area designated includes the offshore waters between Cape Flattery, Washington, and the Umpqua River (Winchester Bay), Oregon, out to the 2,000-m depth contour, and a similar area offshore California.

In Oregon and Washington, loggerhead records have been kept since 1958, with nine strandings recorded over approximately 54 years or less than one stranding every 6-years (NMFS 2013). Green sea turtles inhabit warm coastal waters and are rarely observed off the coastline of Washington, Oregon, or California (NMFS 2012a). The olive ridley sea turtle typically live in tropical and subtropical waters but individuals have been documented as far north as Alaska (NMFS & FWS, 2014). The olive ridley sea turtles are highly migratory and appear to spend most of their time in the oceanic zone and they are rarely observed in the West Coast Exclusive Economic Zone (EEZ) (NMFS 2012). This species is primarily pelagic, feeding on mid-water organisms, though it has been found in coastal areas.

D. Marine Mammals

Southern resident killer whales and humpback whales are known or likely to occur within the Project area (Carretta et al. 2017). Blue and fin whales are rarely sighted off the coast in Oregon's coastal waters, but there were four sightings of blue whales near the Oregon coast during shipboard surveys between 1991 and 2008 (Carretta et al. 2017) and OSU detected one fin whale during surveys conducted from October 2013 to September 2015 (a total of 35 cruises) in the Project area (Henkel et al. 2016). Therefore, blue and fin whales could infrequently occur in the action area. Based on the 1991-2008 shipboard surveys off Oregon, sei and sperm whales would not be expected to occur within the action area due to their offshore distribution (Carretta et al. 2017).

The most current population (June 16, 2018) for southern resident killer whales is 75 animals (census count occurs every year), divided between three pods (J, K, and L pods) that mainly reside in waters around the Puget Sound with K and L ponds spending more time offshore (Center for Whale Research 2018, Carretta et al. 2017 & Ford et al. 2000). Although they have the potential to occur along the outer coast (outside of Puget Sound) at any time during the year, they are more likely to occur along the outer coast from late autumn to early spring (73 FR 4176). Surveys from aircraft conducted offshore of northern California, Oregon, and southern Washington in 2011 and 2012 detected few killer whales (total of 12 individuals), and these were reported at greater depths (e.g., further offshore, 100–2,000 m depth) than the Project area (Adams et al. 2014). However, killer whale vocalizations were detected on four different occasions in April and May 2014 by an acoustic lander deployed inshore of the WEC deployment area (Haxel 2016), which indicates their presence in the action area. During vessel based, standard-line transect surveys conducted from October 2013 to September 2015 (a total of 35 cruises) in the Project area, a total of 4 killer whales were observed (Henkel et al. 2016).

Humpback whales are commonly observed off the California, Oregon, and Washington coasts in spring, summer, and fall (NMFS 2012b). Past (Green et al. 1992) and recent (Tynan et al. 2005) studies noted summer concentrations of humpback whales in upwelled waters over Heceta Bank (about 15-30 miles offshore of Lincoln and Lane counties, Oregon), where they presumably gather for feeding opportunities and preferred sea surface salinity. NOAA also identified Stonewall and Heceta Banks as a “biologically important area” for humpback whale feeding according to its Cetacean Density and Distribution Mapping Working Group (Calambokidis et al. 2015).

Surveys from aircraft conducted offshore of northern California, Oregon, and southern Washington in 2011 and 2012 frequently detected humpback whales (114 sightings of 264 total individuals), although most were reported at deeper depths (100–2,000 m depth) than the Project area, with the exception of higher densities reported inshore at focal areas located both south and north of the Project area (Adams et al. 2014). OSU detected humpback whales vocalizations during underwater noise monitoring at the “nearshore” sampling site east of the Project site (Haxel 2016), and a total of 20 humpback whales were observed during vessel-based, standard line transect surveys conducted from October 2013 to September 2015 (a total of 35 cruises) in the Project area (Henkel et al. 2016).

The offshore waters of Washington, Oregon, and California are thought to be important feeding areas for blue whales in the summer and fall (Carretta et al. 2009). Surveys from aircraft conducted offshore of northern California, Oregon, and southern Washington in 2011 and 2012 detected a few blue whales (10 sightings of 16 total individuals), most of which were in inner shelf waters (0–100 m depths) offshore of Oregon (Adams et al. 2014). OSU did not detect blue whales during vessel-based, standard-line transect surveys conducted from October 2013 to September 2015 (a total of 35 cruises) in the Project area (Henkel et al. 2016). NOAA did not identify the action area as a "biologically important area" for blue whale feeding (Calambokidis et al. 2015).

Surveys from aircraft conducted offshore of northern California, Oregon, and southern Washington in 2011 and 2012 only detected fin whales (6 sightings of 13 total individuals) at depths of >200 m (Adams et al. 2014). In shipboard surveys conducted off Oregon from 1991-2008, all but one fin whale were found much further offshore than PMEC-SETS (Carretta et al. 2015). OSU only detected one fin whale during vessel-based, standard-line transect surveys conducted from October 2013 to September 2015 (a total of 35 cruises) in the Project area (Henkel et al. 2016).

Sei whales are rarely seen off the Washington, Oregon, and California coasts; when observed, individuals are in oceanic waters, much further offshore than where PMEC-SETS is located (Carretta et al. 2015). Surveys out to a distance of 300 nautical miles in 2005 and 2008 resulted in an abundance estimate of 126 sei whales off of Washington, Oregon, and California (Carretta et al. 2015). Surveys from aircraft conducted offshore of northern California, Oregon, and southern Washington in 2011 and 2012 did not detected any sei whales (Adams et al. 2014). OSU did not detect any sei whales during vessel-based, standard-line transect surveys conducted from October 2013 to September 2015 (a total of 35 cruises) in the Project area (Henkel et al. 2016).

Sperm whales primarily prey on other deep water species, like squid, and are rarely found in waters less than 300 m deep (NMFS 2010b). Based on surveys out to a distance of 300 nautical miles from 1991 to 2008, sperm whales are found in oceanic waters offshore of Oregon, much further offshore than where PMEC-SETS is located, and their abundance ranged between 2,000 and 3,000 animals (Carretta et al. 2015). Surveys from aircraft conducted offshore of northern California, Oregon, and southern Washington in 2011 and 2012 only detected sperm whales (2 sightings of 3 total individuals) at depths of >200 m (Adams et al. 2014). OSU did not detect any sperm whales during vessel-based, standard-line transect surveys conducted from October 2013 to September 2015 (a total of 35 cruises) in the Project area (Henkel et al. 2016).

Although Eastern North Pacific (ENP) gray whales are not federally listed, they are primarily found in shallow water and the majority of gray whales follow the coast during migration, staying close to the shoreline except when crossing major bays, straits, and inlets (Braham 1984). Gray whales migrate closest to the Washington/Oregon coastline during the spring months (April-June), when most strandings are observed (Norman *et al.* 2004). Oretega-Ortiz and Mate (2008) tracked the distribution and movement patterns of gray whales off Yaquina Head, slightly north of the action area (~44.7ºN) during the southbound and northbound migration in 2008. A total of 192 whale locations were obtained from scan sampling during an observational study in 2007 & 2008; 58 during southbound migration, 90 during Northbound A migration, and 44 during Northbound B migration (Lagerquist et al. 2017). The average distance from shore to tracked whales ranged from 200 to 13,600 meters; average bottom depth of whale locations was 12-75 meters. The migration paths of tracked whales seemed to follow a constant depth rather than the shoreline. The highest risk period occurs when young calves are migrating from southern lagoons to northern seas during April 1 - June 15. Biologically important areas (BIAs) for the eastern north pacific population of gray whales have been identified for migration and feeding (Calambokidis et al. 2015). The Oregon coast migratory BIAs are based off of each migratory phase extending 10 km for southbound migration, 8 km for northbound phase A and 5km for northbound phase B migration, with an additional 47 km from the coastline added to buffer each BIA (Calambokidis et al. 2015). The Pacific Coast Feeding Group (a distinct local subpopulation of ENP gray whales) feeding BIA is identified as a 199 square km area off of Depoe Bay, Oregon according to its Cetacean Density and Distribution Mapping Working Group (Calambokidis et al. 2015).

Eastern North Pacific Right whales have historically occurred along the West Coast and have been reported as far south as central Baja California in the eastern North Pacific, as far south as Hawaii in the central North Pacific, and as far north as the sub-Arctic waters of the Bering Sea and sea of Okhotsk. Migration patterns of the North Pacific right whale are unknown, although it is assumed the whales spend the summer in far northern feeding grounds and migrate south to warmer waters, such as southern California, during the winter. However, Shelden (2006) suggests that records of right whales in southern California and Hawaii likely represent vagrant individuals. Since 1950, there have been at least 3 sightings from Washington coast, fourteen from California coast, two from Baja California, Mexico, and three from Hawaii (Brownell et al. 2001). The last sighting of a North Pacific Right whale off Washington was in 1992 (Rowlett et al. 1994) and a group of 2-3 individuals were observed off Three Arch Rocks in northern Oregon in 1994 (ODFW 2013). The western Gulf of Alaska and the southeastern Bering Sea are both frequently used areas primarily in the 50-100m isobaths (NMFS 2017d). There are no reliable estimates of current abundance however the population is likely to be very small, and has been estimated to consist of approximately 30 individuals (NMFS 2013).

E. Essential Fish Habitat (EFH)

The MSA (section 3) defines EFH as "those waters and substrate necessary to fish for spawning, breeding, feeding, or growth to maturity." Adverse effects occur when EFH quality or quantity is reduced by a direct or indirect physical, chemical, or biological alteration of the waters or substrate, or by the loss of (or injury to) benthic organisms, prey species and their habitat, or other ecosystem components. Adverse effects on EFH may result from actions occurring within EFH or outside of it and may include site-specific or EFH-wide impacts, including individual, cumulative, or synergistic consequences of actions (50 CFR 600.810). Pursuant to the Magnuson-Stevens Act, EFH has been designated for each of these groups, and all waters within and adjoining the Project area constitute EFH for these groups.

Specifically, EFH has been designated as follows (PMFC 2013): (1) *Groundfish* - Water depths less than or equal to 3,500 m (11,483 feet) to the mean higher high water level or the upriver extent of saltwater intrusion, defined as upstream and landward to where ocean-derived salts measure less than 0.5 parts per thousand during the period of average annual low flow; seamounts in depths greater than 3,500 m (11,483 feet) as mapped in the EFH assessment GIS data; and areas designated as habitat areas of particular concern not already identified by the above criteria; (2) *Highly migratory species* - Varies by species;

(3) Salmon - All waters of the United States between the Canadian border and the Mexican border and out 200 miles (370 km) to the western extent of the Exclusive Economic Zone;
(4) Pelagic - All waters of the United States from the Canadian border to the Mexican border and out 200 miles (370 kilometers) to the western extent of the Exclusive Economic Zone.

The Pacific Fishery Management Council (PFMC) has designated rocky reef habitats as Habitat Areas of Particular Concern (HAPCs), which are distinct subsets of EFH and are considered high priority areas for conservation, management, or research because they are rare, sensitive, stressed by development, or important to ecological function.

VII. PROJECT IMPACTS

The Project has significant impacts on anadromous fish, sea turtles, marine mammals, and the habitats they use in the Pacific Ocean and ocean tributaries. These impacts include, but are not limited to, the following:

- Alteration of Habitat due to:
  - Suspended sediment during installation and redeployment of WECs
  - Disturbance of the benthic community from Project structures
  - Changes to marine community composition and behavior (e.g., use patterns, attraction and avoidance)
  - Potential water quality contamination due to an inadvertent release of toxic substances during installation, operation, and maintenance activities (e.g. antifouling paints and accidental spills of hazardous material)

- Construction effects to surface streams including:
  - Temporary work area isolation and fish salvage
  - Physical habitat disturbance (riparian vegetation removal, substrate/wood debris displacement, & decreased prey abundance)
  - Increased in turbidity and sediment loading
  - Potential for hazardous material or drilling fluid releases

- Underwater Sound generated by:
  - Vessel Noise
  - Horizontal Directional Drilling (HDD)
  - WEC operation

- Electromagnetic Fields generated by:
  - WECs
  - Umbilical cables (connecting the WECs to the subsea connectors)
  - Hubs and subsea connectors
  - Subsea cables to shore

- Risk of Entanglement & Collision

The Project affects fish, sea turtles, marine mammal populations and their habitats in the Project area. These areas include: (1) 2 square nautical mile (1,695 acres) WEC deployment area; (2) 2 square nautical mile cable corridor, (3) terrestrial cable connection point at Driftwood Beach State Recreation Site, (4) buried terrestrial cables that cross ocean tributaries, and (5) the Utility Connection and Monitoring Facility (UCMF). The Project area also includes the acoustic environment around the WEC deployment area to a distance of 125 m (410 ft), a vertical and horizontal distance of 3 m beyond each subsea cable during installation, and the vessel traffic corridor between the WEC deployment area and the primary staging point, Newport Harbor, Lincoln County, Oregon. Non- anadromous fish and other aquatic species in the Pacific Ocean and within the ocean tributaries may also be affected.

As noted above in Section VI, there are 35 fish, reptile, and marine mammal species listed under the ESA that may occur in the area.

RESOURCE MANAGEMENT PLANS

In developing its preliminary terms and conditions, NMFS considered the following resource management plans as described in Table 4:

Table 4. Resource Management Plans

Resource Management Plans		Citation
	NOAA Fisheries West Coast Region Strategic Plan 2016-2020	NMFS 2015a
Salmonids	5-Year Reviews: Summary and Evaluations	
	Lower Columbia River Chinook, Chum, Coho, and Steelhead	NMFS 2016a
	Upper Columbia River Steelhead and Spring-Run Chinook Salmon	NMFS 2016b
	Middle Columbia River Steelhead	NMFS 2016c
	Snake River Sockeye, Spring-Summer Chinook, Fall-Run Chinook, and Steelhead	NMFS 2016d
	Upper Willamette River Steelhead and Chinook Salmon	NMFS 2016e
	California Coastal Chinook Salmon, Northern California Steelhead, and Central California Coast Steelhead	NMFS 2016f
	California Central Coast Steelhead	NMFS 2016g
	Sacramento River Winter-Run Chinook Salmon ESU	NMFS 2016h
	Central Valley Spring-Run Chinook Salmon ESU	NMFS 2016i
	Central Valley Steelhead DPS	NMFS 2016j
	Oregon Coast Coho Salmon	NMFS 2016k
	Southern Oregon/Northern California Coast Coho Salmon	NMFS 2016l
	Central California Coast Coho Salmon	NMFS 2016m
	South-Central California Coast Steelhead Distinct Population Segment	NMFS 2016n
	Status Review Update for Pacific Salmon and Steelhead Listed under the Endangered Species Act: Pacific Northwest	NWFSC 2015
	Recovery Plans	
	Upper Columbia River Spring-Run Chinook and Upper Columbia Steelhead Recovery	UCSRB 2007
	Snake River Sockeye Salmon	NMFS 2015b
	Snake River Fall Chinook	NMFS 2017a
	Snake River Spring/Summer Chinook Salmon	NMFS 2017b
	Upper Willamette River Conservation and Recovery Plan for Chinook Salmon and Steelhead	ODFW & NMFS 2011
	Lower Columbia River Chinook, Chum, Coho, and Steelhead	NMFS 2013a

	Oregon Coast Coho Salmon	NMFS 2016o
	Southern Oregon/Northern California Coast Coho Salmon	NMFS 2014a
	Sacramento Winter-Run Chinook, Central Valley Chinook Spring-Run, and Steelhead	NMFS 2014b
	California Coastal Chinook Salmon, Northern California Steelhead, and Central California Coast Steelhead	NMFS 2016p
	Species in the Spotlight Priority Actions: 2016-2020	
	Sacramento River Winter-Run Chinook Salmon ESU	NMFS 2016q
	Central California Coast Coho Salmon	NMFS 2016r
Other Marine Fish Species	5-Year Reviews: Summary and Evaluations	
	Southern Distinct Population Segment of the North American Green Sturgeon (DRAFT)	NMFS 2018
	Southern Distinct Population Segment of Eulachon	NMFS 2016s
	Recovery Plans	
	Southern Distinct Population Segment of the North American Green Sturgeon	NMFS 2015d
	Southern Distinct Population Segment of Eulachon	NMFS 2017c
Sea Turtles	5-Year Reviews: Summary and Evaluations	
	Leatherback Sea Turtle	NMFS & USFWS 2013
	Green Turtle	Seminoff et al. 2015
	Loggerhead Turtle	Conant et al. 2009
	Olive Ridley Sea Turtle	NMFS & USFWS 2014
	Recovery Plans	
	Leatherback Sea Turtle	NMFS & USFWS 1998a
	Green Turtle	NMFS & USFWS 1998b
	Loggerhead Turtle	NMFS & USFWS 1998c
	Olive Ridley Sea Turtle	NMFS & USFWS 1998d
	Species in the Spotlight Priority Actions: 2016-2020	
	Pacific Leatherback Sea Turtle	NMFS 2016t
	Other Resource Management Plans	
	Biological Report on the Designation of Marine Critical Habitat for the Loggerhead Sea Turtle	NMFS 2013c
Marine Mammals	5-Year Reviews: Summary and Evaluations	

	Southern Resident Killer Whales	NMFS 2016u
	Humpback Whale	Bettridge et al. 2015
	Fin Whale	NMFS 2011a
	Sei Whale	NMFS 2012
	Sperm Whale	NMFS 2015c
	Eastern North Pacific Right Whale	NMFS 2017d
	Recovery Plans	
	Southern Resident Killer Whales	NMFS 2008
	Humpback Whale	NMFS 1991
	Fin Whale	NMFS 2010a
	Sei Whale	NMFS 2011b
	Sperm Whale	NMFS 2010b
	Blue Whale	NMFS 1998
	North Pacific Right Whale	NMFS 2013d
	Species in the Spotlight Priority Actions: 2016-2020	
	Southern Resident Killer Whales	NMFS 2016v
	Other Resource Management Plans	
	Monitoring Plan for Nine Distinct Population Segments of the Humpback Whale	NMFS 2016w
	U.S. Pacific Marine Mammal Stock Assessment of 2016	NMFS 2017e
	2015 Whale Entanglements off the West Coast of the United States	NMFS 2016x
	Technical Guidance for Assessing the Effects of Anthropogenic Sound on Marine Mammal Hearing: Underwater Acoustic Thresholds for Onset of Permanent and Temporary Threshold Shifts.	NMFS 2016y

FERC needs to ensure that the Project is consistent with these resource management plans.

VIII. NMFS' RESOURCE MANAGEMENT GOALS AND OBJECTIVES FOR MARINE SPECIES AFFECTED BY THE PROJECT

NMFS is responsible for the stewardship of the Nation's living marine resources and their habitats. In NMFS' Protected Resources Strategic Plan: 2016-2020 (NMFS 2016), one of its stated goals is to "stabilize the most critically endangered species and improve populations of those species nearing recovery." Through this goal, the Species in the Spotlight Initiative was developed to "guide agency actions to make critical investments that safeguard the most endangered species and provide the final catalyst for recovery of those species with healthy population levels." Species in the Spotlight are based on species that are listed as endangered, have populations that continue to decline, and the best available information points to their extinction, if no action is taken. Of the eight species that are highlighted under the Species in the Spotlight Initiative, four species are within the Project area. Those species are the Central California Coast Coho Evolutionarily Significant Unit (ESU), Sacramento River Winter-run Chinook ESU, Southern Resident Killer Whale Distinct Population Segment (DPS), and the Pacific Leatherback Sea Turtle. The plan also states an agency goal of focusing efforts to improve the status of species with stable or growing populations so that they can be considered for downlisting from endangered to threatened, or delisting under the ESA. The more specific Species in the Spotlight Initiative objectives for this project are stated below.

A. Central California Coast Coho ESU & Sacramento River Winter-Run Chinook ESU

NMFS' recovery strategy for Central California Coast coho salmon and the Sacramento River Winter-run chinook ESU outlines priorities on watersheds and inland areas in the state of California. The Project and the geographic location of the Project does not have any influence on NMFS' recovery strategy goals for the Central California Coast coho salmon or the Sacramento River Winter-run chinook ESU therefore the Project does not need to consider this recovery strategy.

B. Southern Resident Killer Whale DPS

NMFS' recovery strategy for Southern Residents outlines the following priorities: (1) protect killer whales from harmful vessel impacts through enforcement, education, and evaluation; (2) target recovery of critical prey; (3) protect important habitat areas from anthropogenic threats; (3) Improve our knowledge of Southern Resident Killer Whale health to advance recovery; and (4) raise awareness about the recovery needs of Southern Resident Killer Whales and inspire stewardship through outreach and education.

C. Pacific Leatherback Sea Turtle

NMFS' recovery strategy for Pacific leatherback sea turtles outlines the following priorities: (1) reduce fisheries interactions; (2) improve nesting beach protection and increase reproductive output; (3) international cooperation; (4) monitoring and research; and (5) public engagement.

Inclusion of Conditions in Environmental Assessment or Environmental Impact Statement

NMFS requests that FERC include all the following preliminary recommended conditions in Appendix I considered in the Environmental Assessment for this licensing action. We note that FERC has agreed to include coordinated agency conditions such as these in NEPA analysis, pursuant to the Interagency Task Force for Hydropower Relicensing

(FERC, Interagency Task Force Report on NEPA Procedures in FERC Hydroelectric Licensing, December 8, 2000).

IX. SECTION 10(j) PRELIMINARY RECOMMENDED TERMS AND CONDITIONS

Pursuant to section 10(j) of the FPA, 16 USC 803(j), NMFS provides the following preliminary recommended terms and conditions which are necessary for the protection, mitigation, and enhancement of marine resources adversely affected by the Project. We recommend that these preliminary terms and conditions be incorporated into any license issued for the Project.

NMFS, in crafting its preliminary recommendations for the protection, mitigation, and enhancement of marine resources in the proposed license, has drawn upon its expertise and the best available biological and engineering information in order to produce a cohesive package of measures that, if adopted by FERC, would likely provide adequate protection of marine resources affected by the Project. Each of NMFS' recommendations is supported by substantial evidence contained in the record. NMFS has included an index to the administrative record for this filing and will file updated or supplemental supporting information during the proceeding, as necessary.

NMFS expects that measures included in the Appendix I Protection, Mitigation, and Enhancement Measures will still be implemented as described even if they are not included among our preliminary section 10(j) recommended terms and conditions.

A. Measure 1. Electromagnetic Fields

Recommendation:

The Licensee shall take the following measures to minimize and mitigate for potential impacts of electromagnetic fields on marine resources as implemented in Appendix I: Protection, Mitigation, and Enhancement Measures.

Description of Primary Components of Mitigation for Electromagnetic Fields

Mitigation Measure 1 of the Appendix I: Protection, Mitigation, and Enhancement Measures, describes future operations of the Project as proposed as part of the Pacific Marine Energy Center- South Energy Test Site Appendices to Preliminary Draft Environmental Assessment, related to electromagnetic fields. These actions include the following:

- *Subsea Cables and Electrical Infrastructure*
- *EMF Monitoring Plan*
- *Verifying Model Results*
- *EMF Exceedance*

Each of these items is briefly summarized below. These activities are required as part of the plan to ensure compliance with electromagnetic fields, and allow flexibility, as defined in Mitigation Measure 1, to adjust certain items as determined necessary based on new information.

(1) Subsea Cables and Electrical Infrastructure. The licensee shall bury subsea cables to a depth of 1- 2 meters, and utilize shielding on subsea cables, umbilicals, and other electrical infrastructure (including, to the extent feasible, hubs and subsea connectors) to minimize electromagnetic field

(EMF) emissions, to the maximum extent practicable.

(2) EMF Monitoring Plan. The licensee shall implement the EMF Monitoring Plan attached in Appendix H. This monitoring plan may be modified in accordance with the Adaptive Management Framework attached as Appendix J.

(3) Verifying Model Results. If, after eight (8) different WECs have been tested, EMF measurements validate modeled predictions (meaning that 80% of field measurements from the eight (8) different WECs tested do not exceed model predictions by more than 20%), then no additional field measurements will be taken except as explicitly set forth below. If field measurements exceed model predictions by more than 20%, the model will be refined to reflect knowledge gained during field measurements and field measurements will continue pursuant to the EMF

Monitoring Plan until such standard has been met.

Once the model has been validated as provided above, new field measurements verifying model results would only be conducted for the following scenarios:

- *WECs with greater power generation capabilities (rated capacity that is 30% greater than previously studied);*
- *more WECs per berth than previously measured are operational; or*
- *where field monitoring is required under section 4, below, to ensure mitigation actions are successful.*

(4) EMF Exceedance. If the results of field measurements or validated and reliable modeling results indicate levels in excess of biologically relevant levels (e.g., 3 milliteslas (mT), Woodruff et al. 2012,

Normandeau et al. 2011 or newer data) at a distance equal to or greater than 10 m from WECs, the licensee shall notify the AMC forty-eight (48) hours after determining than an *exceedance has occurred and shall implement or shall instruct the relevant WEC testing client to implement the following mitigation actions:*

- *Within sixty (60) days, investigate the source of the exceedance and, based on the results, implement one of the following, to the extent practicable:*
    - *Install additional shielding of project components; or*
    - *Make repairs to Project component(s) to address the exceedance.*
- *Conduct subsequent field monitoring as appropriate within sixty (60) days and notify the AMC within fourteen (14) days following field measurements, to verify that the excess EMF levels associated with the test have been abated.*

If, after taking the steps above, levels cannot be mitigated to below the identified threshold, the licensee shall provide or shall instruct the relevant WEC testing client to provide to the AMC within thirty (30) days a draft plan to implement the following mitigation actions described below. The draft plan shall include a proposed implementation timeline and monitoring provisions to confirm whether the measures were effective. Upon approval of a plan by the AMC pursuant to the AMF attached as Appendix J, the licensee shall ensure that the plan is implemented in accordance with the approved plan and timeline. In no circumstances shall implementation of the plan be undertaken at a time that would jeopardize human safety, property or the environment.

- *Address the potential adverse effect of the levels produced by taking one or more of the following additional mitigation actions or other measures agreed on by the licensee and the AMC:*
    - *Delay subsequent deployment of additional WEC(s) of the specific model that generated EMF above thresholds until resolution of the issue is achieved;*

  - *Investigate interactions of the EMF generated by the WEC(s) at issue and species that are sensitive to EMF; or*
  - *Relocate, remove or cease testing one or more WECs until appropriate measures to ensure levels are below the mitigation threshold can be taken and are successful.*
- *Ensure that the identified action is carried out; and*
- *Conduct subsequent field monitoring and analysis as appropriate within sixty (60) days to verify that the excess EMF levels associated with the test have been abated and inform the AMC within fifteen (15) days following completion of analysis.*

The Licensee shall submit the draft plan to the AMC for approval pursuant to the AMF attached at Appendix J and, upon approval, shall implement or instruct the WEC testing client to implement the plan.

Rationale for Mitigation for Electromagnetic Fields

Electromagnetic fields (EMF) will be generated and transmitted by the WECs, the umbilical cables, the hubs, the subsea connectors, and the subsea cables to shore. Electric field detection occurs by fishes with specialized electroreceptors that include electroreceptive elasmobranchs (e.g., sharks, skates, and rays) and holocephalans (e.g., ratfish), and electrosensitive agnatha (e.g., lamprey), acipenseriformes (e.g., sturgeon), and some teleost fish (Normandeau Associates et al. 2011, Gill et al. 2014). Other species in the Project area that may be capable of detecting magnetic fields include Dungeness crab, salmonids, sturgeon, and sea turtles (Normandeau Associates et al. 2011).

Fish, in particular salmonids and scombrids (e.g., tuna), have a magnetite receptor system and respond to magnetic fields in the 10–12 μT range (Normandeau Associates et al.

2011). Eulachon behavior (e.g., orientation or migration) may potentially be affected by EMF; however, there are no specific studies conducted on their sensitivities (Normandeau Associates et al. 2011).

Sea turtles are sensitive to magnetic fields. Experimental and behavioral studies have been done primarily on loggerhead and green sea turtles. Sensitivity ranges for the loggerhead and green sea turtles were identified in the 0.000469-4,000 µT range for loggerhead turtle and 29.3-200µT range for green turtle (Normandeau Associates et al. 2011). Turtles are capable of sensing magnetic fields from undersea cables and can deviate from their original direction due to an altered natural magnetic field, however, it is still unknown as to how sea turtles detect or process fluctuations in the earth's magnetic field (Normandeau Associates et al. 2011).

Most effects are assumed to be minor and limited to a close distance (meters), with the exception of elasmobranchs that are considered to be the most vulnerable because of their high sensitivity and use of EMF for important behaviors (e.g., prey detection) (Normandeau et al. 2011, Gill et al. 2014).

The majority of the subsea cables will be buried and shielded, however there is some uncertainty related to EMF transmission on how modeling results apply to the Project site specific EMF characteristics and WEC types and subsea connectors that will be deployed through the license term. These measures are intended to provide increased certainty about EMF transmission at the Project site and to determine if any effects to marine species are minor and limited in scope.

B. Measure 2. Benthic Habitat Disturbance from Anchors, WECs and Other Equipment during Operation, Maintenance, and Monitoring Activities

Recommendation:

The Licensee shall take the following measures to minimize and mitigate for potential impacts to benthic habitat from anchors, WECs, and other equipment during operation, maintenance and monitoring activities in Appendix I: Protection, Mitigation, and Enhancement Measures.

Description of Primary Components of Mitigation for Benthic Habitat Impacts from Anchors, WECs, and Other Equipment during Operation, Maintenance, and Monitoring Activities

Mitigation Measure 2 of the Appendix I: Protection, Mitigation, and Enhancement Measures, describes future operations of the Project as proposed as part of the Pacific Marine Energy Center- South Energy Test Site Appendices to Preliminary Draft Environmental Assessment, related to benthic habitat impacts from anchors, WECs, and other equipment during operation, maintenance, and monitoring activities. These actions include the following:

- *Anchors*
- *Benthic Habitat Monitoring Plan*
- *Project Site Box Coring*
- *Cable Route Box Coring*
- *Vessel Anchoring Plan*

Each of these items is briefly summarized below. These activities are required as part of the plan to ensure compliance with benthic disturbance, and allow flexibility, as defined in

Mitigation Measure 2, to adjust certain items as determined necessary based on new information.

(1) Anchors. Recognizing that WEC testing clients may require installation of WEC-specific mooring systems, the licensee shall minimize installation-removal cycles by encouraging WEC testing clients to reuse anchors already in place where practicable.

(2) Benthic Habitat Monitoring Plan. The licensee shall implement the Benthic Habitat Monitoring Plan attached in Appendix H. This monitoring plan may be modified in accordance with the Adaptive Management Framework attached as Appendix J. If monitoring results indicate that WEC anchors or project components on the seafloor have a statistically significant adverse impact (changes beyond the range of seasonal/inter-annual variability) on macrofaunal species composition or abundance at the nearest monitored location outside any individual test berth site (as detailed in 3d below), the licensee shall provide to the AMC within thirty (30) days a draft plan to implement one of the following mitigation actions described below. The draft plan shall include a proposed implementation timeline and monitoring provisions to confirm whether the measures were effective. Upon approval of a plan by the AMC pursuant to the AMF attached as Appendix J, the licensee shall ensure that the plan is implemented in accordance with the approved plan and timeline. In no circumstances shall implementation of the plan be undertaken at a time that would jeopardize human safety, property or the environment.

- *Limit use of specific anchor types in future installations;*
- *Modify and manage deployment frequency or location to allow for recovery of macrofauna;*

- *Use permanent anchoring systems (e.g., for the life of the project); or*
- *Conduct additional monitoring as described below.*

The Licensee shall submit the plan to the AMC for approval pursuant to the AMF attached at Appendix J, and, upon approval, shall implement or instruct the WEC testing client to implement the plan.

(3) Project Site Box Coring. Once the Licensee has conducted five (5) years of post-installation project site box coring sampling under the Benthic Habitat Monitoring Plan with at least nine (9) anchors in place, and upon completion of any subsequent five-year implementation periods as described below, the licensee will modify monitoring efforts as follows:

a) If no statistically significant differences in sediment characteristics (percent silt-clay, median grain size) are observed within or at reference stations outside of test berths, as compared to either pre-installation conditions or reference stations, the licensee shall not be required to conduct further box core surveys.

b) If statistically significant differences are detected in the sediment characteristics within the berths, but no statistically significant differences are detected in macrofaunal characteristics (abundances or diversity) within the berths and no statistically significant differences in sediment characteristics or macrofaunal characteristics are detected at the reference stations outside of the project area, then the licensee shall document project-related changes to sediment characteristics and shall not be required to conduct further box core surveys.

c) If statistically significant differences in macrofaunal characteristics are detected within the berths, but no changes in sediment or macrofaunal characteristics are detected at reference *stations outside of the project area, then the licensee shall continue to conduct project-site box core sampling as described in the Benthic Habitat Monitoring Plan for another five years and repeat the assessment set forth in these sections (1) through (4) If, at the end of the license term, and the licensee proposes to surrender the license, previously occupied berths will be sampled to assess post-decommissioning recovery.*

d) If statistically significant differences in both sediment and macrofaunal characteristics are detected at locations outside of any individual test berth that are beyond the range of seasonal/inter-annual variability expected based on six (6) years of surveys at PMEC-NETS and two (2) years of site characterization surveys at PMEC-SETS), the licensee shall develop a revised Benthic Habitat Monitoring Plan for the AMC's approval, which may include sampling additional box core stations further away from the project to find the edge of the effect.

(4) <u>Cable Route Box Coring</u>. Once the licensee has conducted the initial two seasons of post installation cable route box coring surveys under the Benthic Monitoring Plan, the licensee will modify monitoring efforts as follows:

a) If no statistically significant differences in sediment characteristics are observed in the post installation survey as compared to the pre-installation survey in the same season, the licensee shall not be required to conduct further box core sampling of the cable routes.

b) If statistically significant differences are detected in the sediment characteristics but no differences are detected in macrofaunal characteristics (abundances or diversity), cable route (as defined in Figure A-12 of License Application) sampling will continue as described for two more seasons to assess whether sediment characteristics will return to pre-installation *conditions and/or if there are detectable changes to macrofaunal characteristics over time. If, after the additional two seasons of cable route sampling, there are still no detectable changes to macrofaunal characteristics, the licensee shall not be required to conduct further box core sampling of the cable routes.*

c) If statistically significant differences in both sediment and macrofaunal characteristics are detected in the transect closest to the cable route but not along the reference transects, sampling will continue for two more seasons to assess whether these changes spread beyond the cable corridor to the references transects. If, after the additional two seasons or cable corridor sampling, changes are still limited to the cable corridor, the licensee shall not be required to conduct further box core sampling of the cable routes.

d) If statistically significant differences in both sediment and macrofaunal characteristics are detected in the cable route and the reference transects (either initially or after any additional sampling seasons as described above), that are beyond the range of expected seasonal/interannual variability (previous determined through six (6) years of surveys at PMEC-NETS and two (2) years of site characterization surveys at PMEC-SETS), the licensee shall develop a revised Benthic Habitat Monitoring Plan for AMC approval which may include sampling additional box core stations further away from the cable routes to find the edge of the effect.

(5) Vessel Anchoring Plan. For any Project vessels that may anchor at the project site, the licensee will develop an anchoring plan or protocol for such activity that:

- *Avoids anchoring in known rocky reef or hard substrate habitats to the maximum extent practicable; and*

- *Minimizes the use of anchors within the project area wherever practicable by combining maintenance, monitoring and observational site activities.*

Rationale for Benthic Habitat Impacts from Anchors, WECs, and Other Equipment During Operation, Maintenance, and Monitoring Activities

The subsea cables, subsea connectors, and anchors will result in both temporary and long-term alterations of benthic habitat in the Project area. Temporary disturbances may be recurring at various intervals over the 25-year term of the project if anchors and other bottom components are removed and re-installed for different devices under test. The subsea cables, extending from the subsea connectors to the HDD conduits near shore, would be installed in trenches 1 to 2 m below the seafloor using jet plowing or other trenching methods. This would cause temporary displacement of unconsolidated sediments as the cable is buried. Benthic and infaunal organisms (e.g., amphipods, bivalves, and polychaetes) within the pathway of the plow would be removed, displaced, or killed during the trenching process. Additionally, as the plow moves along the seafloor, slow-moving infaunal or surface dwelling organisms located in the path of the plow's skids or wheels that span the trench likely would be killed. Mobile invertebrates (e.g., crabs), fish species that feed on or near the bottom, and species that shelter on the bottom at times would likely move away from the immediate vicinity of the anchors and cable and move to nearby areas during deployment and removal activities.

While direct effects to the benthic community are not anticipated to be significant, they could result in indirect effects to the local marine community. Colonization of biofouling species on Project structures as well as attraction by structure-oriented invertebrates and fishes could change the local marine species composition, which could affect predator/prey interactions. This mitigation measure identifies benthic habitat impacts from anchors, WECs, *and other equipment that will monitor changes to the sediment characteristics in the vicinity of bottom-mounted WEC components (e.g. anchors) to determine changes to benthic macrofaunal invertebrate communities.*

C. Measure 3. Entanglement or Collision

Recommendation:

The Licensee shall take the following measures to minimize and mitigate for potential impacts for marine species entanglement or collision in Appendix I: Protection, Mitigation, and Enhancement Measures.

Description of Primary Components of Mitigation for Entanglement or Collision

Mitigation Measure 3 of the Appendix I: Protection, Mitigation, and Enhancement Measures, describes future operations of the Project as proposed as part of the Pacific Marine Energy Center- South Energy Test Site Appendices to Preliminary Draft Environmental Assessment, related to marine species entanglement of fishing gear on Project components that may increase the risk of marine species entanglement or collision during operation activities. The following measures to minimize risk of entanglement or collision include the following:

- *Design and Maintenance*
- *Opportunistic Observations*
- *Surface Surveys*
- *Subsurface Surveys*
- *Entangled Fishing Gear Identified*
- *Development of Monitoring Plan*
- *Return/Recycle*

- *Strandings*

Each of these items is briefly summarized below. These minimization measures are required as part of the plan to ensure compliance with entanglement or collision, and allow flexibility, as defined in Mitigation Measure 3, to adjust certain items as determined necessary based on new information.

(1) Design and Maintenance. The licensee shall direct the WEC testing clients to design and maintain cables and moorings in configurations that minimize the potential for marine mammal or sea turtle entrapment or entanglement (e.g., cable and lines should remain under tension) to the extent practicable.

(2) Opportunistic Observations. The licensee shall make opportunistic visual observations from the water surface in the portions of the test site which are being visited to conduct operations, maintenance, or environmental monitoring work and shall review any underwater visual monitoring conducted for other purposes to detect entangled fishing gear that has the potential to increase the risk of marine species entanglement. The licensee will ensure that surface observations will occur during all visits to the project test site, and at least once per quarter each year for the duration of the license.

(3) Surface Surveys. Annually, following the peak storm season and period of maximum activity for the Dungeness crab fishery, the licensee shall conduct surface surveys of active WEC berths during the spring season (mid-March through mid-June), or the earliest possible time after that period that avoids jeopardizing human safety, property or the environment.

(4) Subsurface Surveys. Subsurface surveys of moorings and anchor systems using ROV or other appropriate techniques with approval by NMFS will be conducted annually for the first

10 years after WECs are first deployed, as early as technically feasible (i.e., ocean conditions conducive to effective monitoring) without jeopardizing human safety, property and the environment, during the spring (mid-March through mid-June) as described in the Organism Interaction Monitoring Plan. The licensee will include a description of the timing and any significant delays in conducting such surveys in its Annual Report.

(5) Entangled Fishing Gear Identified.

- *If monitoring shows that fishing gear has become entangled or collected on any Project structure, but is not likely to pose a threat to navigational safety or marine species, the Licensee will notify NMFS, FWS and ODFW within seven (7) days of detection, and shall remove the fishing gear during recovery of WECs or at the next scheduled mooring maintenance period. Until such time as the gear is removed or confirmed absent, the icensee shall observe such gear during subsequent underwater surveys to determine whether the gear must be reclassified as posing a threat requiring removal.*
- *If monitoring shows that fishing derelict gear has become entangled or collected on any Project structure and no organisms are caught within it, but it poses a risk of entanglement to marine species or to navigational safety, the Licensee will notify NMFS, FWS and ODFW within seven (7) days of detection, and shall remove the fishing gear as soon as practicable while avoiding jeopardizing human safety, property or the environment. The Licensee shall notify NMFS, FWS and ODFW within seven (7) days of removal that the fishing gear has been removed.*
- *If monitoring shows that fishing gear has become entangled or collected on any Project structure and marine mammals or sea turtles are observed entangled, injured*

or impinged, the licensee will immediately follow the Reporting Protocol for Injured or Stranded Marine Mammals (listed below) and give NMFS, FWS and ODFW all available information on the incident. If any other marine species is entangled or entrapped in fishing gear or marine debris, the licensee will report the incident to NMFS, FWS and ODFW as soon as practicable but no later than 48 hours from the observation and consult with the appropriate agency regarding whether gear removal is required and will remove the gear if necessary at the earliest time that avoids jeopardizing human safety, property or the environment.

For purposes of this section, any nets or free-floating line from any source and at any depth will be considered to pose a threat or risk of marine species entanglement and will be removed in accordance with the second bullet, above. Free-floating line is defined to mean line either attached or detached from fishing gear not tightly wrapped around facility or testing equipment. Other fishing gear including pots without free-floating line will not be considered to pose a threat or risk to marine species entanglement, but observations will be documented, reported and resurveyed in accordance with the first bullet, above.

(6) <u>Development of Monitoring Plan</u>. If separate sets of fishing gear are observed entangled or collected on Project structures on four separate site visits in any 12 consecutive months, the licensee shall develop a plan to monitor for entangled fishing gear more frequently or using different timing, at mooring or cable types or Project locations that appear prone to accumulating fishing gear and will remove such gear in accordance with section 5, above. Upon obtaining the AMC's concurrence, the licensee shall implement the monitoring plan, and shall do so in a manner that does not jeopardize human safety, property or the environment.

(7) Return/Recycle. The licensee will make every effort, to return recovered fishing gear to the owner if identification is possible, and will be responsible for storing the gear and contacting the owner to retrieve it. The licensee will request owner information from ODFW for gear with tags or other identification markers. In the event that an owner cannot be identified or attempts to return gear are unsuccessful, it may be recycled at Newport's International Terminal, or another suitable (8) Strandings. For any observed Project-related marine mammal or sea turtle strandings, entanglements, impingements, injuries or mortalities, the licensee shall follow the following protocols:

- *Live marine mammals or sea turtles observed swimming but appearing debilitated or injured: Capability to respond to free swimming animals is very limited and relocation is a major issue. In addition, medical treatment facilities for marine mammals and sea turtles are for the most part non-existent in Oregon. Therefore, we recommend that the sighting be recorded as part of the monitoring report and provide the information to the Stranding Network. The data should include: 1) any photos or videos, if possible 2) species or common name of the animal involved; 3) date of observation; 4) location (lat/long in decimal degrees); 5) description of injuries or unusual behavior observed.*
- *Live marine mammals or sea turtles observed entangled in fishing gear or marine debris: The marine mammal disentanglement network in Oregon is based at Hatfield Marine Science Center. Contact with the West Coast Stranding Network should be made immediately if an entanglement is observed and, if possible the reporting vessel should remain on scene while contact is made. Report should include the following information: 1) species or common name of animal involved; 2) location (lat/long in decimal degrees); 3) whether the animal is anchored by the gear or swimming with the*

gear in tow; 4) a description of the entangling gear (line size, line color, size number and color of floats if attached, presence or absence of pots or webbing; 5) if animal is towing gear, give direction of travel and current speed; 6) local weather conditions (sea state, wind speed and direction); 7) whether the vessel can stand by until someone is able to get there. The disentanglement network will determine whether or not a response can be mounted immediately and will advise the reporting vessel on next steps.

- *Dead protected species found entangled or otherwise impinged at the project: These should be reported as part of the monitoring report to NMFS and ODFW, giving all available information on the case. The report should include the following information; 1) species or common name of animal involved; 2) location (lat/long in decimal degrees); 3) whether the animal was found on a project device or anchoring system; 4) a description of injuries or entanglement observed; 5) if fishing gear or other debris was involved, give a description of the gear (line size, line color, size number and color of floats if attached, presence or absence of pots or webbing); 6) photographs if possible and fill out a Level A Data sheet. Guidance on how to fill out the Level A Data sheet is found in "The Examiner's Guide to the Marine Mammal Stranding Report Level A Data" (NOAA Form 89-864, OMB No. 0648-0178). In the event fishing gear is involved, the presence of protected species entangled in the gear should be included in the report initiating gear removal planning and coordination.*

Rationale for Mitigation for Entanglement or Collision of Marine Species

Project structures, including WECs, mooring lines, subsea floats, marker buoys, and umbilical cables may pose a risk to whales and sea turtles if they collide with submerged *components or become entangled with debris (e.g., lost fishing gear) if it accumulates at the surface or on submerged structures. Lost fishing gear with floats such as crab pots with float lines, trawl, or other nets with flotation are more likely to foul or become entangled on Project structures as they are more likely to be dispersed by currents.*

Whales and sea turtles may also collide with vessels visiting the site or transiting between the Newport Harbor and the Project location. On an annual basis, it is expected that vessels will be transiting between Newport Harbor and the Project Location and working within the Project location during 81 days and 105 days for the initial and full build out scenarios described in the Pacific Marine Energy Center- South Energy Test Site Appendices to Preliminary Draft Environmental Assessment.

Humpback whales and southern resident killer whales are known to use the action area with higher frequency than other whale species and could be subject to collision or entanglement. Leatherback sea turtles are unlikely to collide with WECs or mooring lines, because the WECs would be spaced at 50 to 200 m or more apart, which would provide ample space for sea turtles to pass between the WECs and associated mooring lines and umbilical cables, even if their maneuverability is reduced from being in colder water temperatures. There is a slight risk that turtles could be entangled in lost fishing gear caught on Project structures or mooring lines. These measures minimize occurrences of collision and entanglement of marine species and provides mitigation if entanglement or a collision does occur.

D. Measure 4. Organism Interaction Monitoring Plan

Recommendation:

The Licensee shall take the following measures to monitor demersal and water column organisms including but not limited to Dungeness crab, salmonids, rockfish, and forage fish as described in Appendix H: Monitoring Plans; H-2: Organism Interactions.

Description of Primary Components of Monitoring Plan for Organism Interaction

Mitigation Measure 4 of the Appendix I: Protection, Mitigation, and Enhancement Measures, references the implementation of the Organism Interaction Monitoring Plan as described in Appendix H-2 as proposed as part of the Pacific Marine Energy Center- South Energy Test Site Appendices to Preliminary Draft Environmental Assessment, related to organism interaction within the Project site during construction and operation activities. This monitoring plan is required to ensure compliance for mitigation for organism interaction, and allow flexibility, as defined in Mitigation Measure 4, to adjust certain items as determined necessary based on new information in accordance with the Adaptive Management Framework, Appendix J.

The overall goal of this organism interaction monitoring plan is 1) to track changes to pelagic and demersal fish and invertebrates (particularly Dungeness crab) that might be (a) attracted to the installed components or (b) affected due to the potential for reduced fishing pressure, and 2) to track biofouling on the anchors/devices. The information will be provided by the licensee to ODFW for the agency's use in managing ocean and coastal resources. The Plan is described in detail in the following sections:

- *Methods and Equipment*

- *Schedule and Frequency*
- *Constrains & Limitations*
- *Analysis*
- *Results*
- *Reporting*

(1) Methods and Equipment. An ROV will be used for monitoring of biofouling, structure-oriented fish, and distribution of organisms surrounding installed components in the test berth area. The ROV will have forward and downward facing video cameras with live feed to the support vessel. The ROV also will be equipped with a Tritech Gemini multibeam imaging sonar to evaluate whether there are fish beyond the camera's visual field that may avoid the ROV. The ROV will have a pair of lasers at a fixed width to assist with sizing organisms. A single pre-installation (pre-WEC installation) survey will be conducted in the spring/early summer period before the first devices are deployed at PMEC-SETS, as described in the section below, to obtain pre-installation abundances of benthic and lower water column organisms at the test site as well as gain insight on visibility/detectability of seafloor organisms at the test site. Once WECs are deployed, sub-surface components and the surrounding seafloor will be surveyed using videographic observations from ROVs at the frequency described in the section below. While on the vessel, the live video feeds will be watched in real time by a dedicated observer and notes will be taken regarding ocean and seafloor conditions and organisms seen. Any derelict gear observed while at sea will be reported as detailed in the Entanglement Mitigation Measure, and appropriate actions will be taken according to the terms of the Mitigation Measure. Additionally, any derelict gear observed during processing of the video in the lab will be compared to at-sea observations and

any additional observations will be reported and acted upon per the terms of the Mitigation Measure. Each organismal community to be monitored is described in more detail below.

Structure-Associated, Water-Column Fishes

Each sub-surface component type (both WECs in the water column with associated moorings and anchors on the bottom) will be observed for mobile, water-column organisms associated with the structure. To accomplish this, the ROV will partially circle the subsurface components from decreasing distances towards the device to assess the number and species of fish visible in each swath. A similar approach was determined to be effective for assessing fish communities on submerged oil and gas platforms (Ajemian et al. 2015). We will drop the ROV in the water ~25 m away (using a range-finder on the surface) from the WEC (on the downstream side). The ROV will be flown to the first position: 10 m below the surface, 20 m away from the WEC, where it will be held stationary with the camera facing up-current for a 1 minute period [a modified stationary point count (SPC)]. After the stationary observation, the ROV will navigate along a continuous horizontal rove partially around the structure from near one mooring line to near the next. Then we will instruct the ROV to move closer (e.g., to ~10 m away), do a SPC followed by a semi-circular swath, then move ~1-2 m from the WEC to do a SPC followed by a semi-circular swath. At no point would we attempt to maneuver the ROV across or under the mooring lines. Thus, if a WEC is on a three point mooring, the semi-circular swaths would cover an arc of just under 12°, as illustrated in Figure 3. If the draft of the WEC under observation does not extend to 10 m below the surface, we will attempt to conduct the WEC observations as near to the base of the WEC/surface of the water as possible with the caveat that operations closer to the surface make navigation and station keeping for the SPCs more challenging. Then we will instruct the ROV to dive to a position ~20 m away *from the expected position of an anchor, 1-2 m above the bottom. Then SPCs and semi-circular swaths will be conducted moving toward the anchor. We would then transit along the sea floor to the second anchor, conducing SPCs with semi-circular swaths as we approach. This navigational task will be accomplished using a commercial AUV navigation system on the ROV combined with the open-source Robot Operating System (ROS) in an integration developed by the Hollinger lab at Oregon State University (Lawrance et al. 2016). In brief, the system allows for autonomous station keeping as well as traveling between known positions. In 2016 field trials, the ROV was able to reach and traverse between waypoints to within approximately 1 m with respect to the internal navigation determination. Once the position of the WEC is known (after deployment) we will develop dive plans for the ROV that will include the paths of the roves. If multiple sub-surface components of the same type are deployed in a berth, we will attempt to sample at least two of the same type. For example, if a WEC is on a 3-point mooring (3 anchors), then we anticipate we likely will be able to survey the two anchors on the downstream side of the WEC, as it is preferable to maneuver the ROV against the prevailing current rather than go with the flow and potentially be swept into the object of interest. If multiple WECs are deployed within a berth the configuration of the array will affect how many of the individual WECs/anchors can be surveyed; however, our goal will be to get at least three observations of each WEC and anchor types. Although we do not expect a high likelihood of observing mid-water fish in reference areas, as we are descending for the reference band transects (described below), we will pause at 10 m below surface and do an SPC (with multibeam imaging sonar) before continuing the descent to the seafloor.*

Biofouling

Focal observations of major sub-surface components (e.g., WEC, anchor) will be made following the closest swath survey conducted on each component as described above. As practical, multiple (2-3) observations on different faces of the same component type will be made. If there are multiple components of the same type (e.g., anchors), at least two anchors (those on the down-current side of a WEC) will be observed in each berth as described above. Additional anchors may be observed as possible. During the focal inspection, the ROV operator will perform a slow pan of the structure of interest, primarily using the forward camera to observe the structure. During anchor observations, the downward camera will be used to observe scour and organisms in the sediment adjacent to the anchors.

Benthic Fishes and Invertebrates

The ROV will conduct band transect surveys within the individual test berths in use among the bottom mounted components on the seafloor. We will conduct 3 transects each at least 100 m long within each berth. This will enable standardized abundance estimates of benthic fishes and invertebrates at and between the different bottom-mounted components.

Band transect surveys also will be conducted at pre-determined reference areas outside of the PMECSETS Project Site to determine the density of benthic fishes and invertebrates that would be expected in the area in the absence of the installation. We will conduct 6 reference transects each at least 100 m long outside of the Project Site: two north and two south of the Project Site at depths that match the test berths as well as two inshore of the Project Site, which will necessarily be shallower.

Additionally, although the cables will be buried for nearly the entire length, one of the cable routes will be surveyed as part of each semi-annual ROV cruise. (Thus each of the five cables will be surveyed every 2.5 years.) This will include the unburied portions near the sub-sea connector as well as the buried route back towards shore. We will follow the expected route based on GPS coordinates as well as use all reasonably available tools to orient along the cable.

Video Processing

Trained personnel will process collected videos in the laboratory. Videos from the forward-looking and downward-looking cameras will be viewed simultaneously on stacked monitors. The forward-looking versus the downward-looking cameras will be the quantification view depending on the type of observation, as described below. If time codes are recorded onto the audio track of the video footage, a time code wedge will be used to record the time (on the video) of each organism observation, which can be useful for re-finding species of interest on the footage during data analysis.

For the semi-circular swath observations, all organisms encountered on each rove, swath, and SPC will be identified to the lowest possible taxonomic level and enumerated. Because the start/stop time will be logged for each individual rove, swath, and SPC, we will be able to compare the numbers of individuals observed during each survey component. Fishes will be classified as juveniles, sub-adults, or adults (as appropriate for the species), based on size determined using the lasers. Crab and seastar sizes will be estimated using the lasers. We anticipate that with each view of the subsurface components (at different distances), we will count some organisms that had been observed and counted in the previous view. Thus, at each SPC and over the course of the encircling rove, we will determine the maxN (the maximum *number of fish for a given species) within the field of view, a commonly used metric (e.g., Merritt et al. 2011; Cappo et al. 2004; Cappo et al. 2007; Harvey et al. 2007) and note observed behavior. (This metric is sometimes referred to as MinCount because it represents the minimum number of individuals for a particular species during a dive; Ellis and DeMartinie 1995, Watson et al. 2005, Willis et al. 2000). As feasible, we will use the distance travelled over the bottom to convert numbers of each species observed in the water column on the rove to standardized abundances. If we are not able to determine distance travelled, organism counts will be standardized by survey time using the start and stop time of each rove and SPC. As the ROV is transiting from the WEC to the anchors, any fish and/or schools of fish will be documented and reported. However, we do not intend to quantify densities of organisms detected in these "off transect" observations. Upon the approaches to the anchor, in addition to quantification of organisms, we will review the footage to look for evidence of scour. Since we will be conducting slow swaths at three distances, if we detect scour in close proximity to the anchors using this video tool, we will be able to delineate the extent at least relative to the three distances. If we detect scour at all visual survey distances and suspect the extent is broader, we anticipate it would then be detected by the within berth band transects if they are conducted in the direction of the scour and, if very wide-spread, by sediment analysis of the box core grabs, which begin at 50 m away from the anchor.*

For each of the Project component focal observations, the percent cover of fouling on the component will be determined. All organisms will be identified to the lowest possible taxonomic level. We anticipate for the initial observations, total percent cover or perhaps percent cover of film/invertebrates/algae will be the lowest possible taxonomic level. As the community develops, we may be able to distinguish general classes of fouling organisms (e.g., *sponges, ascidians, barnacles, bryozoans, mussels), and the percent cover of each will be determined. As the community further matures, fouling species may be distinguished. Additionally, mobile organisms such as seastars, anemones, and crabs observed on the structures will be identified and sizes estimated using the lasers. A challenge to using video techniques for assessing biofouling can occur if you have many canopy forming and sub-canopy species, making it difficult to observe, let alone identify, all the organisms on a surface. We do not anticipate this will be an issue for assessing biofouling on the anchors as they will be at ~70 m, well below the photic zone, and we did not observe or collect algae on the Ocean Sentinel anchors which were deployed for over two years in shallower waters. Canopy-forming invertebrates such as anemones or those with lots of interstitial spaces such as mussels can present similar challenges for quantifying smaller organisms. However, as described above, we did not observe these species on the Ocean Sentinel anchors at NETS. The extent of biofouling on anchors will vary based on anchor type, complexity of the structure, duration of installation, and height above the seafloor where the potential for abrasion is highest. We recognize that the WECs themselves could support growth of larger organisms (e.g., algae, gooseneck barnacles, mussels; Figure 1) as we collected from the Ocean Sentinel floats, although the algae on the floats was small turf algae, and the floats were not coated with anti-fouling paint.*

For the band transects (pre-test, between device components, and reference transects) standard analysis procedures will be used (e.g., Tissot 2008). Along each transect, the substratum type will be classified (mud/sand/coarse sand/shell hash) and the presence of "litterfall" will be delineated, and all organisms larger than 5 cm will be identified and enumerated. (If we observe large aggregations of small individuals that cannot be *enumerated, we will report their occurrence but will not attempt to quantify them.) Benthic epifauna, some endofauna taxa showing recognizable body parts above the sediment, and fish will be identified to the lowest possible taxonomic level and enumerated. We will use the distance travelled over the bottom to convert numbers of each species observed along the transect to standardized abundances. If we are not able to determine distance travelled, organism counts will be standardized by survey time using the start and stop time of each transect. Fishes will be classified as juveniles, sub-adults, or adults (as appropriate for the species), and crab and seastar sizes will be estimated using the lasers. When interesting behaviors are observed (e.g., crabs feeding on litterfall), they will be documented and reported. Again, this footage also may be used for quantification of the spatial extent of scour.*

Sonar Processing

The use of the multibeam imaging sonar will allow us to estimate the presence of fish that may disperse beyond the field of view before the ROV gets close enough to see them on the optical camera. A suite of metrics may be used to quantify variability of pelagic nekton biomass detected by the multibeam sonar including density, aggregation, center of mass, and dispersion, which have been used to describe a wide range of aquatic organism distribution attributes (Urmy et al. 2012). These metrics, as appropriate, will be compared among structure types. Acoustic images will be analyzed as described within the analysis section, and compared to optical information to determine if fish may be avoiding the ROV.

However, acoustic images will likely be insufficient in detail to identify species.

(2) Schedule and Frequency

Within Site

A single pre-installation ROV survey (pre-WEC installation) will be conducted as early as technically feasible (e.g. ocean conditions conducive to effective monitoring) without jeopardizing human safety, property and the environment in the spring (mid-March to mid-June) prior to our first anticipated testing client. During this survey, we will carry out the survey along the seafloor band transects. For this survey, we will survey transects at 6 locations outside of the Project Site (the Reference transects) as well as 6 transects randomly placed inside the Project Site. Before diving for each set of transects, we will pause at 10 m below the surface to do a SPC, as described above.

Seasonal ROV surveys will be conducted twice per year targeting spring (mid-March to mid-June) and fall seasons (late August to late October) with a minimum of 3 months between data gathering events that meet the objectives of this plan. Spring surveys will be conducted as early in the season as technically feasible to minimize risk of entanglement as described in mitigation measure 3. This schedule likely will result in any new installation being surveyed within three months of deployment (as we anticipate summer deployments that would be observed by the fall survey). During those semiannual surveys, all test berths with WECs installed in them will be surveyed. If multiple structures of the same type are installed in a single berth (e.g., > 3 anchors of the same type) a subset of those structures may be observed on each survey. Semi-annual surveys will continue for at least three years of deployed WECs and anchors.

After three years of semi-annual surveys, if no devices are under test, any hardware remaining in the water will be surveyed once every three years. If survey results indicate consistent and predictable species associations over time (i.e., no significant differences observed in species diversity, density/ maxN, or total number of fish observed in spring versus fall on the multiple WEC, anchor or mooring types/configurations), then for the next 7 years ROV surveys for the purposes of organism interaction monitoring will be conducted annually when WECs are present. After 10 years of ROV surveys, the licensee will consult with the AMC regarding the frequency/need of continued organism interaction ROV surveys. This timeline is based on documented observations where colonization of an artificial reef showed fluctuations in species abundance within the first two years, but after two years most of the species that dominated or characterized the reef after five years had already settled (Hiscock et al. 2010). Of course, the situation at PMEC-SETS may differ since the same structures may not be in place for a continuous three years, so the "stabilization" of species recruitment observed by Hiscock et al. after two years may not be observed at PMEC-SETS.

Cable Route

For biological purposes, one of the cable routes will be surveyed as part of each ROV cruise, including the "pre-WEC installation" survey. Thus, with five cables, each one will be surveyed once after the first 2.5 years of semi-annual sampling and each will be surveyed at least a second and possibly a third time by the end of the 10 years of ROV surveys. This schedule is based on the assumption that all seafloor cables will be entirely and continuously buried, and does not preclude additional observations that may or may not occur for maintenance purposes. If installation or post-construction survey of the cables indicates unburied segments, *the licensee will consult with the AMC regarding the appropriate frequency of organism interaction ROV surveys.*

(3) Constrains & Limitations A constraint in developing this monitoring plan is the variability associated with the Project as a test center. To overcome that, we have written this study to be applicable to deployments of various size, number, and location of device components, the distance between them, and the number and type of mooring hardware associated with the Project components of interest. The major constraints of any ocean-going field project are weather conditions and vessel availability. However, OSU is confident they can successfully conduct surveys sometime in the mid-March to June window and again in the August to October window. The ability to implement ROV surveys is subject to weather and safety constraints. NNMREC will notify the AMC within 10 days of the close of each seasonal window (end of June/October) if it seems likely we will not be able to complete the sampling within that window to discuss whether sampling should be attempted in the next month or deferred until the following season. Furthermore, any inability to perform this study within the time period or spatial extent described here would be communicated to members of the AMC within 10 days from the date determined by NNMREC-OSU that it is unable to complete the tasks identified in this plan, and a contingency plan would be developed and submitted to the AMC within 30 days after notification.

(4) Analysis

Analysis of Video Observations

For the SPCs and semi-circular swath surveys, the maxN of different species as well as total number of fish observed and overall diversity will be compared along distances from the *structure and among structure types. Within species, we will investigate if different size classes are present associated with the WEC (at 10 m below the surface) versus at the anchors (1-2 m above bottom) or at varying distances away from the structures and/or among structure types.*

For the focal observations, percent cover or density (as appropriate) of different biofouling organisms (as identifiable) will be determined and compared among structure types (using either faces of the structure or multiples of the same structure type as replicates). The diversity of fouling organisms also will be compared among structure types. If structures are left in place over long periods of time (perhaps anchors that are re-used) we will (eventually) develop histograms to display the arrival, growth, and succession of major colonizing species.

For the band transects, data will be analyzed as described in Hemery and Henkel (2016). In short, multivariate analysis will be conducted to assess the similarities and/or differences in the organisms along position on transect (distance from a structure), within versus outside the site, and in association with any particular substratum type. We also will conduct univariate analyses on total diversity and abundance against these factors. For particular fish species and Dungeness crabs, we will investigate if different densities and/or size classes are present by comparing size and density distributions before versus after installation of project components, in varying distances away from the structures, among structure types, or within versus outside of the Project Site. Berth-specific visual surveys will allow us to determine if different structures are differentially attractive (versus a baited capture survey where we might catch organisms in one berth that were utilizing habitat in another berth). We also will compare detections of fish using the imaging sonar on the band transects within the Project Site to the reference ROV band transects conducted outside the Project Site.

Visual surveys also allow for behavioral observations, rather than just whether organisms are captured more inside or outside of a particular area (which can be influenced by attraction to bait). For example, with visual surveys we can assess whether crabs are burying near an anchor, using it as additional shelter, or if they are foraging on the organisms growing on the anchors. We will be able to observe whether the density of buried crabs changes in conjunction with sediment changes (if changes in sediment are observed) with increasing distance away from an anchor or inside versus outside the project area. We also will determine and report the ratio of Dungeness crab to rock crab at varying distances away from the structures and/or among structure types.

Analysis of Sonar Observations

The number of targets in the acoustic images will be compared among structure types, and we will attempt to assign the acoustic targets to a species group. The use of the multibeam imaging sonar will allow us to estimate the presence of fish that may disperse beyond the field of view before the ROV gets close enough to see them on the optical camera. We will compare and report the number of targets (individual fish) or aggregations (schools of fish) detected acoustically using the sonar with the numbers of fish/schools of fish detected visually using the cameras and determine the percent of acoustically-detected targets that were not detected using the visual tools.

(5) Results. For the semi-circular swath surveys, we will summarize findings including the total number of fish observed and the relative abundances of different fish species at different distances for the floating (WECs) and bottom (anchor) structures. By comparing the relative abundance of fish across the different distances away from the floating structures, we will be able to describe the spatial pattern of any fish attraction effect and how far it extends.

Comparisons among WEC/anchor types will inform us if differently shaped/sized components have different levels of attractiveness or attract different species. A species list including number of individuals and life stages of each species observed during each survey, as well as over time, will be provided.

The results of the focal observations for biofouling will include graphical representation of percent cover and/or density (as appropriate for the organism type) on different components. A species list including number of individuals and life stages of each species observed during each survey, as well as over time, will be provided.

For the band transects, we will report the densities of organisms along the in-berth transects as compared to the reference transects. We will report the densities of organisms as a function of distance away from structures. We will report the results of all multivariate and univariate analyses described above. Again, if we observe large aggregations of small individuals that cannot be enumerated, we will report their occurrence. A species list including number of individuals and life stages of each species observed during each survey, as well as over time, will be provided.

(6) Reporting. Once the activities under this plan commence, they will be reported annually in NNMREC-OSU's Annual Report, which will be filed with FERC and provided to the AMC. The annual reporting will include the components described below; it will also identify any relevant new information considered in the findings or future monitoring.

NNMREC-OSU will summarize all activities undertaken in implementing the monitoring plan, including a table with monitoring dates and locations if appropriate. In the unlikely event that NNMREC-OSU must deviate from this plan for reasons outside of its *control (e.g., delayed sampling due to adverse weather conditions that pose risk to human safety) it will describe any deviations from the monitoring plan as reported to the AMC and discuss implications of any such deviations.*

The AMC will discuss the monitoring results and any significant findings or conclusions. The AMC will be given the opportunity to provide feedback on the study results prior to any official filing, and if they exist, NNMREC-OSU will describe any disagreements over characterization of results in its final report.

NNMREC-OSU will describe in each Annual Report monitoring activities that are planned for the next reporting period. NNMREC-OSU will provide any proposed modifications to the monitoring plan and rationale for the changes to the AMC.

Rationale for Monitoring Plan for Organism Interaction

The presence of Project components (including but not limited to the subsea cables, subsea connectors, and anchors) will introduce hard substrate previously unavailable to the project area resulting in alterations to benthic habitat. Temporary disturbances may recur at various time intervals over the 25-year term of the project if anchors and other bottom components are removed and re-installed for different devices. These components will be colonized by fouling organisms during the time of deployment and will potentially attract mobile invertebrates and fish to the Project area. The WECs and mooring lines in the water column may also attract fish by providing shelter and habitat for structure-oriented fishes. However, there is uncertainty of what type of community will be attracted to the project structures and how long it will take for that community to establish. Data gaps remain in terms of spatial and temporal trends or distributions of fish within the water column within the

Project site. The Organism Interaction Monitoring Plan will assess the differences in timing, abundance, and size classes of fish and invertebrate species or species groups that colonize or associate with different types of project structures on the bottom and in the water column.

E. Measure 7. Underwater Sound from WECs and Mooring Systems

Recommendation:

The Licensee shall take the following measures to minimize and mitigate for potential impacts of sound from WECs and their mooring systems on marine resources as described in Appendix I: Protection, Mitigation, and Enhancement Measures.

Description of Primary Components of Mitigation for Impacts of Sound from WECs and their Mooring Systems on Marine Resources

Mitigation Measure 7 of the Appendix I: Protection, Mitigation, and Enhancement Measures, describes minimization and mitigation measures for future operations of the Project as proposed as part of the Pacific Marine Energy Center- South Energy Test Site Appendices to Preliminary Draft Environmental Assessment, related to impacts of sound from WECs and their mooring systems on marine resources.. The following measures to minimize and mitigation exposure to sound impacts from WECs and their mooring systems include the following:

- *Equipment*
- *Persistent Sound Not Associated with High Seas State*
- *Temporary Sounds Associated with High Seas States*
- *Reporting and Evaluation*

Each of these items is briefly summarized below. These minimization and mitigation measures are required as part of the plan to ensure compliance with sound impacts that exceed NMFS' published harassment threshold(s) on marine resources, and allow flexibility, as defined in Mitigation Measure 7, to adjust certain items as determined necessary based on new information.

(1) Equipment. The licensee will require WEC testing client(s) to keep their equipment in good working order to minimize sound due to faulty or poorly maintained equipment.

(2) Persistent Sound Not Associated with High Seas State. "Persistently" is defined as exceedances recurring for 4 or more consecutive days that are not during high sea states, where "high seas state" is defined as conditions that meet the National Oceanic and Atmospheric Administration's small craft advisory definition. If acoustic monitoring results indicate that sound from one or more WECs and their mooring systems at a Project berth persistently exceeds NMFS's published harassment threshold(s), modeled at a distance of 100 meters from the source, then the licensee shall notify NMFS and:

- *Instruct the relevant WEC testing client to diagnose and make repairs or modifications to WEC(s) or mooring systems so that they operate as intended as quickly as possible, but no longer than sixty (60) days unless agreed upon by the licensee and NMFS; and*
- *Continue in-situ monitoring and notify NMFS of any exceedances of NMFS's published harassment threshold(s). The licensee will also notify NMFS whether exceedances attributable to the WEC/mooring system are detected in the fourteen (14) days after implementation of the repairs to verify that the WEC and mooring systems are no longer producing noise over threshold levels.*

If the subsequent monitoring results indicate that noise has been abated, monitoring will continue as detailed in the Acoustic Monitoring Plan described in Appendix H-3.

To the extent feasible, the Licensee shall instruct WEC testing client, within 60 days of the initial diagnosis and repair/modifications to WECs or mooring systems, to include a contingency plan in the event that the repairs/modifications to WECs or mooring systems do not abate persistent sound not associated with High Seas State. NMFS will prioritize and approve this contingency plan in the event that the initial repair/modifications have not abated persistent sound. The contingency plan will minimize prolonged exposure to sound exceedance thresholds and negate a 60-day period for a draft plan to be developed and approved by NMFS after the initial repair/modification and 14-day monitoring period has occurred.

If the sound level has not been abated below NMFS's published harassment threshold(s) and a contingency plan was not feasible during the initial diagnosis and repair/modification described above, the licensee shall instruct the relevant WEC testing client to provide to NMFS within thirty (30) days a draft plan to implement one of the following mitigation actions, or other actions agreed upon by the licensee and NMFS, to reduce sound levels below the threshold. The draft plan shall include a proposed implementation timeline and monitoring provisions to confirm whether the measures were effective. Upon approval of a plan by the NMFS, the licensee shall ensure that the plan is implemented in accordance with the approved plan. The mitigation action will be carried out within 30 days unless NMFS has approved an alternate timeframe. In no circumstances shall implementation of the plan be undertaken at a time that would jeopardize human safety, property or the environment. The mitigation action will be carried out within thirty (30) days of NMFS's approval unless NMFS has approved an alternate timeframe.

- *Perform additional or alternative methods of monitoring to identify the specific source and cause of the sound to provide specific information as to the timing, duration and magnitude of the project-related sound and compare to ambient levels, and inform the development of specific actions necessary to reduce sound below threshold;*
- *Modify the operation of the WEC or mooring system components producing the sound (e.g., modify controls to change the motion of the WEC); or*
- *Perform necessary repairs or modifications to minimize sound levels. Subsequent monitoring would be conducted to verify that the sound level associated with the test has been abated.*

After completing the necessary actions, the licensee will continue in-situ monitoring and notify NMFS whether exceedances attributable to the WEC/mooring system are detected in the fourteen (14) days after the expected solution is implemented to verify that the noise associated with the test is no longer over threshold levels.

If, after taking the steps above, persistent sound levels from the operation of the project cannot be mitigated to below NMFS's published threshold(s) for harassment, measured or modeled at 100 meters from any WEC or mooring system, the licensee, in consultation with NMFS, will:

- *Require the testing client to cease operating the WEC, if possible, if doing so will temporarily halt the sound threshold exceedances;*
- *Work with the testing client, NMFS and subject matter experts to determine whether actions can be taken to reduce the sound produced by the WEC or mooring system that is in excess of the threshold; and*

- *Implement the actions identified above to reduce sound produced by the WEC or mooring system or, if no such actions can be identified, either (i) cease testing the WEC at the Project or (ii) obtain approvals under the MMPA and ESA, as appropriate, to continue testing the WEC at the Project.*

Upon re-initiation of operations or redeployment of the WEC and/or mooring system, the licensee will continue in-situ monitoring and notify NMFS whether exceedances attributable to the WEC/mooring system are detected in the fourteen (14) days after the expected solution is implemented to verify that the noise associated with the test is no longer over threshold levels.

(3) Temporary Sounds Associated with High Seas States. If acoustic monitoring indicates that sound pressure levels attributable to operations of any WEC or mooring system are above 120 dBrms nonimpulsive or 160 dBrms impulsive sound, modeled at a distance of 110 meters, and are temporary and associated only with high sea states (i.e., intermittent), the licensee shall determine whether the sound threshold exceedance occurs again during the next high sea state based on in-situ monitoring. "Temporary" means occurring only during high seas states, where "high seas state" is defined as conditions that meet the National Oceanic and Atmospheric Administration's small craft advisory definition. If the exceedance occurs again, the licensee shall notify NMFS and:

- *Instruct the WEC testing client to investigate system monitors or power output components in order to diagnose and make repairs or modifications so that it operates as intended as quickly as possible, but no longer than sixty (60) days unless agreed upon by the licensee and NMFS; and*
- *Continue in-situ monitoring and notify NMFS whether exceedances attributable to the WEC/mooring system are detected (i) in the fourteen (14) days after the expected*

solution and (ii) during the next high sea state, to verify that the noise associated with the test is no longer over threshold levels.

If, after taking the steps above, sound levels from the WEC or mooring system during high sea states cannot be mitigated to below 120 dBrms non-impulsive or 160 dBrms impulsive, modeled at 117 meters, the licensee, in consultation with NMFS, will:

- *Work with the WEC testing client, NMFS and subject matter experts to evaluate the likelihood of additional exceedances during high sea states based on the planned WEC removal schedule and the potential adverse impacts of such exceedances on marine resources; and*
- *Either (i) with NMFS's approval, leave the WEC in place until it is removed as scheduled, (ii) remove the WEC or mooring system responsible for sound exceedances during the soonest feasible window for such an action, or (iii) obtain approvals under the MMPA and ESA, as appropriate, to continue testing the WEC at the Project.*

(4) <u>Reporting and Evaluation</u>. To ensure that the mitigation measures detailed above are providing the mitigation necessary, the licensee will:

- *Provide an annual report in accordance with the Acoustic Monitoring Plan that includes the following:*
    - *Analysis of monitoring results including comparison to ambient conditions and identified thresholds;*
    - *Level, duration and timing of any WEC or mooring-related exceedance of identified thresholds; Mitigation measures carried out and documentation of actions taken including date, time and WEC or structures; and*
    - *Evaluation of whether acoustic monitoring techniques are sufficient to*

adequately assess potential effects of varying operational states.

The licensee will provide the draft annual report to NMFS at least thirty (30) days prior to submitting it to FERC and will indicate in its submittal how comments from NMFS were addressed, provided such comments are received at least ten (10) days prior to submission of the draft report.

Rationale for Mitigation for Impacts of Sound from WECs and their Mooring Systems

During Project operations, sound is expected to be generated by the moving components of the WECs, mooring components (e.g., chain noise) and water flowing past and splashing against Project structures. Cumulative sound over a 24 hour period generated by operating WECs is expected to be lower than the temporary (TTS) and permanent threshold shift (PTS) onset thresholds for injury level for low (LF) to mid-frequency (MF) cetaceans for non-impulse noise (178 & 179 dB re 1 μPa²s for TTS and 198 & 199 dB re 1 μPa²s for PTS) or Phocid (Pw) and Otariid (OW) pinnipeds (181 dB & 199 dB re 1 μPa²s for TTS and 201 dB & 219 dB re 1 μPa²s for PTS), but WEC operation might generate underwater sound exceeding the 120 dBRMS re 1 μPa threshold for marine mammal behavioral disruption within a zone of influence (R2) determined using a practical spreading loss model (NMFS 2012c) from an acoustic measurement made at a distance (R1) from the WEC.

While the Project is not expected to generate sound at levels that could cause injury to marine mammals, Project-related underwater sound has the potential to affect marine mammals by interfering with communication, prey and predator detection, and migration. The temporal and spatial scales of the acoustic disturbance depend on factors such as the amplitude, spectral characteristics and exposure duration of the sounds generated by the Project. This measure will identify and characterize noise generated during WEC installation *and operational WEC testing phases to determine if sound exposure exceeds harassment and injury thresholds and provide mitigation when exceedances does occur.*

F. Measure 6. Dynamic Positioning Vessel Activity

Recommendation:

The Licensee shall take the following measures to minimize and mitigate for potential impacts of dynamic positioning vessel activities on marine resources as described in Appendix I: Protection, Mitigation, and Enhancement Measures.

Description of Primary Components of Mitigation for Dynamic Positioning Vessel Activities on Marine Resources

Mitigation Measure 6 of the Appendix I: Protection, Mitigation, and Enhancement Measures, describes minimization measures to ensure sound by Dynamic Positioning Vessels (DPVs) do not injure marine mammals and mitigation measures for marine mammals if exposure to sound exceeds NMFS' published harassment threshold(s) as proposed as part of the Pacific Marine Energy Center- South Energy Test Site Appendices to Preliminary Draft Environmental Assessment, related to impacts of sound from dynamic positioning vessel activities on marine resources. These minimization and mitigation measures are required as part of the plan to ensure compliance with sound impacts that exceed NMFS' published harassment threshold(s) on marine resources, and allow flexibility, as defined in Mitigation Measure 6, to adjust certain items as determined necessary based on new information.

(1) The licensee will avoid the use of DPVs or other equipment that may exceed NMFS's published thresholds for harassment to the maximum extent practicable during Phase B gray whale migration (April 1 – June 15). To the extent construction activities during this migration

period are proposed, the licensee will consult ODFW regarding the timing of such activities including cable-laying in state waters.

(2) The licensee, with technical assistance from NMFS, will establish and carry out the following actions and protocols necessary to maintain an appropriate acoustic zone of influence in accordance with NMFS's published harassment threshold(s) during DPV operations to minimize behavioral disturbance and protect marine resources, which may be modified by agreement of the licensee and NMFS:

- *The licensee will post qualified marine mammal observers during daylight hours;*
- *The licensee will conduct dynamic positioning ("DP") activities during daylight hours when feasible to ensure observations may be carried out;*
- *DP for cable laying may occur during all hours; however, DP start up for cable laying will only occur during daylight hours; and*
- *The licensee will carry out the following ramp-up procedures, which may be modified by agreement of the licensee and NMFS:*
    - *DP vessel operators shall be required to ramp up upon initial operations;*
    - *During DPV operations, except those associated with cable laying, the licensee shall reduce DP thruster power to the maximum extent practicable if a marine mammal approaches or enters the acoustic zone of influence except under circumstances when human, environmental health or the integrity of the project are compromised; and*
    - *The licensee shall not increase power until the zone is clear of marine mammals for a minimum of thirty (30) minutes.*

(3) The licensee will implement such additional measures as may be imposed pursuant to a Marine Mammal Protection Act authorization.

Rationale for Mitigation for Dynamic Positioning Vessel Activities

Dynamic Positioning Vessel (DPV) will likely be used during cable laying operations during the beginning of the Project and potentially during installation of individual WECs. For vessels used for Project installation and maintenance when fully underway, traveling to and from the test site would not exceed sound intensity greater than 130 to 160 dB (re: 1 μPa) over a frequency range of 20 Hz to 10 kHz" (also see Richardson et al. 1995, DOE 2012). However, vessels with dynamic positioning thrusters generate higher sound intensities. Two offshore wind technology projects estimated the sound source-level for the dynamic positioning cable laying vessel to be 177dB re: 1 μPa at 1m and 180dB re: 1 μPa at 1 m (BOEM 2014, NMFS2015i).

Potential effects of moderate (e.g., non-injury) anthropogenic noises on fish can include disturbance and deterrence, reduced growth and reproduction, interference with predator-prey interactions, and masking of communication (Slabbekoorn et al. 2010). The threshold for causing temporary behavioral changes (startle and stress) on threatened and endangered fish species, as defined by NMFS and FWS, is 150 dB re 1 μPa RMS (FHWG 2009).

In BOEM's analysis of sound from a vessel with dynamic positioning thrusters (177 dB re:1 μPa at 1 m) for cable laying operations off the coast of Virginia, it was concluded that the distances to the Level B Harassment threshold for marine mammals would be approximately 1.4 km to 3.2 km (0.9 to 2 miles) (BOEM 2014). NMFS calculated that the distance to the

Level B Harassment threshold for marine mammals would be up to 6 km for a vessel with dynamic positioning thrusters. This disturbance would occur for approximately 30 days during cable laying operations. Cetaceans are highly mobile and would be expected to avoid the effective range of cable laying operations, thus reducing but not discounting the potential for exposure to sound generated by the dynamic positioning thrusters.

Data are lacking regarding sea turtle response to continuous sounds, but it is assumed that sea turtles may exhibit avoidance behavior when exposed to high amplitude, low frequency sound (e.g., Lenhardt 1994, Bartol 2008, Popper et al. 2014). McCauley et al. (2000) reported alert behavior at a distance of 2 km from the sound source and escape behavior at a distance of 1 km.

Due to the uncertainty of sound effects associated with DPVs this measure will minimize and mitigate when harassment and injury thresholds are exceeded.

G. Measure 8. Pinniped Haulout

Recommendation:

The Licensee shall take the following measures to minimize and mitigate for pinniped haulout on WECs and Marine Project Structures in Appendix I: Protection, Mitigation, and Enhancement Measures.

Description of Primary Components of Mitigation for Pinniped Haulout on WECs and Marine Project Structures

Mitigation Measure 8 of the Appendix I: Protection, Mitigation, and Enhancement Measures, describes mitigation measures for observed pinniped haulout activity on one or more of the WECs or project structures as proposed as part of the Pacific Marine Energy Center- South Energy Test Site Appendices to Preliminary Draft Environmental Assessment, *related to pinniped haulout on WECs and marine project structures. The following measures ensures NMFS haulout protocols are followed during any attempt to access the device or structure.*

The licensee and its agents shall make opportunistic visual observations of pinnipeds in the portions of the test site which are being visited to conduct operations, maintenance, or environmental monitoring work and shall report any observed pinniped haul-out activity to NMFS within seven (7) days of such observation.

If pinnipeds are identified on one or more of the WECs or project structures, the licensee will ensure that the following NMFS haulout protocols are followed during any attempt to access the device or structure, and shall provide a summary of protocols employed to NMFS within fifteen (15) days of having used any such deterrent measures:

- *If pinnipeds are present on one of the project structures and do not leave the structure upon approach up to 100 yards and the pinnipeds are non-ESA listed species, the licensee or its assigns or agents may proceed to deter the pinniped from project structures so long as such measures do not result in the death or serious injury of the animal (pursuant to Section 101(a)(4)(A) of the Marine Mammal Protection Act). Any efforts to deter pinnipeds must take into consideration possible impacts on other species that may be in the area. The licensee shall ensure authorized visitors to the project follow the most up to date NOAA guidance on deterring pinnipeds, current at the time of the occurrence.*
- *If ESA-listed pinnipeds are present on project structures, no intentional deterrence activities may be undertaken; however, the licensee or its assigns or agents may proceed to approach the project structure as originally planned. If the pinnipeds leave*

the project structure as a result of normal vessel approach, all work may continue as planned. If the pinnipeds do not leave the project structure upon approach, only work that can be carried out without injuring pinnipeds or endangering human safety may go forward.

- *If the licensee needs to perform emergency maintenance that requires immediate attention (e.g., closing an opened hatch, repairing a failed mooring or electrical fault) and deterrence of an ESA-listed species is necessary, the licensee will request assistance from the NMFS Regional Stranding Coordinator, Protected Resources Division, 206-526-4747 if the deterrence method will result in the death or serious injury of the animal. To reduce the risk of causing "serious injury" to an animal, deterrence methods should be chosen that avoid penetration or tearing of skin, or rupture of an eye. The licensee will provide an account of the incident to the appropriate staff at NMFS and ODFW as soon as possible but not later than fifteen (15) days following the event.*

<u>Rationale for Mitigation of Pinniped Haulout on WECs and Marine Project Structures</u>

Project structures could potentially provide artificial reef habitat, attracting fish and providing foraging sites for cetaceans and pinnipeds (Cada et al. 2007). When the Project structures need to be accessed by personnel and pinnipeds are hauled out on the structures the licensee is required to comply with Section 101(a)(4) of the Marine Mammal Protection Act (MMPA). This mitigation measure requires the licensee to comply with Section 101 (a)(4) of the MMPA.

H. Measure 11. Benthic Disturbance from Cable Laying and Construction Activities

Recommendation:

The Licensee shall take the following measures to minimize and mitigate for potential impacts to benthic habitat from cable laying and associated construction activities in Appendix I: Protection, Mitigation, and Enhancement Measures.

Description of Primary Components of Mitigation for Benthic Habitat Disturbance from Cable Laying and Associated Construction Activities

Mitigation Measure 11 of the Appendix I: Protection, Mitigation, and Enhancement Measures, describes future operations of the Project as proposed as part of the Pacific Marine Energy Center- South Energy Test Site Appendices to Preliminary Draft Environmental Assessment, related to benthic habitat impacts from cable laying and associated construction activities. These actions include the following:

- *Installation Method*
- *Burying Cables*
- *Cable Routes*
- *Best Practices*

Each of these items is briefly summarized below. These activities are required as part of the plan to ensure compliance with benthic disturbance, and allow flexibility, as defined in Mitigation Measure 11, to adjust certain items as determined necessary based on new information.

(1) Installation Method. The licensee will use horizontal directional drilling (HDD) to install the cable conduits under the nearshore and intertidal habitat (to approximately the 10-m isobath) to minimize substrate disturbance.

(2) Burying Cables. The licensee will bury cables at a depth of 1-2 meters (so as to ensure continuous burial in accordance with implementation requirements of Territorial Sea Plan Part 4) to the maximum extent practicable, to minimize the amount of habitat conversion (soft bottom to hard structure) from laying exposed cable on the seafloor. In areas where a cable cannot be buried or persistently becomes unburied, that portion of the cable will be on the seabed and will be protected by split pipe, concrete mattresses, or other cable protection systems.

(3) Cable Routes. The licensee will develop cable routes that avoid crossing areas with rocky reef and hard substrate to the maximum extent practicable to protect sensitive habitat features.

(4) Best Practices. The licensee will follow best practices during cable installation, operation, and removal activities to avoid or minimize potential effects to sediment, including minimizing the time that the seabed is disturbed and sediment is dispersed and the associated effects by completing cable laying and other construction activities during appropriate construction windows and within one construction season to the extent practicable.

Rationale for Minimization & Mitigation for Impacts to Benthic Habitat from Cable Laying and Associated Construction Activities

It is anticipated that during each deployment, connection, disconnection, and retrieval events, sediment from the seabed would be disturbed. Sediment will be temporarily disturbed as a result of placement of Project components on the seabed. Subsequently, sediment will be *disturbed during recovery as it is likely that the Project components (anchors, cables) will have become buried to varying degrees.*

Suspended sediment during cable laying is expected to dissipate quickly and not reach levels that would harm ESA-listed salmonids (Newcombe and Jensen 1996), and eulachon, and green sturgeon would likely move away from the area of disturbance. Food sources of green sturgeon would also be largely unaffected by suspended sediment. Benthic fauna (e.g. polychaetes, clams, and amphipods) that inhabit the subsea cable route are likely to be adapted to dynamic ecosystems and likely would be unaffected by sediment burial (Maurer et al. 1982, EPA 2011).

HDD has the potential for inadvertent returns of drilling fluids leak through an unidentified weakness or fissure in the soil. HDD uses a slurry, composed of a fine clay material such as bentonite, as a drilling lubricant. The drilling lubricant is non-toxic but could result in increased suspended sediment and turbidity and possibly affect aquatic organisms. As the suspended material settles out of the water column, sedimentation would partially or entirely cover the waterbody substrate and any sessile benthic organisms, although effects would be minor, localized, and temporary .These measures minimize the effects of suspended sediment to benthic organisms and habitat.

I. Measure 12. Water Resources

<u>Recommendation:</u>

The Licensee shall take the following measures to minimize and mitigate for potential impacts to water resources in Appendix I: Protection, Mitigation, and Enhancement Measures.

Description of Primary Components of Mitigation for Water Resources

Mitigation Measure 12 of the Appendix I: Protection, Mitigation, and Enhancement Measures, describes future operations of the Project as proposed as part of the Pacific Marine Energy Center- South Energy Test Site Appendices to Preliminary Draft Environmental Assessment, related to water resource impacts. These actions include the following:

- *Follow industry standards and guidelines for antifouling applications (e.g., TBT-free) on Project structures such as marker buoys, subsurface floats, subsea connectors, and WECs. Industry standards are sometimes published in written documents (e.g., the International Cable Protection Committee's cable recommendations available at ttps://www.iscpc.org/publications/recommendations/) or in manufacturer guidelines (e.g., for a vessel anchor, providing the recommended ratio of water depth to anchor line paid out). These standards are sometimes required as a condition of insurance or warranty. In other cases, industry standards represent unpublished best practices commonly implemented by a particular industry and that evolve over time.*
- *Develop and implement an Emergency Response and Recovery Plan with spill prevention, response actions and control protocols, as well as provisions for recording types and amounts of hazardous fluids contained in WECs and other Project components.*
- *Require all vessel operators to comply with an Emergency Response and Recovery Plan for installation and maintenance of Project facilities.*
- *Prepare waste management, hazardous material, and spill prevention plans, as appropriate, for onshore Project facilities.*

- *Minimize storage and staging of WECs outside of existing docks, ports or other marine industrial facilities.*
- *Project components in the estuarine environment should not bottom out so as to prevent nearshore/estuarine habitat effects.*
- *The licensee should restrict in-water moorage to existing permitted facilities where increased suspended sediment or direct shading will not affect sensitive eelgrass habitat within or adjacent to the permitted facility.*
- *Require that all Project chartered or contracted vessels comply with all current federal and state laws and regulations regarding aquatic invasive species management.*

Rationale for Mitigation for Water Resources

Anti-fouling, spill prevention, and waste management will reduce any possible impacts to water quality. These measures will constrain the use and disposal of all hazardous products and minimize the risk of a spill or contaminants from entering the water. Aquatic invasive species management and minimizing benthic habitat effects in the nearshore/estuarine environment protect primary biological features. Accidental contamination of surface waters can occur when contracted vessels have not been properly disinfected and spread aquatic invasive species when transitioning from one waterbody to another. Project components in the estuarine environment should avoid bottoming out to prevent scour/erosion, degrading areas where potential eelgrass beds are located, and avoiding any reduction in prey availability to salmon and green sturgeon by not disturbing the benthic habitat that contributes to prey availability on multiple trophic levels. Water resource mitigation measures reduce the impacts to decreased water quality and minimize impacts in the nearshore/estuarine environment.

J. Measure 13. Vessel Traffic

Recommendation:

The Licensee shall take the following measures to minimize and mitigate for potential impacts from vessel traffic in transit to/from the Project Site in Appendix I: Protection, Mitigation, and Enhancement Measures.

Description of Primary Components of Mitigation for Vessel Traffic

Mitigation Measure 13 of the Appendix I: Protection, Mitigation, and Enhancement Measures, describes future operations of the Project as proposed as part of the Pacific Marine Energy Center- South Energy Test Site Appendices to Preliminary Draft Environmental Assessment, related to mitigation for vessel traffic.

- *The licensee shall require vessels in transit to/from the Project site to avoid close contact with marine mammals and sea turtles and adhere to NMFS "Be Whale Wise" guidelines to minimize potential vessel impacts to marine mammals.*

Rationale for Minimization and Mitigation Measures for Vessel Traffic

In 2011 under 50 CFS 224, NMFS established regulations under the Endangered Species Act and the Marine Mammal Protection Act to prohibit vessels from approaching killer whales within 200 yards (182.9 m) and from parking in the path of whales when in inland waters of Washington State. The purpose of the final rule is to protect killer whales from interferences and noise associated with vessels. This measure extend the Be Whale Wise guidelines to the Project location in an effort to minimize potential vessel impacts to marine mammals including but not limited to Southern Resident killer whales.

K. Measure 16. Terrestrial Resources

Recommendation:

The Licensee shall take the following measures to minimize and mitigate for potential impacts to terrestrial (onshore) resources in Appendix I: Protection, Mitigation, and Enhancement Measures.

Description of Primary Components of Mitigation for Terrestrial Resources

Mitigation Measure 16 of the Appendix I: Protection, Mitigation, and Enhancement Measures, describes future operations of the Project as proposed as part of the Pacific Marine Energy Center- South Energy Test Site Appendices to Preliminary Draft Environmental Assessment, related to terrestrial resource impacts. These actions include the following:

- *Minimize or avoid terrestrial activities in sensitive ecological areas (e.g., jurisdictional wetlands and nesting areas for listed avian species).*
- *Use HDD to install the transmission cable conduits under the beach and sand dune habitat.*
- *Where feasible, install terrestrial cables along or within previously disturbed routes and locations (e.g., along roadways, utility rights-of-way, etc.).*
- *Prior to construction, conduct a survey of wetlands and rare plants in areas where ground disturbing activities would occur to identify and avoid potential impacts as practicable.*
- *Employ environmental measures during installation, operation, and removal to avoid or minimize potential effects to sediment and soils. For example:*
    - *Minimize disruption of terrestrial geology and soils by maintaining buffers around wetlands to the degree practicable,*

  - *Develop and implement Erosion and Sediment Control Plans, and maintain natural surface drainage patterns.*
  - *Develop and implement stormwater runoff treatment such as low-impact development design at land-based facilities to maintain existing drainage patterns, protect project adjacent habitat, and prevent contamination of streams.*
- *Avoid to the extent practicable, disturbance of snags and of wildlife or legacy trees including live or dead trees that provide benefit to wildlife. If unavoidable, additional pre-construction species specific surveys may be necessary to minimize effects.*
- *Avoid to the extent practicable, disturbance of forested wetlands.*
- *Avoid to the extent practicable, disturbance of wetlands and adjacent areas that may provide habitat for western pond turtle, amphibians, and other semi-aquatic wildlife.*
- *Avoid to the extent practicable, disturbance of riparian wetlands where restoration of natural hydrology may be unsuccessful within a short timeframe. Natural hydrology should be restored after construction is complete, and may require a restoration plan with monitoring until successful restoration can be determined.*
- *Minimize disturbance of streams that support fish, or are connected to fish-bearing streams. Unavoidable work within or adjacent to fish-bearing streams may be subject to in-water work windows. If terrestrial activities directly or indirectly affect any stream used by anadromous fish or fish listed as threatened or endangered under the federal Endangered Species Act, consult with NMFS/FWS staff to avoid and minimize any potential effects to listed species.*

- *Avoid to the extent practicable, disturbance of seaside hoary elfin butterfly habitat within and in the vicinity of Driftwood Beach State Recreation Site. Where unavoidable, species-specific surveys may be necessary on properties outside of Driftwood Beach State Recreation Site but within the construction footprint to determine the extent of occupied habitat and associated mitigation.*
- *Develop a revegetation plan using native species to the extent possible for areas disturbed during construction.*
- *Develop measures that will limit the introduction or spread of invasive species, to be included in each construction plan.*

Rationale for Mitigation for Terrestrial Resources

The physical alteration of instream habitat would have both direct effects, which occur at the time of construction, and indirect effects, which occur later in time. The physical disturbance of instream habitat has the potential to affect existing conditions of the area where cable crossings would occur, such as substrate and large woody debris.

Cable construction requires clearing an approximately 20-foot construction right-of-way. Removing riparian vegetation may cause increased sediment input to the waterbodies, reduced filtering of nutrients washing in from cleared uplands, increased water temperature at and downstream of the cable crossing, reduced detrital and large woody recruitment potential, and increased potential for mass failures. These minimization measures reduce the impacts on fish and their habitat during terrestrial (onshore) construction activities on surface streams.

L. Measure 19. Five-Year Reviews

Recommendation:

The Licensee shall take the following measures to file with FERC a five-year report and provide copies to BOEM, NMFS, USFWS, and ODFW in Appendix I: Protection, Mitigation, and Enhancement Measures.

Description of Primary Components for Five-Year Reviews

Mitigation Measure 19 of the Appendix I: Protection, Mitigation, and Enhancement Measures, describes future operations of the Project as proposed as part of the Pacific Marine Energy Center- South Energy Test Site Appendices to Preliminary Draft Environmental Assessment, related to a five-year reporting process.

Beginning five years and six months after deployment of the first WEC device at the Project, and recurring every five years thereafter, the licensee shall file with FERC a Five Year Report and provide copies to BOEM, NMFS, USFWS, and ODFW. The Five Year Report shall contain (1) a review of all WEC deployments and associated Project activities from the prior five years (not including the most recent six months), including a description of the types and number of WEC devices deployed, frequency and duration of WEC deployments, monitoring activities and results, and any adaptive management criteria or response actions that were applied or modified, and (2) a description of WEC deployment activities that are planned or that are reasonably foreseeable in the next five years including, to the extent known, the types and number of WEC devices likely to be deployed, and the likely duration of such deployments.

<u>Rationale for Five-Year Reviews</u>

This mitigation measure will confirm project effects that are within the scope of the impacts originally evaluated and authorized. Five-year review reports allow each agency to evaluate past and proposed future Project operations to confirm that Project effects are consistent with each agency's prior regulatory review.

M. Measure 20. Fish or Wildlife Emergencies

<u>Recommendation:</u>

The Licensee shall take the following measures during a fish or wildlife emergency in Appendix I: Protection, Mitigation, and Enhancement Measures.

<u>Description of Primary Components for Fish or Wildlife Emergencies</u>

Mitigation Measure 20 of the Appendix I: Protection, Mitigation, and Enhancement Measures, describes future operations of the Project as proposed as part of the Pacific Marine Energy Center- South Energy Test Site Appendices to Preliminary Draft Environmental Assessment, related to fish or wildlife emergencies.

In the event of an emergency in which fish or wildlife are being killed, harmed or endangered by project facilities or operations in a manner that was not anticipated, OSU will notify agencies with regulatory authority as soon as possible and take action to promptly minimize the impacts of the emergency, including implementing any guidance pursuant to agency legal authorities. Within 48 hours after the emergency, OSU will notify the agencies regarding the results of actions taken to minimize impacts to fish or wildlife and will consult with the agencies regarding whether additional actions are necessary to comply with federal, state or local law. Nothing in this provision shall prevent OSU from taking immediate actions to protect life and property, stabilize an incident, or minimize potential damage.

Rationale for Fish and Wildlife Emergencies

The new license should include conditions that require the Licensee to notify the appropriate fish and wildlife agency when emergency situations at Project facilities may cause harm or mortality to fish and wildlife species or their habitats. Such notification by the Licensee allows the agency to document take of ESA-listed species, and determine whether further information is needed to assess impacts to fish and wildlife potentially caused by such situations.

ADDITIONAL PROTECTION, MITIGATION, AND ENHANCEMENT MEASURES

The following additional preliminary recommended terms and conditions which are necessary for the protection, mitigation, and enhancement of our resources that are adversely affected by the Project are described below. These measures were not discussed or agreed upon within the Collaborative Working Group. We recommend that these preliminary terms and conditions be incorporated into any license issued for the Project in addition to the above mentioned preliminary recommended terms and conditions that were discussed and agreed to within the Collaborative Working Group.

N. Work Area Isolation & Fish Salvage

Recommendation

The licensee shall include the following fish salvage and work area isolation best management practices for surface streams that are being impacted from the construction of the terrestrial cables and Utility Connection Management Facility.

Description of Primary Components of Work Area Isolation & Fish Salvage

Work Area Isolation

- *Isolate any work area within the wetted channel from the active stream whenever ESA-listed fish are reasonably certain to be present, unless NMFS and the licensee agree in writing (email) that the work can be done with less potential risk to listed fish without isolating and dewatering the work area (e.g., placing large woody debris).*
- *Engineering design plans for work area isolation will include all isolation elements and fish release areas. Any temporary bypass channels will be reviewed and verified by a NMFS hydraulic engineer to ensure compliance with fish passage criteria (NMFS 2011a).*
- *Dewater the shortest linear extent of work area practicable, unless wetted in-stream work is deemed to be minimally harmful to fish, and is beneficial to other aquatic species.*
    - *Use a coffer dam and a by-pass culvert or pipe, or a lined, non-erodible diversion ditch to divert flow around the dewatered area. Dissipate flow energy to prevent damage to riparian vegetation or stream channel and provide for safe downstream reentry of fish, preferably into pool habitat with cover.*
    - *Where gravity feed is not possible, pump water from the work site to avoid rewatering and to sustain stream flow. Maintain a fish screen on the pump intake to avoid juvenile fish entrainment.*
    - *Pump seepage water to a temporary storage and treatment site, or into upland areas, to allow water to percolate through soil or to filter through vegetation before reentering the stream channel with a treatment system comprised of either a hay bale basin or other sediment control device.*
    - *Monitor below the construction site to prevent stranding of aquatic organisms.*

  - *When construction is complete, re-water the construction site slowly to prevent loss of surface flow downstream, and to prevent a sudden increase in stream turbidity.*
- *Whenever a pump is used to dewater the isolation area and ESA-listed fish may be present, a fish screen will be used that meets the most current version of NMFS's fish screen criteria (NMFS 2011a). The NMFS verification is required for pumping at a rate that exceeds 3 cfs.*

Fish Salvage

- *If practicable, allow listed fish species to migrate out of the work area or remove fish before dewatering; otherwise remove fish from an exclusion area as it is slowly dewatered with methods such as hand or dip-nets, seining, or trapping with minnow traps (or gee-minnow traps).*
- *Fish capture will be supervised by a qualified fisheries biologist, with experience in work area isolation and competent to ensure the safe handling of all fish.*
- *Conduct fish capture activities during periods of the day with the coolest air and water temperatures possible, normally early in the morning to minimize stress and injury of species present.*
- *Monitor the nets frequently enough to ensure they stay secured to the banks and free of organic accumulation.*
- *Electrofishing will be used during the coolest time of day, only after other means of fish capture are determined to be not feasible or ineffective.*
  - *Do not electrofish when the water appears turbid, e.g., when objects are not visible at depth of 12 inches.*
  - *Do not intentionally contact fish with the anode.*

- *Follow NMFS (2000) electrofishing guidelines, including use of only direct current (DC) or pulsed direct current within the following ranges:*
  - *If conductivity is less than 100 microsecond (µs), use 900 to 1100 volts.*
  - *If conductivity is between 100 and 300 µs, use 500 to 800 volts.*
  - *If conductivity greater than 300 µs, use less than 400 volts.*
- *Begin electrofishing with a minimum pulse width and recommended voltage, then gradually increase to the point where fish are immobilized.*
- *Immediately discontinue electrofishing if fish are killed or injured, i.e., dark bands visible on the body, spinal deformations, significant de-scaling, torpid or inability to maintain upright attitude after sufficient recovery time. Recheck machine settings, water temperature and conductivity, and adjust or postpone procedures as necessary to reduce injuries.*

- *If buckets are used to transport fish:*
  - *Minimize the time fish are in a transport bucket.*
  - *Keep buckets in shaded areas or, if no shade is available, covered by a canopy.*
  - *Limit the number of fish within a bucket; fish will be of relatively comparable size to minimize predation.*
  - *Use aerators or replace the water in the buckets at least every 15 minutes with cold clear water.*
  - *Release fish in an area upstream with adequate cover and flow refuge; downstream is acceptable provided the release site is below the influence of construction.*
  - *Be careful to avoid mortality counting errors.*

- *Monitor and record fish presence, handling, and injury during all phases of fish capture and submit a fish salvage report to NMFS within 60 days.*

Rationale for Mitigation and Minimization Measures for Work Area Isolation

Before construction begins, the in-water work area would be temporarily isolated, and any fish present within the work area would be captured and released outside of the isolated area. Consequently, the only potential direct effects on federally listed salmonids during salvage would be from removal operations. If fish are missed during the salvage operations, they could suffer harm or mortality during construction. The licensee did include minimization measures with regard to fish salvage operations by stating that salvage operation protocols will be followed but the licensee does not specify or describe those protocols. Juvenile and adult Oregon Coast coho salmon may be present in the area impacted by work area isolation and fish salvage operations. This measure identifies and requires the licensee to comply with specific fish salvage and work area isolation requirements.

O. Stormwater Management

Recommendation

The licensee shall include the following stormwater management practices for all new impervious surfaces associated with the construction of the Utility Connection Management Facility.

Description for Stormwater Management

- *For water quality, first reduce by treating post-construction runoff using on-site infiltration to the maximum extent feasible. Any runoff not infiltrated on-site must be treated at least 50% of the cumulative rainfall from the 2-year, 24-hour storm before being discharged off-site.*

- *For water quantity, ensure that any discharge of post-construction runoff either directly, or indirectly through a conveyance system, into a fresh waterbody, including wetlands, does not exceed the range of discharge rated for the pre-developed site condition*[1] *from 50% of the 2-year peak flow up to the 10-year peak flow.*
    - *Stormwater control measures for flow control include: catch basins or manholes with outflow controls, detention ponds, roofs, parking lots, tanks, or vaults, and Infiltration facilities*

- *When conveyance is necessary to discharge treated stormwater into a fresh waterbody, including a wetland, the following requirements apply:*
    - *Maintain natural drainage patterns.*
    - *Ensure that treatment for post-construction runoff from the site is completed before it is allowed to commingle with any offsite runoff in the conveyance.*
    - *Prevent erosion of the flow path from the site to the receiving water and, if necessary, provide a discharge facility made entirely of manufactured elements (e.g., pipes, ditches, discharge facility protection) that extends at least to ordinary high water.*
- *Include a maintenance plan and schedule for each stormwater control measure, including the name and contact information for the entity responsible for that maintenance.*

[1] Pre-developed site condition means pre-settlement forest cover, unless historical information indicates otherwise or the immediate area and all subsequent downstream basins have at least 40% impervious cover. In that case, pre-developed condition will mean the existing land cover conditions.

- *Final NMFS review of the stormwater management plan will be required during the ESA consultation process.*

<u>Rationale for Stormwater Management</u>

Stormwater pollutants become more concentrated on impervious surfaces until they either degrade in place or are transported by wind, precipitation, or remain on site. Although stormwater discharge is minor from the proposed new impervious surfaces from the UCMF project component, it will have an incremental impact on pollutant levels caused by all development activity within the range of Oregon Coast coho salmon in the project area. At this scale, the additive effect of persistent pollutants contributed by many small, unrelated land developments has a greater impact on natural processes than the input from larger, individual projects, and the impacts of many small and large projects are all compounded together (NRC 2009; Vestal and Rieser 1995). Treatment of post-construction stormwater runoff reduces the amount of pollutants from entering the freshwater habitat potentially occupied by Oregon Coast coho salmon. In mitigation measure 16 for terrestrial resources as proposed as part of the Pacific Marine Energy Center- South Energy Test Site Appendices to Preliminary Draft Environmental Assessment the licensee states the development and implementation of stormwater runoff treatment such as low-impact development design at land-based facilities to maintain existing drainage patterns, protect project-adjacent habitat, and prevent contamination of streams. The licensee does not specify or describe the amount of water quality or water quantity treatment. This measure requires the licensee to meet NMFS standards for stormwater treatment.

P. Trenching/HDD Onshore Operations

Recommendation

The licensee shall include the following minimization practices for all trenching and/or HDD operation activities on utility line stream crossings associated with the onshore terrestrial portion of the Project.

Description of Project Components for Trenching/HDD Operations

Trenching

- *Restrict trenching to intermittent streams and only trench when the stream is naturally dry.*
- *All trenched areas in intermittent streams shall be backfilled below the ordinary high water line with native material and capped with clean gravel suitable for fish use in the Project area.*
- *Align each crossing as perpendicular to the watercourse as possible.*
- *Ensure that the drilled, bored, or jacked crossings are below the total scour prism.*
- *Any large wood displaced by trenching or plowing will be returned as nearly as possible to its original position, or otherwise arranged to restore habitat functions.*

HDD Operations

- *In preventing and minimizing the effects of an inadvertent return of drilling fluids to the surface (frac-out release) from HDD operations, the following minimization measures shall be taken:*
    - *The licensee will have all necessary equipment and supplies on-site to contain an unintended release of drilling mud.*

- *The entry and exit locations on all directionally drilled crossings shall have dry (upland) land segments where a frac-out can be easily detected, contained, and remediated.*
- *On-site visual monitoring by a knowledgeable HDD inspector must occur during construction operations and of the construction area including coverage upstream and downstream from the crossing for inadvertent returns.*
- *If a frac-out has been detected due to visual signs of surface seepage or loss of circulation/pressure of the drilling fluid, drilling operations will be stopped immediately and will not continue until the response/containment process has been initiated and under control.*
- *The licensee must notify NMFS immediately if an unintended release of drilling mud occurs.*
- *A frac-out contingency plan must be in place to handle potential problems that could arise during the HDD and the plan must have NMFS review and verification. The plan should include the following site specific information:*
    - *Geotechnical information including soil type, elevation, and depth of the HDD;*
    - *A containment, response, and notification plan;*
    - *Clean-up measures; and*
    - *Restoration and post-construction monitoring plan.*

<u>Rationale for Mitigation and Minimization of Trenching/HDD Operations</u>

Excavation and subsequent filling of a trench in a streambank or dry channel is likely to make the area of the trench more or less resistant to erosion, depending on the substrate *composition, the type of excavation, and the type of fill. If the trench area is less resistant to erosion, due to loosening of the substrate or through the use of fill with smaller substrate particles than were originally present, then high stream flows are likely to erode the disturbed substrate, thus mobilizing sediment or abruptly altering the bottom contours or bank stability of the stream. If the trench area is more resistant to erosion, through compaction of the substrate or through the use of fill with larger substrate particles than were originally present, then high stream flows may be less likely to erode the disturbed substrate than the remainder of the streambed or bank, possibly creating hydraulic control points and altering fluvial processes. Similarly, pipelines, cables, and materials used to armor them may create hydraulic control points ("jumps") that degrade channel conditions and impede fish passage, if they remain at the same elevation after being exposed by streambed or bank erosion.*

Horizontal directional drilling operations is considered to be a less intrusive method than traditional open-cut trenching for crossing a waterway or wetland by minimizing riparian vegetation and limiting construction to established entry and exit points (Keykha et al. 2011). However, an inadvertent return of drilling fluids to the surface ("frac-out" release) may occur and have negative effects on riparian and aquatic habitats. A frac-out is typically caused by over-pressurization of the borehole beyond the containment capability of the near-surface geological material and drilling fluid seepage through fractures or weak points to the surface (Kang et al. 2016). If a frac-out occurs, and a large volume of drilling fluid such as bentonite is released, the increase in sediment will have negative effects on water quality, benthic invertebrates, aquatic plants, fish and egg survival (Newcombe and MacDonald 1991; Slade 2000; Newcombe 2003; Cott et al. 2015). This minimization measure reduces impacts of trenching and HDD operations for surface streams in the Project area.

Q. Revegetation Plan

Recommendation

The licensee shall include the following minimization measures for the development of a revegetation plan for areas disturbed during on-shore construction.

Description of Project Components for Revegetation Plan

- *Plant and seed disturbed areas before or at the beginning of the first growing season after construction.*
- *Use a diverse assemblage of vegetation species native to the action area or region, including trees, shrubs, and herbaceous species. Vegetation, such as willow, sedge and rush mats, may be gathered from abandoned floodplains, stream channels, etc. When feasible, use vegetation salvaged from local areas scheduled for clearing due to development.*
- *For long-term revegetation use only species native to the project area or region that will achieve shade and erosion control objectives, including forb, grass, shrub, or tree species that are appropriate for the site.*
- *Short-term stabilization measures may include use of non-native sterile seed mix if native seeds are not available, weed-free certified straw, jute matting, and similar methods.*
- *Do not apply surface fertilizer within 50 feet of any wetland or water body.*
- *Install fencing as necessary to prevent access to revegetated sites by livestock or unauthorized persons.*
- *Do not use invasive or non-native species for site restoration.*

- *Conduct post-construction monitoring and treatment to remove or control invasive plants until native plant species are well-established.*

Rationale for Mitigation and Minimization of Revegetation Plan

Revegetating areas that have been cleared during construction will immediately dissipate erosive energy associated with precipitation and increase soil infiltration. It also will accelerate vegetative succession necessary to restore the delivery of large wood to the riparian area and aquatic system, root strength necessary for slope and bank stability, leaf and other particulate organic matter input, sediment filtering and nutrient absorption from runoff, and shade. Microclimate will become cooler and moister, and wind speed will decrease.

In mitigation measure 16 for terrestrial resources as proposed as part of the Pacific Marine Energy Center- South Energy Test Site Appendices to Preliminary Draft Environmental Assessment the licensee states the development of a revegetation plan using native species to the extent possible for areas disturbed by construction. The licensee does not specify or describe the revegetation plan. This measure provides minimization and mitigation measures for revegetating areas affected by on-shore construction impacts.

R. Decommissioning Plan

Recommendation

The licensee shall include the following components of a removal and decommissioning plan to restore the project site to natural characteristics to the extent practicable and minimize long term project impacts to marine habitat and avoid extending the risk of entanglement with project structures.

Description of Project Components for Decommissioning Plan

In the event the Project is decommissioned for any reason, the Licensee shall develop a Decommissioning Plan, in consultation with and subject to approval by the Fish Agencies (ODFW, NMFS, & USFWS). The licensee will remove all project structures. The Licensee shall require the WEC test clients to remove all project structures that are not intended to be reused within the license term after each completed deployment. The Licensee shall document and share with the Fish Agencies if and when anchors are to be reused in subsequent tests. The Licensee will provide a plan to restore the natural characteristics of the site to the extent practicable by describing the facilities to be removed. The plan will include:

- *a proposed decommissioning schedule;*
- *a description of removal and containment methods;*
- *a description of site clearance activities;*
- *plans for transporting and recycling, reusing, or disposing of the removed facilities; a description of those resources, conditions, and*
- *activities that could be affected by or could affect the proposed the proposed decommissioning activities;*
- *results of any recent biological surveys conducted in the vicinity of the structure and recent observations of marine mammals at the structure site;*
- *mitigation measures to protect archaeological and sensitive biological features during removal activities;*
- *a statement as to the methods that will be used to survey the area after removal to determine any effects on marine life; and*

- *Identification of how the Licensee will restore the site to the natural condition that existed prior to the development of the site, to the extent practicable.*

The Licensee shall provide a draft decommissioning plan to the Fish Agencies for a minimum of 30 days for review and comment and approval, prior to filing the results report with the Commission. The Licensee shall include with the report documentation of consultation with all agencies and approval by the Fish Agencies, copies of comments and recommendations on the draft decommissioning plan after it has been prepared and provided to the Fish Agencies, and specific descriptions of how the Fish Agencies' comments and recommendations are accommodated by the Decommissioning Plan. Upon approval by the Commission, the Licensee shall implement the Plan. After removal of all project components prior to the end of the license term, surveys for post-decommissioning habitat recovery should be conducted to ensure that habitat within the entire project area has been restored and no further mitigation is required.

<u>Rationale for Decommissioning Plan</u>

As stated in the Site Characterization Report for Marine Mammals and in the Benthic Habitat Monitoring Plan, sound, vessel activity, and benthic habitat disturbance associated with site assessment, construction, operation, and decommissioning can disturb marine species and may interfere with important activities, including foraging, resting, socializing, and migration. The licensee has agreed to develop a removal and decommissioning plan in the future as the license term nears its end as proposed as part of the Pacific Marine Energy Center- South Energy Test Site Appendices to Preliminary Draft Environmental Assessment. However, the licensee does not specify or describe the removal and decommissioning plan. This measure provides a description of what should be included in the removal and *decommissioning plan to restore the project site to its natural characteristics to the extent practicable.*

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TO THE ADMINISTRATIVE RECORD

FOR PRELIMINARY COMMENTS AND RECOMMENDED TERMS AND CONDITIONS SUBMITTED BY THE NATIONAL MARINE FISHERIES SERVICE

FOR THE UNITED STATES DEPARTMENT OF COMMERCE

FOR THE PACIFIC MARINE ENERGY CENTER- SOUTH ENERGY TEST SITE,

PROJECT NO. 14616-000

This is the Index for the Administrative Record in support of the National Marine Fisheries Service's (NMFS) Preliminary Recommended Terms and Conditions submitted for filing with the Federal Energy Regulatory Commission (Commission) on or about July 20, 2018. This Administrative Record supports NMFS' Preliminary Recommended Terms and Conditions made pursuant to Section 10(j) of the Federal Power Act for the Pacific Marine Energy Center-South Energy Test Site, FERC No. 14616-000. The documents listed in section A are already in the Commission's record and are not being submitted by NMFS in this filing. The documents listed in section B are not known to be in the Commission's record at this time for the current project proceeding, and thus NMFS is submitting them in this filing on a separate CD.

A. Documents Incorporated by Reference (not enclosed)

All public records and documents currently part of the Commission's record for Project No. 14616-000, including, but not limited to:

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United States Department of the Interior

NATIONAL PARK SERVICE
PACIFIC WEST REGION
333 Bush Street, Suite 500
San Francisco, CA 94104-2828

IN REPLY REFER TO:

ER 18/0191

July 20, 2018

Kimberly D. Bose, Secretary
Federal Energy Regulatory Commission
888 First Street, NE
Washington, DC 20426

Subject: Pacific Marine Energy South Energy Test Site FERC No. 14616-000

Dear Ms. Bose:

The National Park Service (NPS) is writing in response to Oregon State University's Draft License Application and Draft Environmental Assessment dated April 30.

Land and Water Conservation Fund (LWCF) Act

Section 6(f)(3) of the LWCF Act prohibits a conversion of property subject to LWCF requirements without approval from the Secretary of the Interior. This authority has been delegated to the NPS. A conversion is required if any part of LWCF property is used for a non-recreation purpose, or if the property owner transfers rights to another entity for non-recreation purposes. In order for a conversion to be approved, replacement property of current fair market value and of reasonably equivalent usefulness and location must be provided.

As the project is currently scoped, the impacts at Driftwood Beach would require an LWCF conversion. The NPS would need to be a cooperating agency on this National Environmental Policy Act (NEPA) document.

Please consult with Oregon Parks and Recreation Department (OPRD) and the NPS State and Local Assistance Programs to begin addressing the conversion issues:

Ms. Lisa Sumption, Director
Oregon Parks and Recreation Department
725 Summer Street NE, Suite C
Salem, OR 97301-1271
(503) 986-0729

Lisa.Sumption@oregon.gov

Ms. Heather Ramsay, Program Officer
National Park Service
Pacific West Region - Seattle
909 First Avenue, Floor 5
Seattle, WA 98104-1060
(206) 220-4123

Heather_Ramsay@nps.gov

Sincerely,

Ray Murray
Chief, Partnerships Program
National Park Service, Pacific West Region

Oregon

Kate Brown, Governor

Department of Fish and Wildlife
Marine Resources Program
2040 SE Marine Science Drive
Newport, OR 97365
(541) 867-4741
FAX (541) 867-0311
www.dfw.state.or.us/mrp/

July 20, 2018

Kimberly D. Bose, Secretary
Federal Energy Regulatory Commission
888 First Street, NE
Washington D.C. 20426

Electronic Delivery

RE: Draft License Application from Oregon State University for the Pacific Marine Energy Center – South Energy Test Site (P-14616-000) Preliminary Recommendations and Preliminary Comments

Dear Secretary Bose,

On April 25, 2018, the Federal Energy Regulatory Commission (FERC, Commission) issued a *Notice of Draft License Application (DLA) and Draft Preliminary Draft Environmental Assessment (PDEA) and Request for Preliminary Terms and Conditions* for the proposed Pacific Marine Energy Center – South Energy Test Site (FERC No. P-14616-000) project proposed by Oregon State University. The Oregon Department of Fish and Wildlife (ODFW) is aware that this project, as proposed, would consist of facilities located in the Pacific Ocean approximately six nautical miles off the coast of Newport, Oregon, buried subsea and onshore transmission cables, and onshore facilities located in Lincoln County, Oregon.

Attached for filing are preliminary recommendations, pursuant to Federal Power Act Sections 10(j) and 10(a), and preliminary comments from ODFW. Final recommendations and comments will be filed at a future date upon request from the Commission. For clarification or further discussion of these comments please contact me at 541-867-4741 extension 292.

Sincerely,

Delia Kelly

Delia Kelly
Ocean Energy Coordinator
Oregon Department of Fish and Wildlife

Ec: Service List (FERC No. P-14616-000)
Dr. Burke Hales, Oregon State University
Caren Braby (ODFW); Ken Homolka (ODFW); Dave Fox (ODFW)

OREGON DEPARTMENT OF FISH AND WILDLIFE

Preliminary Section 10(j) and Section 10(a) Recommendations and Preliminary Comments

for

OREGON STATE UNIVERSITY'S

Pacific Marine Energy Center – South Energy Test Site

FERC P-14616-000

July 2018

Oregon Department of Fish and Wildlife
Newport, Oregon

UNITED STATES OF AMERICA
FEDERAL ENERGY REGULATORY COMMISSION

Oregon State University	)	**FERC P-14616-000**
	)	**Pacific Marine Energy Center –**
	)	**South Energy Test Site**
Draft License Application for a Major	)	
Unconstructed Project and Preliminary	)	
Draft Environmental Assessment	)	

OREGON DEPARTMENT OF FISH AND WILDLIFE

PRELIMINARY SECTION 10(j) AND SECTION 10(a) RECOMMENDATIONS AND PRELIMINARY COMMENTS

INTRODUCTION

In accordance with the Federal Energy Regulatory Commission's (FERC, Commission) April 25, 2018 *Notice of Draft License Application (DLA) and Draft Preliminary Draft Environmental Assessment (PDEA) and Request for Preliminary Terms and Conditions*, the Oregon Department of Fish and Wildlife (ODFW) submits the following preliminary comments and recommendations, pursuant to Sections 10(j) and 10(a) of the Federal Power Act, 16 USC 803(j), and the Fish and Wildlife Coordination Act, 16 USC 661 et seq. Oregon State University (OSU, applicant, licensee) is seeking a new license to construct and operate the proposed Pacific Marine Energy Center - South Energy Test Site (PMEC-SETS, project). The project area includes habitat for listed species and a diverse array of marine, freshwater, and upland species of fish and wildlife under ODFW's management jurisdiction. Detailed construction plans including final proposed project footprints for construction and operation have not been finalized, but are proposed to be submitted with the Final License Application (FLA). Following review of detailed plans and designs, along with any additional or revised analysis performed by OSU, FERC or other entities, ODFW intends to file final comments and recommendations. ODFW reserves the right to amend or modify these preliminary recommendations pursuant to Title 18 CFR § 4.34(b)(4), if warranted, based on analysis of new information and conclusions, results of the Commission's environmental analysis process, upon further analysis of potential impacts, or if new proposals are developed and included in the licensing record by other resource agencies, the applicant, or FERC.

PROJECT DESCRIPTION

The applicant has filed with the Commission a DLA package including a PDEA and multiple appendices under FERC project number P-14616-000. The applicant requests a 25-year original license for the installation and operation of PMEC-SETS, to be located in the Pacific Ocean and in Lincoln County, Oregon. The primary purpose of the proposed project is to serve as a facility to allow clients to test full-scale wave energy converters (WECs), with generation and transmittal of power to the grid being a secondary purpose. As currently proposed, the test facility would include:

A. Four test berths in the Pacific Ocean, approximately six nautical miles (nm) off the coast of Newport, Oregon on the outer continental shelf in water depths of 65 to 78 meters (m), within an area of approximately two square nm (1,695 acres), and support for up to 20 commercial-scale WECs generating up to 20 megawatts (MW).
B. Five subsea connectors.
C. Five subsea cables (four electrical and one auxiliary) that would be individually buried 1-2 m deep to the extent possible from the test berths to the 10-m isobaths, encompassing a cable corridor area of two square nm.

D. Five individual horizontal directional drills (HDD) to run subsea cables under the beach and dunes, transmitting data and energy from the test berths to onshore facilities.

E. Five beach manholes, each consisting of a 10 X 10 X10 foot (ft) concrete vault, all buried at Driftwood Beach State Recreation Site (Driftwood) near Seal Rock, Oregon, designed to house the interconnection between subsea and terrestrial cables.

F. Terrestrial cables running from manholes about 0.7 miles (mi) to the east and south.

G. A newly built Utility Connection and Monitoring Facility (UCMF) designed to transfer power to a grid connection point with the Central Lincoln People's Utility District (CLPUD) in Lincoln County, Oregon.

As proposed, the License would authorize management and facility oversight by the applicant as well as testing activities by future test clients, who would be subject to License requirements and test center protocols and procedures. Test equipment could include:

A. WECs, deployed singly or in arrays, up to a maximum of 20;

B. Mooring cables;

C. Anchors;

D. Umbilical cables; and

E. Array hubs.

ODFW'S STATUTES, POLICIES, AND RULES

ODFW has authority pursuant to Sections 10(j) and 10(a) of the Federal Power Act and the Fish and Wildlife Coordination Act (16 U.S.C. § 661 et seq.) to provide fish and wildlife recommendations to FERC regarding protection, mitigation, and enhancement of fish and wildlife and their habitat affected by operation and management of the project. ODFW is authorized to implement the fish and wildlife policies of the State of Oregon and is uniquely qualified to further those policies through its recommendations to protect, conserve and improve fish and wildlife resources within the project area. ODFW has a direct interest in the proposed action because the project has the potential to affect fish and wildlife resources that are within ODFW's statutory purview. ODFW is the state agency established to manage fish and wildlife resources in Oregon pursuant to Oregon Revised Statutes (ORS), Oregon Administrative Rules (OAR) and associated policies including:

• <u>Threatened and Endangered Wildlife Species (ORS 496.171 through 496.182)</u>

> Protect and recover species listed as threatened or endangered while minimizing duplication and overlap between state and federal laws dealing with threatened or endangered species.

• <u>Threatened and Endangered Species List (OAR 635-100-0080 through 0160)</u>

> Manage species listed as threatened or endangered under the state Endangered Species Act (ESA) and their habitats so that the status of the species improves to a point where listing is no longer necessary. Accomplish this goal through voluntary incentives, encouraging appropriate species management, coordinated

planning, habitat protection and restoration, and other means as appropriate, in a manner consistent with the provisions of ORS 496.182.

- <u>Food Fish Management Policy (ORS 506.109)</u>

  Manage food fish to provide the optimum economic, commercial, recreational and aesthetic benefits for present and future generations of citizens of this state. Maintain all species of food fish at optimum levels in all suitable waters of the state and prevent the extinction of any indigenous species. Develop and manage the lands and waters of this state in a manner that will optimize the production, utilization and public enjoyment of food fish. Develop and maintain access to the lands and waters of the state and the food fish resources thereon. Regulate food fish populations and the utilization and public enjoyment of food fish. Preserve the economic contribution of the sports and commercial fishing industries in a manner consistent with sound food fish management practices.

- <u>Fisheries Conservation Zone (ORS 506.750 & 755)</u>

  The State of Oregon has a special interest in the maintenance of the productivity of the living resources in the area of the high seas adjacent to its territorial sea. Preservation of complex interrelationships of the marine environment within the continental shelf of the Pacific Ocean off the coast of the State of Oregon is necessary to conserve coastal species of fish and to guarantee the well-being of the economy and welfare of the state and its people. The State of Oregon adopts a Fisheries Conservation Zone for the maintenance, preservation and protection of all coastal species of fish and other marine fisheries resources between the mean high water mark of the state and a straight line extension of the lateral boundaries of the state drawn seaward to a distance of 50 statute miles.

- Aquatic Invasive Species Prevention (ORS 830.560 through 587)

  A person may not launch a boat into the waters of this state if any aquatic invasive species is present.

- Aquatic Invasive Species Control (OAR 635-059-0000 through 0010)

  Protect Oregon's water resources, fish, wildlife and their habitat from harm due to the introduction and/or spread of aquatic invasive species.

- Western Snowy Plover Conservation Program (OAR 635-105-0000 through 0040)

  Serve as the survival guidelines for the western snowy plover, *Charadrius alexandrinus nivosus*, and provides overall direction for the protection and conservation of the western snowy plover in Oregon.

- Scientific Taking Permit (ORS 497.298)

  Establishes policy that any person desiring to take wildlife for scientific purposes shall first obtain a permit

- The Oregon Plan (ORS 541.898)

  Establishes a comprehensive program for the protection and recovery of species and for the restoration of watersheds throughout this state.

- Wildlife Policy (ORS 496.012)

  Establishes wildlife management policy to prevent serious depletion of any indigenous species, maintain all species of fish and wildlife at optimum levels, provide the optimum recreational and aesthetic benefits for present and future generations of the citizens of this state, make decisions that affect wildlife resources of the state for the benefit of the wildlife resources, and to make decisions that allow for the best social, economic and recreational utilization of wildlife resources by all user groups.

- Policy to Recover and Sustain Native Stocks (ORS 496.435)

  Establishes goal of the State of Oregon to recover and sustain native stocks of salmon and trout at their historic levels of abundance.

- Fish Passage Law (ORS 509.580 - 509.645)

  Requires upstream and downstream passage at all artificial obstructions in those Oregon waters in which migratory native fish are currently or have historically been present.

- Fish Passage Rules (OAR 635-412-0005 through 0040)

  Defines the rules that establish general criteria for determining the adequacy of fish passage and alternatives to fish passage including waiver or exemption. Defines "native migratory fish" to include some marine or anadromous species including *Acipenser medirostris* -- Green Sturgeon; *Amphistichus rhodoterus* -- Redtail surfperch; *Hypomesus pretiosus* -- Surf smelt; *Lampetra tridentate* -- Pacific lamprey; *Oncorhynchus keta* -- Chum salmon; *Oncorhynchus kisutch* -- Coho salmon; *Oncorhynchus tshawytscha* -- Chinook salmon; *Spirinchus thaleichthys* -- Longfin smelt; *Thaleichthys pacificus* -- Eulachon.

- Native Fish Conservation Policy (OAR 635-007-0502 through 0535)

  Establishes the policy of the State of Oregon to (1) prevent the serious depletion of any native fish species by protecting natural ecological communities, conserving genetic resources, managing consumptive and non-consumptive fisheries; (2) maintain and restore naturally produced native fish species, taking full advantage of the productive capacity of natural habitats; and (3) foster and sustain opportunities for sport, commercial, and tribal fishers.

- Fish and Wildlife Habitat Mitigation Policy (OAR 635-415-0000 through 0030)

  The purpose of these rules is to further the Wildlife Policy (ORS 496.012) and the Food Fish Management Policy (ORS 506.109) of the State of Oregon through the application of consistent goals and standards to mitigate impacts to fish and wildlife habitat caused by land and water development actions. The policy provides goals and standards for general application to individual development actions, and for the development of more detailed policies for specific classes of development actions or habitat types. The Department shall apply the requirements of this division when developing recommendations to other state, federal, or local agencies regarding development actions for which mitigation for impacts to fish and wildlife habitat is authorized or required by federal, state, or local environmental laws or land use regulations.

- Wildlife Diversity Plan (OARs 635-100-0001 through 0030)

  Maintain Oregon's wildlife diversity by protecting and enhancing populations and habitats of native wildlife at self-sustaining levels throughout natural geographic ranges.

- Sensitive Species List (OAR 635-100-0040)

  Establishes the category of sensitive species for the purpose of prioritizing conservation actions to prevent species from becoming eligible for listing as threatened or endangered species. "Sensitive" refers to wildlife species, subspecies, or populations that are facing one or more threats to their populations, habitat quantity or habitat quality or that are subject to a decline in number of sufficient magnitude such that they may become eligible for listing on the state Threatened and Endangered Species List.

- Trout Management (OAR 635-500-0100 through 0120)

  Maintain the genetic diversity and integrity of wild trout stocks; and protect, restore, and enhance trout habitat.

- Oregon Conservation Strategy and Oregon Nearshore Strategy

  Establishes the overarching state strategy for conserving fish and wildlife, provides a shared set of priorities for addressing Oregon's conservation needs, and presents a menu of recommended voluntary actions and tools for conservation. The goals of the Oregon Conservation Strategy are to maintain healthy fish and wildlife populations by maintaining and restoring functioning habitats, preventing declines of at-risk species, and reversing declines in these resources where possible. The mission of the Oregon Nearshore Strategy is to promote actions that will conserve ecological functions and nearshore marine resources to provide long-term ecological, economic, and social benefits for current and future generations of Oregonians. The Oregon Nearshore Strategy presents recommendations for voluntary actions that can contribute to the sustainability of marine resources and ecological functions.

In addition to ODFW's statutes, policies and rules, Oregon state policy pertinent to the protection of fish and wildlife resources or the analysis of potential impacts from marine renewable energy projects include:

- Territorial Sea Plan (OAR 660-036-0000 *et. seq.*) Parts Four and Five

    Oregon's Territorial Sea Plan Part Four, Uses of the Seafloor, was adopted by the Land Conservation and Development Commission (LCDC) in 2000, and describes mandatory policies and implementation requirements for the routing and operation of seafloor cables. Territorial Sea Plan Part Five: Use of the Territorial Sea for the Development of Renewable Energy Facilities or Other Related Structures, Equipment or Facilities, was adopted by LCDC in 2009. Part Five describes a process for making decisions concerning the development of renewable energy facilities in the territorial sea intended to protect living marine organisms, ecosystem integrity, marine habitat and areas important to fisheries from potential adverse effects of renewable energy siting, development, operation, and decommissioning.

- Geographic Location Description

    The Geographic Location Description (GLD) was approved by NOAA in 2015 and delineates an area from the seaward limit of the territorial sea to 500 fathoms wherein offshore energy development has the potential to affect state resources, and so will be subject to review by the Oregon Coastal Management Program under the Coastal Zone Management Act Federal Consistency Provision. The GLD provides analysis of reasonably foreseeable effects on Oregon's coastal resources and uses from certain federal license or permit activities for ocean energy developments that may be proposed in the federal waters off of Oregon.

- Essential Salmonid Habitat (OAR 141-102-0000)

  It is the policy of the State of Oregon to protect areas designated as essential salmonid habitat (ESH) including the waters of this state. To achieve this policy, the Department of State Lands shall consult with the Department of Fish and Wildlife concerning the status of Oregon's indigenous anadromous salmonid species and review all projects proposed in ESH pursuant to the standards set forth in the state's Removal-Fill Law (ORS 196.600 to 196.990) and rules (OAR 141-085).

- Removal-Fill Authorizations Within Waters of Oregon Including Wetlands (OAR, 141-085-0500 et. seq.)

  Jurisdictional waters of the state include streams, estuaries, wetlands and the Pacific Ocean from the line of extreme low tide seaward to the limits of the territorial sea. A removal-fill authorization is required for fill or removal activities in waters of this state equal to or exceeding 50 cubic yards. A removal-fill authorization is required for any fill or removal activities in Oregon state scenic waterways, essential salmonid habitat, compensatory mitigation sites, or the territorial sea for ocean renewable energy facilities.

- Oregon Shore Permit (ORS 390.650)

  In order to promote the public health, safety and welfare, to protect the state recreation areas, and to preserve values adjacent to and adjoining such areas, the natural beauty of the ocean shore and the public recreational benefit derived therefrom, it is necessary to control and regulate improvements on the ocean shore. Unless a permit therefor is granted by the State Parks and Recreation

> Department, no person shall make an improvement on any property that is within the ocean shore.

Together, these statutes, rules, and policies set forth the goals, objectives, and standards for the analysis of fish and wildlife populations potentially affected by the proposed PMEC-SETS Project. The fundamental principle behind ODFW's recommendations is to ensure that Oregon's statues, rules and policies are implemented in this proceeding; and that Oregon's fish and wildlife resources are maintained, enhanced and protected.

PROCEDURAL BACKGOUND

Licensing consultation on project design and assessment of potential impacts was conducted under FERC's Alternative Licensing Process (ALP), which was selected as the preferred FERC licensing approach by the parties engaged in early consultation as being the most appropriate approach for the proposed project by providing a consultation process that enabled federal and state agencies, and stakeholders to work cooperatively toward the ultimate DLA currently proposed. Pre-formal consultation with agencies began in the fall of 2012 to share information and to prepare for the formal licensing consultation process. In January 2013, OSU formed an advisory team comprised of federal and state agencies involved in the PMEC-SETS authorization process, as well as non-governmental organizations representing stakeholder interests, to collectively explore the Project and identify key regulatory and environmental considerations. This advisory group is called the Collaborative Workgroup (CWG) and ODFW participated fully in this extensive effort, providing input regarding the identification, avoidance, and minimization of impacts on fish and wildlife resources. Agency staff have actively contributed to scoping of issues (see ODFW scoping recommendation letter dated August 4, 2014), sharing data and expertise, drafting measures to avoid or mitigate impacts on sensitive resources, and development of monitoring and study plans. To the extent possible, the recommendations set forth herein are intended to reflect and be consistent with agreements reached through the collaborative process between OSU and the CWG during initial stages of the ALP.

PRELIMINARY SECTION 10(j) RECOMMENDATIONS

Pursuant to Section 10(j)(1) (16 USC 803(j)(1)) of the Federal Power Act (FPA), when issuing a license, the Commission will include conditions based on the recommendations by the state fish and wildlife agencies submitted pursuant to the Fish and Wildlife Coordination Act (16 USC 661 et seq.) to "adequately and equitably protect, mitigate damages to, and enhance fish and wildlife (including related spawning grounds and habitat)" affected by the development, operation, and management of a project. In connection with its environmental review of an application for license, the Commission will analyze all recommended conditions timely filed by fish and wildlife agencies, and will include those recommended measures unless it believes they are inconsistent with the FPA or other applicable law. In its notice dated April 25, 2018, the Commission solicited (1) preliminary terms, conditions, and recommendations on the draft PDEA, and (2) comments on the DLA. Pursuant to Section 10(j) of the FPA and to carry out the purposes of the Fish and Wildlife Coordination Act (16 U.S.C. 661 et seq.), ODFW offers the following preliminary recommendations intended to be consistent with agreements reached by the CWG, to the extent possible. Recommendations may deviate from content proposed by the applicant where either agreement was not reached during CWG discussions or new material is provided in the DLA package that results in modified input from ODFW.

Preliminary 10(j) Recommendation 1: Proposed Plans and Measures

ODFW is recommending the following plans and measures proposed by the applicant in their April 20, 2018 DLA package be incorporated as proposed as enforceable conditions of a FERC license:

A. Emergency Response and Recovery Plan, PDEA Appendix G
B. Benthic Sediments Monitoring Plan, PDEA Appendix H-1
C. Organism Interactions Monitoring Plan, PDEA Appendix H-2

ODFW is recommending the following plans and measures proposed by the applicant in their April 20, 2018 DLA package be incorporated as modified by subsequent recommendations, and made enforceable conditions of a FERC license:

A. Bird and Bat Conservation Strategy, PDEA Appendix B, see Preliminary 10(j) Recommendation #2
B. Navigation Safety Risk Assessment, PDEA Appendix E, see Preliminary 10(a) Recommendation #1
C. Operations and Maintenance Plan, PDEA Appendix F, see Preliminary 10(a) Recommendation #2
D. Acoustic Monitoring Plan, PDEA Appendix H-3, see Preliminary 10(j) Recommendation # 4

E. Electromagnetic Field Monitoring Plan, PDEA Appendix H-4, see Preliminary 10(j) Recommendation #3
F. Protection, Mitigation, and Enhancement Measures, PDEA Appendix I, see the following Preliminary 10(j) and 10(a) Recommendations
G. Adaptive management Framework, PDEA Appendix J, see Preliminary 10(j) Recommendation #9
H. Habitat Mitigation Plan, PDEA Appendix K, see Preliminary 10(j) Recommendation #5

Rational: In January 2013, OSU formed the CWG, comprised of federal and state agencies involved in the PMEC-SETS authorization process, as well as non-governmental organizations representing stakeholder interests, to collectively explore the Project and identify key regulatory and environmental considerations (PDEA 1-12). A primary focus of the CWG was to develop plans and measures designed to meet regulatory standards, minimize impacts on the environment, and facilitate the safe and compliant deployment of WECs. ODFW participated fully in the CWG, and worked directly with OSU or sub-groups, to cooperatively develop several of the plans and measures listed above. As communicated by OSU during CWG processes, it was the applicant's intent that these plans and measures would be included in the application materials to FERC. ODFW recommends that FERC incorporate the plans and measures agreed upon by the CWG, or as modified by ODFW recommendations, as license requirements.

Preliminary 10(j) Recommendation 2: Bird and Bat Conservation Strategy

The licensee shall implement the Bird and Bat Conservation Strategy (BBCS) included as PDEA Appendix B, and PM&E number 9: Mitigation for Birds and Bats, with the following modifications:

A. BBCS tables 2, 3 and 4 footnotes cite 2016 updates to the Oregon Nearshore Strategy (ONS) and sensitive species list but neither are in the reference section. The licensee shall add the 2016 ONS and sensitive species list updates to the reference list.

B. As agreed to by the US Fish and Wildlife Service (USFWS), ODFW and the applicant during development of the BBCS, to minimize potential effects of the project on bats, the licensee shall avoid construction activities near bat maternity roosts during the maternity season, or implement buffer zones for terrestrial construction activities. Without ODFW's review, the applicant added an alternative measure that if construction work must occur within the noise buffer zones during the maternity season, engineering controls will be implemented. The licensee shall remove from consideration the option to implement engineering controls until such time as USFWS and ODFW have reviewed and agreed to include such measures.

C. PM&E measures 6-9 are subject to on-going coordination with the specific resource agencies noted in each measure. PM&E measure 9, mitigation for birds and bats, does not identify any such agencies, and shall be modified to include USFWS and ODFW as consulting agencies for birds and bats.

Rationale: ODFW worked collaboratively with the applicant and USFWS to develop the BBCS, providing updated source materials and participating in development of environmental measures including buffers around bat maternity roosts. The addition of engineering controls as an alternative to buffers constitutes a significant change to what was considered by ODFW. As such, we recommend the applicant revert to environmental measures agreed upon during development of the BBCS, until such time as USFWS and ODFW have reviewed and agreed to include engineering controls as an alternative to maternity roost buffers.

Per PM&E measure 9, Mitigation for Birds and Bats, the licensee shall implement the Environmental Measures section as described in the BBCS, attached as PDEA Appendix B. As proposed, this measure is grouped with measures 6-9 as PM&E measures that are implemented adaptively in consultation with a specific agency or agencies that have regulatory authority over the resources that may be affected. The measure as written does not identify any such agency or agencies, and should be modified to include USFWS and ODFW as consulting agencies for birds and bats.

Preliminary 10(j) Recommendation 3: Electromagnetic Field Monitoring Plan

The licensee shall implement the Electromagnetic Field (EMF) Monitoring Plan included as PDEA Appendix H-4, with the following modifications:

A. The EMF plan states that the cable will be buried except within the footprint of the test site or in places with hard substrate, and all power cables would be shielded and armored and would not emit any electric fields directly.The licensee shall add, in accordance with PM&Es 1 and 15, that OSU shall utilize shielding on subsea cables, umbilical cables and other electrical infrastructure (including, to the extent feasible, hubs and subsea connectors) to minimize EMF emissions to the maximum extent practicable.

B. The definition of what is considered “biologically relevant” is critical to the analysis of EMF measurements and modeling results, and is currently based on a small amount of data indicating species response to EMF. The licensee shall add to the EMF Monitoring Plan and to PM&E number 1(4) that the definition of what is considered “biologically relevant” may be modified during the license term if future best available science indicates it is appropriate to do so, as determined by the adaptive management committee.

Rationale: ODFW has reviewed the applicant’s proposed monitoring and mitigation strategy proposed to address EMF produced by the project and finds that the monitoring plan should be made consistent with PM&Es 1 and 15. To be consistent, the monitoring plan should also commit the applicant to shielding cables, umbilical cables and other electrical infrastructure (including, to the extent feasible, hubs and subsea connectors) to minimize EMF emissions to the maximum extent practicable. ODFW believes that if it is technically feasible to shield all electrical infrastructure components, then shielding should be applied.

ODFW worked collaboratively with the applicant and the CWG to develop monitoring plans, including plans to measure and model EMF. We searched the existing literature base and participated in lengthy discussions surrounding marine species response to EMF emissions to establish an agreed upon level of EMF that could be considered biologically relevant. The monitoring plan proposes that models will estimate if EMF is likely to exceed biologically relevant levels at a distance of 10 m from WECs, and EMF emissions that exceed ambient levels are not considered biologically relevant unless they exceed 3 milliteslas (mT). According to the PDEA, if results of modeling and/or field surveys indicate that EMF attributable to the WECs has the potential to elicit a behavioral response from green sturgeon, salmonids, or other species of concern and exceeds the mitigation threshold, adaptive management and mitigation measures to address the unanticipated adverse effects would be implemented by OSU. PM&E measure 1(4), EMF exceedance, proposes that if the results of field measurements or validated and reliable modeling results indicate levels in excess of biologically relevant levels (e.g., 3 milliteslas (mT), Woodruff et al. 2012, Normandeau et al. 2011 or newer data) at a distance equal to or greater than 10 m from WECs, the licensee shall implement mitigation actions. The potential to elicit a biological response at 3 mT is based on the best currently available science, but an abundance of data regarding biological relevance of EMF does not exist at this time. ODFW agreed to use of the 3mT level only if the level and definition of "biologically relevant" could be changed as new information becomes available indicating that a change in the 3 mT level is warranted. The applicant agreed that the monitoring plan would clarify that the threshold may change with updated guidance. Such clarification should be added to monitoring plan, and the revised monitoring plan should be implemented as a license requirement.

Preliminary 10(j) Recommendation 4: Acoustic Monitoring Plan and Mitigation

The licensee shall implement the Acoustic Monitoring Plan included as PDEA Appendix H-3, and mitigation measures related to acoustic impacts including PM&Es 5, 6, and 7, with the following modifications:

A. Results of acoustic site-characterization studies were contaminated by "self-noise" from the hydrophone mooring system. Add to the monitoring plan methods to reduce or address "self-noise" and maximize successful collection of acoustic data during any sea state to fulfil stated objectives of the monitoring plan.
B. The license shall require that the licensee schedule project construction activities in the territorial sea outside of the phase b gray whale migration.
C. The licensee shall require WEC testing clients to prepare contingency plans and stock replacement parts to prepare to remedy acoustic exceedance events and expedite the timeline proposed by the applicant.

Rational A: ODFW worked with the applicant and the CWG to develop acoustic site characterization study objectives and overcome challenges experienced during studies conducted in 2013 and 2014 and reported in March 2016. Reported in the DLA is an update to the initial acoustic study conducted in 2013 to 2014. There has been no prior review of this update report of the subsequent acoustic site characterization study that was conducted in 2015. In this update the applicant reports that

> *mooring "self-noise" contamination begins to emerge within the record near August 6, 2015 affecting frequencies in discrete bands ranging from 400 – 5000 Hz, with highest amplitudes in the 600-1200 Hz range. This "self-noise" becomes increasingly louder and more frequent as the weather conditions degraded later in the fall season and the compliancy of the mooring system became more active. The mooring generated, "self-noise" contamination sounds are the result of wear*

> *on the rubber and chaffing noise mitigation materials that were wrapped over the chain and metal shackle components of the mooring system. In particular, the connection point between the steel float and chain links developed an identifiable "rubbing" sound of metal on metal that appears randomly and gets progressively louder and more frequent. Due to the high density of detected "self-noise" and its influence on measured noise levels, analysis of ambient noise is limited to the time period from June 24 – August 6, 2015 prior to the development of the contamination signal.*

As reported by the applicant, within the six week period, wave heights ranged 0.7-3.1m, almost entirely below small craft advisory (high seas). Recordings ranged 83-138 dB, and less than 1% of the measurements surpasses the 116 dB level, however maximum levels reported represent an underestimate of the highest acoustic energy events when vessel noise saturated the hydrophone and data were clipped. As a result of these recording limitations, the analysis of the 6-wk period (June 24 – August 6 2015) of low self-noise contamination does not capture a range of environmental conditions, and so does not meet objectives of either the 2016 or 2018 report. Conditions were relatively calm during this study period, so higher noise would be expected with increased higher seas and increased WEC activity.

In the 2016 report of 2013-2014 initial study, the applicant proposed that "*future deployments will include jacketed wire instead of chain elements to quiet mooring system noise levels*." However, as evidenced by the results of the 2015 study, wrapping the chain and metal shackle components of the mooring system with rubber and chaffing noise mitigation materials was not sufficient to quiet self-noise from the mooring system. The licensee shall describe how monitoring activities described in the monitoring plan will overcome self-noise contamination and provide the necessary data to document sound produced by the project during all seasons and conditions. Such clarification shall be added to the monitoring plan, and the revised monitoring plan shall be implemented as a license requirement.

Rationale B: According to the applicant, the primary source of sound would be from vessels at the site, and is predicted to be no greater than 130-160 dB, with Dynamic Positioning Vessel (DPV) noise up to 180 dB. The applicant reports that for a project off of Virginia, DPV sound was predicted to remain above the level B harassment threshold for marine mammals as far as 6 kilometers (km; 3.24 nm) from the source. Disturbance from cable laying activities would occur for 30 days at PMEC-SETS. The applicant expects that highly mobile cetaceans would avoid the area, and avoidance of the area due to sound would not significantly impair essential life functions (foraging, migration, rearing) or impair the health, survivability, or reproduction of individual whales. Per PM&E measure 6, to mitigate for potential impacts of DPV activities on marine resources, the licensee will implement such additional measures as may be imposed pursuant to a Marine Mammal Protection Act authorization. Per PM&E measure 10, operations and maintenance activities will not cause injury or harassment of marine mammals without any necessary authorization under the Marine Mammal Protection Act (MMPA).

Gray whales remain listed by the state as endangered. In a report specifically designed to assess gray whale distribution off of Oregon and use of the PMEC-SETS proposed WEC deployment area, researchers at OSU’s Marine Mammal Institute stated that the chosen area "*does not appear to be one of extensive use by gray whales. We believe the number of gray whales occurring within the area to be extremely low during northbound Phase B migration and during the summer/fall feeding season when animals are much closer to shore. Some gray whales may occur in the area during southbound and northbound Phase A migration (winter and early spring), but those numbers likely represent a small portion of the population, present at the site for a brief period of time as they migrate past (Lagerquist et al, 2017)*". However, this assessment was designed to help the applicant assess potential exposure of gray whales to risks of operation at the deployment area approximately 6 nm offshore in water depths from 65-78 m. ODFW remains concerned that cable laying may occur within the nearshore area used by mother calf pairs during the phase b migration and recommends that the license require avoidance of this sensitive timeframe for cable laying activities.

In its analysis of unavoidable adverse effects, the applicant states that gray whales were detected as far offshore as 11 miles (17.7 km) and would be expected to occur at PMEC-SETS. ODFW notes that gray whales have been documented in various proximities to Oregon's shoreline in waters ranging 12-90 meters deep, and from 0.28 to more than 25 km from shore (Ortega-Ortiz and Mate, 2008; Herzing and Mate, 1984; Rugh et al, 1999; Adams et al, 2014). There is evidence that smaller whales preferentially travel in shallower waters closer to shore, and that mother-calf pairs travel extremely close to shore (i.e. 100-800 m from shore) (Herzing and Mate, 1984). Flyover surveys of marine mammals in 2011-2012 from Grays Harbor, WA, to Fort Bragg, CA, documented 26 sightings of 40 gray whales (Adams et al, 2014). Of these sightings, all but two were within 25 km of the coast and the majority occurred within the 1-100m depth stratum (Adams et al, 2014). ODFW does not consider it acceptable to characterize adverse effects on this state-listed species as unavoidable unless every possible measure has been taken to avoid adverse effects. More could be done to avoid at least the most sensitive timeframe, phase b.

Based on ODFW's recommendation, state and federal authorizations have been conditioned to avoid the sensitive gray whale phase b migration. The Oregon DSL has conditioned its authorization of fiber optic cables to avoid this sensitive timeframe or monitor for presence of whales and delay or suspend operations while they are in the area. With the issuance of an original license to project number 12713-002, FERC required Ocean Power Technologies (OPT) to "*schedule project construction activities outside of the gray whale migration period*" (FERC, 2012a), which was clarified to mean avoidance of the most vulnerable period. While the PMEC-SETS test site is outside the territorial sea and farther offshore than was OPT's licensed deployment area, the installation of five separate cables for PMEC-SETS will cross the nearshore area that is traveled each year by mother-calf pairs, and may coincide with the most vulnerable period of the gray whale migration. Additionally, it is possible that noise from cable laying may remain above the level B harassment threshold for marine mammals as far as six km (3.24 nm) from the source. ODFW is concerned that noise from cable laying between the 10-m isobath and the WEC deployment area six nm offshore may disrupt this sensitive mother-calf migration.

Per PM&E measure 15, the applicant will minimize construction activities during key gray whale migration periods, to the extent possible. Per PM&E measure 6, the applicant has proposed to avoid the use of DPVs or other equipment that may exceed the National Marine Fisheries Service's (NMFS) published threshold for injury to the maximum extent practicable during phase b gray whale migration (April 1 – June 15). To the extent construction activities during this migration period are proposed, the licensee will consult ODFW regarding the timing of such activities including cable-laying in state waters. However, to maximize protection of this sensitive migration, ODFW recommends that FERC require as a license article that the applicant schedule project construction activities associated with cable laying outside of the phase b gray whale migration.

Rationale C: Per proposed PM&E measure 7(2), if acoustic monitoring results indicate that sound from one or more WECs and their mooring systems at a project berth persistently exceeds NMFS's published harassment threshold(s), modeled at a distance of 100 meters from the source, then the licensee shall notify NMFS and take mitigation actions. The measure describes as long as 166 days, plus time for NMFS review of test-specific mitigation plans and an unspecified period to determine a final mitigation approach, to reach a solution. As proposed, the mitigation action may take too long to reach a solution, and as such is not likely to successfully mitigate impacts. More immediate action needs to be taken for this measure to be effective. To expedite mitigation actions and resolution of acoustic exceedance, during the initial attempt to repair or otherwise mitigate the sound exceedance, the licensee shall instruct the client to prepare a plan for secondary mitigation procedures in the event primary mitigation was unsuccessful at abating the acoustic exceedance, thereby reducing the need for a 30-day period to draft the secondary plan in the event that initial mitigation has failed. At NMFS's discretion, devices may be removed if the first mitigation attempt is unsuccessful, motivating the client to maximize investment into fixing the problem the first time and not allowing prolonged exposure to sound exceeding thresholds.

The following table compares the mitigation timeframes proposed by the applicant to those recommended by ODFW. ODFW recommended timeframes allow for two options, neither of which support up to 30 days to draft a secondary mitigation approach or an unspecified timeframe for a third and final mitigation approach, and both of which reduce the period of potential exposure to sound above NMFS's threshold. The first recommendation is based on NMFS's decision to allow WECs to remain in the water through a secondary mitigation approach. The second recommendation is based on NMFS's decision to require removal of WECs from the water after initial mitigation approach failed to remedy acoustic exceedance.

Mitigation Step	Timeframe (days)		
	OSU Proposed	ODFW Recommended [1]	ODFW Recommended [2]
1. Detection of "persistent" sound exceedance	4	4	4
2. Diagnose and make repairs or modifications	up to 60	up to 60	up to 60
3. Monitor to verify mitigation success or determine exceedance has not been abated	14	14	14
4. NMFS requires removal of device for onshore remediation	0	0	unspecified
5. Provide to NMFS a draft plan to implement secondary mitigation	up to 30	0	0
6. NMFS approval of secondary mitigation plan	unspecified	unspecified	0
7. Implement secondary mitigation	30	30	0
8. Monitor to verify mitigation success or determine exceedance has not been abated	14	14	0
9. Cease operating WEC or obtain MMPA and ESA approval to continue testing.	unspecified	unspecified	0
10. Take additional actions to reduce sound	unspecified	0	0
11. Monitor to verify mitigation success or determine exceedance has not been abated	14	0	0
Total:	166, plus NMFS review and final mitigation decision	122 plus NMFS review	78

[1] Timeframe to reach resolution if NMFS does not determine it is necessary to remove the device from the water at mitigation step 4.

[2] Timeframe to reach resolution if NMFS determines it is necessary to remove the device from the water at mitigation step 4.

The licensee shall require clients to have contingency plans and spare parts available, thereby eliminating the need for a 30-day period between NMFS approval of a plan and the time the client will carry out the action. An unwillingness to plan ahead for potential mitigation needs should not be the justification for prolonged acoustic exceedance impacts. ODFW recommends that the licensee require WEC testing clients to prepare contingency plans and stock replacement parts nearby to be ready to take action to remedy acoustic exceedance events and expedite the timeline proposed by the applicant. Further, ODFW recommends that NMFS may require removal of a device if the first mitigation attempt is unsuccessful, should circumstances warrant taking such a measure.

Preliminary 10(j) Recommendation 5: Onshore Habitat Mitigation Plan

ODFW and the applicant have drafted a Habitat Mitigation Plan (HMP) pursuant to Oregon's habitat mitigation policy (OAR 635-415), wherein all habitats within the onshore portions of the project area have been categorized by quality and value to wildlife. The licensee shall modify the HMP included as PDEA Appendix K, as follows:

A. Upon delivery of construction and operation footprints and construction methods for specific segments of the onshore project components, the licensee shall work with ODFW to complete the analysis of affected habitat type and quality.

B. Clarify that although OSU added consideration of kinnikinnick habitat for the seaside hoary elfin butterfly to the HMP, plants and terrestrial invertebrates are not within the Oregon Fish and Wildlife Commission's (OFWC) jurisdiction and so are not subject to the habitat mitigation policy. Recommended conservation actions for the seaside hoary elfin are provided in the Oregon Conservation Strategy.

C. Upon completion of the analysis, additional mitigation of project impacts on onshore habitat may be necessary.

D. Any impacts on Category 2 habitat (e.g. streams, wetlands, bat maternity roosts, and western snowy plover nests) must be mitigated for to meet the net benefit standard required by policy. If these habitats can't be avoided, temporary and permanent impacts must be mitigated to the net benefit of the affected species. Once modified in consultation with ODFW and approved by ODFW, the final HMP shall be implemented by the license.

<u>Rationale</u>: The draft HMP is included as Appendix K of the PDEA in the DLA package. Both ODFW and the applicant contributed in a good faith effort to assemble as much of the analysis as possible with information available prior to submittal of the DLA package, and acknowledged that the remaining analysis would be completed once the applicant could describe specifically what (e.g. boring, trenching) and where (e.g. construction and operation footprints) construction activities would be involved in the onshore development of the project. This information must be provided to ODFW in time for us to perform remaining analysis and include final recommendations to FERC.

ODFW is aware that OSU surveyed the onshore project area, as described in the Habitat Characterization Report included as PDEA Appendix C, and identified patches of kinnikinnick that may act as host plants for the extremely rare seaside hoary elfin butterfly (*Incisalia polia maritima)* (Ross, 2005). Although OSU added consideration of kinnikinnick habitat for the seaside hoary elfin butterfly to the HMP, plants and terrestrial invertebrates are not within the OFWC jurisdiction and so are not subject to the habitat mitigation policy. The responsibility for management of terrestrial invertebrates is delegated to the Oregon Department of Agriculture, but select species are identified as needing conservation action described in the Oregon Conservation Strategy. This species of butterfly is listed as a strategy species in the Oregon Conservation Strategy, which recommends conservation actions that protect habitat known to support this species. ODFW recommends that mitigation for impacts on this very rare butterfly species could be addressed by the HMP with clarification that conservation actions for the seaside hoary elfin are provided in the Oregon Conservation Strategy, and not pursuant to the habitat mitigation policy.

In it's PDEA, the applicant states it has developed a HMP to address recommendations by ODFW regarding Oregon's Habitat Mitigation Policy for onshore habitat impacts; this document does not represent any environmental measures in addition to those proposed. ODFW disagrees with this characterization and has maintained with the applicant throughout this assessment of onshore habitat that additional mitigation may be necessary, a determination that cannot be made until construction plans and associated information are provided and ODFW completes its habitat analysis in accordance with OAR 635-415.

Per OAR 635-415-0025 (2)(a), for any impacts on Category 2 habitat, temporary or permanent, "*The mitigation goal if impacts are unavoidable, is no net loss of either habitat quantity or quality and to provide a net benefit of habitat quantity or quality*." If the applicant's intention is that impacts on Category 2 habitat will be only temporary and restored after construction is complete, then restoration or other appropriate mitigation should seek to achieve a net benefit for the affected species. ODFW prefers that impacts on Category 2 habitat within the project area can be avoided completely, in which case mitigation to the net benefit standard would be minimal or unnecessary.

ODFW does not concur with all habitat categorizations provided in the Habitat Characterization Report (PDEA Appendix C), which were the work of OSU and their consultants. Information contained in the Habitat Characterization Report was provided as reference material to provide the results of habitat surveys performed in the project area vicinity. In the Habitat Characterization Report, the applicant states that a draft summary report was submitted to ODFW August 2, 2017, and ODFW provided comments on August 22, 2017 (HC 6). To clarify, ODFW was not asked to and did not provide comments on the report, but did provide a table of habitat categorization we would agree to, and that table served as a starting point for the HCP. ODFW acknowledges and appreciates the applicants efforts to survey onshore habitat (reported in the Habitat Characterization Report, PDEA Appendix C), and to use survey results to responsibly site onshore facilities. ODFW and the applicant have reached agreement on preliminary habitat categorizations described in the draft HMP (PDEA Appendix K). However, preliminary assessment of potential impacts and approximate acreages of impact are estimated throughout this report and final determination of temporary and permanent impacts and exact acreages will be provided after final construction plans are available. Per PM&E measure 16, the applicant will minimize or avoid terrestrial activities in sensitive ecological areas (e.g., jurisdictional wetlands and nesting areas for listed avian species). The HMP and any necessary mitigation measures shall be deemed final when approved by ODFW as consistent with state policy. The final HMP and any necessary mitigation measures shall be implemented by the applicant and required by the FERC license.

Preliminary 10(j) Recommendation 6: Fish Streams

In its PDEA, the applicant asserts that impacts to Friday Creek will be avoided by boring under the streambed, and if feasible, other streams will be bored under as well. ODFW recommends boring under all fish-bearing streams including Friday Creek and stream 4, which is connected to Friday Creek. If the project must trench through stream 4, the licensee shall use in-water work windows (IWWW) prescribed by ODFW to minimize impacts on fish, and consult ODFW regarding the need for fish salvage.

Removal of riparian vegetation could expose surface waters and increase temperature. Streambank restoration shall be conducted in accordance with the restoration and monitoring plan to be completed before construction begins. The licensee shall propose a schedule for development and implementation of a riparian restoration and monitoring plan and shall consult ODFW for a list of critical components.

Rationale: To minimize disturbance of streams that support fish, or are connected to fish-bearing streams, proposed PM&E measure 16 includes that unavoidable work within or adjacent to fish-bearing streams may be subject to IWWW. If terrestrial activities directly or indirectly affect any stream used by anadromous fish or fish listed as threatened or endangered under the federal ESA, the licensee shall consult with NMFS and USFWS staff to avoid and minimize any potential effects to listed species. ODFW recommends that FERC require, as a condition of the license, that any unavoidable work in fish streams be conducted in accordance with IWWW prescribed by ODFW. These IWWW are well established and a common practice for multiple development types in

Oregon that involve work in fish streams. The IWWW guidelines consider important fish species including game fish and anadromous, threatened, endangered, or sensitive species. Time periods were established to avoid the vulnerable life stages of these fish including migration, spawning and rearing. As identified by the guidance, the preferred work period applies to the listed streams, unlisted upstream tributaries, and associated reservoirs and lakes. These guidelines provide the public a way of planning in-water work during periods of time that would have the least impact on important fish, wildlife, and habitat resources. ODFW will use the guidelines as a basis for commenting on planning and regulatory processes. The recommended work window for coastal streams is July 1 to September 15.

During project surveys, fish presence was documented in stream 4, a tributary to Friday Creek which likely provides habitat for anadromous cutthroat trout, but fish species could not be confirmed. Survey crews assumed fish presence in Twombly and Friday Creeks, both of which pass through the study area. ODFW conducted a site visit in August, 2017, to look at habitat within the project area visible from public access points, and documented suitable fish habitat in Friday Creek and stream 4. ODFW also noted that all wetlands and streams in the vicinity of the proposed project are ultimately connected to each other during periods of inundation with connectivity to the sensitive Buckley Creek system located to the southwest of proposed project activities. Wetlands and waterbodies should be crossed during the dry season to minimize disturbance to the Buckley Creek system.

According to the PDEA,

> *vegetation removal near streams could indirectly affect water quality by increasing exposure of surface waters to solar radiation, thereby increasing water temperatures. However, riparian vegetation removal would be small relative to existing cover along a stream corridor. Additionally, implementation of mitigation measures and other BMPs would minimize potential impacts on water quality. Cable construction requires clearing an approximately 20-foot construction right-of-way. Removing riparian vegetation may cause increased sediment input to the waterbodies, reduced filtering of nutrients washing in from cleared uplands, increased water temperature at and downstream of the cable crossing, reduced detrital and large woody debris recruitment potential, and increased potential for mass failures. The existing conditions that could be affected include water temperature, sediments/turbidity, large woody debris, streambank condition, increase in drainage network, and riparian reserves. Riparian vegetation (habitat) rehabilitation would include a comprehensive monitoring strategy to evaluate impacts of construction activities, address unanticipated impacts, and determine efficacy of restoration measures. OSU would restore the cable corridor in accordance with ODFW recommendations.*

Per PM&E measure 16, mitigation for terrestrial resources, the applicant would avoid to the extent practicable, disturbance of riparian wetlands where restoration of natural hydrology may be unsuccessful within a short timeframe. Natural hydrology should be restored after construction is complete, and may require a restoration plan with monitoring until successful restoration can be determined. The applicant plans to perform proper channel restoration to return banks and channels to preconstruction condition or better through proper cable alignment, burial depth, construction BMPs, channel and bank restoration and post-construction monitoring. The applicant’s riparian rehabilitation would include a comprehensive monitoring strategy to evaluate impacts of construction activities, address unanticipated impacts, and determine efficacy of restoration measures to be performed in accordance with ODFW recommendations. Per PM&E measure 14, the applicant would develop and implement Erosion and Sediment Control Plans, where appropriate, to minimize effects of ground disturbing activities associated with installation of the terrestrial cables and/or other terrestrial construction. The applicant would avoid or minimize potential for erosion, sedimentation, and increased turbidity by implementing a Storm water Pollution Prevention Plan and Erosion and Sediment Control Plan and would maintain methods until vegetation is established within the riparian zone. The applicant would conduct streambank restoration in accordance with a restoration and monitoring plan to be completed before construction begins. ODFW is uncertain how these plans will address site-specific habitat concerns, and requests that the applicant propose a schedule for development and implementation of riparian restoration. ODFW should be consulted during plan development to verify that the above plan attributes and any other critical components are included to adequately protect and restore habitat.

Preliminary 10(j) Recommendation 7: Estuarine Resources

To minimize impacts on estuarine habitat and species, the licensee shall:

A. Fabricate project components at existing permitted land-based facilities, allowing all coatings and paints to fully cure prior to deployment into the estuary

B. Restrict use of the estuary to commercial dockage that has been designed, permitted and is used for dockage, where the docks have been and continue to be dredged.

The applicant has identified transport of WECs and other components from Newport Harbor as an activity that is interdependent to the project. The licensee shall clarify whether references to Newport Harbor (a name not used in Oregon) refer to Yaquina Bay or a specific location within the estuary.

Rationale: Yaquina Bay is designated Essential Salmonid Habitat (OAR 141-102-0000), critical habitat for green sturgeon, and an estuarine essential fish habitat (EFH) habitat area of particular concern (HAPC). As stated in our August 4, 2014 scoping letter to FERC, ODFW is concerned that activities in the estuary could have negative impacts on sensitive resources including eelgrass beds (also considered within seagrass HAPC), salmon smolts, shellfish and crabs, juvenile groundfish, forage fish, birds, marine mammals, or green sturgeon.

Estuaries are characterized as having high productivity and biodiversity resulting from the multitude of species that have adapted to exploit the variable and dynamic environmental conditions (NOAA, No Date a). Unconsolidated soft-sediment habitat is widespread in Oregon bays and estuaries (Cortright et al., 1987), providing many ecological functions and values including nutrient cycling and habitat for foraging by invertebrates, fish, birds, and marine mammals. Some commercially valuable species (e.g., Dungeness crab, several flatfish species) use the soft-sediment habitat as a nursery or foraging areas. Diverse communities of arthropods, annelids, cnidarians, mollusks, echinoderms, and other invertebrates are specifically adapted to survive, feed, grow, and reproduce in the unconsolidated sediments (Simenstad 1983; Emmett et al., 2000). The mixed communities of living bivalves and the beds of their non-living shells (i.e., shell rubble or shell hash) function to help stabilize unconsolidated sediments and provide heterogeneous habitat for numerous species of adult and juvenile fishes, crabs, shrimp, amphipods, worms, and other estuarine organisms. Several species of demersal fishes inhabit Oregon estuaries and many of these (e.g., Starry flounder, English sole, sand sole, staghorn sculpins, sturgeon) are benthic feeders that utilize subtidal habitat to locate their prey, as well as for spawning and rearing. Subtidal habitat is also used by many species of migratory fishes such as fall Chinook salmon, coho salmon, steelhead, chum salmon, coastal cutthroat trout, eulachon, topsmelt, Pacific herring, longfin smelt, surf smelt, northern anchovy, etc., and other species (e.g., lingcod, greenling, rockfishes, gobies, sand lance, surfperches, threespine stickleback, Pacific tomcod, and sturgeons). Estuaries support a complex food web that includes resident (infaunal, epifaunal, motile) and transitory (seasonal, migratory) species that form the foundation for the estuarine food web and cycle of life in Oregon bays and estuaries.

The applicant states in various ways throughout the DLA, PDEA, and appendices, that project components would be fabricated at existing permitted land-based facilities, and would be staged at mobilization sites for vessel transport to the site for installation. The Port of Newport would likely serve as the primary staging area, and primary estuarine activities would be berthing one or more WECs dockside in Yaquina Bay and vessel traffic to transport equipment. As described in the PDEA and appendices, antifouling paints are already present on vessels and structures in Yaquina Bay and nearshore marine waters and concentrations of antifouling paints in the marine environment are expected to be undetectable. According to the applicant, antifouling marine applications can leach copper, zinc, iron, and ethyl benzene. A key concern for water quality and marine or estuarine species would be potential leaching of copper ions from antifouling paint, affecting water quality (ODEQ, 2011) and salmonids (Hecht et al, 2007). Once in the aquatic environment, copper can be dissolved, or bound to organic and inorganic materials either in suspension or in sediment (Hecht et al, 2007). Copper in its dissolved state is highly toxic to a broad range of aquatic species including algae, macrophytes, aquatic invertebrates, and fishes including anadromous salmon and steelhead (Hecht et al, 2007). Scientific literature indicates that dissolved copper (dCu) is a potent neurotoxin that directly damages the sensory capabilities of salmonids at low concentrations (Hecht et al, 2007). Salmonid sensory systems mediate ecologically important behaviors involved in predator avoidance, migration, and reproduction (Hecht et al, 2007). Impairment of these behaviors can limit an individual salmonid's potential to complete its life cycle and thus may have adverse consequences at the scale of wild populations (Hecht et al, 2007). More than three decades of experimental results have shown that the sensory systems of salmonids are particularly vulnerable to the neurotoxic effects of dCu, potentially affecting survival, growth, behavior, osmoregulation, sensory function, and other life history characteristics (Hecht et al, 2007). Evidence shows that juvenile sensory system–mediated behaviors are also affected by short-term exposures to dCu (Hecht et al, 2007). Cured paint is far less likely than uncured paint to leach contaminants like copper into the estuarine environment where concentration levels may be sufficient to affect marine and anadromous fish and other organisms. According to the applicant, only TBT-free antifouling agents would be used and coatings would be fully cured prior to deployment. ODFW recommends that, to minimize impacts from the projects use of antifouling paint on estuarine, marine, and anadromous organisms, the licensee shall require test clients to fabricate project components at existing permitted land-based facilities, allowing all coatings and paints to fully cure prior to deployment into the estuary.

Estuaries provide vital habitat for marine fish that rear juveniles in protected shallow water habitats, without which juveniles would be exposed to increased predation and physical forces beyond their swimming ability (NOAA, No Date a). The calmer waters, nutrient input, and sedimentation of estuaries provides excellent growing medium for plants, forming the base of a highly productive ecosystem that influences many habitats and species beyond its borders (NOAA, No Date a). Native eelgrass (*Zostera marina*) occurs in intertidal and shallow subtidal habitat with soft sediment and adequate light, primarily within estuaries in Oregon (ODFW, 2016). Native eelgrass is an Oregon Conservation Strategy species, and recommended conservation actions include minimizing impacts related to development (ODFW, 2016). Eelgrass is one of two common marine angiosperms collectively known as seagrass, which is a subset of EFH designated as a HAPC because these areas are important for healthy fish populations and provide important ecological services (e.g. shelter for juvenile fishes, shoreline stabilization, improved water quality) and/or are vulnerable to degradation (NOAA, No Date b). HAPCs are considered high priority areas for conservation, management, or research because they are rare, sensitive, stressed by development, or important to ecosystem function (NOAA, No Date b). Established eelgrass is desirable due to its ability to stabilize sediments and reduce erosion, which in turn improves water quality and provides habitat for various aquatic and coastal species (Murphy et al, 2011). In addition, plants are directly consumed by a variety of migratory birds (Murphy et al, 2011). Eelgrass populations have declined over the past 40 years due to poor water quality in coastal regions, most likely due to the lack of sunlight penetrating the water column (Murphy et al, 2011). Poor water quality is a result of increased turbidity due to sediment from runoff (Murphy et al, 2011) and direct shading of plants also contributes to population declines. Depending on water clarity, eelgrass may grow in depths of more than 5 m on the Pacific Northwest coast of the United States (Murphy et al, 2011). According to the applicant, test clients would use commercial dockage that has been designed, permitted and is used for dockage, where the docks have been and continue to be dredged; for example the International Terminal is dredged to 33 ft. OSU would minimize storage and staging of WECs outside of existing dock, port, or other marine industrial facilities. ODFW recommends the license restrict use of the estuary to commercial dockage that has been designed, permitted and is used for dockage, where the docks have been and continue to be dredged. The applicant should restrict in-water moorage to existing permitted facilities where increased turbidity or direct shading will not affect sensitive eelgrass habitat within or adjacent to the permitted facility.

Throughout the analysis, the applicant refers to Newport Harbor. However, to ODFW's knowledge, no such place exists in Oregon. ODFW anticipates that the applicant is referring to Yaquina Bay which is located in Newport, OR, and requests that the applicant clarify if they mean Yaquina Bay or a specific location within the estuary. Using correct names in the analysis will avoid confusion regarding specific locations where environmental attributes, potential impacts, or planned actions are being discussed.

Preliminary 10(j) Recommendation 8: Invasive Species

To protect Oregon's water resources, fish, wildlife and their habitat from harm due to the introduction and/or spread of aquatic invasive species, the licensee shall implement the following measures to limit the introduction or spread of invasive species from vessels, WECs, or construction activities. Per PM&E measure 12, mitigation for water resources, the applicant shall require that all project chartered or contracted vessels comply with all current federal and state laws and regulations regarding aquatic invasive species management. Per PM&E 16, mitigation for terrestrial resources, the applicant shall develop measures that will limit the introduction or spread of invasive species, to be included in each construction plan. If aquatic invasive species are found on or inside a watercraft, the owner or operator must provide ODFW with an accurate history as to where the watercraft has been during the last six months. Information shall include;

(1) All waterbody(s) in which the watercraft has been moored or operated;

(2) The length of time that the watercraft has been out of water;

(3) All locations where the watercraft has been stored; and

(4) If previously inspected, the agency and individual which conducted the inspection.

Rationale: As stated in our August 4, 2014 scoping letter to FERC, ODFW recommends that invasive species control be implemented for any vessel or device entering Yaquina Bay. To protect Oregon's native species, ODFW recommends that OAR 635-059-0000 *et. seq*. Aquatic Invasive Species Control rules be applied to project vessels, WECs, and construction activities. Per OAR 635-059-0000 *et. seq*. "Aquatic Invasive Species" is any species of wildlife, fish (excluding game fish) or freshwater or marine invertebrates that are listed in the "United States Geological Service list of Aquatic Nonindigenous species in Oregon" dated June 4, 2009 or that is listed as a mollusk or crustacean in OAR 635-056-0050 as a Prohibited Species.

Preliminary 10(j) Recommendation 9: Adaptive Management

Proposed PM&E measures that are implemented pursuant to the Adaptive Management Framework (AMF) address potential project impacts where there is uncertainty and where a number of agency stakeholders have authority or interest. They include EMF, benthic monitoring, entanglement, organism interaction monitoring, and acoustic monitoring. As described on AMF page 1, the Adaptive Management Committee (AMC) will evaluate monitoring plan results, make changes to monitoring plans, and make decisions regarding whether to adopt additional or modify existing mitigation measures 1, 2 and 3. The licensee shall rectify this statement in the AMF and be clear that the AMC will evaluate and make changes and decisions regarding all five measures subject to the AMF.

Rationale: The AMF submitted as PDEA Appendix J with the draft license application package shall be revised to be clear that the AMC will evaluate and make changes and decisions regarding all five measures subject to the AMF because all of these measures have components about adding or modifying based on evaluation. Once rectified, the revised AMF shall be implemented by the applicant as a license requirement.

Preliminary 10(j) Recommendation 10: Revegetation and Restoration Plans

The licensee shall develop, in consultation with ODFW, Revegetation and Restoration Plan(s) to include:

A. Methods and schedule for implementation, monitoring, and reporting.
B. Completion timeframes, success criteria, and secondary mitigation measures including reseeding, soil amendment, supplemental irrigation or other water management to ensure establishment of native vegetation.
C. Methods to address soil compaction and erosion control, and to restore natural drainage patterns.
D. Short-term soil stabilization measures, if necessary.
E. Noxious weed control measures and monitoring of noxious weed control and revegetation efforts for three years post construction, two times per year (spring and fall) and every third year thereafter to determine success.
F. Mitigation areas, if necessary, with mitigation goals to be met by revegetation.
G. Seed and plant with native vegetation, per PM&E 16, in consultation with ODFW to maximize benefit to fish and wildlife.
H. Compliance with measures described in the HMP, pursuant to the Habitat Mitigation Policy.

Rationale: ODFW has worked with the applicant to draft a HMP to satisfy onshore habitat mitigation needs pursuant to the Habitat Mitigation Policy (OAR 635-415). The applicant proposes to develop revegetation and restoration plans for disturbance of onshore habitat, and onshore mitigation described in the HMP would rely heavily on revegetation and restoration procedures. For ODFW to determine the likely success of such procedures to meet habitat restoration needs, ODFW must be consulted in the development of revegetation and restoration plans. ODFW recommends that these efforts be conducted in consultation with ODFW to maximize successful completion of habitat restoration objectives and compliance with state law and policy. Disturbances associated with the development, operation and maintenance of the project will impact terrestrial habitat and result in the removal of terrestrial vegetation. Reduction in native vegetation types, as well as increased potential for introduction of non-native vegetation, may potentially impact those wildlife species that depend on them. The Revegetation Plan(s) will identify specific actions that the applicant is to undertake to ensure that noxious and/or invasive plants are not introduced or spread throughout the Project area and that native plant communities are restored, maintained and enhanced. Similarly, periodic monitoring for noxious and invasive plants will ensure prompt and appropriate actions as identified in the plan(s) to control, suppress, contain, and eradicate these plants, reducing impact to native plant communities and wildlife habitat.

The need for revegetation would be minimized by the applicants stated commitment to construct upland facilities within previously disturbed areas of Driftwood and avoid vegetation clearing. Per PM&E measure 16 the applicant would develop a revegetation plan using native species to the extent possible for areas disturbed during construction and would, where feasible, install terrestrial cables along or within previously disturbed routes and locations (e.g., along roadways, utility rights-of-way, etc.). In accordance with PM&E measure 17, mitigation for land use, construction work areas or staging areas should be sited on other disturbed areas if possible. According to the PDEA and appendices, terrestrial cable construction requires clearing a 20-foot-wide construction right-of-way and will be installed by a combination of boring and/or trenching from the western edge of Highway 101, bored under Highway 101, and then bored and/or trenched along the east side of Highway 101. ODFW supports cable installation along the east side as opposed to the west side of Highway 101 to avoid direct construction impacts on the sensitive Buckley Creek wetland complex on the west side of Highway 101. ODFW strongly prefers construction in previously disturbed or developed areas to reduce or avoid habitat disturbance to undisturbed areas. Where habitat disturbance is not avoided, ODFW will provide site-specific revegetation and restoration recommendations and the applicant will restore the cable corridor in accordance with ODFW recommendations.

Preliminary 10(j) Recommendation 11: Horizontal Directional Drill Contingency Plan

According to the applicant, construction contaminants and HDD drill lubricant can impact habitat, but depth of boring operations will be designed so that there is low risk of inadvertent release and a contingency plan will be developed to minimize potential release. Further, the applicant states that through implementation of construction BMPs, no detrimental effects to freshwater fish are expected from hazardous materials release. To determine best construction practices appropriate to meet the objectives of the HMP, ODFW would work with the applicant to develop an HDD Contingency Plan. The licensee shall develop a draft HDD Contingency Plan for review no later than at such time as the FLA is submitted, and shall append the draft plan to the draft EA for review in the context of other project plans and procedures. The licensee shall include in this draft plan:

A. Description of HDD locations, maps, coordinates and spatial dimensions, including marine HDD beneath the beach and any terrestrial HDD.

B. Description of HDD laydown area location (Driftwood), manhole spacing (20 feet apart), and drill site preparation and set up.

C. Description of HDD target depth beneath dunes and beach habitat, diameter of the HDD hole, and approximate dimensions (distance, width, depth) of the HDD cable corridor.

D. HDD methods (drill and leave).

E. Schedule and timing (one month per borehole, 6-8 months in total).

F. Construction best operating procedures designed to minimize the potential for inadvertent return of drilling fluids.

G. Description of anticipated support services such as marine vessels or divers.

H. Inspection procedures to facilitate timely detection of inadvertent return, if any.

I. Monitoring (e.g. drill mud pressure and volume), containment, response recovery and clean-up of inadvertent release, and notification procedures, including notification of ODFW.

J. Emergency response equipment to be stored on-site during HDD operations.

K. Map of potential vehicle beach access points and description of consultation procedures with OPRD.

L. Map of environmentally sensitive sites (e.g. western snowy plover potential habitat, seaside hoary elfin potential habitat, streams, wetlands, dune habitat).

M. Identify approved locations for spoil piles on previously disturbed, paved, areas selected to avoid impacts on habitat.

N. Identify procedures and approved disposal sites for spoils and drilling mud.

O. Describe demobilization procedures.

The licensee shall incorporate comments on the draft plan and finalize the plan for submittal to FERC. Upon Commission approval, the licensee shall implement the final HDD plan. If modifications to the approved plan are necessary, the licensee shall revise the plan in consultation with parties who commented on the draft plan.

Rationale: Per PM&E measures 14 and 16, the applicant will use HDD to install the transmission cable conduits under the nearshore, intertidal (out to approximately the 10-m isobath), beach, and sand dune habitats to minimize substrate disturbance. HDD is a useful technique with the potential to avoid the environmental impacts associated with conventional construction techniques, but there are risks to consider (Reid and Anderson, 1998). During HDD activities, drilling fluid is pumped down the inside of the bore pipe and exits through the drill head (Snohomish PUD, 2012). The drilling fluid is typically composed of naturally occurring bentonite clay which is insoluble and made up of small particles that function as a lubricant for the drill head and pipe, a transport for the cuttings being removed from the hole, and as a sealant that coats the drill hole (Snohomish PUD, 2012). Drilling fluids typically consist of 95% water and 5% bentonite clay, and may also contain an organic polymer to add to its viscosity and lubricating ability (Marathon Pipe Line, LLC, 2016). The drilling mud pressure and volume are monitored during drilling operations to assure there are no leakages due to fractures in the structure of the material being drilled through (Snohomish PUD, 2012, Marathon Pipe Line, LLC, 2016). By monitoring the pressure and volume, such fractures can be identified as they occur and steps can be taken to eliminate the problem (Snohomish PUD, 2012). The driller can stop or slow down the operations to give the mud a chance to seal the fracture or an alternative route can be taken (Snohomish PUD, 2012). If a fracture is present it is possible for drilling mud to escape the drill hole; this is called a “fracout” (Snohomish PUD, 2012). Inadvertant release could result from “fracout” or from containment failure of drilling fluids at HDD entrance or exit points (Marathon Pipe Line, LLC, 2016). Drilling fluids may escape when mud migrates along rock joints or through permeable gravel due to excessive pressure or approach slope; the volume of inadvertent release depending on porosity of the substrate, extent of the porous material, pressure exerted on the mud, viscosity of the mud, and other factors (Reid and Anderson, 1998). Highly permeable soils are most susceptible to “fracout”, especially during the entrance and exit phases of the drill, as this is when the greatest pressures are exerted on the bore walls in shallow soils (Marathon Pipe Line, LLC, 2016).

The inadvertent release of drill fluids into the environment can contaminate habitat, alter hydrology, or harm fish and wildlife. If discharged into a waterbody, mud settling rates depend on the properties of the mud and the salinity of the water, with settling rates generally increasing with particle size and the salinity of the water (Reid and Anderson, 1998). Bentonite clay holds water and can function as an aquitard limiting groundwater flow in and out of a wetland, and any changes to wetland hydrology can translate to poor conditions for wetland plant establishment, root development and growth (Reid and Anderson, 1998). Drilling muds can smother wetland plants, reduce light or otherwise alter growing conditions (Reid and Anderson, 1998). Inadvertent release in streams may affect aquatic invertebrates by forming a physical barrier to burrows, decreasing the emergence rate and causing invertebrate draft and potentially more severe effects to invertebrate communities and/or habitat quality (Reid and Anderson, 1998). Direct effects on fish may result from increased sediment loading and suspended fine sediments, with the severity depending on the species and life stages present, the timing of the release, and the ability of the waterbody to process released muds without degrading existing habitats (Reid and Anderson, 1998).

ODFW has worked with the applicant to develop a draft HMP, included as PDEA Appendix K. The HMP describes habitat types, categorized by quality, within the onshore portion of the project area and including several sensitive habitat areas where an inadvertent release of drill fluid could have moderate to severe consequences to species health or habitat quality. The HDD Contingency Plan including ODFW's recommended components is necessary to establish species and habitat protection during HDD activities.

Preliminary 10(j) Recommendation 12: Decommissioning

When each individual test is complete, any materials to be disposed of would be disposed of at permitted facilities in accordance with federal, state, and local environmental control regulations. The applicant proposes to develop a Removal and Decommissioning Plan for the overall facility as the license term nears its end and will implement it with decommissioning of the overall project. The license shall require full removal of all anchors and adequate insurance to do so. In the event the project is decommissioned for any reason, the licensee shall develop a decommissioning plan and the plan shall include:

A. Proposed decommissioning schedule.
B. Description of removal and containment methods.

C. Description of site clearance activities.

D. Plans for transporting and recycling, reusing, or disposing of the removed project components, including removal of all anchors and equipment from the water at the time of decommissioning and destination location of appropriate land-based permitted disposal or storage facility.

E. Description of those resources, conditions, and activities that could be affected by or could affect the proposed decommissioning activities.

F. Results of any recent habitat or biological surveys conducted in the vicinity of the structure.

G. Mitigation measures to protect sensitive biological resources during removal activities or subsequently restore habitat features.

H. Description of methods that will be used to survey the area after removal to determine any effects on marine life or habitat.

I. Description of how the applicant will restore the site to the natural condition that existed prior to the development of the project area.

J. Plans to conduct post decommissioning underwater visual surveys to demonstrate that all equipment has been removed and habitat has been returned to its pre-installation state.

K. Plans to provide a report of post-decommissioning survey results.

The licensee shall develop the decommissioning plan in consultation with ODFW. The licensee shall provide a draft decommissioning plan to ODFW for a minimum of 30 days for review and comment. The licensee shall revise the draft plan in accordance with agency recommendations prior to submitting the draft plan to FERC. The licensee shall include documentation of agency consultation and specific identification of how agency comments and recommendations are accommodated by the decommissioning plan. Upon approval by FERC, the licensee shall implement the plan. After removal of all project components that will be removed but before the end of the license term, surveys for post-decommissioning habitat recovery should be conducted to ensure that habitat within the entire project area (e.g. offshore deployment area, nearshore cable corridor, onshore facilities) has been restored and no further mitigation is required. The licensee shall provide a draft report to the agencies documenting the successful removal of all equipment, any equipment decommissioned on site or planed for reuse and any necessary approvals to do so, and sufficient restoration of affected areas or additional mitigation planned to achieve complete restoration.

Rationale: The installation of the project is anticipated to alter the environment at the site, and restrict boating and fishing activities in the area. If the project were decommissioned, project features may continue to alter the environment, restrict fishing, or present continued or future environmental impacts. For example, project features that remain in the ocean could continue to represent an entanglement risk to large cetaceans or fishing gears. Therefore, the licensee should develop a plan for project decommissioning and ensure project components do not negatively affect environmental, commercial or recreational interests after the project no longer provides opportunities for device testing or benefits of power generation. In accordance with PM&E measure 2, part (3)(c), previously occupied berths will be sampled to assess post-decommissioning recovery of benthic habitat. ODFW recommends that this plan should be developed with sufficient time to review, revise and implement the plan, and to perform post-decommissioning habitat studies. Decommissioning activities in the ocean are challenging, costly, and time-consuming, and therefore necessitate advance planning and consultation to achieve plan objectives within the license term.

Although the Territorial Sea Plan Part Five does not apply to facilities installed in federal waters, decommissioning requirements for renewable energy facilities within the territorial sea can be used as guidelines for PMEC-SETS decommissioning expectations. Per section D.4 of the Territorial Sea Plan Part 5 (2009), the applicant should:

> *"provide a plan to restore the natural characteristics of the site to the extent practicable by describing the facilities to be removed. The plan should include; a proposed decommissioning schedule; a description of removal and containment methods; description of site clearance activities; plans for transporting and recycling, reusing, or disposing of the removed facilities; a description of those resources, conditions, and activities that could be affected by or could affect the proposed decommissioning activities; results of any recent biological surveys conducted in the vicinity of the structure and recent observations of marine mammals at the structure site; mitigation measures to protect archaeological and sensitive biological features during removal activities; and a statement as to the methods that will be used to survey the area after removal to determine any effects on marine life. A decommissioning plan should identify how the project owner will restore the site to the natural condition that existed prior to the development of the site, to the extent practicable."*

As proposed, most anchors would be retrieved by hoisting on board a vessel or towing behind a vessel to shore where the anchor would be recovered by shore side crane. For WECs, the applicant would require test clients to dispose of materials at permitted facilities in accordance with federal, state and local environmental control regulations. Reporting requirements will allow ODFW to evaluate and ensure proper procedures are followed.

PRELIMINARY SECTION 10(a) RECOMMENDATIONS

Pursuant to Section 10(a) of the FPA, the Commission must ensure that the project to be licensed is best adapted to a comprehensive plan for developing the waterway for beneficial public purposes. In making this judgement, the Commission considers comprehensive plans prepared by federal and state entities, and the recommendations of federal and state resource agencies. In its notice dated April 25, 2018, the Commission solicited (1) preliminary terms, conditions, and recommendations on the draft PDEA, and (2) comments on the DLA. Pursuant to Section 10(a) of the FPA, ODFW offers the following preliminary recommendations intended to be consistent with agreements reached by the CWG, to the extent possible. Recommendations may deviate from content proposed by the applicant where either agreement was not reached during CWG discussions or new material is provided in the DLA package that results in modified input from ODFW.

Preliminary 10(a) Recommendation 1: Navigation Plan and Surface Markers

The applicant proposes to mark some project equipment, to the extent possible. For example a surface buoy would mark the subsea connector, and marker buoys may be in place between WEC deployments if anchors are not removed at the same time as the WECs. ODFW recommends that the applicant be required, by license article, to successfully and continuously mark all at-sea equipment that lacks a surface expression.

Per PM&E measure 17, the licensee shall mark project structures with appropriate navigation aids as required by the US Coast Guard (USCG). According to the Navigation Safety Risk Assessment (PDEA Appendix E) marking may include daymarks, lighting, radar reflectors, and automatic identification system equipment, and will monitor position of equipment and effectiveness and operation of navigational markers. At minimum, the surface marker buoy type shall be approved by USCG, and shall be sufficient to ensure continuous marking and compliance with the license.

Rationale: ODFW has a responsibility, per the Food Fish Management Policy (ORS 506.109), to manage food fish to provide the optimum economic, commercial, recreational and aesthetic benefits for present and future generations of the citizens of this state. Unmarked hazards heighten risks for ocean fishing vessels and may present an obstacle to the successful landing of commercial and recreational catch of marine fish. As proposed, the applicant seeks to authorize deployment of equipment including multiple seafloor components (e.g. anchors, subsea connectors, exposed cable within berths) and does not anticipate a navigation or fishing closure. Per PM&E measure 17, the applicant would mark project structures with appropriate navigation aids, as required by the USCG.

As required by article 403 of their original license, Ocean Power Technologies Inc. (OPT) consulted agencies including ODFW to develop a navigation lighting plan that would fully describe the system used to provide lighting per USCG requirements to provide for navigation safety and minimize the potential for adverse effects on aesthetics and offshore birds (FERC, 2012a). Per the license, the lighting design and operation plan would include a description of the lighting provided on each of the PowerBuoys, as well as a plan-view drawing showing the locations of all aids to navigation at the site (FERC, 2012a). Per article 307 of OPT's license, following the start of operations and by December 31 of each year thereafter, the licensee would have been required to file an Annual Navigation Safety Report including a description of the operation and maintenance of private aids to navigation during the previous year (FERC, 2012a). Although a WEC was never deployed, an anchor and sub-surface float were installed in 2012 and the float sank that same year (OPT, 2013a) presenting hazards and needing to be marked until the subsurface float was removed on October 17, 2013, (OPT, 2014) and for approximately 22 months total before the last components were decommissioned from the site on August 31, 2014 (OPT, 2016a). During this time several surface marker assemblies (marker, anchor, and connecting line) were deployed and each sank, needing to be replaced (OPT, 2014), with periods of several months of unmarked equipment before replacement markers were installed (OPT, 2013b). Based on agency review of OPT's decommissioning report and associated documentation, one surface marker was recovered with part of its connecting line and without its anchor (OPT 2016b). ODFW notes that several surface marker assemblies were deployed at the project site but failed to maintain buoyancy, and we assume the remaining deployed surface marker assemblies were unrecovered, their locations presumably unknown (OPT 2016b). OPT reported "lessons learned" including the need for improved tendon lines, improved notification procedures, and maintaining a complete replacement surface marker assembly for ready deployment should replacement marking be necessary (OPT, 2013b). Despite use of an improved tendon line, each surface marker assembly sank or disappeared and OPT redeployed new markers of the same or similar USCG-approved type, size, and model despite the apparent lack of sea worthiness. ODFW recommends that lessons learned from OPT's difficulty maintaining continuous navigation marking be applied to future ocean energy projects. Surface markers deployed at PMEC-SETS shall not only be USCG-approved but shall successfully provide continuous marking of all projects components that lack a surface expression, as required by the license.

Preliminary 10(a) Recommendation 2: Operations and Maintenance Plan

The applicant seeks a license for project operations that will incorporate test client activities. As disclosed by the Operations and Maintenance (O&M) Plan, included as PDEA Appendix F, clients who are testing at PMEC-SETS will be required to develop their own O&M plans which will need to be approved by OSU. The FERC license shall also require that clients must include in their plans applicable elements of the project's O&M plan. The license shall require that each client's O&M plan include:

A. Quarterly inspections from the surface of all components at PMEC-SETS, subsurface ROV survey of all project components at least every 3 years, seafloor ROV survey at each cable every 2.5 years, monthly UCMF inspection, and weekly supervisory control and data acquisition (SCADA) diagnostic of PMEC-SETS.
B. Subsea connectors will be inspected when WECs are connected or disconnected and on a schedule determined by the manufacturer (eg every 5 years).
C. Environmental monitoring instruments may require periodic cleaning to remove excessive bio-fouling, which would likely be done at sea. Cables and manholes do

not require routine maintenance.

During O&M activities, OSU will carry out any obligations it may have under the PM&Es and pursuant to the project license. Reports will be produced following each inspection and maintenance procedure in accordance with PMEC-SETS operating procedures. The licensee shall provide a notification chart describing all parties who receive O&M reports, and shall include such materials with the annual reports.

Rationale: ODFW's interest in O&M procedures is associated with equipment survivability as it relates to potential impacts on species, habitat and other ocean user groups. The applicant's O&M plan is all that is available for review by ODFW at this time. If issued, the license will authorize work by the applicant as well as testing activities to be carried out by test clients. As such, the O&M procedures proposed by the applicant and reviewed by ODFW shall be implemented both by the applicant and by future test clients. In addition, ODFW requests receipt of any annual reports submitted to FERC on O&M outcomes from the previous year. Results of test center O&M activities would inform the growing knowledgebase as to whether fish, wildlife and habitat concerns were appropriate and addressed.

PRELIMINARY COMMENTS

In its notice dated April 25, 2018, the Commission solicited (1) preliminary terms, conditions, and recommendations on the draft PDEA, and (2) comments on the DLA. Further, per the Commission's notice, all comments must bear the heading Preliminary Comments, Preliminary Recommendations, Preliminary Terms and Conditions, or

Preliminary Prescriptions. The following preliminary comments are intended to provide ODFW's input regarding fish and wildlife resources as presented in OSU's DLA package filed April 20, 2018. In order to encourage collaboration and facilitate as much agreement as possible ahead of the FERC filing process, ODFW fully participated in CWG discussions and development of work products between 2013 and 2018. Application materials include the DLA, PDEA and appendices that are based upon information and studies developed during pre-licensing studies and discussions between the applicant and the CWG. ODFW's preliminary comments are based on participation in that process and comparison of those outcomes with the subsequent application package. ODFW's preliminary comments on the DLA package including the PDEA and appendices are as follows:

Preliminary Comment 1: Project Description

The applicant should provide construction methods and project footprints for construction and operation as soon as possible, and no later than at such time as the FLA is submitted. ODFW requires information about what specifically OSU is proposing to do (e.g. boring or trenching the terrestrial cable route) and where activities will occur (e.g. final marine cable corridor area) to complete the analysis of potential impacts and provide final recommendations to FERC. In addition, the applicant should clarify and make consistent all aspects of the project description throughout the license application and environmental assessment, including all appendices. Issues needing clarification or consistency include:

A. Subsea cable approximate area (2 square nautical miles) and length (8.3 nautical miles) is provided in some documents and not in others.

B. Minimum width of subsea corridor is 60-400 meters, provide maximum and actual anticipated width.

C. Four subsea connectors each having a footprint of about 30 square feet. Habitat modifications would be permanent for the subsea connectors (about 120 square feet total) and long-term for WEC anchors (up to 5 years or longer).

D. Five terrestrial cables would run in underground conduits, extending .2 miles on Driftwood to Highway101, .3 miles south on Highway 101, and .2 miles on private property to the UCMF, for a total distance of 0.7 miles. Rectify discrepancies in BBCS, PDEA, and throughout the application documents to avoid confusion.

E. Describe terrestrial cable construction plans including methods and cable corridor width (e.g. 20 feet) and depth. Clarify whether cables will be laid in separate conduits in one bundle, or will multiple boreholes or trench lines be necessary. To minimize disturbance, ODFW recommends a single line (one conduit containing all terrestrial cables).

F. Clarify whether the terrestrial cable goes to the UCMF then back down Wenger Lane to Highway 101, and if there will be additional trenching or power pole installation to achieve grid connection. Include this information in the total disturbance area for impact assessment, whether grid connection activities are performed by OSU as part of the action or by CLPUD as an interrelated or interdependent action.

G. Clarify intentions to close or maintain public access to park facilities at Driftwood during construction.

H. Describe how UCMF construction and operation will impact terrestrial resources.

I. Clarify the area proposed for new paving and expand discussion of the UCMF and include any paving activity planned for Wenger Lane or other areas. Per the PDEA, access to the UCMF would be via a paved 30-ft-wide spur road approximately 100 feet long. From review of the application for a Lincoln County Conditional Use Permit, ODFW understands that the applicant is proposing to install asphalt paving of a section of Wenger Lane approximately 20 feet wide by 700 feet long (Lincoln County Department of Planning and Development, 2018). Installation of impervious surfaces (e.g. paving dirt roads, new rooftops, paved parking area) to an area with significant precipitation could result in storm water runoff or changes to absorption rates which may alter wetland, waterbody, and upland habitat.

J. Parking and laydown area would be approximately 130 feet by 140 feet and large enough for semi-truck access. The entire area for the road, parking, and UCMF would be 2 acres and would be fenced and covered by security cameras and lighting. As ODFW commented to Lincoln County for the Conditional Use Permit, lighting shall be shielded or directed downward away from trees to minimize impacts on nocturnal species (Lincoln County Department of Planning and Development, 2018).

K. Describe the intended use of the UCMF site (power conditioning, monitoring, energy and data storage, and maintenance/supply area are all indoors). As ODFW recommended to Lincoln County for the Conditional Use Permit, intended uses should not be permitted to include outdoor storage, workshop facilities, equipment build out or repair, or storage or cleaning of marine equipment (Lincoln County Department of Planning and Development, 2018). Such activities could elevate concerns related to potential degradation of habitat quality from noise, pollutants, or other sources.

L. Clarify whether WEC deployment would be expected to take no more than seven days to install one mooring system and WEC (see PDEA page 2-25) or if it would take one to two days to deploy a single WEC and up to seven days to deploy a small array of WECs (see PDEA page 2-27).

M. Describe intended outreach throughout the PDEA and DLA documents. In the Navigation Safety and Risk Assessment (PDEA Appendix E), OSU states it would conduct additional outreach to inform mariners traveling in the vicinity of Project structures of activities to be avoided, and in PM&E measure 17, the applicant proposes to conduct outreach to mariners about the structures or activities to be avoided (e.g., Notice to Mariners, flyers posted at marinas and docks).

Per 18 CFR 4.35, a filed application may be amended during the application process and before license issuance (FERC, 2004). When an amendment to the application is filed that would significantly change the proposed project development plans, any resource agency may modify the recommendations, terms and conditions previously submitted to the Commission (FERC, 2004). ODFW reserves the right to modify recommendations if final construction methods, footprints, or any other future amendments are outside those previously considered.

Preliminary Comment 2: Grid-Connection and System Upgrades

As proposed, the power line from the electrical meters at the UCMF to the grid-connection on Highway 101 would be owned and maintained by the CLPUD. If the lines are underground, OSU would install conduits. If the lines are overhead, CLPUD would install the poles and complete the installation. The applicant estimates that CLPUD can handle initial project capacity up to 10MW but would require major system upgrades to accommodate the planned 20MW for the project.

The applicant should submit a plan for future grid infrastructure, which describes the extent of new infrastructure to be added for the project and the potential affects to fish and wildlife or habitat. If the applicant will eventually need additional trench lines or poles to support transmission of energy produced by the project, then potential future impacts on fish and wildlife and habitat must be considered as part of the action or as interdependent or interrelated actions in ODFW's analysis of the project.

Preliminary Comment 3: Anchors

As a test facility, the installation and removal of test equipment will occur more frequently at PMEC-SETS than it would at a commercial wave energy development. ODFW is concerned that if 20 WECs are installed in the same year, 80 anchor installations could occur in that year, likely condensed into one summer period. The applicant should clarify the frequency with which anchor installation or recovery might occur and provide an anticipated maximum frequency of anchor installations. Anchor installation and removal is discussed in the analysis but is inconsistent. Examples of installation/removal frequency discussion include:

A. Even under the full build-out scenario, anchor installation/removal is not expected of occur more than once a year at PMEC-SETS.
B. Anchor deployment and recovery would be infrequent, for a given WEC not likely more than once a year.
C. Although it is highly uncertain, WEC mooring system turnover could affect 2 berths per year. Habitat modifications would be long-term for WEC anchors (up to 5 years or longer).

As described by the applicant, the extent of permanent habitat modification would vary depending on anchor type and number of anchors, but disturbed areas are expected to recover by natural sediment transport processes as anchors are removed. To reduce disturbance to the seafloor, OSU will reuse anchors wherever possible. There would be long-term loss of sand habitat within the anchor footprint, OSU estimates as much as 2 acres at full build out, however this doesn't take into account anchors that are left on site for reuse. ODFW encourages actions that minimize disturbance to the seafloor, including reuse of fully functional anchors. However, to successfully minimize disturbance and avoid delayed anchor removal or abandonment of project or test equipment, the applicant should:

A. Document by signed agreement the intent of individual test clients to remove anchors when the test concludes, or for OSU to take over responsibility of anchor removal. Any costs of removal not covered by clients will be paid by OSU.
B. Remove all anchors at the end of license.

C. Mark anchors left in between tests with continuous surface marking.

D. Discuss anchor recovery methods and back up plans for all potential anchor types.

E. Clarify whether OSU will require test clients to remove any anchors prior to subsequent test that will not be reused or might they let anchors accumulate until final facility decommissioning. All anchors will be removed at conclusion of active testing activity or by the end of the license period.

F. Plan well in advance for anchor installation or removal, especially if multiple vessels would be needed at one time.

G. Not install anchoring and mooring systems with percussive pile driving or drilling, and avoid any activities creating a comparable noise level to pile driving activity either during installation or operation of the project. Document this commitment consistently throughout the analysis.

OSU states that anchors and mooring systems used at PMEC-SETS would be the same or similar to those commonly used in the marine environment. However, ODFW is concerned that the anchors for this project are anticipated to be significantly larger than anything else previously installed off of Oregon. Per the PDEA and appendices, suction caisson anchors can be easily removed, installation of the anchoring and mooring system for this project will not involve percussive pile driving or drilling, and neither installation nor operation of the project will involve any activities creating a comparable noise level to pile driving activity. The applicant should document throughout the analysis that no pile-driving or installation procedure with comparable noise level will be used at PMEC-SETS. The applicant should provide examples of installation and removal of suction anchors being successful offshore of Oregon or the U.S. west coast, and provide any associated information about the extent of scour or anchor scars left by installed or removed suction anchors.

To date, most marine renewable energy (MRE) deployments off of Oregon have had difficulty with equipment and anchor removal, which becomes very time-consuming and may make it difficult to maintain compliance with regulatory requirements. The applicant used the NRC Quest at NETS to remove a small clump anchor, and expects that similar vessels stationed in Washington and Oregon ports will be available for PMEC-SETS. The number of vessels needed for anchor installation and removal will depend on the quantity and size of anchors being deployed, but typically requires two to four specialized work vessels (e.g. tugs, barges). The applicant should consider in its analysis that vessel availability is a regular limitation for marine operations off of Oregon, and describe a realistic anchor installation and recovery scenario that does not assume timely availability of required vessels. Anchor installation/removal activities rely on specific weather windows so the timeframes within which anchor removal or installation could occur are also limited, which may further complicate successful timely removal of equipment and anchors.

It is likely that project components will become buried to varying degrees and once anchors are partially sanded in they can become extremely difficult to remove. The longer anchors stay in, likely the harder and more costly recovery will be. The applicant should expand the analysis to provide some certainty that equipment will be recoverable.

It is the responsibility of the applicant to finance and ensure successful anchor removal, which may involve grappling or multiple vessels. If anchors stay in for reuse in subsequent tests, that responsibility extends to whatever such time as the anchors are removed.

Preliminary Comment 4: Scour and Sediment Transport

As described in the PDEA and appendices, anchors on the seabed introduce hard substrate to a predominantly soft sediment area and could result in localized areas of scour or deposition. Scour is a natural process that occurs in the marine environment at the interface between soft and hard substrate. Initial project surveys indicate that geology of the test site appears to be primarily an extensive field of paleo dunes with fine sand to silt in the low areas and partially consolidated medium to course sand in the up to 5-meter-high dunes. The southern part of the site consists of sand waves that may represent active sediment transport and mapping data indicate a potential transition to fine sand at deeper depths greater than 70 m. The applicant states that sediments with a silty fraction have much greater potential for changes related to scour (as fine grains are more easily moved), and the particle size range found at PMEC-SETS is less susceptible to movement than areas with finer-grained sediment (percent fines at PMEC-SETS were very low, less than 1%).

The applicant anticipates that scour depths may be up to one m and widths may extend as far from the anchors as 20 m, but would be unlikely to persist beyond 150 m. Anchors plus scour may affect 48 acres at full build out, or 3 percent of the Project site. OSU reports modeled maximum scour depths around cylinder anchors predicting 0.064 X diameter, plus 0.028 X diameter of accretion nearby, meaning a 10-m-diameter anchor would amount to .64 m scour and .28 m accretion in the lee of the anchor. OSU reports field observations of scour in sandy habitats have been .5-1.0 m for a 10.5-m-diameter obstruction. Site characterization reports reviewed by the CWG included a sediment map with a key of sediment types shown from the initial marine survey, which indicated mud and fine sand in the project area. However, this map was not included with the PDEA. The applicant will perform marine geophysical and geotechnical surveys (see comment 5 below) and should provide results, including a map of sediment types within the project area, as soon as possible and no later than at such time as the FLA is submitted.

OSU reports settlement rates modeled off of Rhode Island and Virginia indicate that resettling of disturbed sediment would complete within 10 and 6-7 minutes following disturbance, respectively. However, mean median grain size at PMEC-SETS is bigger than these sites, so settlement would be expected to occur faster. Fine sediments, if re-suspended, would be advected the farthest away before redepositing and OSU estimates that grain sizes in the range of PMEC-SETS suspended 10 m in the water column would settle within 6.5 minutes. Suspended sediment resulting from cable laying, subsea connection installation and anchor installation/removal is expected to last for minutes or tens of minutes. However, it is important to note that these estimates of sediment settlement rates are based on a brief disturbance event whereas the more frequent activity at PMEC-SETS may induce ongoing disturbance for days (eg anchor installation) weeks (cable installation) or months (WEC operation). The applicant expects that scour holes or sediment pits would revert back to native physical condition relatively quickly, some estimate 100 days, because the project area is a high energy site with sand substrate as opposed to less energetic areas with finer muddy sediments; full recovery between disturbances is expected. The applicant should consider in the analysis that, based on pre-removal and post-decommissioning sonar and ROV video surveys conducted by OPT around seafloor equipment installed approximately 2.5 nautical miles off of Reedsport Oregon (OPT 2016b):

A. After 13 months installed, the scar left by a sunken sub-surface float was still visible, had persisted for 13 months post-removal (October 2013 to November 2014), and was approximately 30 feet long.

B. After 23 months installed, the anchor had partially settled into the soft sediment, and scour and deposition were visible in the sediment against the anchor. The hole left by the anchor was approximately 3-4 feet deep and easily identified on the sonar, documenting pit persistence for approximately 6-8 weeks between anchor removal and post-removal survey. The full duration of persistence is unknown as additional survey would be necessary to identify if and when sediment scar healing occurred.

Although scour occurs naturally, it may be accelerated by installation of MRE projects. Measurements of the extent and persistence of scour at the proposed test site can be scaled up for larger developments and will help ODFW anticipate potential impacts from future commercial development off of Oregon.

Preliminary Comment 5: Marine Geological Surveys

The applicant plans to conduct focused and detailed geophysical and geotechnical surveys in June and July 2018 at PMEC-SETS and within the subsea corridor. The purpose is to ascertain the best route to shore with the primary focus being to avoid hard substrates and maximize burial depth. Per PM&E measure 17, the applicant would avoid, to the extent practicable, anchoring in areas known to contain hard substrate or rocky reef habitats as identified by available seafloor mapping. ODFW supports surveys of the proposed project area, and requests an opportunity to review results of surveys to offer recommendations on final siting. ODFW anticipates that final marine surveys will be presented in the FLA and that information will include maps of the seafloor sediment type at the proposed deployment area and along the marine cable corridor. ODFW strongly recommends avoidance of any rocky habitat identified by surveys. In addition, information provided with results of this survey will be critical to ODFW's assessment of the potential for increased scour (see comment 4 above). ODFW reserves the right to comment to FERC pending the outcome of these surveys.

Preliminary Comment 6: Marine Mammal Surveys

Results displayed in the marine mammal site characterization report are from October 2013 to September 2015. Data analysis is in progress, and at this stage of analysis OSU can only make inferences towards trends in the observational data. Analyzing occurrence and distribution by combining acoustic surveys from 2014 with all visual surveys will result in a more robust data set for identifying trends and habitat use patterns. ODFW is concerned that no results are reported 2.5 years following completion of survey activities.

It is essential to have these results in the FLA so ODFW can consider what is known about marine mammal use of the project area in our final recommendations.

Preliminary Comment 7: Entanglement Hazards

As proposed, direct seafloor disturbance could result from anchors (see comment 3 above), the footprint of the four subsea connectors, umbilical cables, and the approximately 300 meters of subsea cable that would remain unburied, laid on the seabed in a U-form (looped), to allow access during maintenance activities. OSU proposes to mark the subsea connector with a surface buoy but the subsea cable would be exposed within the footprint of the test site and along the cable corridor in places with hard substrate. No fishing or navigation closures are proposed. The applicant should justify the need for 300 meters of unburied subsea cable in water depths less than 80 meters. The applicant should propose measures to ensure continuous marking of potential at-sea hazards (e.g. subsea connectors not in use) and perform outreach to fishery participants to increase awareness of marked and unmarked at-sea hazards and any changes in equipment status (deployed on station, off station, decommissioned). The applicant should minimize the extent of unburied seafloor cables and structures to minimize conflicts and safety hazards with fishery participants. The applicant should perform marine geological surveys (see comment 5 above) to identify and avoid rocky substrate to achieve complete and continuous burial in the cable corridor between the WEC deployment area and the HDD entrance at the 10-m isobath.

According to the applicants analysis, whales are not known to collide or entangle with taut moorings, which would be used at PMEC-SETS. According to proposed PM&E measure 3, mitigation for marine species entanglement or collision, the applicant shall direct the WEC testing clients to design and maintain cables and moorings in configurations that minimize the potential for marine mammal or sea turtle entrapment or entanglement (e.g., cable and lines should remain under tension) to the extent practicable. ODFW concurs that taut configurations present the lowest relative risk of entanglement (Harnois et al, 2015) and recommends that the applicant should require all clients to design and maintain cables and moorings to minimize entrapment or entanglement. An additional hazard presents itself when derelict fishing gear becomes caught on lines and cables, increasing the surface area of the zone for potential entanglement (Benjamins et al. 2014). Marine mammals are prone to becoming entangled in fishing gear; appendages (pectoral fins and flukes) are caught and tangled in lines and nets, which could cause an individual to drown when it cannot reach the surface to breathe (DLCD, 2015) or to starve when entangled gear prevents the animal from foraging. When demonstration scale MREs are scaled up to an array of multiple devices it creates a field of entanglement and avoidance hazards (DLCD, 2015). Fishing gear may entangle on project structures and will be identified and removed per PM&E measure 3.

According to the applicant's analysis, there are few examples of marine megafauna entangled in moorings or cables of any kind. However, a tidal energy site in the Bay of Fundy, Canada, has been associated with entrapment and mortality of humpback whales (James, 2013), and whale entanglements with seafloor cables do occur (National Marine Sanctuaries, 2017). Another significant hazard for some animals may be tethers between devices such as mooring cables, chains, guy-lines, or power cables, which marine mammals must be able to detect in order to avoid (DLCD, 2015). Models have predicted significant encounter rates between marine mammals and MRE devices; these are expected to increase when water is more turbid, such as during storms (Wilson et al. 2007). Avoidance becomes more complicated when several cables are used per device or multiple devices are present (DLCD, 2015), or at night or in turbid environments where structures may be visually undetectable and provide little or no opportunity for a behavioral response (Wilson et al, 2007).

The applicant should expand its analysis to describe feeding strategy of whale species potentially present in the vicinity of the project area including the cable corridor. For example, gray whales are bottom-feeders, and roll on their sides swimming slowly along the seafloor sucking sediment and benthic amphipods through coarse baleen plates (NOAA, 2013; Weller, 2010). This feeding activity suspends sediment in the water column creating long trails of “mud plumes” that can be seen in the water column or from the surface (Weller, 2010). Seafloor foraging activity may increase an individual’s risk of entanglement in project equipment exposed on the seafloor.

The applicant asserts that mooring lines and umbilical cables would have little slack and would not form loops which could entangle turtles. Increased curvature of a mooring line increases the risk that line may form a loop around the body of an animal from which it would not be able to extract itself (Harnois et al, 2015). The applicant should add throughout the analysis, whenever discussing potential species entanglement that mooring lines and umbilical cables would be designed to avoid looping. Per PM&E measure 15, mitigation for aquatic resources and threatened and endangered species, the applicant will design and maintain cables and moorings in configurations to minimize the potential for marine mammal entrapment or entanglement. PM&E measure 6 establishes that cables and lines should remain under tension. For consistency with what the CWG agreed to in 2017, the applicant should add "with no easy forming loops".

Preliminary Comment 8: Marine Fish Entrainment

Some devices use water intakes and if the pathway of water movement into the device is not screened, fish may be entrained and subjected to direct physical damage, abrasion, or, if there are significant pressure changes, various types of barotrauma effects (DLCD, 2015). The susceptibility of various species to these potential impacts would depend on the location of the device and the location of the water intake with respect to position in the water column (DLCD, 2015). For example, if the water intake is on a device floating on the surface, pelagic species and life history stages would be most vulnerable to impact, especially those that are likely to be attracted to the device for shelter (DLCD, 2015). Examples include pelagic species such as Pacific herring, or species with pelagic larval stages that settle on hard substrate, such as newly-settling rockfish (DLCD, 2015). Entrainment could cause direct mortality to fish species of conservation concern, such as juvenile stages of ESA listed salmonid stocks (DLCD, 2015). These species' populations are found in both state and federal waters, and the state and federal government share management responsibility for their conservation and recovery (DLCD, 2015). Impacts to these species in federal waters may also impact Oregon's conservation programs, potentially increasing the cost or time for species recovery (DLCD, 2015).

According to the applicant, no WECs will entrain or trap fish or other marine organisms into turbines or other components used for power generation. However, WECs like oscillating water column devices are "*structures that are partially submerged and hollow, open to the sea below the water line*" and fish remain vulnerable to any open system. The CWG expressed concern that ESA-listed fish could be entrained in WEC ballast water intakes, which may be used to achieve and maintain position, and may be operated manually or automatically. Because of the extremely low volume of seawater needed for ballast (eg 50-150 gallons per day), the expansive surrounding ocean, and high mobility of fish, OSU estimates that it is unlikely that entrainment of listed fish (salmonids, eulachon, green sturgeon) would occur.

ODFW has a responsibility to promote and sustain fish stocks for current and future users. ODFW's primary concern with unscreened water intakes is the movement of water either continuously or at large volumes. Oregon's first fish screening laws were established in 1898 and the current statewide screening program began in 1947, resulting in decades of experience within ODFW identifying screening needs and overcoming challenges. Although fish screening techniques are not well established for the marine environment, ODFW and other state and federal agencies are adept at creating solutions to achieve fish protection objectives using methods appropriate for the species and the environment. For example, NMFS and Maine Department of Marine Resources submitted a condition that would require the TideWorks Hydroelectric Project, FERC numbers 13656-000 and 13656-001, to install screens around a proposed tidal turbine unit (FERC, 2012b). The agencies' condition stated that the screen must (1) have a clear opening of one-inch or less; (2) maintain an approach velocity of two feet per second or less; and (3) be demonstrated to be effective (FERC, 2012b). During CWG analysis of potential project affects, ODFW advised the applicant and other CWG members that more information is needed to consider whether screening is needed and if so, what criteria should be used. The applicant should expand their analysis to include:

A. Ballast needs of any WEC types to be considered in this analysis.
B. Velocity with which in-ballast would occur for any WEC types to be considered in this analysis.
C. Volume of water needed to "trim" ballast for any WEC types to be considered in this analysis, and frequency with which "trimming" may be necessary.
D. Discussion of any continuous or fluctuating ballast systems, which should be avoided.
E. Discussion of any power generating systems that are open to the water column, which would be avoided.

Preliminary Comment 9: Marine Species Attraction

As described in the PDEA, fish attraction or artificial reef effects may occur as structures on the seabed, in the water column, and near the surface will add complexity, which could result in changes to biofouling species, species interaction, predator-prey interaction, pinniped haulout, seabird perching, or changes to the marine community composition and behavior. California sea lions and harbor porpoise may be attracted by prey aggregations caused by attraction to artificial lighting (DLCD, 2015). Additionally, zooplankton are known to aggregate toward light sources during nocturnal periods (McConnell et al. 2010), making it possible that the mysid prey of gray whales may aggregate near underwater lighting (DLCD, 2015). Structure on the water surface or in the water column will likely act as fish aggregation devices and attract species of pelagic fish and several shark species (Boehlert and Gill 2010; Klure, et al. 2012). In addition, fouling organisms that will settle on the subsurface structure will likely attract other species in response to the additional surface structure created by the fouling organisms and the presence of additional food resources (DLCD, 2015). Underwater MRE surfaces, such as platforms, cables, anchors, and pipes are likely to be colonized by invertebrates and encrusting organisms to create an artificial reef (DLCD, 2015). Such an artificial reef may aggregate fish or zooplankton that may attract marine mammals for increased foraging opportunities on concentrated prey (DLCD, 2015).

Habitat alterations at or near the project site in federal waters could potentially impact fish, invertebrates, or fisheries that are of interest to the state (DLCD, 2015). Habitat impacts that reduce availability of fish can contribute to reduced commercial fishery landings or increase the cost for catching fish (DLCD, 2015). Habitat impacts can also negatively affect fish species of conservation concern, such as ESA-listed or overfished species (DLCD, 2015). These species' populations are found in both state and federal waters, and the state and federal government share management responsibility for their conservation and recovery (DLCD, 2015). Any impact to these species in federal waters also impacts Oregon's conservation programs, potentially increasing the cost or time for species recovery.(DLCD, 2015). Habitat changes have the following effects on fish and selected invertebrates:

A. Attract concentrations of predators that could prey on species not otherwise exposed to similar concentrations of predators.
B. Attract fish and mobile invertebrates away from their previous locations, which, in turn could limit fishery catch in those areas.
C. Decrease habitat of species that were previously located at the site, which could alter species composition at the site (Boehlert and Gill 2010; Klure, et al. 2012).

According to the applicant, some pelagic fish are associated with floating objects, but fish associations with fish attraction devices (FADs) are not found in temperate waters like they are known to in tropical waters and as such, project structures in the water column and at the surface are unlikely to act as FADs that would attract pelagic fish (e.g. pelagic salmon) or make them more vulnerable to predation. Per the PDEA and appendices, rockfish are structure oriented and in temperate ocean waters off of Oregon fish associations with midwater and surface structures were generally limited to pelagic juvenile rockfishes. The applicant does not expect ESA-listed fish to be attracted to or associate regularly with the structures, therefore they would not be expected to be at increased risk of predation. Juvenile and adult salmonids are highly mobile and movements generally follow available prey, which includes highly mobile pelagic or surface-oriented crustaceans and fish. The applicant should clarify why, if pelagic fish may be attracted, would project structures be unlikely to act as FADs. ODFW disagrees with the applicant's conclusions that fish attraction is unlikely, and requests that the analysis be revised to conclude that uncertainty about fish attraction to MRE remains, but fish attraction to structure off of Oregon is well documented and should be analyzed.

ODFW is concerned that fish will be attracted to structure introduced by the project and subjected to increased predation pressure. Increased predation that can result from aggregation of predators could potentially cause direct mortality to fish species of conservation concern, such as ESA-listed or overfished species, or could reduce the abundance of species that may be important to fisheries (DLCD, 2015). These species' populations are found in both state and federal waters, and the state and federal government share management responsibility for their conservation and recovery (DLCD, 2015). Above surface WECs or other platforms might attract use by pinnipeds as haul out sites (DLCD, 2015). California and Steller's sea lions are regularly seen hauled out on offshore buoys in Oregon, making it likely that MRE platforms will also be used by pinnipeds when accessible (DLCD, 2015). As described in the PDEA and appendices, surveys at the North Energy Test Site (NETS) indicate shell hash may accumulate and may occur up to 250 meters from an anchor, which might increase complexity and attract fish. At the same time, it is unknown if EMF from cables or other project affects might either attract or repel electro-sensitive species such as elasmobranchs (e.g. sharks, skates, rays) which are top-order predators that are highly influential to marine food web and ecosystem structure. The applicant should discuss potential changes in predation further, including expanded analysis of potential attraction of elasmobranchs because these are apex predators that target prey including salmon, and in some cases are fishery limiting species. ODFW requests that the applicant provide any information currently available to assist in the analysis of potential project effects.

Preliminary Comment 10: Oregon Endangered Species Act

The Oregon Endangered Species Act (ORS 496.171 et. seq. & OAR 635-100) requires state agencies to protect and promote recovery of state listed species. In its PDEA, section 3.3.5 T&E species, the applicant discusses federally endangered (FE) and federally threatened (FT) species, but the PDEA does not discuss state endangered (SE) or state threatened (ST) species not federally listed (gray whale, brown pelican) or the north Pacific right whale which is both SE and FE. The applicant should add to the analysis:

- Gray whale, SE, not federally listed
- North Pacific right whale, SE, FE
- California brown pelican, SE, not federally listed

In the PDEA, text for federally listed species should consistently and correctly include state listing, including:

- leatherback sea turtle FE and SE
- Green sea turtle FT and SE
- Loggerhead sea turtle FE and ST
- Olive (Pacific) Ridley sea turtle FT and ST
- Humpback, blue, fin, sei, and sperm whales FE and SE
- Short-tailed albatross FE and SE

Gray whale: Gray whales remain listed by the state as endangered. According to the PDEA, to minimize effects to marine mammals, the applicant would implement environmental measures including minimizing construction during key gray whale migration periods, to the extent possible. OSU would further minimize or avoid impacts on gray whales by implementing PM&E measures 6, 10 and 15. ODFW supports these measures and strongly discourages activities like cable laying during this sensitive timeframe (see 10(j) recommendation 4 above).

The Cetacean & Sound Mapping effort by NOAA includes Biologically Important Areas (BIAs) where cetacean species or populations are known to concentrate for specific behaviors, which provides additional context within which to examine potential interactions between cetaceans and human activities (NOAA, no date c). For the eastern north pacific (ENP) population of gray whales, BIAs are based on migratory corridors as they transit between primary feeding areas in northern latitudes and breeding areas off Mexico (Calambokidis et al, 2015). Migratory BIAs encompass the proposed PMEC-SETS project area and include the area from shore to a certain distance, unique to each migratory phase, including 10km for the southbound migration, 8km for northbound phase A and 5km for northbound phase B, with an additional 47km from the coastline added to buffer each BIA (Calambokidis et al, 2015; NOAA, no date c). At its greatest extent, the migratory corridor BIA identifies a 138,000 square km area of importance for gray whales (Calambokidis et al, 2015).

Feeding BIAs have been delineated for the Pacific coast feeding group (PCFG), a sub-population of ENP gray whales. Based on primary feeding areas for the resident population, PCFG feeding BIAs include a 199 square km area (Calambokidis et al, 2015) inshore of the proposed PMEC-SETS project area (NOAA, no date c). The PCFG Depot Bay feeding BIA includes the nearshore area off of Newport and terminates just north of Seal Rock (Calambokidis et al, 2015; NOAA, no date c). ODFW requests that the applicant add this information to its analysis.

Humpback whale: Humpback whales are most abundant off of Oregon and the U.S. West Coast from spring through fall but have also been detected during winter (Calambokidis et al, 2015). Individuals migrating past Oregon are likely in transit between northern feeding areas and southern wintering grounds, and remain loyal to specific locations of both (Calambokidis et al, 2015). Seven feeding BIAs were identified off the west coast representing only 3% of U.S. waters but encompassing 89% of documented observations (Calambokidis et al, 2015). According to the applicant's analysis, the project area is not known to be an important foraging area for any of the ESA-listed whales. Based on high concentrations of feeding humpback whales, a 2,573 square km area encompassing Stonewall and Heceta Banks was identified as a feeding BIA and one of the most critical areas for humpback whales (Calambokidis et al, 2015). Based on comparison of PMEC-SETS coordinates, the online interactive BIA map and GIS shapefile data (https://cetsound.noaa.gov/important) and figure 4.5(b) from Calambokidis et al, 2015, the humpback whale Stonewall and Heceta Bank feeding BIA encompasses the proposed project area and extends to a large area to the west and southwest of the proposed project area. Individual whales remain loyal to preferred feeding areas and may frequently use or transit through the project area to access the Stonewall and Heceta Banks BIA. The applicant should add this information to their analysis and should provide a map with

BIA spatial data overlaid by all marine project components (e.g. cable corridor, WEC deployment area, vessel transit corridor, etc.).

Western snowy plover: As reported by the applicant in their PDEA and appendices, western snowy plover nesting was observed in 2017 to the north and south of the Driftwood. The applicant should also consider in their analysis that western snowy plover nesting was observed during the past two breeding seasons (2017-2018) on the beach immediately adjacent to and in close proximity to Driftwood. OSU also reports that no plovers were reported during winter surveys conducted at South Beach State Park in 1991-1994, 2001-2003, and in 2007. However, updated survey reports indicate that plovers have been documented on the central coast during winter window surveys coordinated by USFWS, including at South Beach State park during multiple recent years (USFWS, 2018).

The applicant proposes to conduct multiple HDDs from Driftwood under the beach and if HDD activity is initiated within the western snowy plover nesting season, nest surveys and noise monitoring will be conducted. The applicant considers noise significant if it increases from background by more than 10dBA, and considers the anticipated HDD noise level within potential snowy plover habitat unlikely to exceed this value. The applicant should explain how they reached this conclusion, while their analysis also includes that surf noise is approximately 60 dBA and HDD is approximately 92dBA at 50’ and 76 dBA at 300’. Noise predictions for HDD in potential habitat already exceeds 60 + 10 = 70 dBA levels of what might be considered significant according to the applicant's analysis.

Based on review of the DLA application package, including the PDEA and appendices, ODFW is uncertain what level of public access is proposed to occur at Driftwood, and is concerned that beach and dune habitat within the park may be negatively affected if public use is not addressed appropriately. The applicant should clarify if public beach access and parking will be maintained during construction (see PDEA page 3-168 & PM&E 17), or significantly restricted (see PDEA page 3-171), or if the public beach access, restrooms, parking, and picnic facilities would be closed during construction (see PDEA appendix A page 5-65). ODFW anticipates that this issue will be addressed by the applicant in consultation with OPRD, but recommends that the analysis clarify the anticipated level of public access so we may determine habitat concerns, if any.

In the draft HMP included as PDEA Appendix K, the applicant has included that "*all heavy duty equipment activities in the Driftwood parking lot will occur at least 164 feet (50 m) from any potentially suitable habitat for western snowy plover, consistent with the Habitat Conservation Plan (HCP)*". Prior to submittal of the DLA package, ODFW worked with the applicant to develop the HMP and had agreed to including a HCP mitigation measure establishing a buffer of 50 m for all activities, not only heavy duty equipment (ICF International, 2010). The applicant should revise the HMP to be consistent with protection measures established by the HCP and agreed to by ODFW.

Marbled murrelets: According to the analysis, marbled murrelet occurrences would likely be limited to 1-2 murrelets in the WEC deployment area but more frequently along the cable and vessel routes. According to the PDEA and appendices, no individuals were observed at NETS or within the explicit boundary of PMEC-SETS during boat surveys. However, as reported in the Site Characterization Report – Seabirds, included as PDEA Appendix D, the applicant recorded 35 marbled murrelets, mostly in the eastern portion of PMEC-SETS and adjacent nearshore area near the mouth of the estuary; all murrelets were observed within 17 km (9.2 nm) of shore, mostly very near to shore in <50m depth. The applicant should clarify that individual birds were observed during the site characterization survey to the west, north, and east of the project area so it is reasonable to assume they could also occur within the PMEC-SETS boundary. The applicant should issue a correction throughout application documents that, following the OFWC June 7 2018 decision declining to uplist marbled murrelets, the species will remain listed as threatened by Oregon ESA.

Short-tailed albatross: The Habitat Characterization Report, included as PDEA Appendix C, states the short-tailed albatross is listed as threatened by the State of Oregon, but should say endangered.

Preliminary Comment 11: Onshore Habitat Survey

Included in PM&E measure 16, mitigation for terrestrial resources, the applicant would avoid to the extent practicable, disturbance of seaside hoary elfin butterfly habitat within and in the vicinity of Driftwood. Where unavoidable, species-specific surveys may be necessary on properties outside of Driftwood but within the construction footprint to determine the extent of occupied habitat and associated mitigation. Kinnikinnick patches within Driftwood are occupied by butterflies and have been targeted for conservation measures by Oregon Parks and Recreation Department (OPRD). Potential habitat patches outside of Driftwood have not been surveyed so it is unknown whether butterflies occupy those areas. To determine if conservation actions are appropriate, the applicant should contract a specialist to assess and possibly survey kinnikinnick patches delineated within the project area but outside of Driftwood to determine if habitat is suitable for, or occupied by, the seaside hoary elfin. Surveys should be conducted by experts, in the appropriate season, and preferably in accordance with procedures used on OPRD property (Ross, 2005).

Preliminary Comment 12: Wetlands and Waterbodies

During onshore surveys the applicant delineated several wetlands within the project area, as reported in the Habitat Characterization Report included as PDEA Appendix C. Delineations identified eight freshwater wetlands, including three forested four scrub-shrub and one emergent. Per PM&E measure 16, the applicant would:

- *Prior to construction, conduct a survey of wetlands and rare plants in areas where ground disturbing activities would occur to identify and avoid potential impacts as practicable.*
- *Employ environmental measures during installation, operation, and removal to avoid or minimize potential effects to sediment and soils. For example:*
    - *Minimize disruption of terrestrial geology and soils by maintaining buffers around wetlands to the degree practicable,*
    - *Develop and implement Erosion and Sediment Control Plans, and maintain natural surface drainage patterns.*
    - *Develop and implement stormwater runoff treatment such as low-impact development design at land-based facilities to maintain existing drainage patterns, protect project-adjacent habitat, and prevent contamination of streams.*

- *Avoid to the extent practicable, disturbance of forested wetlands.*
- *Avoid to the extent practicable, disturbance of wetlands and adjacent areas that may provide habitat for western pond turtle, amphibians, and other semi-aquatic wildlife.*
- *Avoid to the extent practicable, disturbance of riparian wetlands where restoration of natural hydrology may be unsuccessful within a short timeframe. Natural hydrology should be restored after construction is complete, and may require a restoration plan with monitoring until successful restoration can be determined.*

The applicant should bore under sensitive wetlands surrounding fish-bearing streams to avoid disturbance, or if boring is not technically feasible, should consult ODFW regarding fish salvage and IWWW (see 10(j) recommendation 6).

According to PM&E measure 16, mitigation for terrestrial resources, the applicant will develop and implement stormwater runoff treatment such as low-impact development design at land-based facilities to maintain existing drainage patterns, protect project adjacent habitat, and prevent contamination of streams. ODFW noted during review of the applicants materials submitted to Lincoln County for the Conditional Use Permit that OSU plans to direct storm water from building downspouts into underground pipes and capture storm water from paved surfaces in area drains (Lincoln County Department of Planning and Development, 2018). Storm water would then be carried in these pipes and outfall at the west side of the paved UCMF and north of the exit drive (Lincoln County Department of Planning and Development, 2018). Water would then be carried in a vegetated swale where it would flow into the existing wetland below and ensure that wetland receives sufficient hydrological recharge. (Lincoln County Department of Planning and Development, 2018). Consistent with the final order of the Lincoln County Planning Commission for the Conditional Use Permit, the applicant should obtain a

NPDES 1200-C construction stormwater permit from the Oregon Department of Environmental Quality (ODEQ; Lincoln County Planning Commission, 2018) if more than one acre of land is disturbed including temporary work areas. Also, the applicant should implement a method of post-construction stormwater management that complies with ODEQ requirements (Lincoln County Planning Commission, 2018) described in the Section 401 Water Quality Certification Post-Construction Stormwater Management Plan Submission Guidelines (ODEQ, 2016).The applicant should provide a plan for stormwater management with their environmental analysis so that ODFW may determine if concerns for onsite and adjacent wetland, stream, and upland habitats are adequately addressed. The analysis should clearly describe how natural drainage will be restored and recharge of on-site wetlands will be accomplished.

According to the applicant, the project does not meet the requirements for a Spill (SPCC) plan or a Facility Response Plan, but the applicant has developed an Emergency Response and Recovery Plan, included as PDEA appendix G, to prevent and if needed mitigate minor spills or leaks of fluids into the marine environment, that would include spill prevention and control measures. Also, PM&E measure 12, mitigation for water resources, includes preparing spill prevention plans for onshore project facilities. If the applicant needs a Section 404 removal/fill permit from the US Corp of Engineers, the applicant should meet all Federal and State water quality standards required by the Clean Water Act in accordance with the water quality certification issued by the ODEQ under section 401 of the Clean Water Act, which requires post-construction stormwater plans.

Preliminary Comment 13: Cumulative Effects Analysis

According to PDEA section 3.2.1, the geographic scope of the analysis for cumulatively affected resources encompasses onshore facilities, the subsea cable area from shore to the edge of the territorial sea, and the offshore facility site. The applicant should add the subsea cable from the western edge of the territorial sea to the offshore facility site, as well as a discussion of any onshore developments (e.g. utility lines, culverts, residential, road improvements) with the potential to have cumulative effects. ODFW has management responsibility for fish and wildlife in marine, freshwater, and upland habitats, and needs to consider all potential cumulative effects in its analysis of the proposed project.

Data collected at the NETS is used by the applicant as proxy data to speculate potential conditions and impacts of development at PMEC-SETS. For example, wave climate information collected at NETS is considered by OSU to be representative of PMEC-SETS given they are 9 miles apart. However, in some cases NETS is not a good proxy for PMEC-SETS given the differences in existing conditions. Any use of NETS data as a proxy for PMEC-SETS should be accompanied by acknowledgment in the differences in site depth, nearby bathymetry (shoreline, headland, reefs), and proximity to shore, as well as the distance between the sites. In the PDEA, NETS is considered a planned or existing "Project in the Vicinity" with potential cumulative impacts. OSU states it has been conducting ongoing environmental studies at the nearby NETS since 2009. ODFW is aware of studies conducted between 2009- 2015, at which point all equipment was removed and no subsequent deployment occurred. The applicant should clarify what studies have been performed at NETS since equipment removal on November 6, 2015.

The proposed Camp Rilea Ocean Renewable Energy Project is considered a planned or existing "Project in the Vicinity" with potential cumulative impacts, and would be located 100 miles north of PMEC-SETS, and may consist of multiple types of WECs. ODFW is not aware of any applications on file with DSL or initiation of the states review process for MRE projects in state waters indicating a project proposal at Camp Rilea. The applicant should clarify the status of Camp Rilea as of the time of PMEC-SETS filing.

Preliminary Comment 14: Schedule to Develop and Implement Project Plans

The applicant intends to develop and implement several plans not provided as part of the DLA, PDEA or appendices (e.g. HDD contingency plans, construction plans, revegetation plans, restoration plans, erosion control plans, others). The applicant should propose a schedule for development and implementation of these plans, so that ODFW can anticipate when information contained in these plans will be made available to support determination of potential impacts on fish and wildlife and habitat.

CONCLUSION

ODFW does not object to the issuance of a new license for the Project, provided our comments are addressed in the Final License Application and analysis, and our recommendations are fully incorporated into the new License. ODFW reserves the right to amend these recommendations, if warranted, based on the results of new information and conclusions developed during the Commission's environmental analysis.

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CERTIFICATE OF SERVICE

UNITED STATES OF AMERICA
FEDERAL ENERGY REGULATORY COMMISSION

Oregon State University	**) FERC 14616-000**
	) Pacific Marine Energy Center –
	) South Energy Test Site
Draft License Application for a Major	**)**
Unconstructed Project and Preliminary	**)**
Draft Environmental Assessment	**)**

CERTIFICATE OF SERVICE

I certify that I have served the foregoing Oregon Department of Fish and Wildlife PRELIMINARY COMMENTS and PRELIMINARY RECOMMNENDATIONS for the PMEC-SETS Project upon each person designated on the official service list compiled by the Secretary in this proceeding.

Dated: July 20, 2018

Delia Kelly

Delia Kelly
Ocean Energy Coordinator

Oregon

Kate Brown, Governor

Parks and Recreation Department
725 Summer St. NE, Suite C
Salem, OR 97301-1271
(503) 986-0980
Fax (503) 986-0794
www.oregonstateparks.org

Online submission
July 20th 2018

Secretary Kimberly D. Bose
Federal Energy Regulatory Commission
888 First Street NE
Washington, D.C. 20426

Re: FERC Docket No. P-14616-000

Dear Secretary Bose,

Oregon Parks and Recreation Department (OPRD) is submitting the following comments in response to the public notice for the Pacific Marine Energy Center-South Energy Test Site (PMEC-SETS) project proposed by Oregon State University (OSU) approximately six nm offshore of Newport, Oregon. OPRD is the state agency charged with management and permitting decisions for activities on the Ocean Shore State Recreation Area, as specified in Oregon's Beach Laws (ORS 390.605-390.770). The "State Recreation Area" is described as the area of land or water, or a combination of, that is under the jurisdiction of OPRD that is used by the public for recreational purposes. The "Ocean Shore" means the land lying between the extreme low tide of the Pacific Ocean and the statutory vegetation line (ORS 390.770) or the line of established upland shore vegetation, whichever is farther inland. Additionally, OPRD owns and operates over seventy oceanfront state parks along the Oregon Coast, including Driftwood Beach State Recreation Site (Driftwood). The State Historic Preservation Office (SHPO) is also housed within OPRD; however, SHPO must be consulted separately.

OPRD participated in the alternative licensing process as a member of the Collaborative Workgroup (CWG). OPRD is providing the following comments with the hopes of remaining consistent with agreements reached by the CWG. However, some content included in the application had not been reviewed by the CWG prior to Draft License Application (DLA) submission, and some may not yet be developed (e.g., detailed final terrestrial construction plans). The following are comments on the DLA package to inform the development of subsequent documentation for the PMEC-SETS project.

State Park Property
The project, as proposed, involves using the OPRD property known as Driftwood Beach State Recreation Site (Driftwood) in Seal Rock, Oregon as the underground cable landing and splicing location. Construction operations at Driftwood during the first phase of this project (underground construction), as proposed, will occur over a period of 6-8 months and for safety reasons, the park would need to be closed to the public. During the second phase of construction (cable installation), recreational use of the property will also be impacted due to construction estimated to last 45-60 days.

If use of park property is approved, OPRD will need to resolve operations of the park in coordination with OSU. OPRD plans to do this in consultation with ODFW to address any potential habitat disturbance concerns resulting from closure(s) of the state park. OSU should further clarify intended outreach to include the public, including park users as it relates to proposed park closures.

As previously discussed with the applicant, the Driftwood property potentially impacted by this proposed project was acquired with assistance of the federal Land and Water Conservation Fund (LWCF) administered by the National Park Service (NPS), and is subject to requirements of Section 6(f)(3) of the Land and Water Conservation Fund (LWCF) Act. The activities proposed by the applicant will constitute a “conversion of use” under Chapter 8 of the LWCF State Assistance Program Manual. Replacement land must be provided to OPRD to compensate for the converted property. The proponent must bear all costs associated with providing the replacement property and processing the conversion. As yet, no replacement lands have been identified. Approval of a LWCF conversion requires action on the part of the Oregon Parks and Recreation Commission (OPRC), as well as NPS.

Only the OPRC can approve the granting of real property rights. Oregon Administrative Rule 736-019-0070 provides criteria for an exchange initiated by parties other than the department. In this instance, the OPRC may approve an exchange if the OPRC determines that the proposed exchange provides “overwhelming public benefit to the park system, its visitors, and the citizens of Oregon.” The OPRC has sole discretion to determine whether a proposal provides an overwhelming public benefit to the park system, its visitors, and citizens, which is resounding, clear and obvious. A draft proposal of this project has been presented to OPRC as an informational item. However, OPRC has not granted approval for the transfer of property rights at this time. OPRD anticipates that at a minimum, an Intergovernmental Agreement (IGA) would accompany any property rights documentation (e.g., easement, sales agreements) outlining requirements of OSU’s use of State Park property both for the construction period(s) and long-term underground use for cable landing and power transmission. OPRD has had general conversations with the applicant, including an informational presentation to the OPRC by the applicant. However, further details about proposed construction activities, including detailed timing and footprints of disturbance, placement of equipment and decommissioning plans have not been provided at this time.

OPRD manages the Driftwood property as at State Highway Rest Area under an agreement with the Oregon Department of Transportation (ODOT). ODOT must be notified at least three months in advance of closures lasting more than 90 days. Additionally, coordination needs to occur with ODOT to ensure adequate advance signage exists for motorists regarding temporary park closure(s) along with any permits required by ODOT (e.g., right of way permits for signage on the state highway).

State Park Resources

Sensitive natural resources are known to occur on this property, including wetlands and rare wildlife species. As a part of comprehensive planning efforts for the South Beach Management Unit, OPRD natural resource staff conducted detailed inventories of all park resources. As part of the planning process, botanical and wildlife values were assessed and mapped, sensitive species were surveyed for, and an appropriate degree of resource protection assigned. Assessments indicate that the proposed park landing site demands a high level of resource protection and development opportunities are very limited. OPRD's understanding is the applicant plans to contain all construction activities within previously disturbed areas (e.g., roads, parking lot) which will minimize impacts to these resources. Any use of state park property, if approved, will be contingent on avoidance of sensitive resources and impacts to park and beach visitors. OPRD has reviewed and supports the recommendations of ODFW being submitted during this comment period, including all of those for state park property (Driftwood) and the Ocean Shore State Recreation Area.

Of particular note is the potential for a butterfly, the seaside hoary elfin (*Callophyrys polios maritima*), to be present in the vicinity of potential onshore project facilities. The Driftwood property is one of only three known historical populations in the world where this rare butterfly (a maritime sub-species that is morphologically and ecologically distinct) has been documented. This species is ranked as Critically Imperiled in Oregon by the Oregon Biodiversity Information Center and the genetically distinct population in Lincoln County is currently the only known location in Oregon. Restoration projects are currently underway at Driftwood to enhance the existing habitat and restore new habitat for the species. Given the rarity of the species, complete avoidance of the host plant, kinnikinick (*Arctostaphylos uva-ursi*), will be necessary for any land-based activities on state park property.

Additionally, state and federally listed western snowy plovers (*Charadrius nivosus nivosus*) have nested for the past two breeding seasons (2017-2018) on the beach immediately adjacent to and in close proximity to Driftwood. In 2017, five nests were located in the vicinity and there have been four nests near Driftwood so far this year (2018). Additionally, plovers have been documented on the central coast during winter window surveys coordinated by USFWS, including at South Beach State Park every winter from 2015-2018 and at Bayshore in 2017. This spring, plovers initiated nesting at South Beach at least three times with one nest successfully hatching earlier this month (July 2018). If nests or adult plovers are detected during breeding season (March 15-September 15) in the vicinity of Driftwood, protective measures should be implemented in coordination with USFWS, OPRD, and ODFW. The stated buffer of 50 meters "consistent with the Habitat Conservation Plan" was not designed for application to "heavy duty equipment activities" rather, to protect active nests from recreation-related disturbance (e.g., pedestrians) recreating on the ocean shore. Therefore, since all project related activities are non-recreational in nature, they should occur *at least* 50 meters from plover habitat and be approved through consultation with USFWS.

Several fish bearing streams flow through Driftwood, including Friday Creek and the associated wetland system. OPRD supports ODFW's recommendation to drill (rather than trench) under sensitive resources, including fish-bearing streams and wetlands including all of those running through OPRD property. Work should occur during ODFW established in-water work windows. OPRD Stewardship staff should be involved in the development of any upland or riparian restoration and monitoring plans (including the associated erosion and sediment control plan) that occur on or have the potential to impact OPRD property. Restoration of the cable corridor running through Driftwood must occur in accordance with ODFW recommendations in consultation with OPRD Stewardship staff.

Given the scenic quality of the coastal landscape and seascape at coastal parks, visualizations may need to be conducted from potentially impacted viewpoints *depending on the heights* of the proposed wave energy devices being used at the facility. Please refer to the visual resource protection standards established in the Oregon Territorial Sea Plan along with suggested project review criteria for more information.

Cultural resources

Please refer to the information submitted by the State Historic Preservation Office regarding data needs (e.g., side-scan sonar and sub-bottom profile data) and requests to help avoid landforms where cultural remains may exist both offshore below federal and state waters, along the cable-route and onshore (SHPO Case # 14-0893). Before commencing any work, SHPO approval must be attained and appropriate consultation with potentially affected tribes must occur.

Ocean Shore Permitting

Under ORS 390.640 and ORS 390.715, any person conducting an ocean shore alteration, or placing any pipeline, cable line, or other conduit over, across or under the state recreation area or submerged lands adjoining the Ocean Shore, must submit an “Ocean Shore Alteration Permit” application to OPRD. Documents prepared by the applicant describe cable routes and a landing location, all of which will require a permit from OPRD to cross under the Ocean Shore. No application has been received at this time.

OPRD will have to be consulted if the applicant needs to perform any activities on the Ocean Shore. For example, if an emergency staging area on the beach is necessary or if vehicles are required on the beach for any reason a permit is required. Both response to WECs outside of operational boundaries and HDD contingency plans will rely on beach access for containment response and monitoring. If necessary, access will likely rely on existing vehicle access points such as Quail Street, approximately 1.32 miles north of the Driftwood Beach State Recreation Site. Western snowy plovers have nested for the past two breeding seasons (2017-2018) adjacent to Driftwood but also to the north and south including near the Quail Street beach access. Any vehicles accessing the beach need to discuss access options with OPRD to get updated information about areas to avoid. Prior to any work being conducted on the beach, OPRD would require, at a minimum, a “Motor Vehicle on the Ocean Shore” permit and consultation with staff to address these and other issues.

Ocean Shore Safety

As the managers of the ocean shore as a recreation area, OPRD should be involved when the applicant develops the proposed Emergency Response and Recovery Plan(s), especially as it relates to potential marine debris. Modeling that helps predict probable landfall locations of project generated marine debris at various times of the year would be helpful. Impact analysis should include potential resource concerns associated with landfall of project related marine debris and associated removal efforts, particularly for sensitive areas such as rocky intertidal habitat and western snowy plover nesting areas. Any potential impact to ocean shore resources, recreational use of the beach and the safety of visitors should be considered in development of these plans. Funding to cover any costs incurred for emergency recovery efforts, including those developed by individual technology developers eventually testing at PMEC-SETS, should also be clarified.

Concurrence with ODFW recommendations

Oregon Parks and Recreation Department supports Oregon Department of Fish and Wildlife’s 10(j) recommendations regarding proposed plans and measures and which should be included as enforceable conditions of the FERC license. This recommendation is consistent with discussions that occurred during the CWG process. Additionally, OPRD concurs with ODFW that onshore habitat impacts cannot be fully analyzed for the Habitat Mitigation Plan (HMP) until finalized and detailed construction plans and associated information are provided. OPRD will rely on this assessment and recommendations from ODFW in the development of permits and property documents to protect state park and ocean shore resources.

Ongoing coordination

OPRD is not listed as a member of the Adaptive Management Committee (AMC) that will help provide ongoing consultation for PM&E measures (i.e., Adaptive Management). This is likely because the existing limited list of topics the AMC is responsible for are marine in nature and generally outside the scope of OPRD jurisdiction. However, OPRD needs to be included in ongoing discussions and adaptive management for resources on, or potential impacts to, natural, cultural, and recreational resources on state park property and the Ocean Shore State Recreation Area during the entire life of the project, both during and post-construction. A few examples of areas of interest to OPRD that may require adaptive management and should involve ongoing consultation with OPRD staff include: Removal and Decommissioning Plan, Bird and Bat Conservation Plan, Operations and Maintenance Plan, Construction Plan, Emergency Response Plan (including plans for inadvertent fluid release/HDD contingencies), Terrestrial Restoration Plans etc. OPRD would also like to receive the Annual Report provided to the AMC and participate in any sub-committee meetings that address any topics related to state park or ocean shore resources.

Thank you for your time and the opportunity to comment. Please feel free to contact any of my staff, listed below, with any questions.

Sincerely,

Trevor Taylor
Stewardship Manager

Laurel Hillmann, Ocean Shore Specialist (laurel.hillmann@oregon.gov)
Jay Sennewald, Ocean Shore Permit Coordinator (jay.sennewald@oregon.gov)
Celeste Lebo, North Coast Parks Natural Resource Specialist (celeste.lebo@oregon.gov)
Alice Beals, Acquisition and Property Specialist (alice.beals@oregon.gov)
Samuel Willis, Coastal Park Archaeologist (samuel.willis@oregon.gov)

Ec: Service List (FERC No. P-14616-000)
Dr. Burke Hales, Oregon State University

CERTIFICATE OF SERVICE

UNITED STATES OF AMERICA
FEDERAL ENERGY REGULATORY COMMISSION

Oregon State University	**) FERC P-14616-000**
	) Pacific Marine Energy Center –
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CERTIFICATE OF SERVICE

I certify that I have served the foregoing Oregon Parks and Recreation Department PRELIMINARY COMMENTS and PRELIMINARY RECOMMNENDATIONS for the PMEC-SETS Project upon each person designated on the official service list compiled by the Secretary in this proceeding.

Laurel Hillmann
Natural Resource Specialist

Dated: July 20, 2018

Document Content(s)

July 23, 2018

Mr. Jim Hastreiter
Federal Energy Regulatory Commission
888 First Street NE
Washington, DC 20426
james.hastreiter@ferc.gov

Dr. Burke Hales
Attn: DLA comments
College of Earth, Ocean and Atmospheric Sciences
Oregon State University
104 CEOAS Administration Building
Corvallis, OR 97331-5503
ceoas_NewWaves@oregonstate.edu

Re: Comments and Recommendations for Draft License Application for the Proposed Pacific Marine Energy Center – South Energy Test Site, FERC Project No. P-14616-000

Dear Mr. Hastreiter and Dr. Hales:

On behalf of the Natural Resources Defense Council ("NRDC")[1], the Center for Biological Diversity ("Center")[2], Whale and Dolphin Conservation ("WDC")[3], and Defenders of Wildlife[4] (collectively "conservation groups") and our millions of members and online activists, we are writing to express our serious concern about the proposed Pacific Marine Energy Center-South Energy Test Site ("PMEC-SETS"). With Oregon's territorial seas and federal waters already facing threats from marine habitat degradation, ocean acidification, and increasing human activity, it is essential that Oregon State University ("OSU") consider the impact of the project on vulnerable marine species—including the endangered Southern Resident killer whales—and compile a data-rich baseline and cumulative impacts analysis before moving forward in the decision-making process.

The conservation groups strongly support the development of renewable energy as a critical component of efforts to reduce greenhouse gas emissions, avoid the worst consequences of global warming, and to assist Oregon and the nation in meeting emission reduction targets. The generation of electricity from renewable sources is critical to shifting our energy system away from fossil fuels. However, like any project, proposed power projects must be thoughtfully planned to minimize impacts to the environment. To that end, renewable energy projects should be sited to avoid impacts to sensitive species and habitats. Only by

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[1] NRDC is a national nonprofit environmental organization with more than 3 million members and online activists. NRDC uses law, science and the support of its members to ensure a safe and healthy environment for all living things. Fighting global warming pollution, protecting the marine environment and advancing a clean renewable energy future are all top priorities for NRDC.
[2] The Center is a non-profit public interest conservation organization with more than 1.1 million members and online activists dedicated to protecting imperiled species and their habitats, including efforts to protect the environment from the risks of offshore energy development.
[3] WDC is the leading global charity dedicated to the conservation and protection of whales, dolphins, and our shared oceans. Our vision is a world where every whale and dolphin is safe and free. We operate under the guiding principle that whales and dolphins play an integral role in the marine ecosystem and therefore the health of our planet.
[4] Defenders of Wildlife is a major national conservation organization focused solely on wildlife and habitat conservation and the safeguarding of biodiversity. Defenders of Wildlife's work is guided by and anchored in the inherent value of wildlife and the natural world.

maintaining the highest environmental standards with regard to local impacts and effects on species and habitat, can renewable energy production be truly sustainable. While the conservation groups support the development of new renewable energy sources, including offshore wave energy, the Federal Energy Regulatory Commission ("FERC") must adequately analyze the impacts of the proposed PMEC-SETS on the marine environment and the diverse assemblage of marine mammals, birds, and fish that depend on Oregon's marine environment.

We urge FERC to seize this opportunity to set a high precedential bar for the environmentally sustainable assessment of wave energy facilities. We also recognize that with the loss of its oldest matriarch and several other whales over recent years, the Southern Resident killer whale population is now at a 30-year low of only 75 whales. Accordingly, we have identified several research goals, environmental considerations, and data gaps that OSU and FERC should resolve before any further action on the PMEC-SETS license application.

We strongly recommend that OSU:

- Implement intensive pre-approval site assessments modeled on international standards with a special focus on marine mammals, salmon, forage fish, and birds.
- Conduct and analyze three years of monthly boat-based and aerial surveys of the Southern Resident killer whale and other imperiled marine species to establish a comprehensive data-rich baseline.
- Incorporate the proposed critical habitat expansion of the Southern Resident killer whale into site assessments and undertake thorough cumulative impacts analysis regarding ocean noise, entanglement, entrainment, and other disruptions to marine mammal foraging and migration patterns.
- Consult with marine scientists and experts to identify and integrate the most up-to-date survey data and modeling on predictive habitat and climate-induced shifts.
- Prioritize research programs based on the highest level precautionary protections for Southern Resident killer whales and other marine mammals in accordance with Oregon's state planning Goal 19.
- Fund research on conservation strategies for the Southern Resident killer whale and threatened marine mammals, comparable to those already established for birds and bats.
- Develop a research budget for quantifying impacts to ecosystem services and minimizing negative impacts to marine mammals, birds, and fish equal to or greater than the budget for technology testing.
- Conduct full tribal consultations to include traditional ecological knowledge in the pre-approval process.

As FERC and OSU are aware the PEMC-SETS facility must comply with the Endangered Species Act, the Coastal Zone Management Act, and the Marine Mammal Protection Act regarding any impacts to Southern Resident killer whales and other protected species. In addition, although this is a federal project, FERC and OSU are obligated to ensure that the proposed activities are in compliance with all relevant state[5] and local law.[6] Since the State of Oregon prioritizes conservation and a precautionary approach to protecting marine resources,[7] FERC and OSU should take steps to ensure that the proposed federal project does not harm the

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[5] Oregon Coastal Management Plan, ("In order to be consistent with the Oregon Coastal Management Program, the proposed project must be consistent with enforceable policies contained within three program components: the statewide planning goals, applicable acknowledged local comprehensive plans and land use regulations, and specific state agency authorities (e.g. those governing the Oregon Territorial Sea Plan and the Oregon Beach Bill."), https://www.oregon.gov/LCD/OCMP/Pages/FederalConsistency.aspx; *see also* 16 U.S.C. § 1451.
[6] *Id.*
[7] Or. Admin. R. 660-015-0010(4); *see also* Or. Dep't of Land Conservation & Dev., Oregon's Statewide Planning Goals & Guidelines, Goal 19: Ocean Resources (2010), https://www.oregon.gov/LCD/docs/goals/goal19.pdf [hereinafter "Statewide Planning Goal 19"].

Southern Resident killer whales, critical ecosystem services and marine resources that sustain the state's livelihoods and economy.[8] The Oregon Territorial Sea Plan requires all federal and state agencies to assess the reasonably foreseeable adverse effects of proposed actions that may affect the marine environment.[9]

Additionally, as the proposed project is intended to be an internationally recognized testing facility, the testing site should also be in compliance with EU environmental investigation standards.[10] To ensure that these standards are met, research programs and funding of the PMEC-SETS should prioritize the sustainability of healthy ecosystems as a part of its development and further testing of renewable energy generation technology; with the overriding objective to be projects that do not harm marine food webs and processes. Accordingly, the development of the site should not be rushed and based on a minimum of 3 years of pre-siting baseline assessment of key species in accordance with EU environmental investigation standards.

I. Background on the PMEC-SETS

The overall project, as drafted, proposes various test locations along the coastline that would be the 'hubs' for the national development of wave energy devices.[11] As a part of this enterprise, OSU submitted its Draft License Application along with its Preliminary Draft Environmental Assessment for the proposed PMEC-SETS. In accordance with FERC's regulations, the applicants must consult with appropriate resource agencies, tribes, and other entities before filing an application for a license. In submitting its application, OSU asserts that it has followed these procedural guidelines, and is now seeking authorization from FERC to engage in its proposed activities. We reviewed the materials and found the assessment to be based on significantly outdated scientific data and that it did not account for recent research by NOAA on marine mammals and climate impacts to marine systems.

Before FERC may authorize OSU's academic project, the agency must determine whether the project adversely affects endangered and protected species, including marine mammals.[12] Recent scientific research has shown that many marine mammal species forage within the region that the PMEC-SETS is proposed to be developed.[13] If the agency chooses to authorize the project, then it must be sure that the project does not harass or harm protected marine mammals like the Southern Resident killer whale, the gray whale, and the humpback whale populations known to migrate within Oregon coastal waters.

A. Background on the Endangered Southern Resident Killer Whale

The Southern Resident killer whale (*Orcinus orca*) population of the Pacific Northwest is one of the most critically imperiled populations of marine mammals on the planet. Historically, the Southern Resident killer whale population was at an estimated 200 individuals. In contrast, with the recent death of the population's oldest matriarch (J2) and several other individuals in the past two years, the population now stands at a 30-year low of only 75 individual animals.[14] Both the United States and Canada formally protect the whales because of their high risk of extinction. The United States listed the whales as endangered under the

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[8] *Id.*; *See also* 16 U.S.C. § 1451 *et seq.*
[9] Statewide Planning Goal 19 at 2 ("Prior to taking an action that is likely to affect ocean resources or uses of Oregon's territorial sea, state, and federal agencies shall assess the reasonably foreseeable adverse effects of the action as required in the Oregon Territorial Sea Plan."); *see also* 16 U.S.C. § 1451 *et seq.*
[10] Standard Investigation of the Impacts of Offshore Wind Turbines on the Marine Environment (StUK4) 2013. German Federal Maritime and Hydrographic Agency Bundesamt fur Seeschifffahrt und Hydrographie (BSH) Hamburg und Rostock 2013.
[11] Oregon State University, Pacific Marine Energy Center, Available at: http://nnmrec.oregonstate.edu/
[12] 16 U.S.C. § 1536; *see also Id.* § 1382.
[13] John Calambokidis et. al, Biologically Important Areas for Selected Cetaceans Within U.S. Waters – West Coast Region, 39-41, Aquatic Mammals (2015).
[14] Center for Whale Research, 2017 SRKW Census – July 1 (2017).

Endangered Species Act in 2005,[15] and Canada formally designated the whales as endangered under the Species At Risk Act in 2003.[16]

Researchers have attributed the most recent reductions and slow rate of recovery among Southern Resident killer whales to a variety of anthropogenic and ecological factors, including inadequate prey, exposure to persistent organic pollutants, and vessel disturbance.[17]

Southern Resident killer whales depend heavily on sufficient populations of salmon for their survival, social cohesion, and reproductive success.[18] During the past century and a half, human activities, including dam construction, artificial propagation and habitat degradation, have profoundly reduced the regional abundance of these prey species, thereby contributing to Southern Resident population declines.[19]

Global warming and increased ocean acidification pose additional threats to local salmon populations as well as the Southern Resident killer whales.[20] Given the correlation between declines in Chinook populations and mortality among Southern Residents,[21] any reduction in salmon abundance will likely have negative consequences for the whales.[22] For these reasons the project should demonstrate that there will be no adverse impact to the Southern Residents or their preferred prey, if permitted by FERC, and this finding should be made before any further action is taken on the project.

While monitoring is critically important, OSU's proposed methods are inadequate as a sole element of protecting the critically endangered Southern Residents.[23] OSU and FERC must study the impacts of sound, entanglement, entrainment, disruption to communication, foraging and migration before the project is

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[15] Endangered Status for Southern Resident Killer Whales, 70 Fed. Reg. 69903 (Nov. 18, 2005); *see also* Nat'l Marine Fisheries Serv., Recovering Threatened and Endangered Species Report to Congress (FY 2015-2016) (Nov. 30, 2017), https://www.fisheries.noaa.gov/resource/document/recovering-threatened-and-endangered-species-report-congress-fy-2015-2016.

[16] *See* Fisheries and Oceans Canada, Recovery Strategy for the Northern and Southern Resident Killer Whales (*Orcinus orca*) in Canada, Species at Risk Act Recovery Strategy Series (2011), http://www.sararegistry.gc.ca/virtual_sara/files/plans/rs_epaulard_killer_whale_v02_1011_eng.pdf.

[17] *See, e.g.,* Katherine L Ayres et al., Distinguishing the Impacts of Inadequate Prey and Vessel Traffic on an Endangered Killer Whale (Orcinus orca) Population, 7 PLoS ONCE e36842, at *8 – 9 (2012) (concluding that the Southern Resident population becomes "somewhat food limited during the course of the summer" and, therefore, that "the early spring period when the whales are typically in coastal waters might be a more important foraging time than was previously believed.").

[18] Shannon Marie McCluskey, *Space Use Patterns and Population Trends of Southern Resident Killer Whales (Orcinus orca) in Relation to Distribution and Abundance of Pacific Salmon (Oncorhynchus spp.) in the Inland Waters of Washington State and British Columbia 12 (2006)*; *See also* Nat'l Marine Fisheries Serv.*, Recovery Plan for Southern Resident Killer Whales* (Orcinus orca) 1-2 (2008).

[19] *Id.*; *See also* Nat'l Marine Fisheries Serv., *Endangered Species Act Section 7(a)(2) Biological Opinion and Magnuson-Stevens Fishery Conservation and Management Act Essential Fish Habitat Consultation: F/NWR/2010/06051* 143 (2011) (finding that decreased Chinook abundance resulting from proposed fishing operations would "reduce the whale population by -/05 to -1/3 whales").

[20] *Id.*; Center for Whale Research, *Southern Resident Killer Whales*, http://www.whaleresearch.com/#!orcas/cto2; See also Eric J. Ward et al., Quantifying the Effects of Prey Abundance on Killer Whale Reproduction, 46 J. OF APPLIED ECOLOGY 632, 636 (2009) ("Southern Resident Killer Whales are among the world's most chemically contaminated marine mammals.")

[21] John K. B. Ford et al., *Linking Killer Whale Survival and Prey Abundance: Food Limitation in the Ocean's Apex Predator?,* 6 BIOLOGY LETTERS 139, 141 (2010).

[22] Nat'l Marine Fisheries Serv., *Recovery Plan for Southern Resident Killer Whales (Orcinus orca)* 1-2 (2008).

[23] Oregon State University, Pacific Marine Energy Center South Energy Test Site Preliminary Draft Environmental Assessment FERC Project No. 14616, 3-148 (2018) ("OSU would conduct opportunistic surface observations at least quarterly to detect and remove marine debris from the Project (Appendix I), review results of Organism Interactions Monitoring Plan (Appendix H) for lost fishing gear, and remove detected lost fishing gear to minimize the risk of marine mammal entanglement.").

authorized. We recommend a minimum of three years of monthly boat based and aerial surveys be conducted and analyzed before authorizing the project.

B. Background on Gray Whale

Once found in both the Atlantic and Pacific Oceans, gray whales can only be found in the Northern Pacific Ocean. Categorized into two distinct populations, the Western Northern Pacific population and the Eastern Pacific population, scientific evidence has shown that both populations migrate along the United States West Coast.[24] The Western Northern Population is currently listed as "endangered," and its habitat should be considered in OSU's wave energy application decision.[25]

Gray whales are known for having one of the longest migrations of any marine mammal. During their journey, they can typically be found in shallow coastal waters in the North Pacific Ocean in the summer months.[26] While in the fall/winter months they travel as far as Mexico to forage and breed.[27] In both migration seasons, gray whales are known to pass through Oregon coastal waters, generally stopping in coastal lagoons, like Depoe Bay.[28] Additionally, a subset of the Eastern North Pacific gray whale population remains in foraging areas from Northern California through Southeast Alaska to feed during the summer and fall. These whales are known as the Pacific Coast Feeding Group, and currently consist of approximately 200 individuals.[29]

Since gray whales feed and migrate relatively close to shore, concern has grown about the impact of maritime traffic around the whales. Near shore industrialization and development further increase the likelihood of the population's exposure to pollutants as well as ship strikes, and gear entanglement. FERC should consider the possible impacts of OSU's wave energy project on the gray whale, and its migration patterns in deciding whether to authorize the project.

C. Background on Humpback Whale

Humpback whales can be found in oceans all over the world; feeding on shrimp-like krill and small fish, these large marine mammals strain huge volumes of ocean water through baleen plates.[30]

Scientific research has shown that throughout the Northern Pacific Ocean, humpback whales remain loyal to specific feeding and wintering areas.[31] With over seven biologically important areas identified by scientists

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[24] Calambokidis et. al, *supra* note 13 at 39-41, 43 ("Data suggests that [gray whales] from both eastern and western feeding areas migrate along the US West Coast.").
[25] Nat'l Marine Fisheries Serv., Gray Whales, Available at: https://www.fisheries.noaa.gov/species/gray-whale
[26] *Id.*
[27] Patrick Rogers, Saving the Breeding Grounds of the Pacific Gray Whale, Natural Resources Defense Council: Our Victories, (May 12, 2016).
[28] Calambokidis et. al, *Biologically Important Areas for Selected Cetaceans Within U.S. Waters – West Coast Region*, 39-41, 44 Aquatic Mammals (2015).
[29] A.R. Lang et al. 2014. Assessment of genetic structure among eastern North Pacific gray whales on their feeding grounds. Marine Mammal Science doi:10.1111/mms.12129; See: "What is the PCFG? A review of available information" from Northwest Fisheries Science Center, available at: http://www.westcoast.fisheries.noaa.gov/publications/protected_species/marine_mammals/cetaceans/gray_whales/studies_under_review/scordino_et_al._2011_sc-63-awmp1.pdf; and "Demographic distinctness of the Pacific Coast Feeding Group of gray whales (*Eschrictius robustus*)" available at: https://swfsc.noaa.gov/textblock.aspx?Division=PRD&ParentMenuId=229&id=16955
[30] Nat'l Marine Fisheries Serv., Humpback Whales ("Humpback whales filter feed on small crustaceans (mostly krill) and small fish, consuming up to 3,000 pounds of food per day."), https://www.fisheries.noaa.gov/species/humpback-whale.
[31] Calambokidis et. al, *supra* note 13 at 39-41, 46-47.

along the West coast, including one in Oregon, humpback whales can generally be found from spring until fall within US coastal waters.

On September 8, 2016, the Fisheries Service divided the globally listed endangered humpback whale species into 14 distinct population segments (DPS), two of which are present off Oregon: the Fisheries Service listed the Central America DPS as endangered, and the Mexico DPS as threatened.[32] Whales from the endangered Central America breeding ground, which number around 400 in total, feed almost exclusively offshore of California and Oregon. The Mexico DPS of humpback whales feeds all along the West Coast, including waters off of British Columbia and northern Washington. From fall through spring, the waters between British Columbia and California, are rich with nutrients essential to the survival of humpback whale species.[33]

Since humpback whales are known to forage within areas near to the proposed wave energy development, FERC must consider whether the authorization of such conduct would negatively affect this stock.

II. FERC/OSU Are Obligated to Meet Certain Legal Requirements Before Project Authorization

The Endangered Species Act was passed by the U.S. Congress, in 1973, "to halt and reverse the trend toward species extinction, whatever the cost."[34] The Act is designed to ensure the recovery of endangered and threatened species, not merely the survival of their existing numbers.[35] It achieves its goal by outlawing direct harm to listed species and by protecting "the ecosystems upon which endangered species and threatened species depend."[36] In particular, the act protects species and their critical habitat. Critical habitat is defined as "the specific areas within the geographical area occupied by the species…on which are found those physical or biological features (I) essential to the conservation of the species and (II) which may require special management considerations or protection," and the "specific areas outside the geographical area occupied by the species…[that] are essential for the conservation of the species."[37]

At the Act's core is a prohibition on the "take" of any endangered species. Section 9 prohibits the "take" of an endangered species "within the United States or the territorial sea of the United States."[38] It is well established that "take" includes acoustic harassment from underwater noise that disrupts of marine mammal behaviors, such as foraging, breeding, and resting.[39] The take prohibitions applies to federal agencies. FERC is prohibited from undertaking any discretionary action such as the approval of a license application that is "likely to jeopardize the continued existence" of any endangered or threatened species or to "destroy or adversely modify" any designated critical habitat.[40] To comply with its duty to avoid jeopardy or adverse modification of critical habitat, and to receive authorization for incidental take for marine species that might result from the PMEC-SETS facility, FERC must undertake section 7 consultation with the National Marine Fisheries Service (NMFS).

The Marine Mammal Protection Act (MMPA), enacted in 1972 with bipartisan support, is a landmark conservation law that prohibits activities that harass, hunt, capture, or kill marine mammals, including the iconic Southern Resident killer whale. Since it was enacted, not a single marine mammal species has gone extinct in U.S. waters. Today, however, NOAA Fisheries lists our region's Southern Resident killer whales as one of eight species most at risk of extinction in the near future.

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[32] 81 Fed. Reg. 62259 (September 8, 2016).
[33] Allen, Sarah g. et. al, Field Guide to Marine Mammals of the Pacific Coast: Baja California, Oregon, Washington, British Columbia 167-170 (Univ. of Calif. Press eds., 2011).
[34] *Tennessee Valley Auth. v. Hill*, 437 U.S. 153, 184 (1978).
[35] *See* 16 U.S.C. §§ 1531(b), 1532(3).
[36] *Id.* § 1531(b).
[37] *Id.* § 1532(5).
[38] *Id.* § 1538(a)(1)(b).
[39] *Native Vill. Of Chickaloon v. Nat'l Marine Fisheries Serv.*, 947 F. Supp. 2d 1031, 1057 (D. Alaska 2013).
[40] 16 U.S.C. § 1536(a)(2).

Under the MMPA, individuals and federal agencies must obtain authorization by permits from NMFS before engaging in activities that could take marine mammals by harming, harassing, injuring or killing them.[41] FERC must therefore ensure that the PMEC-SETS facility will not result in the unpermitted 'take' of a protected marine mammal species and must obtain, if necessary, an appropriate MMPA incidental harassment or incidental take authorization from NMFS prior to licensing this facility.[42]

Finally, under the Coastal Zone Management Act ("CZMA"), FERC must ensure that OSU's wave energy policy is consistent with Oregon's Coastal Zone Management Plan.[43] As a part of Oregon's Coastal Zone Management Plan, the State has drafted Statewide Planning Goals regarding its natural resources.[44] Statewide Planning Goal 19 declares that all actions must be developed in a way that conserves marine resources and essential ecosystems.[45]

III. OSU Must Demonstrate that the PMEC-SETS Project Is Not Likely to Jeopardize the Continued Existence of the Southern Resident Killer Whale and Will Not Adversely Modify the Critical Habitat of the Southern Resident Killer Whale Before FERC Approves the Application

A. OSU Must Collect More Robust Data on Marine Mammals to Make Accurate Impact Assessments and Close Research and Data Gaps

Despite over a decade of internationally coordinated research, many wave, tidal, and offshore wind projects have noted the lack of adequate data on marine mammals needed to make accurate impact assessments.[46] Indeed, Oregon's data is notably poor. The Oregon Department of Fish and Wildlife ("ODFW"),[47] the state

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[41] 16 U.S.C. §1362(18)(A) ("The term 'harassment' means any act of pursuit, torment, or annoyance which-(i) has the potential to injure a marine mammal or marine mammal stock on the wild; or (ii) has the potential to disturb a marine mammal or marine mammal stock in the wild by causing disruption of behavioral patterns, including, but not limited to, migration, breathing, nursing, breeding, feeding or sheltering.").
[42] 16 U.S.C. §1362(18)(A); see also 16 U.S.C. §1382(b).
[43] *Id.* § 1456(b)(3)(A) ("…[A]ny applicant for a required Federal license or permit to conduct an activity, in or outside of the coastal zone, affecting any land or water use or natural resource of the coastal zone of tat state shall provide in the application to the licensing or permitting agency a certification that the proposed activity complies with the enforceable policies of the state's approved program and that such activity will be conducted in a manner consistent with the program.").
[44] Oregon Coastal Zone Management Program, 1-2 (1978), https://www.oregon.gov/LCD/OCMP/docs/green_book.pdf.
[45] Statewide Planning Goal 19, OAR 660-015-0010(4) ("To carry out this goal, all actions by local, state, and federal agencies that are likely to affect the ocean resources and used of Oregon's territorial sea shall be developed and conducted to conserve marine resources and ecological functions for the purpose of providing long-term ecological, economic, and social values and benefits and to give higher priority to the protection of renewable marine resources – i.e., living marine organisms-than to the development of non-renewable ocean resources."); *see also* 16 U.S.C. § 1451 *et seq.*
[46] U.S. Dep't of the Interior, Bureau of Ocean Energy Mgmt., BOEM 2013-0113, Oregon Marine Renewable Energy Environmental Science Conference Proceedings (2013), https://www.boem.gov/ESPIS/5/5255.pdf; Pacific Northwest Nat'l Lab., Environmental Effects of Marine Energy Development around the World Annex IV Final Report (Jan. 2013), https://www1.eere.energy.gov/water/pdfs/annex_iv_report.pdf; Bundesamt für Seeschifffahrt und Hydrographie (BSH), Standard Investigation of the Impacts of Offshore Wind Turbines on the Marine Environment (StUK4) (Oct. 2013), http://www.oddzialywaniawiatrakow.pl/upload/File/7003eng.pdf.
[47] Or. Dep't of Land Conservation & Dev't, Final STAC Review of Oregon MarineMap Data and Information (June 2012), https://oregonocean.info/index.php/ocean-documents/ocean-energy/scientific-and-technical-advisory-committee-review/1164-final-stac-review-of-oregon-marinemap-data-and-information-june-20-2012.

of Oregon's Territorial Sea Plan,[48] and NOAA Fisheries[49] have all identified data gaps that pose critical threats to marine mammals, including the Southern Resident killer whale and other threatened and endangered species that migrate through Oregon's territorial seas. Thus, while OSU has a valid interest in quickly moving forward with the PMEC-SETS project, it is important that OSU identify and fill all data gaps by conducting intensive pre-approval site assessments modeled on international standards.[50] The pre-approval assessment process should have a special focus on marine mammals, salmon, forage fish, birds, and the processes upon which these species—and Oregonian livelihoods—depend.

Environmental groups have long sought critical habitat expansion of the Southern Resident killer whale, with NOAA Fisheries publicly stating that it would reconsider the whale's critical habitat to include coastal waters and the Center for Biological Diversity filing legal notice for unlawful delay of habitat designation just over one month ago.[51] Similarly, NOAA Fisheries' obligation to designate critical habitat for humpback whales on the West Coast is the subject of an environmental coalition lawsuit.[52] Despite these ongoing, contentious efforts to expand the Southern Resident killer whale's critical habitat and identify humpback whale critical habitat, the environmental assessment for PMEC-SETS does not discuss how potential habitat expansion factored into stakeholder meetings from 2013-2017. Likewise, while the environmental assessment mentions unavoidable adverse impacts to gray whales, it does not discuss the 18 other marine mammals known to live in or pass through Oregon's waters.[53] It is imperative that the environmental assessment incorporate marine mammal – and Southern Resident killer whale – conservation strategies, comparable to those already included for birds and bats.[54]

Moreover, these data gaps preclude any meaningful cumulative impacts analysis for the entire range of the Southern Resident killer whale and other marine species. Due to the sensitivity of the Southern Residents to marine noise, it is essential to calculate total noise to the whale along its entire range.

B. FERC's Pre-Approval Assessment Must Be Based on the Most Up-to-Date Research and Data

Accurate and up-to-date scientific data is indispensable for any environmental impact analysis. However, OSU's permitting application and site characterization frequently rely on outdated information that does not contemplate climate-related shifts, emerging data on fish stocks, and dynamic ocean management.[55] For instance, OSU relies on NEPA scoping data and initial agency consultations from 2014,[56] and its application cites documents from 2014 or earlier.[57] Similarly, the PMEC-SETS application does not cite research from

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[48] Or. Sci. & Tech. Advisory Comm., Preliminary Evaluation of Oregon Marine Map Data and Information (June 2012), https://www.oregon.gov/LCD/OPAC/docs/resources/STACEvalOMMDataInfoFinal.pdf.
[49] Nat'l Marine Fisheries Serv., NMFS-F/SPO-92, Ecological Effects of Wave Energy Development in the Pacific Northwest (Oct. 2007), https://spo.nmfs.noaa.gov/tm/Wave%20Energy%20NOAATM92%20for%20web.pdf.
[50] *See* Bundesamt für Seeschifffahrt und Hydrographie (BSH), *supra* note **Error! Bookmark not defined.**.
[51] Press Release, Center for Biological Diversity, Lawsuit Launched to Protect Endangered Orcas' West Coast Habitat (June 6, 2018), https://www.biologicaldiversity.org/news/press_releases/2018/southern-resident-killer-whale-06-06-2018.php.
[52] Press Release, Center for Biological Diversity, Turtle Island Restoration Network, and Wishtoyo Foundation, Lawsuit Challenges Trump Administration's Failure to Protect Pacific Humpback Whales Threatened by Fishing Gear, Ship Strikes, Oil Spills (March 15, 2018), https://www.biologicaldiversity.org/news/press_releases/2018/humpback-whale-03-15-2018.php.
[53] Oregon State University, Pacific Marine Energy Center South Energy Test Site Preliminary Draft Environmental Assessment FERC Project No. 14616, 5-8.
[54] *Id.* at Appendix B.
[55] *See* Elliott L. Hazen et al., WhaleWatch: A Dynamic Management Tool for Predicting Blue Whale Density in the California Current, 54 J. Applied Ecology 1415 (2017).
[56] Oregon State University, Pacific Marine Energy Center South Energy Test Site Preliminary Draft Environmental Assessment FERC Project No. 14616, 1-11.
[57] *Id.* at 7-1—7-35.

critical NOAA Fisheries models developed since 2010, even though survey data and modeling on predictive habitat and climate induced shifts have been produced since that time.[58] Thus, the pre-approval assessment process should include, at a minimum, consultative review with marine scientists to analyze project impacts to Southern Resident killer whales, Biologically Important Areas, and other important habitat for cetaceans based on the best available science.

C. OSU Should Prioritize Research Programs Based on the Highest Level of Precautionary Protections for Southern Resident Killer Whales and Other Marine Mammals

In order to meet statewide planning law and agency mandates, OSU and the State of Oregon must address the specific research priorities identified below before proceeding with any ocean energy development.

First, OSU has proposed to "conduct opportunistic surface observations at least quarterly to detect and remove marine debris from the project . . . [and] review results of Organism Interactions Monitoring Plan . . . to minimize risk of marine mammal entanglement."[59] OSU also plans to implement an "Acoustic Monitoring Plan" to address the "uncertainty associated with this new industry."[60] While monitoring is a critically important component of any research program, it is patently inadequate as the sole element of a research program. The likely impacts of sound, entanglement, entrainment, and other disruptions to the communication, foraging, and migration patterns of marine mammals must be verified before any marine energy devices hit the water. Many of these questions can be answered first utilizing baseline research carried out digitally or in labs prior to *in situ* testing to ensure there are no adverse impacts to marine mammals, birds, fish, larvae, and other biological processes.

If PMEC-SETS research activities are confirmed as having no adverse impact, then we recommend intensive, regular, and long-term monitoring aligned with EU standards be key aspects of the project going forward.[61] If approved, the PMEC-SETS research program should remain at the forefront of marine technology development, continually updating its precautionary protections for the Southern Resident killer whale, in close consultation with NOAA Fisheries, Canada's Department of Fisheries and Oceans, Cascadia Research, the Marine Mammal Institute, and other marine scientists.

Second, because PMEC-SETS aims to be an internationally recognized model facility, it should be required to follow a stringent environmental protocol, rather than the streamlined permitting standards of a pilot project. Prior to any FERC approval, OSU should conduct long-term surveys, such as a 3-year aerial and boat survey of key marine mammal species, including the Southern Resident killer whale, blue whale, humpback whale, gray whale, fin whale, and harbor porpoise.

Finally, it is imperative that OSU's environmental assessment address previous analyses and concerns regarding the Southern Resident killer whale and wave energy, specifically those raised in the Snohomish Public Utility District proposal,[62] the early proposal for the Makah Bay Offshore Wave Energy Pilot Project

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[58] *See* Hazen et al., *supra* note 55.
[59] Oregon State University, Pacific Marine Energy Center South Energy Test Site Preliminary Draft Environmental Assessment FERC Project No. 14616, 3-148.
[60] *Id.* at 3-147.
[61] *See* Bundesamt für Seeschifffahrt und Hydrographie (BSH), *supra* note **Error! Bookmark not defined.**.
[62] U.S. Fed. Energy Regulatory Comm., Final Environmental Assessment for Hydropower License, Admiralty Inlet Pilot Tidal Project—FERC Project No. 12690-005 (DOE/EA-1949) (Aug. 2013), https://www.snopud.com/Site/Content/Documents/tidal/FERC_finalEA080913.pdf; *see also* Press Release, Snohomish County Public Utility District, Snohomish PUD Tidal Power Project Not to Advance (Sept. 30, 2014), https://www.snopud.com/Site/Content/Documents/tidal/Sitedocs/TidalAnnounce914.pdf.

in the Olympic Coast National Marine Sanctuary,[63] and the 2008 Southern Resident Killer Whale Recovery Plan.[64]

IV. Conclusion

In sum, NRDC, CBD, WDC, and Defenders of Wildlife believe that if offshore wave energy is to be developed, it should be done in a science based, environmentally-sound manner that reflects the vital importance of Oregon's marine environment and does not harm the Southern Resident killer whales or any other threatened or endangered species. We appreciate the opportunity to provide comments, and we would be happy to discuss our comments further in person, telephonically (310-434-2300), or over email (ggoodstefani@nrdc.org).

Thank you,

Giulia Good Stefani
Staff Attorney, Marine Mammal Protection Project
Natural Resources Defense Council

Colleen Weiler
Jessica Rekos Fellow for Orca Conservation
Whale and Dolphin Conservation

Quinn Read
Northwest Director
Defenders of Wildlife

Catherine Kilduff
Senior Attorney
Center for Biological Diversity

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[63] U.S. Fed. Energy Regulatory Comm., Order Issuing Conditioned Original License Project No. 12751-000 (Dec. 21, 2017), https://www.ferc.gov/whats-new/comm-meet/2007/122007/H-1.pdf.
[64] Nat'l Marine Fisheries Service, Recovery Plan for Southern Resident Killer Whales (*Orcinus orca*) (Jan. 2008), http://www.nmfs.noaa.gov/pr/pdfs/recovery/whale_killer.pdf.

United States Department of the Interior

FISH AND WILDLIFE SERVICE
911 NE 11th Avenue
Portland, Oregon 97232-4181

In Reply Refer To:
FWS/R1/AES/FERC Project No. P-14616-000

Dr. Burke Hales
College of Earth, Ocean and Atmospheric Sciences
Oregon State University
104 CEOAS Administration Building
Corvallis, OR 97331-5503

JUL 24 2018

Dear Dr. Hales:

The U.S. Fish and Wildlife Service (Service) has reviewed the Draft License Application (DLA), the Draft Preliminary Draft Environmental Assessment, the Draft Biological Assessment, and the Draft Bird and Bat Conservation Strategy dated April 25, 2018 for the Pacific Marine Energy Center South Energy Test Site (Project), Federal Energy Regulatory Commission (FERC) No. 14616. The Project is located in the Pacific Ocean 6 nautical miles off the central Oregon coast near the city of Newport, and in Lincoln County, Oregon. Oregon State University (Applicant) would be the owner and operator of the Project. The following comments, recommendations, terms and conditions, and prescriptions are provided in accordance with the provisions of the Fish and Wildlife Coordination Act (16 U.S.C. 661 et seq.), the Federal Power Act (FPA), (16 U.S.C. 791 et seq.), the Endangered Species Act (ESA), 16 U.S.C. §1531 et seq., the Migratory Bird Treaty Act (16 U.S.C. 702-711), and the National Environmental Policy Act (42 U.S.C. 4321 et seq.). This letter includes a reservation of the Service's authority pursuant to Section 18 of the FPA.

BACKGROUND

The Applicant has proposed to test full-scale wave energy converters (WECs), with generation and transmittal of power to the grid. WECs are designed to generate electricity by capturing the kinetic energy of ocean waves. Three types of WECs would be tested at the proposed site: point absorbers, attenuators, and oscillating water column. The Project would be located in the Pacific Ocean, approximately six nautical miles off the coast of Newport, Oregon on the Outer Continental Shelf (OCS) and would occupy an area of approximately two square nautical miles (1,695 acres). The Project could support up to 20 commercial-scale WECs and transfer power to a grid connection point with the Central Lincoln People's Utility District (CLPUD) in Lincoln County, Oregon. The Applicant is seeking a 25-year FERC license with an installed capacity not to exceed 20 MW at any time under the FERC license term.

The Applicant is working with the U.S. Department of Energy's (DOE) and with the Bureau of Ocean Energy Management (BOEM). The Applicant will support DOE goals and objectives to improve performance of WECs, lowering energy costs, and accelerating deployment of innovative technologies for clean, domestic power generation. The Applicant has also submitted a research lease application to the BOEM. The FERC is the lead agency for the Preliminary

Draft Environmental Assessment (PDEA) in coordination and cooperation with BOEM, United States Army Corps of Engineers (USACE), and DOE.

FISH PASSAGE

Reservation of Authority

Because the Project is proposing to use new technology, there is limited information available on site-specific Project effects to fish and wildlife and their habitats. Therefore, the Service is unclear what measures may be necessary for the protection of fish and wildlife resources in the development of WECs. One of the important purposes of the Project is the collection of environmental information that may be used to inform future recommendations to support adaptive management. Also, because of the uncertainties regarding how marine hydrokinetic projects may or may not affect the movement of fish, the Service, on behalf of the Department, is reserving authority pursuant to Section 18 of the FPA, as amended, to prescribe the construction, operation, and maintenance of fishways in the future during the term of the Project license. Accordingly, any license issued by the Commission must contain the following reservation of authority: Authority is hereby reserved to the Commission to require such fishways as may be prescribed during the term of the license by the Secretary of the Interior pursuant to his authority under Section 18 of the FPA.

Terms and Conditions

Construction and proposed modifications to be made Driftwood Beach State Recreation Site (DBSRS) have the potential to impact Friday Creek, Buckley Creek, Twombly Creek, and two other unnamed streams. Activities and impacts to these waterways were not previously discussed and mitigation measures have not been vetted. These creeks support cutthroat trout (*Oncorhynchus clarkii*). Pursuant to section 10(j) of the FPA (16 U.S.C. 791 et seq.) and to carry out the purposes of the Fish and Wildlife Coordination Act (16 U.S.C. 661 et seq.), the Service recommends that any construction activities follow the east side of the Highway 101. We recommend any construction activities conducted use a horizontal directional drill under the streams.

The Service also recommends that stormwater drainage be managed in accordance with the USACE, the Environmental Protection Agency, and the State of Oregon Department of Environmental Quality.

WEC deployment and recovery as part of the Project may increase vessel traffic in Yaquina Bay. Increased vessel traffic has the potential to decrease water quality and promote invasive species. To protect sensitive areas in the estuary such as eel grass and fish nurseries the Service recommends restricting use in Yaquina Bay estuary to staying within navigation channels and specifically designated areas for vessel use such as existing permitted docks and dredged areas.

THREATENED AND ENDANGERED SPECIES CONSULTATION

Section 7 of the ESA and its implementing regulations (at 50 CFR Part 402) require Federal agencies to review their actions at the earliest possible time to determine whether any action may affect listed species or critical habitat. If the proposed action "may affect" federally listed species under the Service's jurisdiction, consultation with the Service will be required. Because listed species are likely to occur in the Project area, we recommend that the Commission enter into consultation with the Service associated with Project construction and operation.

In the draft biological assessment you determined that the proposed project, "may affect, is likely to adversely affect" the marbled murrelet and the short-tailed albatross. The information for these species appears to support a determination of "may affect, is not likely to adversely affect". Please review your rationale and ensure these determinations are correct.

As noted by the applicant in the draft BA western snowy plover nesting was observed in 2017 to the north and south of Driftwood Beach State Recreation Site. Nesting was also observed at two separate occasions in 2018 (May and July). The Service recommends the applicant consult with both the Service and the Oregon Department of Fish and Wildlife (ODFW) for the latest information regarding nesting western snowy plovers. Additionally, western snowy plover information and publications can be found at https://www.fws.gov/arcata/es/birds/wsp/plover.html.

BATS AND MIGRATORY BIRDS

The Bird and Bat Conservation Strategy (BBCS) contains additional mitigation measures such as noise buffers and shielding not previously discussed with the Service. To address these unvetted mitigation measures regarding bats, the Service recommends coordination with the Service and ODFW regarding the use of noise buffers and shielding as means to minimize effects on roosting bats. Additionally, some mitigation measures are subject to on-going coordination with specific resource agencies noted in each measure with some exceptions. Listed on page 24 of the BBCS mitigation measure beginning, "If construction work must occur within the noise buffer zones..." includes terms not previously discussed with the Service. The Service recommends this measure be modified to include coordination with the Service and ODFW.

GENERAL COMMENTS

Lighting

The Service encourages all pertinent items including WECs and onshore ancillary buildings and equipment install lighting that meets the minimum U.S. Coast Guard and National Oceanic and Atmospheric Administration (NOAA) requirements, are not white in color, and which flash or repeat at intervals (not constantly lit) to avoid and reduce seabirds and coastal migratory birds from being attracted to the site.

Regarding construction activities, the Service recommends, to the maximum extent practicable, limit construction activities to the time between dawn and dusk to avoid the illumination of adjacent habitat areas. If construction activity time restrictions are not possible, use down shielding or directional lighting to avoid light trespass into bird habitat (i.e., use a 'Cobra' style light rather than an omnidirectional light system to direct light down to the roadbed). To the maximum extent practicable, while allowing for the public safety, low intensity energy saving lighting (e.g. low pressure sodium lamps) will be used. Minimize illumination of lighting on associated construction or operation structures by using motion sensors or heat sensors. Bright white light such as metal halide, halogen, fluorescent, mercury vapor and incandescent lamps should not be used.

Additionally, we recommend that if lighting the Utility Connection and Monitoring Facility (UCMF) is required at night, it should be appropriately shielded and directed to minimize artificial light attraction and prevent potential injury or mortality to seabirds.

SUMMARY COMMENTS

The Service supports responsible development of renewable energy resources, and supports a balanced approach to testing and deployment of new technologies in conjunction with the conservation of species and their habitats. The Service does not object to the issuance of a new license for the Pacific Marine Energy Center South Energy Test Site provided our comments to minimize impacts to fish and wildlife resources are incorporated in the Final License Application. We request that these comments be included in the record as an official statement of the Service's position.

The Service appreciates the opportunity to review and comment on the subject Notice. If you have any questions regarding these comments, recommendations, and preliminary prescriptions, please contact Mrs. Stefanie Stavrakas, Alternative Energy Coordinator at 503-231-2262

Sincerely,

Regional Director

Acting

cc:
FERC File reference P-14616
FERC Jim Hastreiter
Oregon Fish and Wildlife Office

NMFS 9/10/18

PMEC-SETS Comments and Questions

1. What is the range in diameters for mooring lines?

2. Under Mitigation Measure #6 for DPV activity

- should be plural for thresholds and should include harassment level
- In NMFS preliminary 10(j)s, safety/exclusion zone has been changed to acoustic zone of influence.
- remove shut down procedures since they are not being proposed and would not be practicable.
- Start-up typically includes 30 minutes of pre-clearance of marine mammals not 15 minutes. This has been changed in NMFS preliminary 10(j)s based on headquarters comments.
- In the BA, there is no mention of ramping up procedures and sound thresholds during that period.
- In NMFS preliminary 10(j)s, under bullet #2, instead of "the licensee, <u>with consultation</u> with NMFS, will establish and carry out the following actions", this has been changed to "the licensee, <u>with technical assistance</u> from NMFS, will establish and carry out the following actions".

4. Trenching surface waters

- If trenching to install the terrestrial power cable near surface streams, how much vegetation is being cleared? Will the area be revegetated?

5. Suction Piles

- 2-27: the sound being generated from suction piles is not described even though it states it is described in Section 5.2.1.

6. Cable Route

- Does the 2 square nautical mile cable route include the cable corridor?

7. Suspended Sediment

- 5-6: "suspended sediment resulting from cable laying, subsea connector installation, and anchor installation/removal is expected to last for minutes or tens of minutes." Please clarify what tens of minutes means in this context.

8. Fish Salvage

- Where is fish salvage occurring and how large of an area is being isolated? What method is being used to isolate. How long will isolation occur? Will a bypass pipe be installed? When will isolation occur?

9. Stormwater

- Stormwater from increased impervious surface is not included or analyzed as an impact to fish in surface streams.

10. Acoustics

- 5-44: To model WEC sound using a conservative source term of 151dB re: 1 µPa at 1 m, assuming a radius of 125 m would represent approximately 12 acres surrounded each WEC, in which noise would exceed 120dB. In the PME's the radius is described as 100m. Please clarify this.
- It would be helpful if the project team included a Figure to visualize the size of WEC with the 12 acre acoustic zone of influence around each WEC, the project coordinates, and the biological important areas (BIAs) for Humpback and Gray whales. If the zone of influence is that large, I would like to see how close that acoustic signature is to BIAs.

11. Action Area

- How was it determined that 3 m around each subsea cable was the furthest distance that sediment and benthic changes from installation are expected to be measurable?

12. Auxiliary Cable

In the Navigational Safety Risk Assessment report (p. 516) and page 32 of the BA, the following statement is made "The auxiliary cable will increase the monitoring capabilities at PMEC-SETS. Such cable connections allow for extended deployments of instruments with high data bandwidths or power requirements."

In the past there have been conversations on the use of underwater video monitoring to detect species presence and detect if any derelict gear has accrued. The reason to not use underwater video monitoring was because of the amount of data that it collects and no way to store that amount of data. If the auxiliary cable increases monitoring capabilities in real-time and is connected to the on-shore UCMF, then please explain why underwater video monitoring is not feasible.

13. Under Mitigation Measure # 7: mitigation for impacts of sound from WECs and their mooring systems on marine resources.

Prior to deployment, can the test client submit a draft plan to be approved by NMFS on mitigation actions that will be carried out if persistent sound not associated with High Seas State has not been abated after 74 days (60 days of diagnose and repairs, 14 days of monitoring after repair)? This could cut down the time it takes to carry out a mitigation action on a WEC that is exceeding sound thresholds.

14. Anticipated scour depth disturbance from anchors

5-8 in BA: "As a representative calculation, for a 10 m diameter gravity base anchor at the PMEC-SETS, this would amount to 0.64 m equilibrium scour depth at the upstream side of the anchor and up to 0.28 m of accretion in lee of the structure. Field observations of scour in sandy sediment have been reported at 0.5 to 1.0 m for a 10.5 m diameter obstruction (Bishop 1980, from Whitehouse 1998). A second calculation was made using the methods of Sumer and Fredsoe (2002); assuming a water depth of 60 m, a wave height of 10 m, a wave period of 15 second and a 10 m diameter anchor, the maximum scour depth was estimated at 1 m." –How do you think there will only be anticipated scour depths up to 1m when Sumer and Fredsoe found a 10.5 m in diameter obstruction created a max scour depth of 1 m. PMEC SETS is proposing a maximum size of a 34 sf diameter anchor. Please explain rationale further on the anticipated maximum scour depth of 1m.

15. Ballast intake size

5-18 of BA: "One example is the Azura (formally WET-NZ) WEC that has deployed at PMEC-NETS and is currently deployed at the Navy Wave Energy Test Site (WETS) in Hawaii. Although not full scale, nor commercial in size, it can offer context for this issue." The BA goes into detail on how much water the ballast tank needs for Azura and the size of the ball valves. However, this is still not full scale. Is it possible to provide a ratio for Azura to extrapolate and determine a more accurate expected amount of water required and the size of the ballast tank opening for a full scale WEC?

16. Vegetation Removal for cable construction

5-40 of BA: riparian vegetation will be removed for the 20-foot construction right-of-way. How much, what type of vegetation? Any trees? A revegetation plan will include a comprehensive monitoring plan, I have asked for this in our 10(j)s.

16. Acoustic Monitoring Plan

Page 2 Section 1.2: "The sound pressure level (SPL) for Columbia Power Technologies' 1/7-scale WEC was **estimated at 151 dB re: 1 µPa** at 1 m and 126 dB re: 1 µPa at 10 m (Basset et al. 2011). In the EA prepared for the Hawaii Wave Energy Test Site, engineers conservatively assumed that a full-sized WEC would be **3–6 dB louder** than the 1/7 scale version, and estimated that the maximum SPL for a WEC would be **148–151 dB re: 1 µPa** at 1 m and 129–132 dB re: 1 µPa at 10 m (NAVFAC 2014).

If a full-size WEC is 3-6dB louder than the 1/7 scale WEC estimated at 151dB, then wouldn't the full scale WEC be 154-157 dB?

Page 3 Section 4.1: Will the recording equipment be calibrated? How sensitive are the hydrophones in dB re 1 V/microPa?

17. Eastern Pacific Right Whale- Endangered.

I have added this as a species that should be included as an affected marine resource. See NMFS preliminary 10(j)s for detailed information.

18. Mitigation Measure # 12 Water Resources

- The BA states that the test clients will use commercial dockage that has been designed, permitted, and used for dockage. In NMFS preliminary 10(j)s I have added a bullet that reflects what is stated in the BA "*The licensee should restrict in-water moorage to existing permitted facilities where increased suspended sediment or direct shading will not affect sensitive eelgrass habitat within or adjacent to the permitted facility."*

APPENDIX M

Geophysical and Geotechnical Survey Reports:

- Marine Geophysical and Geotechnical Surveys, Terrasond, 2019
- Marine Geophysical and Geotechnical Services, Siemens & Associates, 2018
- Terrestrial Seismic Survey and Evaluation, Siemens & Associates, 2019
- Results of Geophysical Exploration, Siemens & Associates, 2019

PMEC-SETS MARINE GEOPHYSICAL AND GEOTECHNICAL SURVEYS

Survey Dates:
August 1, 2018 – October 2, 2018

DETAILS OF SURVEY OPERATIONS

Submittal:

May 3, 2019

Submitted to:

Oregon State University

Submitted by:

TERRASOND
PRECISION GEOSPATIAL SOLUTIONS
801 NW 42nd Street, Suite 215
Seattle, WA 98107 USA
Phone: +1 (206) 420-8304

LOCATION MAP

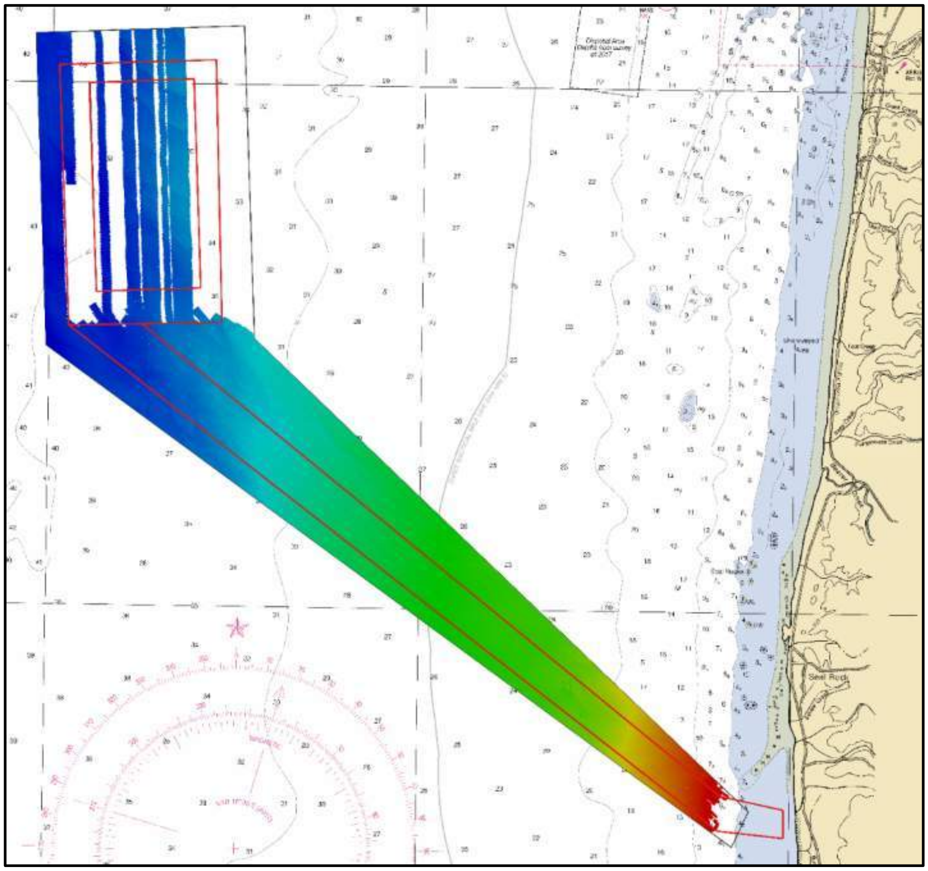

Figure 1.Survey area overview with cable corridor multibeam data coverage. The cable corridor, SETS area, and SETS buffer area indicated in red. (Background ENC: NOAA Chart 18561 "Approaches to Yaquina Bay;Depoe Bay")

SITE SUMMARY

PMEC-SETS SITE, OREGON (OFFSHORE)

The Pacific Marine Energy Center - South Energy Test Site (PMEC-SETS) is a research area with a long-term goal of determining the viability of wave energy off the U.S. by providing a grid-connected ocean test facility for wave energy conversion devices. The PMEC-SETS area is located between six and eight nautical miles offshore Newport, Oregon. The associated cable corridor area links the southern boundary of the SETS area to the Oregon coastline with the near-shore extent terminating approximately 9.5 NM south of Newport, Oregon. Water depths in the survey region range from approximately 10m to 100m. Generally, the seafloor gently slopes westward with contours roughly parallel to the adjacent Oregon coastline. A region of rocky outcrops is found near the shallow extent of the surveyed area. The long history of active crab and shrimp fisheries in the region was evidenced by numerous abandoned crab pots and relict fishing gear discovered during survey towing operations.

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1 SCOPE OF WORK

The Pacific Marine Energy Center South Energy Test Site (PMEC-SETS) Marine Geophysical and Geotechnical Surveys project consisted of two phases of data collection aimed to aid in identification of a viable subsea cable route for future grid integration of the PMEC-SETS. An area encompassing the proposed cable route, referred to as the cable corridor, was prioritized for data collection followed by the wave energy test site and test site boundary areas (referred to collectively as the SETS area). The cable corridor extended from the 10m contour to the SETS area increasing in corridor width from 200m to 800m with increased water depth.

The geophysical phase of data collection required the acquisition of side scan sonar (SSS), sub-bottom profiler (SBP), Multibeam echo sounder (MBES), and magnetometer (MAG) data. Towed systems were tracked using and ultra-short baseline (USBL) beacon and transponder system.

The geotechnical phase of data collection required the acquisition of seafloor sediment and shallow subsurface geological samples via a percussive vibrocore.

The general scope of work accomplished under this contract for both phases is as follows:

1. Mobilization of TerraSond personnel and geophysical survey equipment from Seattle, WA to Newport, OR, and retrofitting the OSU R/V Pacific Storm for survey.
2. Geophysical data acquisition, recording and processing over the anchoring sites, consisting of SSS, SBP, MBES, MAG, and Geotechnical data acquisition consisting of vibrocore sampling.
3. Preparation of this survey report.
4. Preparation of charting and data deliverables.

2 OPERATIONS OVERVIEW

2.1 PROJECT TIMELINE

TerraSond's Seattle based field crew mobilized to Newport, Oregon on July 31st, 2018 to install all necessary survey equipment onboard the OSU Research Vessel Pacific Storm. The installation of geophysical survey equipment was delayed until August 4th due to ongoing OSU vessel maintenance. During August 4th-5th mobilization activities were completed.

On August 6th all survey operations were suspended due to an OSU vessel mechanical issue. Following vessel repairs, survey activities re-commenced August 12th and equipment calibrations were completed. Vessel mechanical failure on August 14th prevented further survey operations until August 27th.

Geophysical survey operations were conducted from August 27th to September 9th (excluding a three-day period of adverse weather conditions from September 2nd-4th). Due to a scheduling conflict, TerraSond was required to de-mobilize towed sensors and deck equipment from the vessel on September 10th for the OSU vessel to complete a prior OSU commitment.

On September 17th, following the OSU vessels return, TerraSond remobilized survey equipment and re-commenced survey operations. On September 21st the geophysical survey phase was completed, and equipment de-mobilization was conducted on September 22nd. On September 23rd mobilization of geotechnical equipment was completed. Adverse weather conditions prevented coring operations from September 24th to September 27th. On September 28th vibrocore acquisition was conducted prior to adverse weather conditions developing.

Poor weather and resulting heightened sea-state continued until September 30th. On October 1st following discussion with OSU vessel Captain, 3U project representative and TerraSond management, project demobilization was initiated. On October 2nd TerraSond crew returned to Seattle with all survey gear and equipment.

2.2 MARINE MAMMAL OBSERVERS

Over the duration of the project a pair of Marine Mammal Observers (MMOs) were onboard during all geophysical and geotechnical work. A copy of the daily MMO Reports can be found in APPENDIX G . The predominant marine mammal sightings were of porpoises, sea lions and whales. The cumulative reported Marine Mammal species sightings during the project duration are summarized in Table 1. It is important to note that the reported number of sightings for a given species do not reflect the actual number of animals in the area, as sightings may be repeat observations of individuals at interval over the course of work. The numbers tabulated merely reflect a simple summation of sightings over the project duration.

Table 1. Marine observations.

Species	Number of Sightings
Harbor Porpoise	20-35
CA Sea Lion	8
Humpback Whale	1
Grey Whale	11

The survey crew worked in conjunction with the OSU vessel operators and the MMOs to ensure every effort was made to mitigate the effect of data acquisition on marine life during survey operations. On several occasions geophysical survey operations were halted temporarily due to limited visibility (eg. Fog) for Marine Mammal observation to proceed as permitted. On other occasions survey work was ceased at the request of the MMO due to a marine mammal within the exclusion zone. The effects of geophysical or geotechnical equipment operation were not observed to impact marine mammals at any time during this project.

3 PROJECT SAFETY

A project safety meeting was held at the beginning of each project phase to review the Work Package Plan (WPP). Job Safety Analysis (JSA) worksheets were completed by the crew in the field. Behavior Based Safety (BBS) cards were utilized to ensure safe behavior and work environment throughout the project. No safety incidents occurred during the duration of the project.

A copy of the BBS cards, HASP, and completed JSAs are provided in

4 PROJECT GEODETICS

The survey was conducted in the following geodetics:

- Horizontal Datum: World Geodetic System 1984 (WGS84)
- Horizontal Projection: Universal Transverse Mercator (UTM) Zone 10 North
- Vertical Datum: Mean Lower Low Water (MLLW) *TIDE Station ID:9435380* (Epoch 1983-2001)
- Units: Metric

All data acquisition, processing, and GIS preparation were done with specified geodetics. All times for data were recorded in UTC.

5 SURVEY VESSEL AND EQUIPMENT

5.1 SURVEY VESSEL

The vessel used in the survey was the R/V *Pacific Storm*, an 84' OA steel-hulled vessel with a 24' beam. The converted trawler is owned and operated by Oregon State University (OSU) Ship Operations for marine research. The survey vessel is shown in Figure 2.

Figure 2. R/V PACIFIC STORM (source: http://ceoas.oregonstate.edu/pacificstorm/)

The vessel was equipped with an over-the-side pole mount. The mount had a rotary actuator that swung the pole outboard to deploy the sonar. The pole was clamped into place during the survey. The pole mount was used to mount the MBES and the USBL transducer. The Pacific Storm also featured a 5-ton stern hydraulic A-frame which was used in conjunction with an electric winch to deploy and tow the towed sensors (side scan, SBP, and magnetometer). The a-frame can be seen in Figure 3.

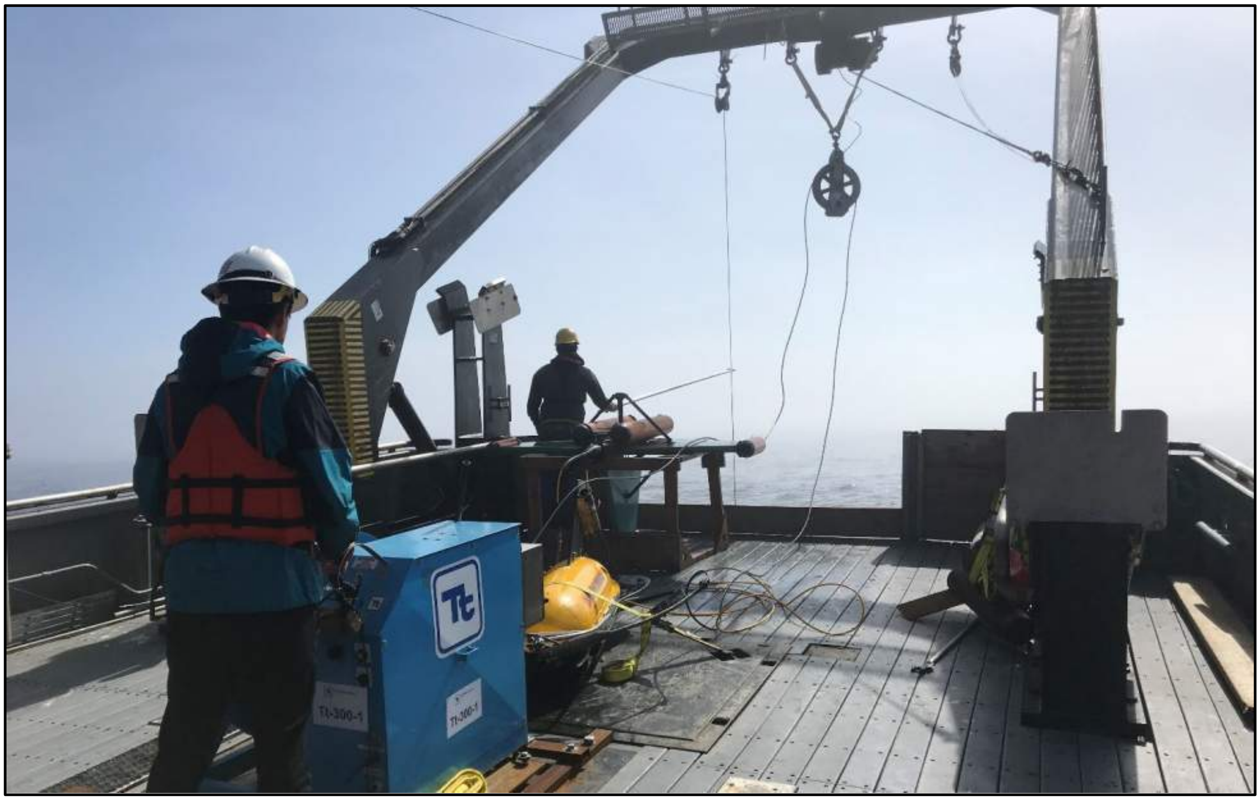

Figure 3. Work deck of R/V Pacific Storm during equipment retrieval procedure following equipment calibration. EdgeTech 2000 DSS, Marine Magnetics SeaQuest, winch and a-frame.

The inertial navigation system used for the survey was Applanix POS MV. The POS MV consists of a motion reference unit (MRU) coupled with two GPS receivers. The MRU was rigidly mounted on the working deck near the vessel center of gravity and the antennas were mounted port and starboard on the Vessel tower. The POS MV output RTK position, heave, pitch, and roll to the other sensors. Vessel offsets for the sensors were surveyed by TerraSond and are summarized in Table 2. The offsets for the equipment were measured using a Trimble s7 total station and RTK GPS Trimble R10s on August 12th, 2018. Quality assurance checks were done to verify the sensor locations and draft measurements. The equipment used in this project is summarized in Section 5.2 and detailed further in Section 5.3.

Table 2. Vessel offset measurement values.

Point	FWD+ (m)	STBD+ (m)	UP+ (m)
Port-antenna	5.030	-1.106	9.305
Starboard-antenna	4.957	1.385	9.281
C-NAV	4.760	0.170	9.307
MD-port	0.113	-3.546	0.712
MD-starboard	0.113	3.516	0.712
IMU	0.634	0.995	0.830
CRP	0.000	0.000	0.000
MBES	0.609	3.940	-4.495
USBL	-0.610	3.940	-4.295

5.2 SURVEY EQUIPMENT SUMMARY

TerraSond selected a suite of equipment that would meet or exceed the requirements for the geophysical survey operations. Table 3 summarizes the selected equipment, and an illustration of the sensor installation locations is provided in Figure 4.

Table 3. Survey Equipment Summary

System	Manufacturer	Model
Multibeam Sonar	Reson	7125 (400 kHz)
Side Scan Sonar	EdgeTech	2000 DSS (300/600 kHz)
Sub-Bottom Profiler	EdgeTech	2000 DSS (2-16 kHz)
Magnetometer	Marine Magnetics	SeaQuest
USBL Positioning System	Sonardyne	Ranger GDT
Inertial Navigation System	Applanix	POS MV v5
Surface Sound Speed Probe	AML Oceanographics	Micro-X
Sound Velocimeter	AML Oceanographics	Minos-X
CTD	Lockheed Martin Sippican	XBT T-10
Vibrocore	Rossfelder	P-3 Percussive vibrocorer
Winch	DT Marine	7.5 HP 350m 0.45” double-armored coax cable

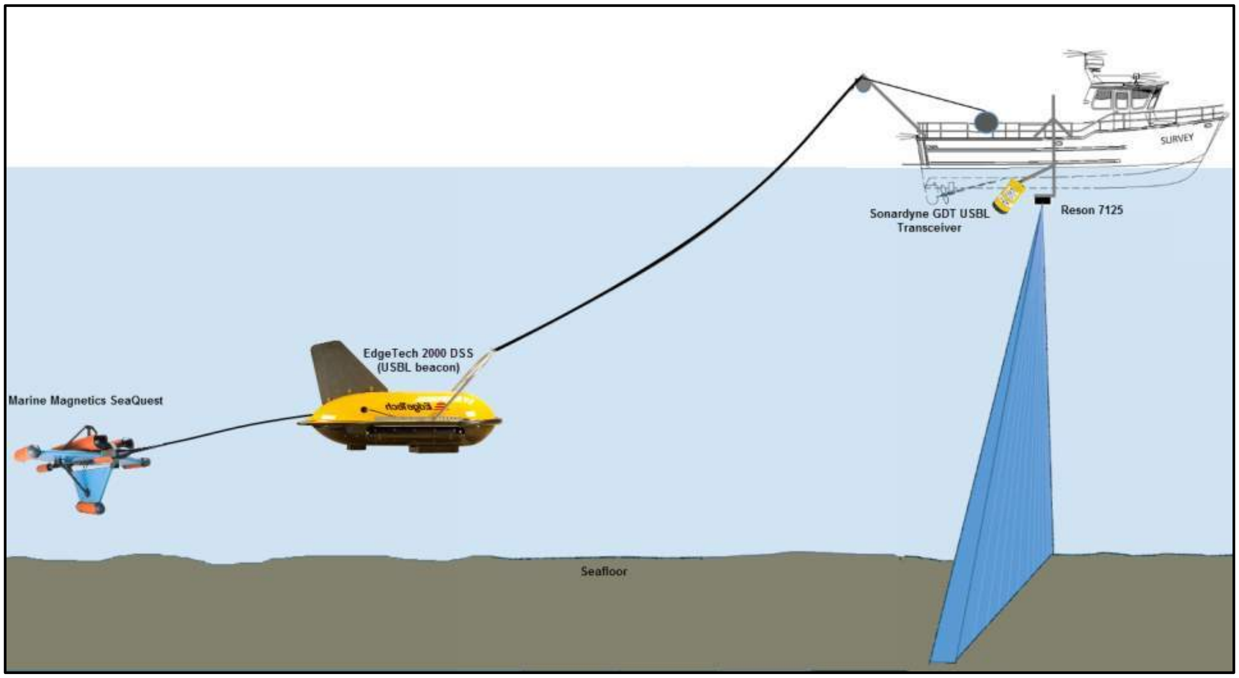

Figure 4.Simplistic diagram of geophysical survey equipment configuration including EdgeTech 2000 DSS combined side scan/SBP towfish, the Marine Magnetics SeaQuest, Reson 7125 multibeam echosounder, and Sonardyne GDT USBL tranciever (not explicitly shown: USBL beacon on Edgetech towfish).

5.3 SURVEY EQUIPMENT

5.3.1 Inertial Navigation System and DGPS

Positioning and navigation was provided by an Applanix POS MV IMU45 Inertial Navigation System (INS) receiving corrections from a local Real Time Kinematic (RTK) base station for multibeam and USBL beacon correction for the towed arrays. The POS MV provided precise heading and attitude measurements. The POS MV utilizes a high-quality Inertial Motion Unit (IMU) coupled with dual GNNS receivers to provide accurate attitude corrections. Specifications for the INS are provided in Table 4.

Table 4. Inertial Navigation System and RTK Positioning system Parameters

Applanix POS MV IMU45	
RTK Positioning	.0.02-0.10cm accuracy
Roll & Pitch	0.02°
Heading	0.02° (2m baseline)
Heave (True Heave)	5cm or 5% (2cm or 2%)

The project was not collected using DGPS, being close enough to shore TerraSond utilized local control to provide Real Time Kinematic (RTK) data out to the ship. RTK data is more accurate and the survey can be positioned horizontally and vertical correct in real time during acquisition. RTK corrections were received from a base station GPS positioned at the OSU ship operations dock. The base station was set using NOAA tidal bench mark C-590 (Table 5.) as a reference. C-590 is a primary bench mark from the nearest tide gauge (NOAA ID: 9435380, South Beach OR). The quality assurance procedure for the creation of the

TerraSond base station is described in Section 6.1. This provides the specifications for the RTK GPS base station control point.

Table 5. RTK GPS Base Station Parameters and Reference Monument.

RTK GPS Base Station Control Point		
Reference Benchmark	C 590 TIDAL	
PID	QE1114	
UTM Zone 10 Position	4941855.075N 417084.332E	
NAVD88 (MLLW)	4.52m (4.75m)	
GPS	Trimble R10	
Broadcast Message Types	CMR+	

5.3.2 Multibeam Echosounder

Multibeam echosounder bathymetry was collected with a Reson 7125 SV at 400 kHz. The Reson 7125 SV Multibeam sonar equipment specifications are provided in Table 6.

Table 6. Multibeam Echosounder Parameters.

Multibeam Echosounder Parameters (Reson 7125 SV)	
Max Swath Angle	165°
Frequency	400 kHz
Along-track Transmit Beam Width	1°
Across-track Receive Beam Width	0.5°

5.3.3 Side Scan Sonar

TerraSond selected the EdgeTech 2000 DSS (combined side scan and SBP profiling system) for side scan survey operations. The EdgeTech 2000 DSS operates with simultaneous dual frequencies of 300 and 600 kHz. The EdgeTech 2000 DSS is also equipped with pitch, role, heading and depth sensors that can be used to monitor flight stability in real-time. The side scan sonar equipment specifications and operational parameters are provided in Table 7.

Table 7. Side Scan Sonar Parameters.

Side Scan Sonar Parameters (2000 DSS)	
Frequency	Simultaneous Dual 300/600kHz
Range Setting	75m
Beam-width & Along Track Resolution	300kHz (0.6 deg or 1.0m @ 100m)
Beam-width & Along Track Resolution	600kHz (0.26 deg or 0.45m @ 100m)

5.3.4 Sub-Bottom Profiler

TerraSond selected the EdgeTech 2000 DSS (combined side scan and sub-bottom profiling system) for sub-bottom profiling operations. The towfish was towed at altitudes not exceeding 6m above the seafloor. Full resolution imagery was displayed in EdgeTech Discover SB in real-time for monitoring by the TerraSond technician. The sub-bottom profiler equipment specifications and operational parameters are provided in Table 8.

Table 8. Sub-Bottom Profiler Parameters.

Sub-Bottom Profiler Parameters (EdgeTech 2000 DSS)	
Pulse	2-16 kHz (20ms)
Vertical Resolution	6-10cm
Typical Penetration	6-80m (sediment type dependent)

5.3.5 Magnetometer

TerraSond selected the Marine Magnetics SeaQuest for magnetometer survey operations. The SeaQuest utilizes an Overhauser sensor for unmatched accuracy. The SeaQuest also features no dead zone, no heading error and no temperature drift, and is equipped with a pressure sensor for depth recordings. The SeaQuest was tethered behind the EdgeTech 2000 DSS, receiving power and transmitting in real-time data through the side scan/sub-bottom towfish. The magnetometer specifications and operational parameters are provided in Table 9.

Table 9. Magnetometer Parameters.

Magnetometer Towfish Parameters (Marine Magnetics SeaQuest)	
Absolute Accuracy	0.1nT
Resolution	0.001nT
Magnetic Sensor	Overhauser
Sampling Rate Range	0.2Hz-4Hz
Range	18,000nT-120,000nT
Recording Software	BOB (Marine Magnetics)

5.3.6 USBL

TerraSond selected the Sonardyne LUSBL GDT USBL Transceiver for positioning of the towfish. This transceiver offers a hemispherical pattern of acoustic coverage enabling tracking of targets from below and to the side of the vessel. For this reason, it is suitable for both towfish tracking and vibrocoring operations. The technical specifications can be found in Table 10.

Table 10. USBL Positioning system technical specifications.

Sonardyne GDT USBL Transceiver	
Frequency	Frequency MF (18-36 kHz)
Maximum Power	Maximum Power 36-72 V DC 25W continuous
Communication	Communication RS 485 baud rate switchable
Transceiver Operating Range	Transceiver Operating Range up to 7000 m
Acoustic Coverage	Acoustic Coverage +/- 90 degrees

The Transceiver was collocated with the pole-mounted multibeam echo sounder and used in conjunction with Applied Acoustic Engineering beacons (referred to herein as USBL beacons).

5.3.7 Vibrocore

TerraSond selected the Rossfelder P-3 Modular Percussive Vibrocorer to acquire the geotechnical cores. The specifications for the vibrocorer are summarized in Table 11. The unit can utilize drive tubes ranging from 3-10" with clamp adaptors; however, it is designed for ideal use with 4" diameter drive tubes. TerraSond selected 4" stainless steel drive tubes to be used in conjunction with Busada 200 thermoplastic core liners. The float package version of the P-3 was utilized. A diagram of the Vibrocore operations can be found in Section 6.12.

Table 11. Vibrocore specifications and utilization parameters.

Rossfelder P-3 Percussive Vibrocorer	
Working Depth	600m
Force	16.0-24.0 KN (60 Hz) 10.9-16.4 KN (50 Hz) (1 KN = 225 lbs)
Vibration Frequency	3,450 vpm (60 Hz), 2,850 vpm (50 Hz)
Drive Tube	4.0" OD Stainless Steel
Core liner	3.75" OD

6 CALIBRATIONS AND CHECKS

6.1 RTK GPS POSITION

The base station was set using NOAA tidal bench mark C-590 as a reference (NOAA ID: 9435380, South Beach OR). Five minutes of RTK GNSS observation was used to create TerraSond-1 control point. The base station was set and 3-minute RTK observation were again made at C-590. To ensure the integrity of the RTK GPS position, check shots were recorded at established bench marks before survey operations. Results from the base station checks are tabulated in Table 12.

Table 12. RTK Base station check shot results.

Description	Northing (m)	Easting (m)	Elevation (MLLW) (m)
TerraSond-1	4,941,907.99	417,047.74	6.16
C-590	4,941855.08	417,084.33	4.75
Check – C-590	4,941855.08	417,084.33	4.756
Delta	0.00	0.00	-0.006

A GPS RTK check shot was also taken on a reference location on the vessel while simultaneously recording the position of the vessel reference point in the acquisition software. The points were compared for horizontal and vertical vessel positioning. Results shown in Table 13.

Table 13. Vessel position check shot results.

Point	Northing (m)	Easting (m)	Elevation (m)
QPS QINSy	4,942470.75	416,896.46	2.57
GPS Topo	4,942470.71	416,896.52	2.53
Delta	0.04	-0.06	+0.04

6.2 WATER LEVEL CHECK

A water surface elevation check was performed prior to survey operations to verify the acquisition software was providing correct vertical coordinates in the project specified datum. A separate RTK GPS receiving corrections from the GPS base station was used to measure the water surface elevation. The value was compared to the water surface elevation recorded by the vessels GPS and acquisition software.

6.3 CABLE COUNTER

A cable counter calibration was performed prior to the start of survey operations. A “zeroing” point with a measured offset to the towfish center was marked on the tow cable. As all position data for the Edgetech DSS 2000 towed sensor was provided by USBL beacon and the altimeters for each towed sensor, the cable counter was not relied on as a primary source of positioning but was maintained for redundancy.

6.4 BAR CHECK

A bar check was performed at the beginning of the project to verify that proper offsets were entered in the acquisition and processing software. Static draft of the multibeam was first calculated by measuring offsets with respect to CRP and waterline. A metal grate was then lowered to 5m and 6m below the waterline, under the multibeam transducer. The raw multibeam readings on the bar were recorded. The multibeam draft, as a result of the bar check, was determined and compared to the calculated draft yielding an average 0.01m difference at both depths.

6.5 GAMS CALIBRATION

The Applanix POS M/V was calibrated onsite after physical installation. The offsets for the equipment was entered in the Applanix software, POSview and a GAMS calibration was started. Once started the vessel completed multiple circular and "figure-eight" maneuvers until the software completed its calibration. The results are shown in Figure 5 below.

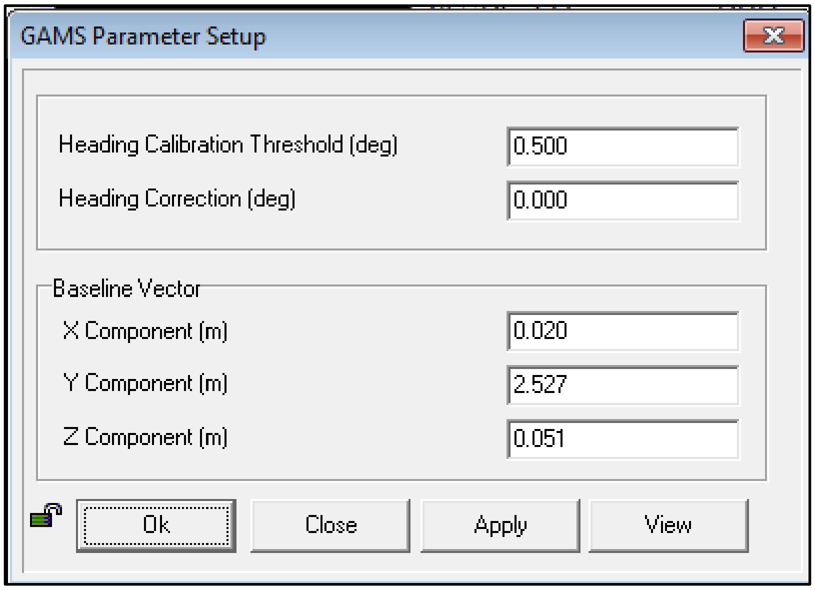

Figure 5.GAMS calibration results from Applanix POSview software.

6.6 MULTIBEAM CALIBRATION VALUES

An MBES calibration (Patch test) was conducted to the north east of the project area over an identified region of sand waves to determine multibeam sensor mounting offsets (pitch, roll, and yaw) and navigation latency as well as the corresponding alignment errors between the motion reference unit and the multibeam. To complete the calibration the acquired lines were examined using the CARIS HIPS and SIPS software calibration tool. The resulting sensor mounting offsets were entered into the vessel configuration file in CARIS and applied to all subsequently collected multibeam data. The patch test results as well as the CARIS HIPS vessel offsets are shown in Table 14. The lines used during the MBES patch test are shown in Table 15. Sound velocity cast were taken during the calibration procedure.

Table 14. Multibeam Patchtest Results (CARIS reference convention).

Parameter	Values
Latency	0.0
Pitch	0.2^{o}
Roll	0.82^{o}
Yaw	-0.46^{o}

Table 15. Lines used in MBES Patch Test Calibration

Line Name
0008 - Patch_2018_08_12_Patch-test – 0001.xtf
0009 - Patch_2018_08_12_Patch-test – 0001.xtf
0010 - Patch_2018_08_12_Patch-test – 0001.xtf
0011 - Patch_2018_08_12_Patch-test – 0001.xtf
0012 - Patch_2018_08_12_Patch-test – 0001.xtf
0013 - Patch_2018_08_12_Patch-test – 0001.xtf
0014 - Patch_2018_08_12_Patch-test – 0001.xtf
0015 - Patch_2018_08_12_Patch-test – 0001.xtf
0016 - Patch_2018_08_12_Patch-test – 0001.xtf
0017 - Patch_2018_08_12_Patch-test – 0001.xtf
0018 - Patch_2018_08_12_Patch-test – 0001.xtf
0019 - Patch_2018_08_12_Patch-test – 0001.xtf
0020 - Patch_2018_08_12_Patch-test – 0001.xtf
0021 - Patch_2018_08_12_Patch-test – 0001.xtf

6.7 MULTIBEAM CROSS LINE CHECKS

Throughout the cable corridor, several lines were run perpendicular (cross lines) to the main scheme lines. This allows for blunders or systematic errors to be detected. When using beam to beam comparison, each cross line is compared to a gridded surface which only contains main scheme lines. All cross lines met the minimum error specification. The crossline analysis is described in detail in Section 8.1

6.8 USBL TRACKING SYSTEM

The USBL tracking system for the towed sensors (side scan, sub-bottom profiler, and magnetometer) was calibrated with the vessel following a designed box-line scheme (shown in Figure 6) to "Box-in" a transponder/beacon deployed onto the seabed as a target node. The filenames of lines used to calibrate the USBL are shown in Table 16. Sound velocity cast were taken during the calibration procedure.

Table 16. Lines used to calibrate USBL system.

Line Name
0024 - USBL_2018-08-12_usbl_Cal - 0001
0025 - New_2018-08-12_usbl_Cal - 0001
0026 - New_2018-08-12_usbl_Cal - 0001
0027 - USBL_2018-08-12_usbl_Cal - 0001
0028 - USBL_2018-08-12_usbl_Cal - 0001
0029 - USBL_2018-08-12_usbl_Cal - 0001
0030 - USBL_2018-08-12_usbl_Cal - 0001
0031 - USBL_2018-08-12_usbl_Cal - 0001

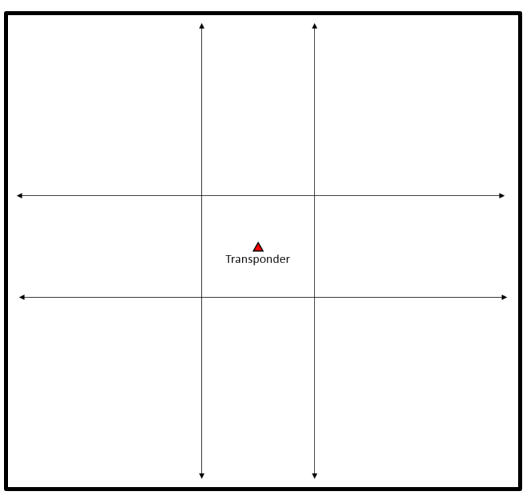

Figure 6.Box-line scheme around target transponder (Target Node) depicted in diagram form.

Position data were acquired and processed using QINSy software. QINSy software uses least-squares adjustment to compute for the angle offset of the transducer. Eight lines were acquired to box in the transponder. Data from these 8 lines were utilized to compute for the angle offsets. The results of the least-squares adjustment and corresponding offset angles are shown in Table 17, and the target node position is shown in Table 18. The uncorrected and corrected target node positions are shown in Figure 7. The final calibration results were applied in the acquisition software and used throughout all subsequent survey activities.

Table 17. Least Squares Computation Results and Calibration Values.

Parameter	Computed Value	SD	Calibration Value
Scale Factor	1.00000	N/A	N/A
Roll Angle	-4.387°	1.674°	**-4.38°**
Pitch Angle	-43.850°	0.775°	**-43.85°**
Heading Angle	8.148°	1.775°	**-8.15°**

Table 18. Target Node position.

Coordinate	Value (m)	SD (m)
Easting TP	403528.68	1.04
Northing TP	4935662.28	1.10
Height TP	-66.58	1.56

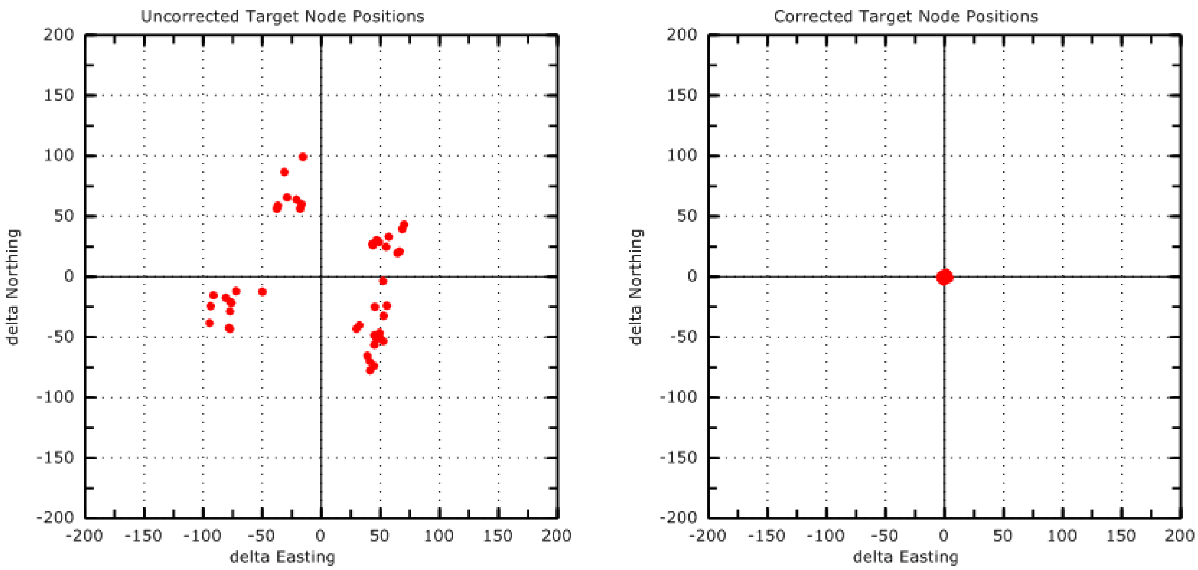

Figure 7.Uncorrected and corrected target node positions.

6.9 SIDE SCAN SONAR

Prior to survey, the survey technician verified communications had been established with the sonar and performed a rub test on both port and starboard sonar transducers. Prior to deploying the towfish, TerraSond survey technicians zeroed the pressure sensor and confirmed that position data were being supplied by the USBL beacon and recorded within the side scan files. During survey, the towfish was towed at altitudes not exceeding 6m. Flight characteristics were continuously monitored including heading, pitch, and roll. The acoustic data were also examined for excessive noise. Data quality and resolutions was examined at the range of 75m. As a daily quality control measure, side scan mosaics were compared against the multibeam data and adjacent sonar files to confirm positional agreement with prior data and the proper operation of the USBL beacon. An example of this daily QC check is shown in Figure 8.

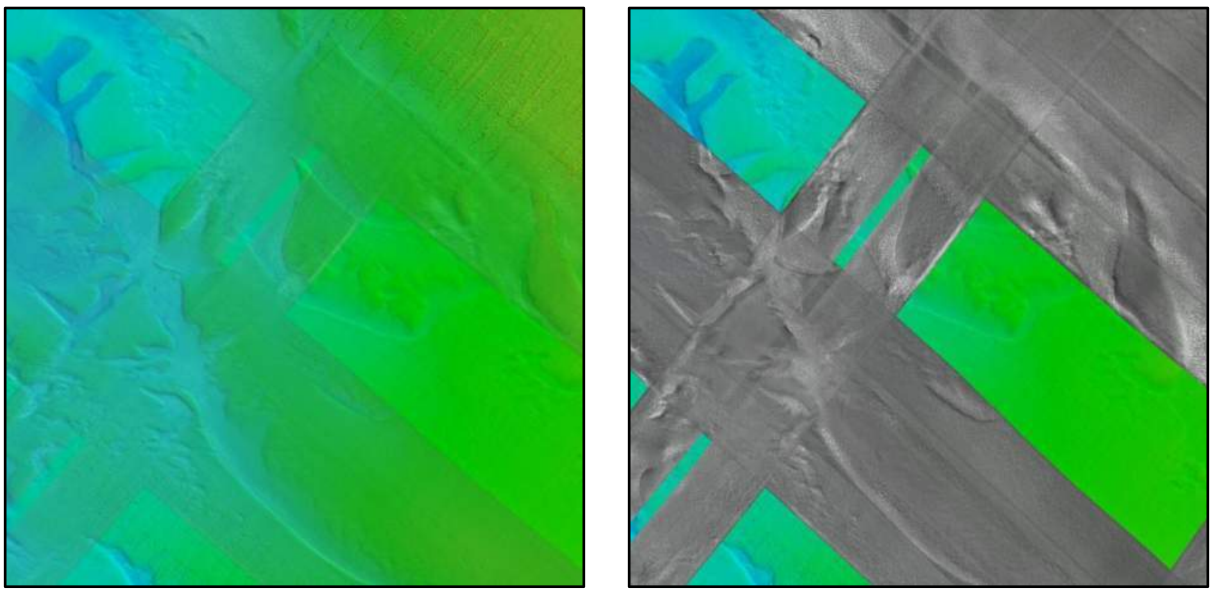

Figure 8. Example positional comparison of side scan mosaic with multibeam GeoTiff. (Left: Multibeam surface with 25% oppacity side scan mosaic overlay, Right: Multibeam surface with 100% oppacity side scan mosaic overlay)

6.10 MAGNETOMETER

Prior to survey, the survey technician verified that communications had been established with the magnetometer and that data were being recorded. During the USBL calibration procedure the magnetometer was run over the anchor for the USBL calibration target node in order to verify that it was detecting a known ferrous object. During survey, the magnetometer data were examined for excessive noise. Recorded data were examined in post processing in near real time to ensure quality data had been recorded. Signal-to-noise ratio and the stability of the total field readings were examined continuously during acquisition. The survey technician also used the expected total field strength and the internal quality indicators to verify the magnetometer was operating correctly. The magnetometer was found to be receiving and recording both accurate and stable readings of the magnetic field strength. It also was detecting small changes in the magnetic field strength caused by the local features.

6.11 SUB-BOTTOM PROFILER

Prior to survey, the survey technician verified communications with the sonar and listened for the transmit pulse. During a brief period of sea trials, a variety of pulse combinations were tested to evaluate penetration and resolution.

During data acquisition the *.JSF files went through a daily QA/QC processing to ensure the data were of sufficient quality to meet the contract specifications. During QA/QC the acoustic data were examined for excessive noise, appropriate altitude, and adequate penetration, (≥30 meters).

6.12 VIBROCORE

The Vibrocoring operation procedures were discussed and rehearsed while at dock to ensure safe and efficient operation while offshore. Use of the RV Pacific Storms A-frame, winch and crane allowed for safe picking of the vibrocorer with minimal requirements for personnel proximate to the aft deck rails. A USBL beacon was attached to the Vibrocore float package. This configuration provided accurate positioning of the vibrocorer during the decent through the water column and once in place on the seabed. The Vibrocore deployment is shown in diagram form in Figure 9.

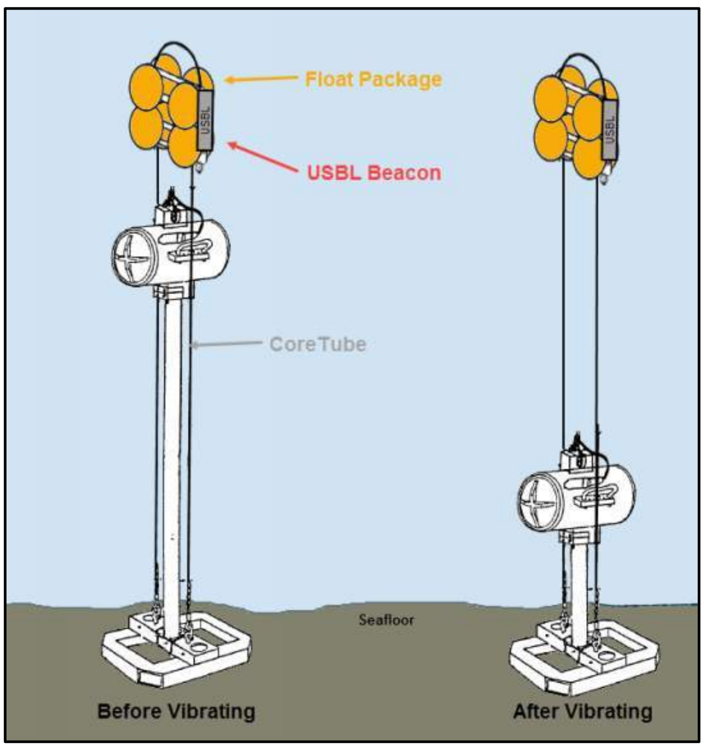

Figure 9.Diagram of vibrocore operations and USBL configuration.

7 DATA REDUCTION AND PROCESSING

7.1 SOUND VELOCITY

Sound velocity measurements were taken at interval throughout every data collection period. A minimum of two sound velocity casts were taken every day (typically immediately preceding and following survey operations) with the AML Oceanographics sound velocity probe. During survey operations rapid casts were done using Lockheed Martin Sippican XBT probes. The temperatures and depth data collected with XBT probes was used in conjunction with averaged salinity values from the daily AML casts to compute a corrected sound velocity via the Chen and Millero UNESCO equation. The resulting daily sound velocity dataset was compiled into a unified sound velocity model and applied to sonar data in post processing.

7.2 MULTIBEAM ECHOSOUNDER

Multibeam echosounder data were processed using CARIS HIPS version 9.1.9. HIPS provides data processing tools that allow you to take all of the raw sensor data recorded during data acquisition and create a final sounding set. The general HIPS workflow is composed of the following steps:

1. Data Conversion: Raw data are converted from the native QINSy format to a HIPS format.
2. Sensor Editing: Sensor data such as heave, pitch, roll and navigation is reviewed. The data can be edited for spikes, smoothed, interpolated or rejected if necessary.
3. Sound Velocity Processing: Sound velocity processing converts the soundings from raw beam angle and time of flight measurements to soundings based on the sound velocity profile of the water column and vessel attitude measurements. Vessel offset parameters computed from patch test results and vessel surveys are applied during this step.
4. Swath Editing: Soundings from individual lines are cleaned in the Swath Editor. The Swath Editor allows the hydrographer to examine and reject erroneous data and filter lines based on swath limits.
5. Merging: Water level and other vertical corrections are applied to the soundings. The soundings are converted from time, beam and ping format referenced to the vessel location, to a fully geo-registered sounding.
6. Subset Editing: Subset editing is the final step in the data cleaning process. The Subset Editor allows the hydrographer to view data from multiple survey lines in a region in a single 2D and 3D spatial editor.
7. Surface Processing: After the data has been cleaned and finalized, HIPS creates a gridded surface from the data called a base surface. The horizontal resolution of the surface is user specified and depends on the resolution of the acquired data and the accuracy requirements.

These general procedures were followed during processing. Line data were imported daily and inspected for irregularities in navigation and motion data. Errant sensor data were rejected with basic interpolation. Sound speeds from the daily sound velocity casts were applied to all survey lines based on a 'nearest in distance within four hours' criteria. Statistical outliers, noise, and errant data caused by particulates suspended in the water column or excess vessel motion, etc. were rejected in swath and subset editors. Data were merged, and surfaces were created. 0.5m surfaces within the Cable Corridor were generated and 1.0m surfaces were generated for the increased depths of the SETS area. The generated surfaces were clipped to bounding polygons ensuring coverage of the project area and the elimination of erratic outer beams from the outermost plan lines.

ASCII Points were generated from both surfaces in CARIS. The points for both the SETS area and Cable Corridor area were generated in NADV88 and also vertically corrected to Mean Lower Low Water (MLLW) datum via RTK GPS based on NOAA Tidal Bench Mark C 590 (PID: QE1114).

7.3 BACKSCATTER

Backscatter intensity values were collected concurrent with bathymetry from the Reson 7125. The Backscatter data were written to QINSy *.DB and *.QPD files which were processed using QPS Fledermaus FMGeocoder Toolbox software. The software can read multiple Backscatter filetypes, apply corrections, and then create a 2D representation of the ocean floor called a Backscatter mosaic. Backscatter mosaics were created and then exported to GeoTiff format. A depiction of the Backscatter GeoTiff deliverable is shown in Figure 10 overlying the NOAA Chart 18561 “Approaches to Yaquina Bay; Depoe Bay.

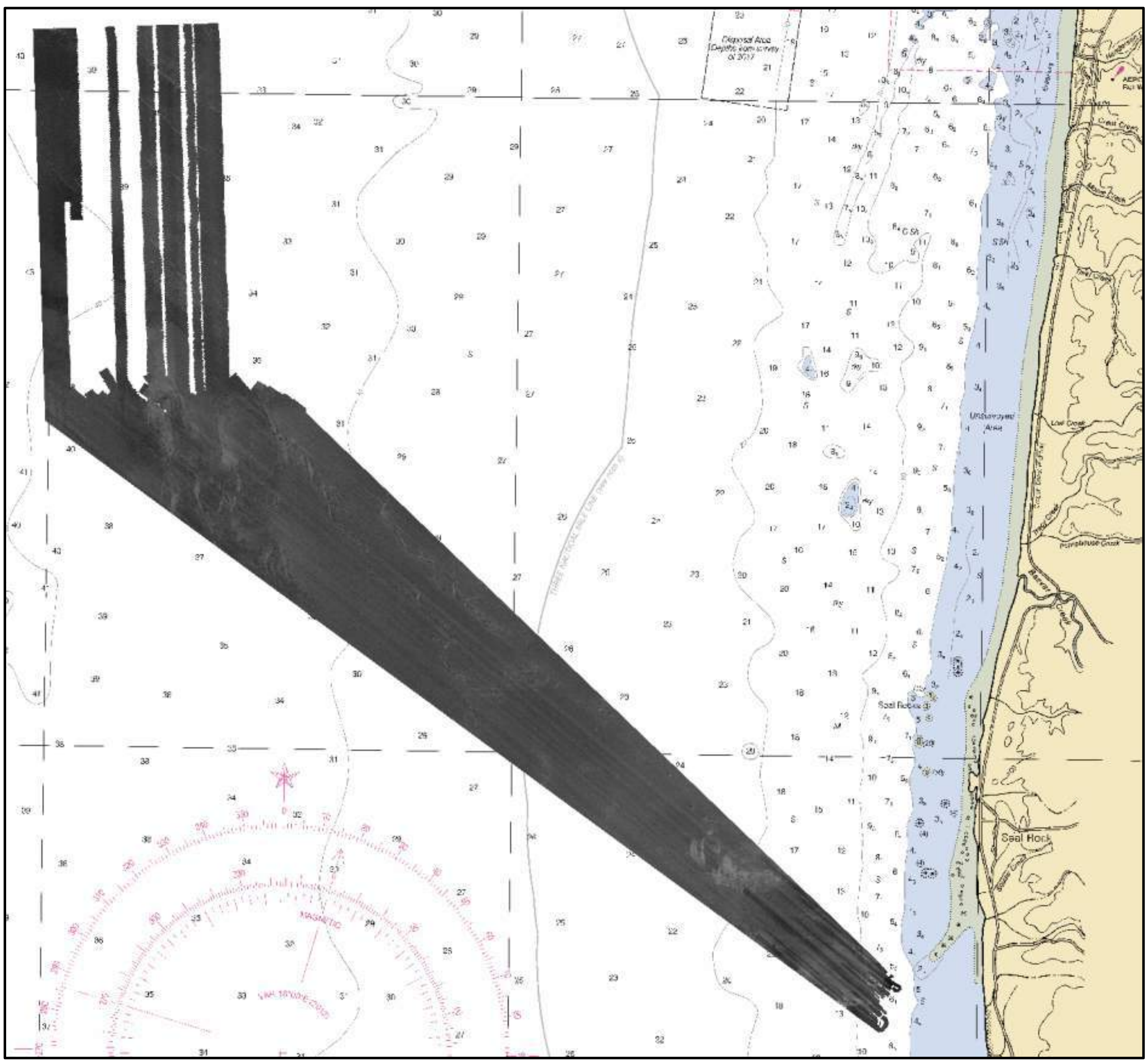

Figure 10. Overview of Backscatter data collected in the SETS and Cable Corridor areas.

7.4 SIDE SCAN SONAR

Side scan data were collected in an EdgeTech *.JSF file format with navigation input via a GGA string from the Sonardyne Ranger USBL system. This configuration eliminated the requirement to measure and correct for layback and sheave. The data were processed using Chesapeake Technologies SonarWiz 7.

SonarWiz provides tools that allow raw side scan data recorded during acquisition to be processed and exported as a cumulative georeferenced raster image. The general SonarWiz workflow utilized during preparation of final deliverables consists of the following steps:

1. Importing Raw Data: Raw data are converted from the native EdgeTech *.JSF format to the *.CSF format used in SonarWiz

2. Navigation Editing: Inspecting imported data for issues such as extraneous line segments or sections of erratic maneuvering. Identified poor quality data can be corrected or removed from the project at this stage.

3. Cable Out/Layback: Cable out and Layback adjustments were unnecessary due to the navigation input from the USBL system.

4. Bottom Tracking: Bottom tracking can be done manually by digitizing along an identified seafloor or automatically by the SonarWiz bottom tracking.

5. Nadir Transparency: Allows for the elimination of nadir noise due to cavitation and turbulent flow from data.

6. Gains and Filters: Apply corrections such as: Empirical Gain Normalization (EGN), TVG, AGC, and Band Pass filtering.

7. De-stripe filter: The pitching of the tow vehicle causes a striping artifact to appear in the image. To remove this artifact a rolling ensemble smoothing filter based on a set number of pings is applied to the data along with the EGN processing.

8. Generate Mosaic: Create a high-fidelity sonar raster in desired map projection of specified line files.

9. Export GeoTiff: Export Mosaic(s) to cumulative georeferenced raster image.

These general procedures were followed during final processing of the side scan deliverables. During import, 100% of the data were converted to CSF format. Once imported, the vessel track lines and sonar images were inspected, and any poor-quality data were flagged and removed. Line segments with erratic course changes were split off from the full line and discarded. Short line fragments were also discarded. Each side scan file was bottom tracked using auto settings and manual review. The motion artifact attributed to towfish atitude variation was removed using a rolling filter of 300 pings. The empirical gain normalization function in SonarWiz was used to make the final gain adjustments. Finally, a nadir transparency of 7.0 meters was applied to all collected side scan lines to remove water column, turbulence, and induced noise from the data in preparation for the creation of final images.

Several 0.5m/pixel resolution greyshade pallette GeoTiff raster images were produced for the final deliverables. One cumulative image was produced, and multiple single day images were produced representing individual days of geophysical acquisition. All GeoTiff images are in UTM Zone 10N projection, WGS84 Datum and the units are meters.

Reflectivity was analyzed using the side scan sonar data. Based on the data available four types of reflectivity polygons were generated. These data were compared to the multibeam and backscatter surfaces for analysis and quality control. These data were not compared to the sub bottom data nor any bottom samples. The following reflectivity types were generated:

1. G-HiR-texture (BEDROCK)
2. G-HiR (high reflectivity, typically rippled scour depressions (RSD) with SAND)
3. G-MedR (gravelly SAND, mainly nearshore)
4. G-LowR (silty SAND / SILT, mainly everything deeper that isn't RSD)

7.5 MAGNETOMETER

Magnetometer data were acquired in Marine Magnetics BOB software and reviewed in MagPick. During acquisition a 10m Layback was applied based on the tether length from the Marine Magnetics SeaQuest towfish to the EdgeTech DSS 2000 towfish. Magnetometer data were subjected to a basic QA/QC check in MagPick as shown in Figure 11. The aft magnetometer sensor was determined to be problematic, the remaining sensors were fully functional throughout the duration of the project. As a result, the raw readings for horizontal gradient should be used instead of relying on the raw total gradient calculated internally by the magnetometer during survey. The horizontal gradients passed all QA/QC tests, and magnetic features were identifiable. No corrections or refinement were applied.

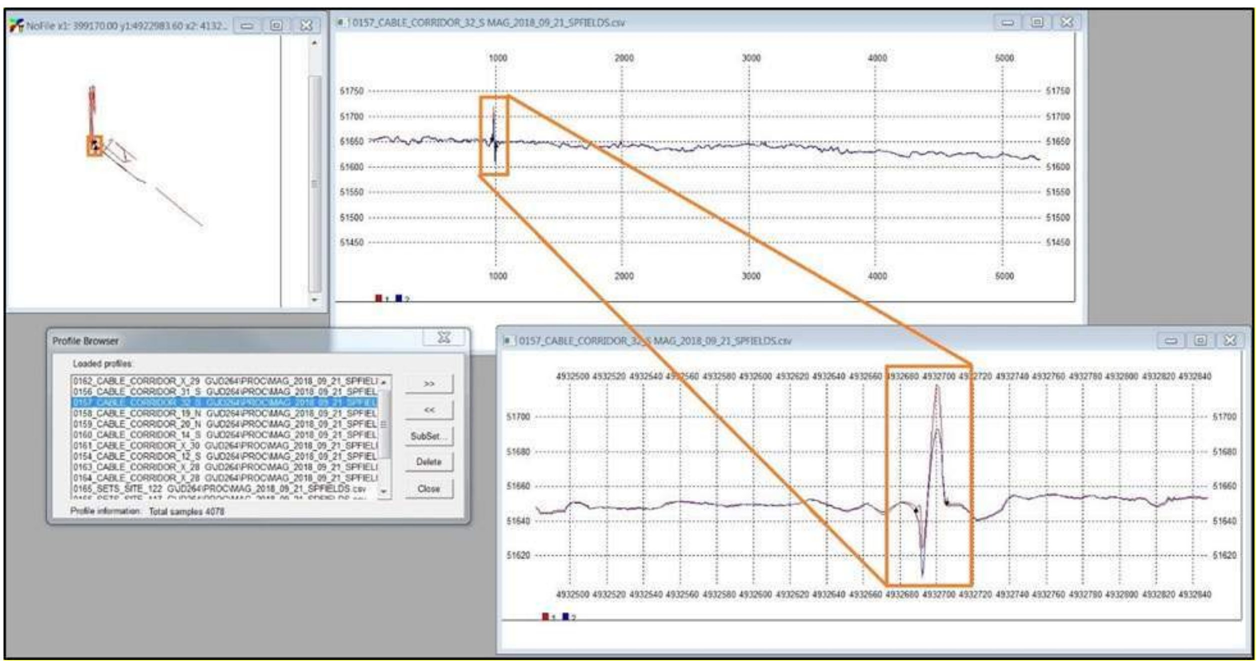

Figure 11. Magnetometer data during the QA/QC review using MagPick software.

7.6 SUB-BOTTOM

Sub-bottom data were recorded in EdgeTech *.JSF format and processed using Chesapeake Technologies SonarWiz 7. Positioning of the towfish was provided by the USBL system. This configuration eliminated the requirement to measure and correct for layback and sheave offset due to USBL positions being written directly to the *.JSF files during acquisition. The general SonarWiz workflow utilized during preparation of final deliverables consists of the following steps:

1. Importing Raw Data: Raw data are converted from the native EdgeTech *.JSF format to the *.SGY format used in SonarWiz

2. Navigation Editing: Inspecting imported data for issues such as extraneous line segments or sections of erratic maneuvering. Identified poor quality data can be corrected or removed from the project at this stage.

3. Cable Out/Layback: Cable out and Layback adjustments were unnecessary due to the navigation input from the USBL system.

4. Bottom Tracking: Bottom tracking can be done manually by digitizing along an identified seafloor or automatically by the SonarWiz bottom tracking and Gamma correction tools.

5. Gains and Filters: Apply corrections such as: TVG, AGC, Heave Compensating Swell Filter, and Band Pass filtering.

6. Export Images: Exported images of the processed sub-bottom transects.

7. Export Tracklines: Towfish Navigation tracklines are exported to allow for georeferencing.

These basic steps were followed during final processing of the sub-bottom deliverables. Acquired sub-bottom *.JSF files were imported into SonarWiz as a single channel, (CH1). Importing 25% of acquired range provided sufficient coverage to ensure compliance with the desired 30m penetration below seafloor throughout the project while rejecting extraneous data. No band pass was applied during import. Each sub-bottom profile was bottom tracked automatically and then manually reviewed and digitized where necessary to ensure proper seafloor detection. Gain settings were adjusted, and the swell period was estimated by observing the number of waves that occurred within a 30 second time span. This was used to set the swell filter. An example of a line segment of sub-bottom data during bottom tracking and swell correction procedure can be seen in Figure 12.

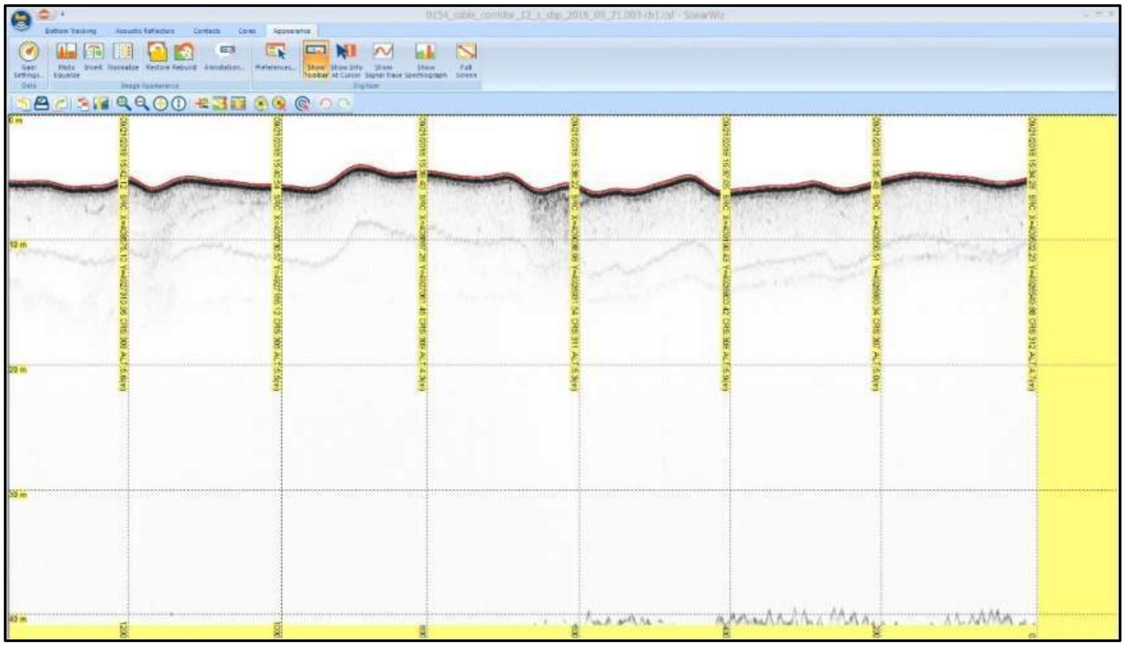

Figure 12. View of a representative sub-bottom line segment in SonarWiz software after bottom tracking and swell correction precedure.

During acquisition, *.JSF files were automatically split at 250MB increments in the collection software. At the request of the client these file segments were combined and re-split into geospatially consistent sections. To implement this the original *.JSF files were aggregated into one *.SGY file for each survey plan line. The created *.SGY files were then imported into SonarWiz. The same import and processing procedures used to complete daily QA/QC checks during acquisition were repeated on the aggregated *.SGY files. Then the files were split using a prepared station template. Stations were established at 1000m intervals along the project centerline. Stations originated at the southern extent of the cable corridor and ended at the northern extent of the SETS area. The station template can be seen in Figure 13 and is detailed in

APPENDIX D.

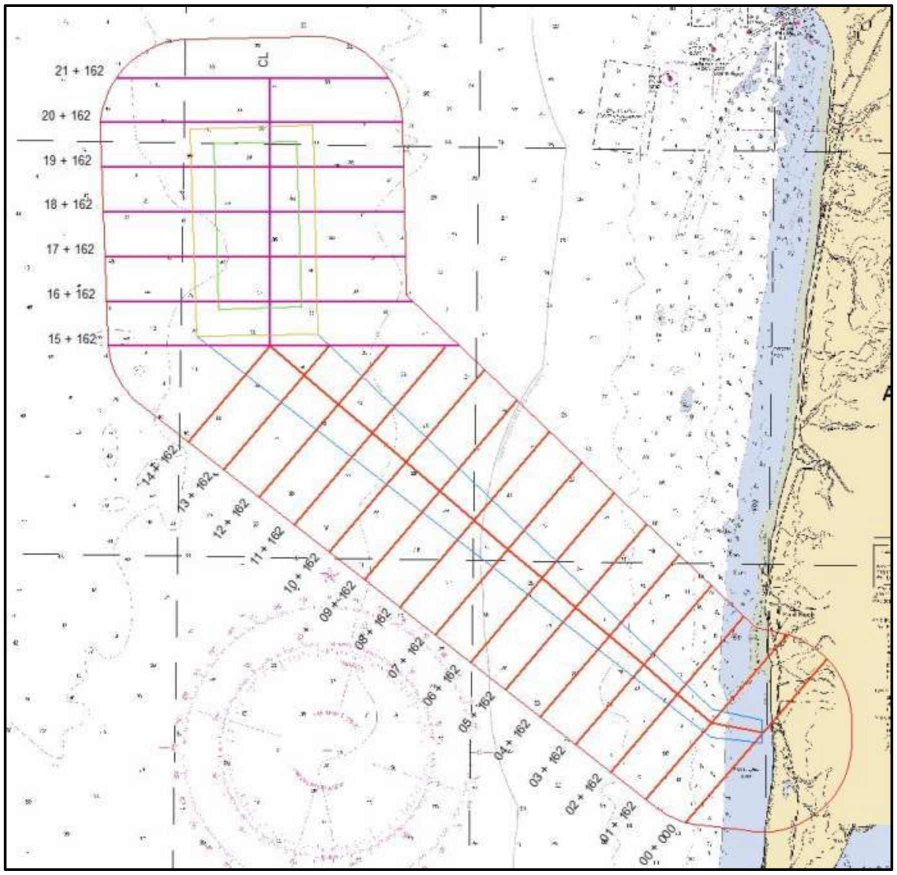

Figure 13. Depiction of the station template used to split sub-bottom data into regular sections. Complete station template can be seen in APPENDIX D: SUB-BOTTOM STATION TEMPLATE.

The splits were placed using a free hand mouse in SonarWiz. Each split was placed as near as possible to one of the depicted station lines in Figure 13. If a line extended more than 300m past a station line in either direction it was split into another segment. The final sub-bottom images were reoriented to consistently show the NW end of a selected segment on the left of the image (as opposed to being based on the direction of vessel travel during acquisition). Lines acquired perpendicular to the plan lines (cross lines) were not split but were oriented to ensure all crosslines are viewed with the SW end on the left of the image.

After the files were split they were exported from SonarWiz as *TIFF images. The Sub-bottom track lines were exported from SonarWiz to SHP files. These exported files were later combined in ArcMap as a GIS package for final deliverables. The GIS package is detailed in Section 8.6.

8 DATA QUALITY AND SUMMARY

8.1 MULTIBEAM ECHOSOUNDER

To confirm the accuracy of the MBES data, a crossline analysis was completed on the data after generating the surfaces. A crossline is a line run perpendicular to the main scheme lines, it is not used for coverage but only as a Quality Control measurement. A base surface of the main scheme lines was generated and the QC Report function in CARIS HIPs was utilized for the crossline analysis. The QC report compares a crossline with the base surface. The beams of the crossline were analyzed against the surface to determine if the data were meeting IHO Special Order for navigation surveys as specified in EM1110-2-1003. All the crosslines in each survey area passed the 95% confidence level. Each individual crossline report can be found in APPENDIX C. Soundings for both sites were vertically corrected to Mean Lower Low Water (MLLW) datum via RTK GPS based on NOAA Tidal Bench Mark C 590 (PID: QE1114).

8.2 BACKSCATTER

The Backscatter data revealed seafloor features consistent with the features identified in the side scan data as seen in Figure 14, showing a side along comparison of Backscatter and side scan data. The comparison of side scan and Backscatter data again confirms the accuracy of the USBL positioning equipment configuration.

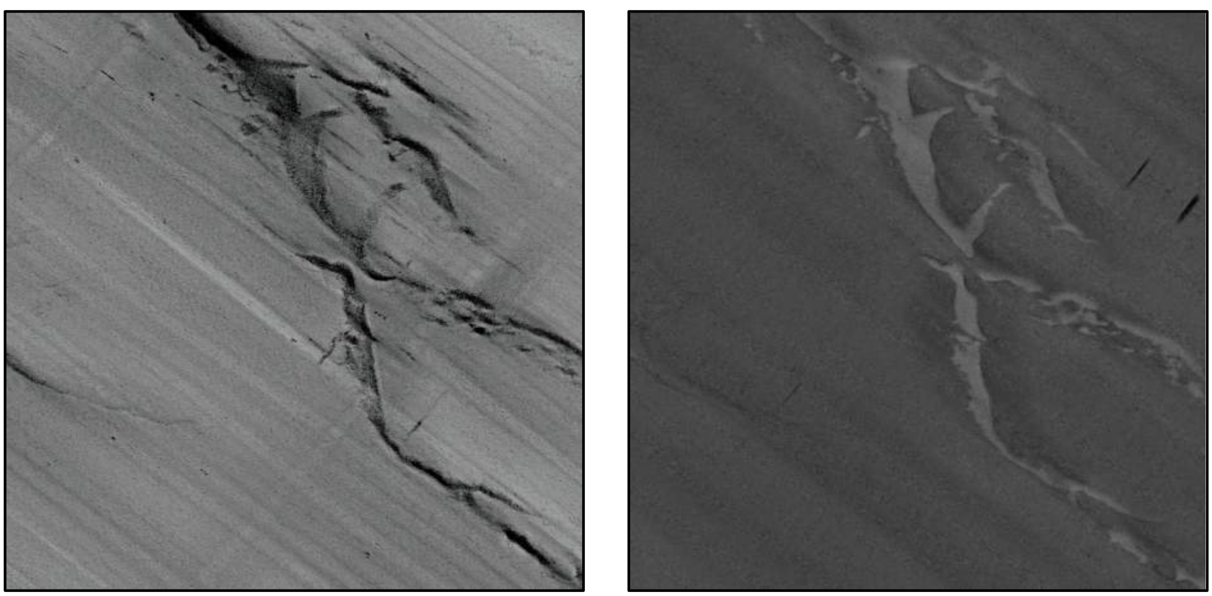

Figure 14. Seafloor feature comparison in a small section of 0.5m master side scan GeoTiff (Left) and cumulative 0.5m Backscatter GeoTiff (Right).

The positions and nature of the seafloor features are observed to be consistent across sensors.

8.3 SIDE SCAN SONAR

The SSS data were of expected quality with a resolution fine enough to detect seafloor features. An example of slant range corrected side scan waterfall imagery is shown in Figure 15.

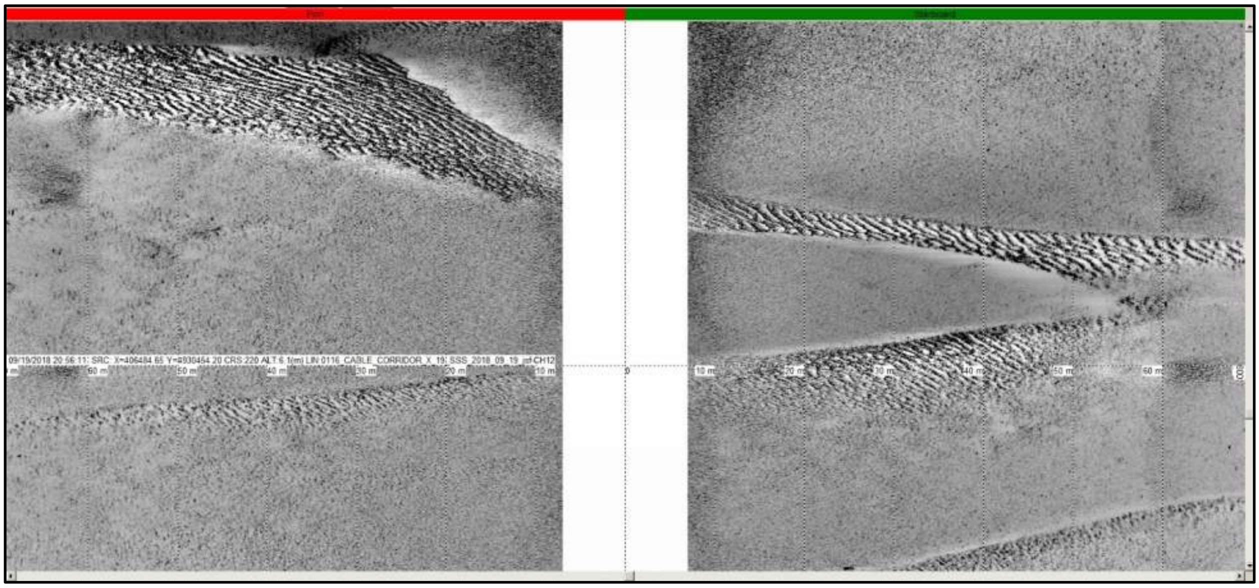

Figure 15. High frequency side scan image example from survey line 0116_CABLE_CORRIDOR_X_19.

Positioning of the towfish using real-time information from the USBL beacon collocated with the sensors provided accurate results. Side scan data were aligned with the multibeam bathymetry using distinctive features on a daily basis to ensure consistency. Using a 75m range setting and 30m line spacing, 300% seafloor coverage was generally achieved.

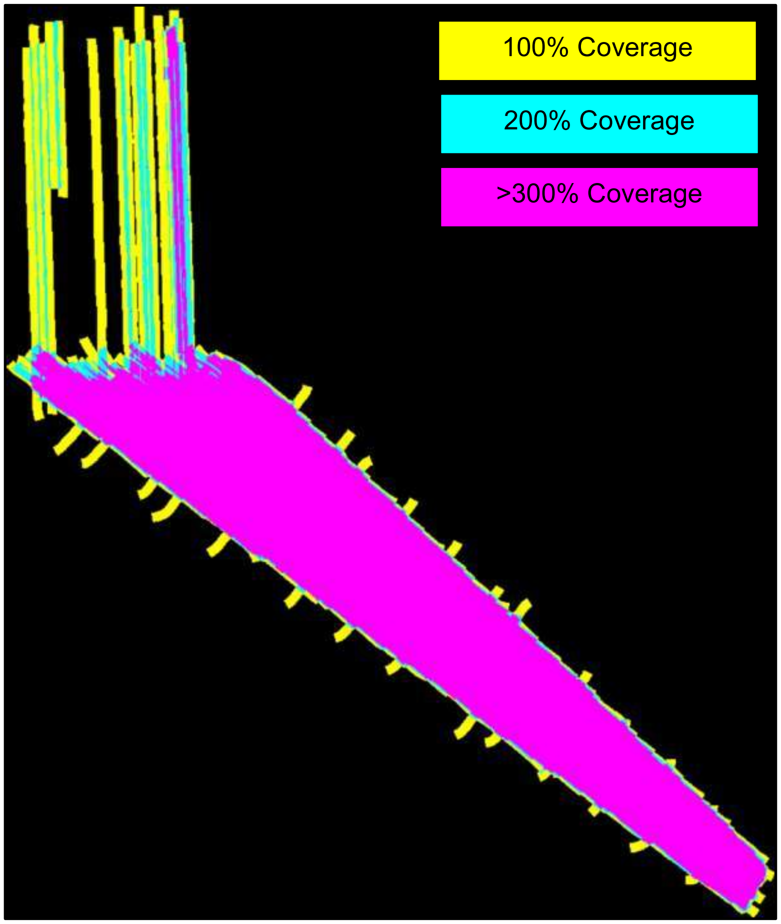

Figure 16. Cumulative raw SSS overlap coverage symbolized by color.

As seen in Figure 16, the cable corridor was completed with coverage exceeding 300%. The unfinished SETS area was covered to overlaps ranging from primarily 100%-200% with one area of 300% coverage (shown in Figure 16). Additional coverage from project QC crosslines can be seen as orthogonal protrusions from the cable corridor side scan coverage. Notably, coverage provided by crosslines was not substituted for lack of coverage from plan lines thus area covered by crosslines and main-scheme lines typically had a combined coverage of 400%.

8.4 SUB-BOTTOM PROFILER

The sub-bottom profiler data were of expected quality with adequate penetration and resolution to track sub-seafloor horizons to a depth of at least 30m. The sea floor was consistently identified. Overall the data were free from noise interference. The positioning provided by the USBL system met or exceeded specifications. An example of the sub-bottom data after filtering and data processing is shown in Figure 17.

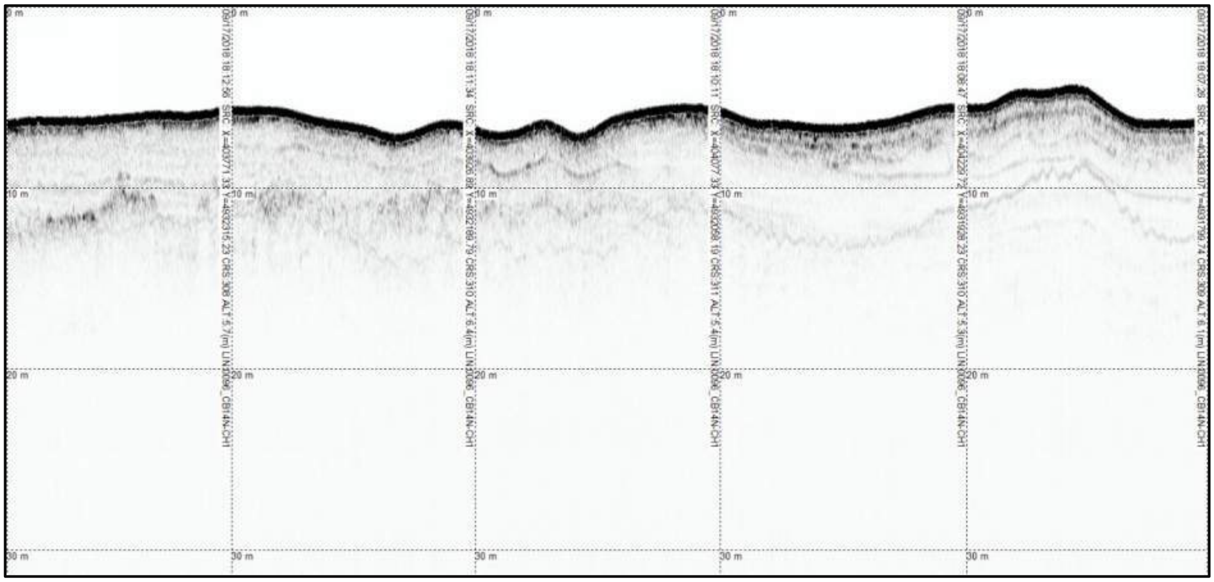

Figure 17.Processed profile of sub-bottom line segement.

Stratigraphic horizons were visible within the profiles. The sediments are hypothesized to be primarily sand with some gravel due to the signal attenuation and nature of the stratigraphy however, accurate identification of the stratigraphic units cannot be ascertained prior to geotechnical sampling.

8.5 MAGNETOMETER

Acquired magnetometer data were shown to consistently measure the horizontal magnetic gradient throughout the survey, a representative example of a potential magnetic anomaly is shown in Figure 18 as they appear in the QC software MagPick.

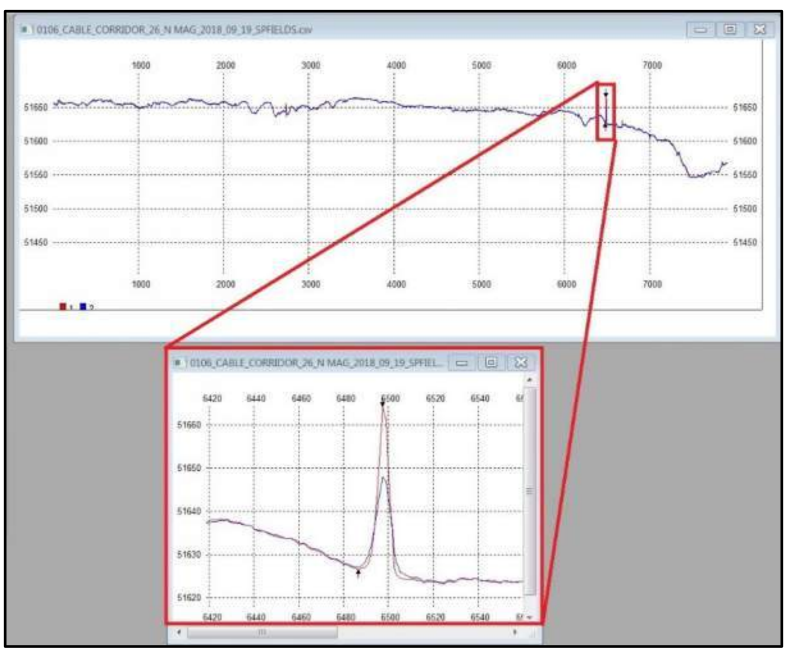

Figure 18.Example of a spike in the horizontal magnetic gradient as seen within MagPick QC software.

The aft sensor of the magnetometer was determined to be faulty and repairs were attempted during inclement weather downtime, but the measured vertical magnetic gradient remained suspect. The cause of the issues with the aft sensor is unclear however numerous incidents involving abandoned crab gear and relict 'ghost' fishing lines may have played a role. Text files included with each day of Magnetometer data in the final deliverable data package indicate the state of the aft sensor for that acquisition day. Both port and starboard magnetometer sensors were operational for the duration of the survey operations. As a result, the raw total gradient is not valid as it incorporates readings from the aft sensor.

8.6 GIS PACKAGE

An ArcMap project was created to present sub-bottom, Backscatter, and side scan data in a unified geospatial context. As discussed in Section 7.6 the sub-bottom files were split into 1000m line segments at the request of the client. The line segments were then exported from SonarWiz to *.SHP files. The exported files were combined using the Merge function in ArcMap. This created one .*SHP file for each plan line collected. The individual segments each had one record in the *.DBF file. An additional field was added to the attribute table. This field was a text field entitled "Image", containing a relative path to the corresponding sub-bottom *.TIFF image. An active hyperlinked shape file allows the user to click on any feature and the GIS displays the corresponding sub-bottom *TIFF image in a separate viewer as shown in Figure 19. The final GeoTIFF images for side scan and Backscatter were also incorporated into the GIS as map layers. Side scan GeoTIFFs for individual acquisition days were provided in addition to the cumulative image.

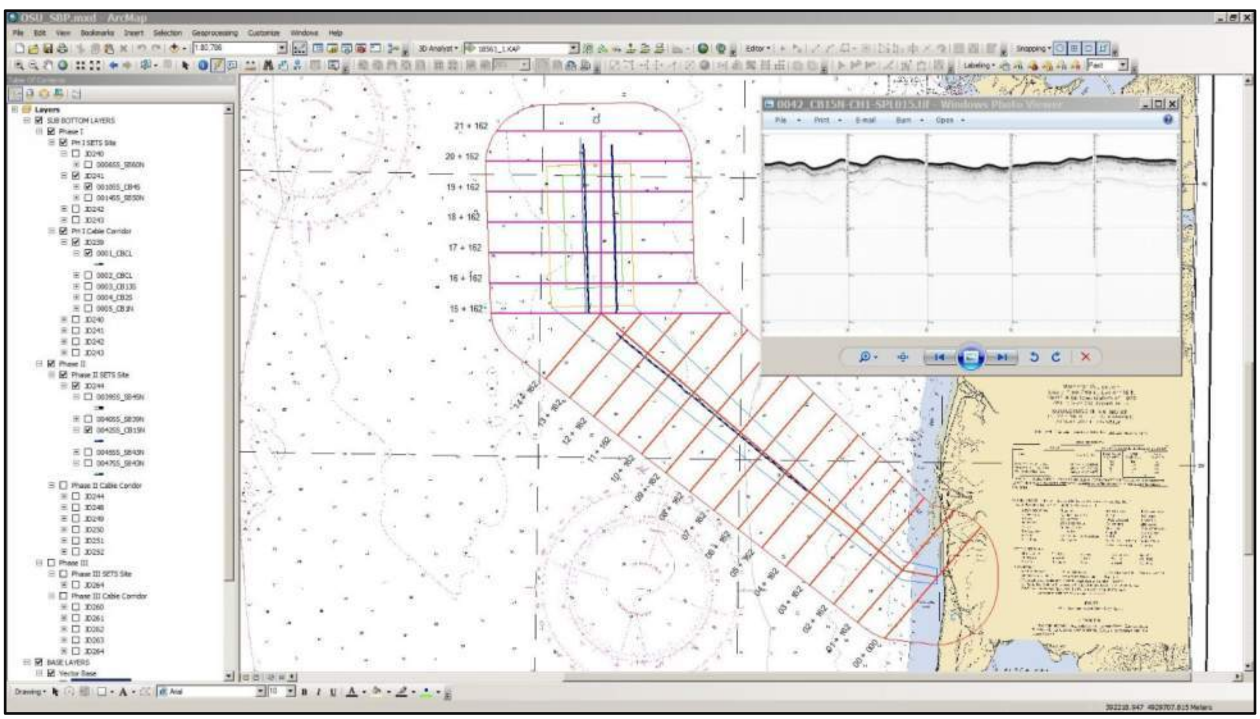

Figure 19.'Click-able' hyperlinked sub-bottom image open in separate viewer as provided in the GIS project.

The GIS project was organized in a manner which maintains the chronology of the data acquisition. The GIS package contains three "Group Layers" based on data type, designated as "SUB BOTTOM LAYERS", "SIDE SCAN SONAR LAYERS", and "BACK SCATTER LAYERS". Under each of the group layers there are sub-groups for the respective chronological phase. The data were originally organized into three SonarWiz projects (Phase I, Phase II, and Phase III), as a method of maintaining manageable project sizes for the SonarWiz software during acquisition. In the GIS project the same chronological phases are retained as sub-groups within each data type. The sub-bottom data are subsequently organized based on location (SETS or cable corridor) and acquisition date (in Julian Day). The side scan data are similarly organized by phase and Julian Day. This data structure can be seen in Figure 20 as the Table of Contents within the GIS project.

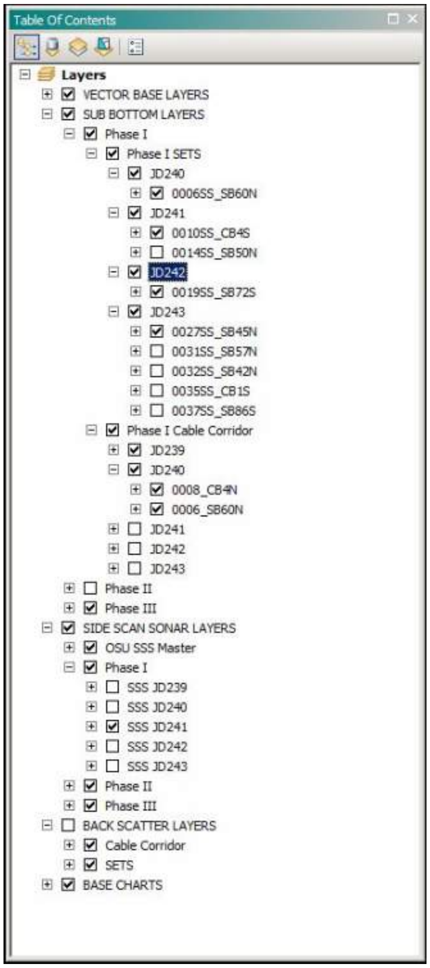

Figure 20. Table of contents showing the data organization within the GIS.

The GIS project and hyperlinks to the sub-bottom images use relative paths. If the path structure is retained from the main directory of the GIS project and data package the project will be transportable. The main directory is "….\GIS". The file paths must not be altered below this point if the project is to be transportable.

8.7 SEDIMENT SAMPLES

One core was retrieved, analyzed, and photographed from the survey area. The sample was collected with a Rossfelder P-3 percussive vibrocorer. The core was taken during a short period of agreeable weather conditions within the cable corridor. The geospatial attributes of the core are described in Table 19. Due to degraded weather conditions prior to and following retrieval of this sample no further cores were attempted.

Table 19. Summary information for vibrocore sample.

Core Sample Summary	
Sample ID	VC-P1-2
Latitude	N 44 28' 39.32"
Longitude	W 124 6' 56.49"
Depth (m)	29

The core sample was analyzed on site by a TerraSond Geophysicist. The core was relatively homogenous, consisting primarily of well sorted fine sand with lesser amounts of broken shell fragments, well-worked gravel inclusions, and some cobble. This sample geology can be seen in Figure 21.

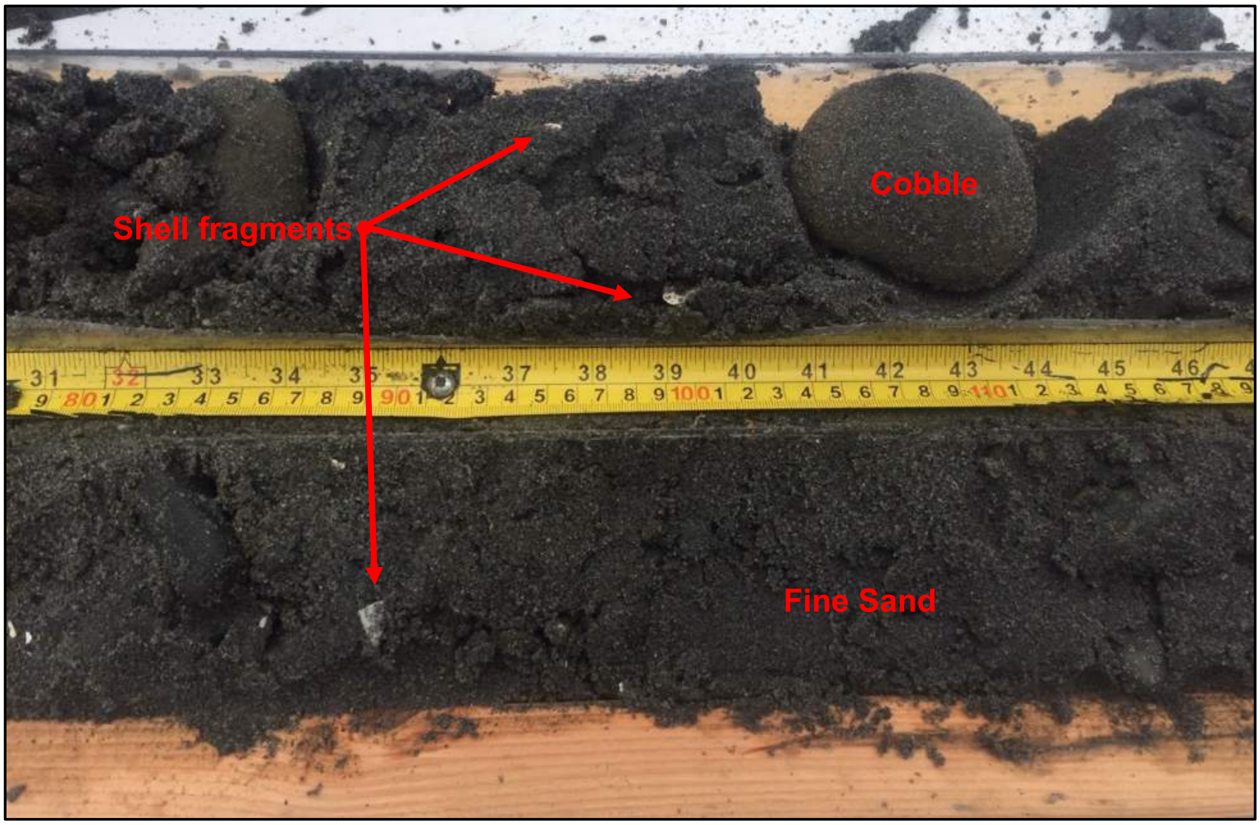

Figure 21. Representative section of Core Sample VC-P1-2 with annotations indicating fine sand, shell fragment inclusions, and minor amounts of cobble inclusions.

The analysis was conducted in a manner consistent with the procedures requested by the client and the OSU Marine and Geology Repository (MGR) representative. The summary log sheet for sample VC-P1-2 and Sediment sample photos are provided in APPENDIX E. After analysis all sample material was prepared for cataloging as directed by the MGR representative.

8.8 SUMMARY

TerraSond was able carried out successful Geophysical survey at the proposed PMEC-SETS cable corridor and portion of the site. Time limitation provided a challenge to complete the full site. Therefore, the cable corridor was prioritized to be completed before the actual site.

For Phase 2 Geotechnical survey, a single core sample was acquired within the cable corridor and analyzed. Due to weather vulnerability and limitation to ships maneuverability, no other seabed samples were acquired.

There were few observed fishing vessels as the Dungeness crab season was at end for the duration of the survey. There were low counts of visible marker buoys along the cable corridor. Hence the vessel was easily maneuvered to avoid entanglement with observed buoys.

The long history of active crab and shrimp fisheries in the region was reflected by numerous abandoned crab pots and relict fishing gear discovered during survey towing operations. Lost or abandoned fishing gear, known colloquially “ghost gear” (Figure 22 and Figure 23), was encountered during survey and affected operations. Most of the “ghost gear” was present in the southern end of the site or NW end of the cable corridor. The relict fishing gear and neutrally buoyant “ghost lines” are not detectable with the geophysical survey equipment until equipment passes over the location. The “ghost lines” are then caught on the tethered tow system. There were approximately 10 occurrences of entanglement of survey equipment with these ghost gears. They caused survey equipment damage and delays to the survey data acquisition. It is foreseeable that these “Ghost Gear” and “Ghost Lines” could intermittently affect the cable burial operations and/or jetting equipment.

Figure 22. Crab Pot retrieved as it was entangled with towed system

Figure 23. Ghost Gear line with biological growth

Apart from commercial crabbing fleet, recreational and commercial chartered fishing fleet were observed near the southern eastern corner end of the cable corridor. Due to specific geomorphology features of the area, it was favored by the recreational and charted fishing fleet for lingcod and other species. Less than 20 vessels were observed during each survey day.

The observed bathymetry of the PMEC-SETS is consistent with the expected morphology of a continental shelf region. Generally, the seafloor slopes gently (less than 2°) to the WNW with contours roughly parallel to the adjacent Oregon coastline. The minimum observed seabed depth was 11.6m at 412722.0E, 4924783.0N, and the maximum observed seabed depth was 77.2m (MLLW) at 400659.0E, 4932844.4N.

One region of the cable corridor, observed in the MBES data to have a higher rugosity than elsewhere within the surveyed area, is found near the shallow extent of survey. This bathymetrically rough area is located along the northern edge of the corridor, in water depths between approximately 17m and 21m (MLLW), and trending in the N-S direction. Localized slopes are very steep (greater than 12°). This area is interpreted to be exposed ROCK based on the increased strength of acoustic return in both backscatter and side scan data suggesting harder surface material. This area is shown in Figure 24.

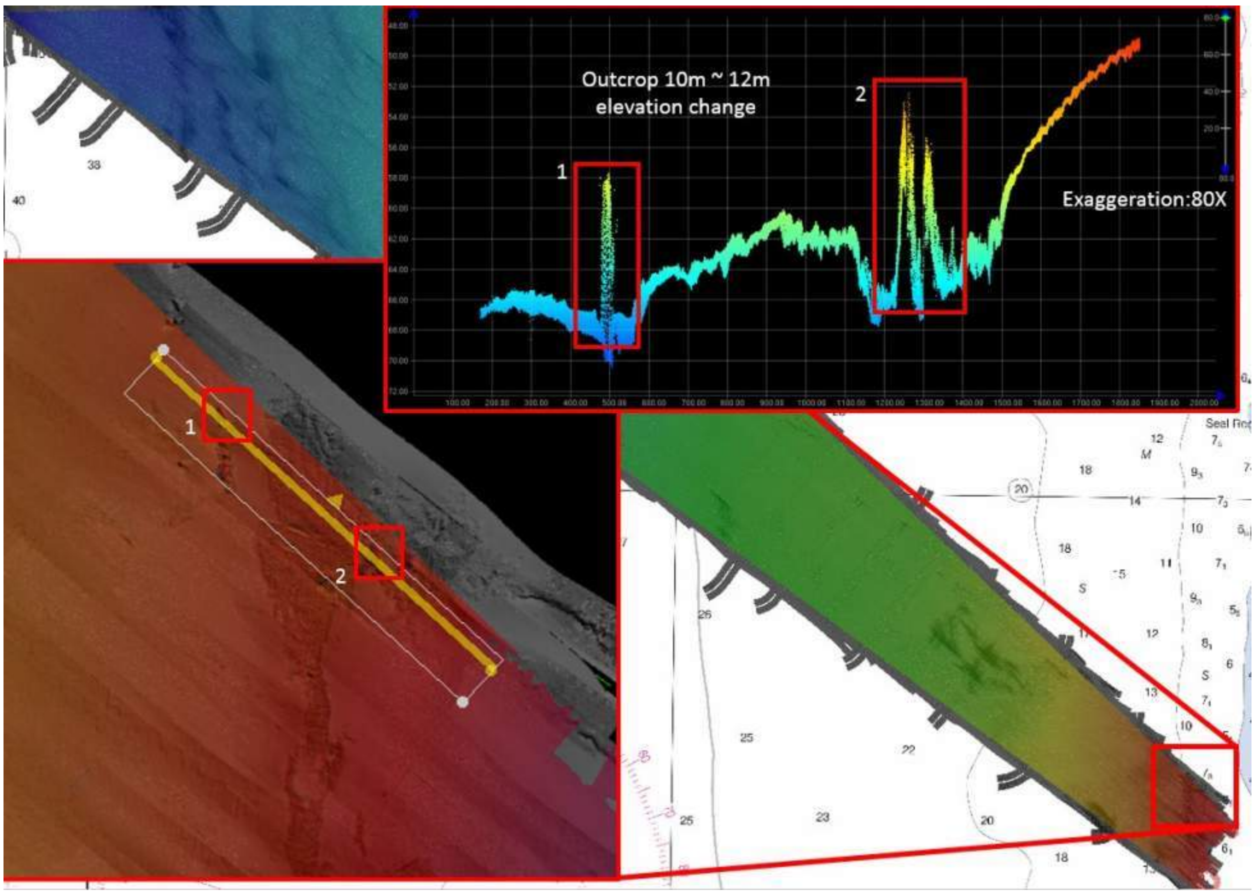

Figure 24. MBES and SSS overlay image of area of Cable Corridor interpretted to contain rock outcroppings. Image contains inset of the "rocky" area with respect to surveyed cable corridor extents.

Overall, the shelf sediments are expected to be primarily SAND, ranging from predominately fine SAND near shore to predominately medium SAND, and occasionally coarse SAND or GRAVEL in deeper water *(Oregon State Waters Mapping Program, 2012 and Goldfinger et al., 2012).* SSS data show a range of lower reflectivity interpreted to be relatively finer grained sands, to medium to strong reflectivity interpreted to be coarser grained sands, to very strong reflectivity interpreted to be ROCK.

Rippled scour depressions (Figure 25 and Figure 26) were recognized in the area by *Goldfinger et al. (2014)* and observed in the western part of the cable corridor and across the width of the SETS area. The features are visible in MBES, backscatter and SSS data. Rippled scoured depressions are observed in continental shelf areas worldwide *(Davis et al., 2013)* and are thought to be formed by storm generated currents. They are often elongate, shallow (less than 2m deep) depressions filled with relatively coarser grained seabed sediments (with higher SSS reflectivity) relative to the surrounding seabed sediments (with lower SSS reflectivity). The observed depressions are sometimes arcuate, with somewhat feathery edges (Figure 14). The depressions observed in the cable corridor have locally very steep (greater than 12°) gradients around their inward sloping edges. The ripples within the depressions, where observed (for example at 409825.1N, 4926695.0E, 44m MLLW), are visible in both MBES and SSS data.

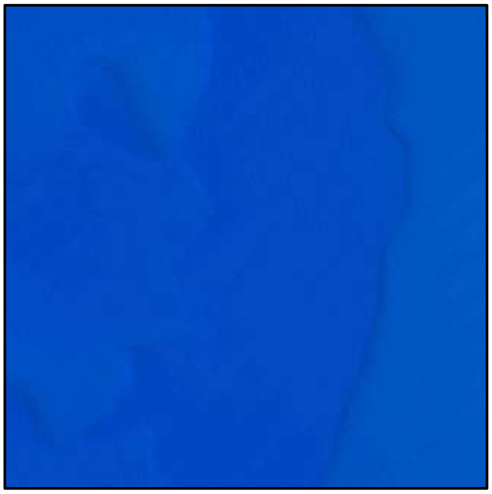

Figure 25. MBES data showing rippled scour depression

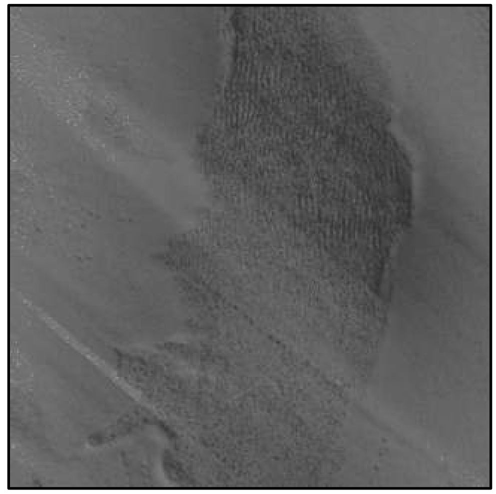

Figure 26. SSS data showing rippled scour depression

Shallow (less than 0.5m deep), circular or oval pits that are typically 1m x 3m in dimension are observed in water depths between 60m and 70m (MLLW) across the western part of the cable corridor. The pits are regularly spaced and arrayed in curvilinear clusters (seen in Figure 27). These pits are interpreted to be biological in nature, mostly likely pits that result from bottom feeding gray whales *(Mate, 2005; Nelson et al., 1993; Johnson et al., 1983; Nerini et al., 1980)*. The bottom feeding whales may "porpoise" along the seabed, scooping up sediment, benthic prey and/or epibenthic prey, and leaving a line of pits to mark their feeding trail.

Figure 27. Example of MBES data showing oval pits created from mammal feeding behaviors

Sediment bedforms, intepreted to be relict, subaerial dunes *(Goldfinger et al., 2014)*, are observed best in MBES data in the NE part of the SETS area, as seen in Figure 28. The bedforms have WNW-ESE trending wave crests, wave heights of 1m to 3m and wavelengths of approximately 500m. The relict dunes are assymetrical in profile indicating they formed in a prevailing NE wind direction. The relict dunes are further incised by drainage channels, and have rippled scour depressions along the base of their SW-facing slip faces. Ripples observed in the depressions have N-S trending wave crests and wave lengths of approximately 2m. Seabed gradients are locally steeper (greater than 10°) where the dunes have been incised.

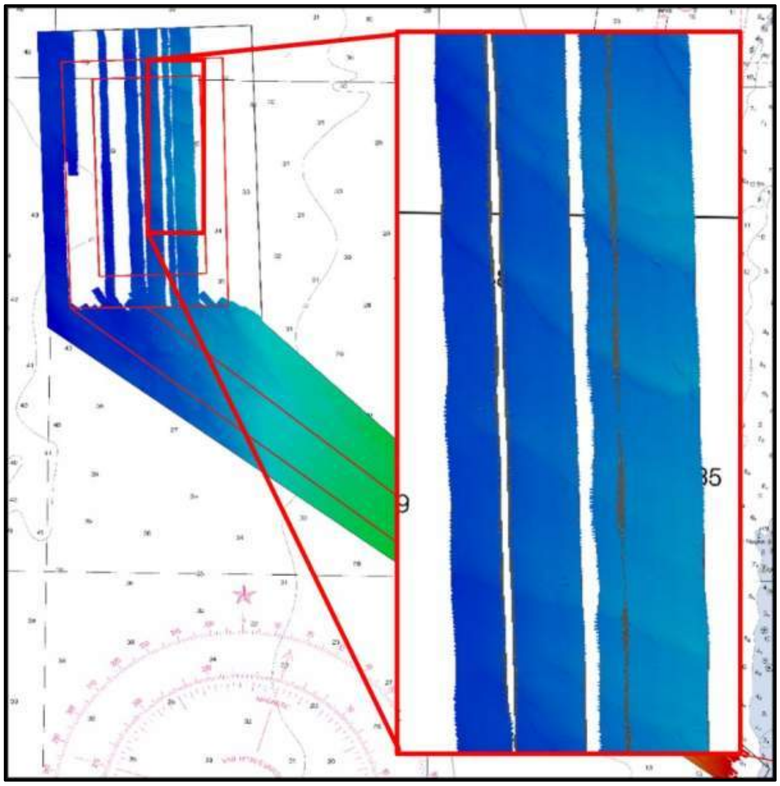

Figure 28. Sediment bedforms interpretted as relict subaerial dunes shown in MBES data relative to project location.

Also observed in MBES and SSS data were narrow, curvilinear features, trending ENE (pependicular to contours), in water depths between 26m and 38m (MLLW). The features, shown in Figure 29, are interpreted to be trawl marks from an unidentified style of bottom fishing. The marks are remarkably wide (3m to 5m) and less than 0.5m deep.

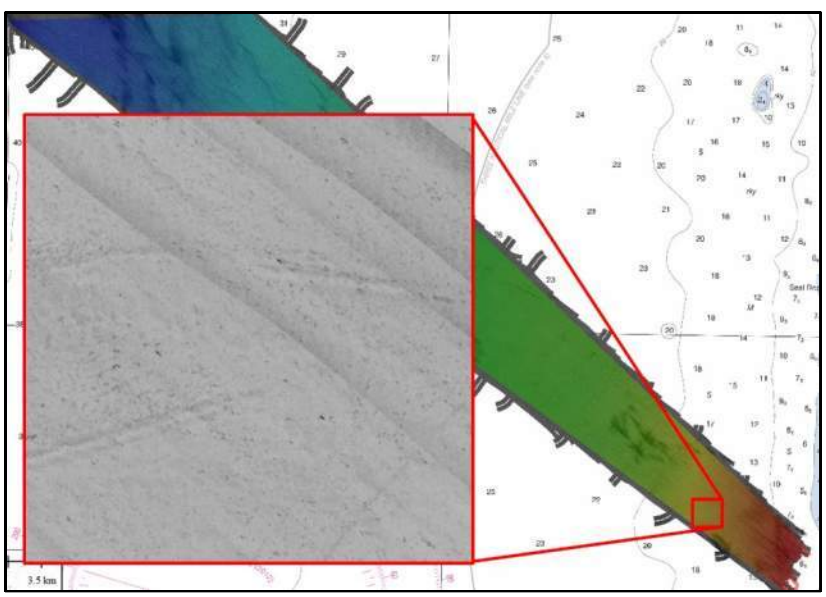

Figure 29. Narrow curvilinear features observed in MBES and SSS data relative to location within surveyed project area.

8.9 REFERENCES

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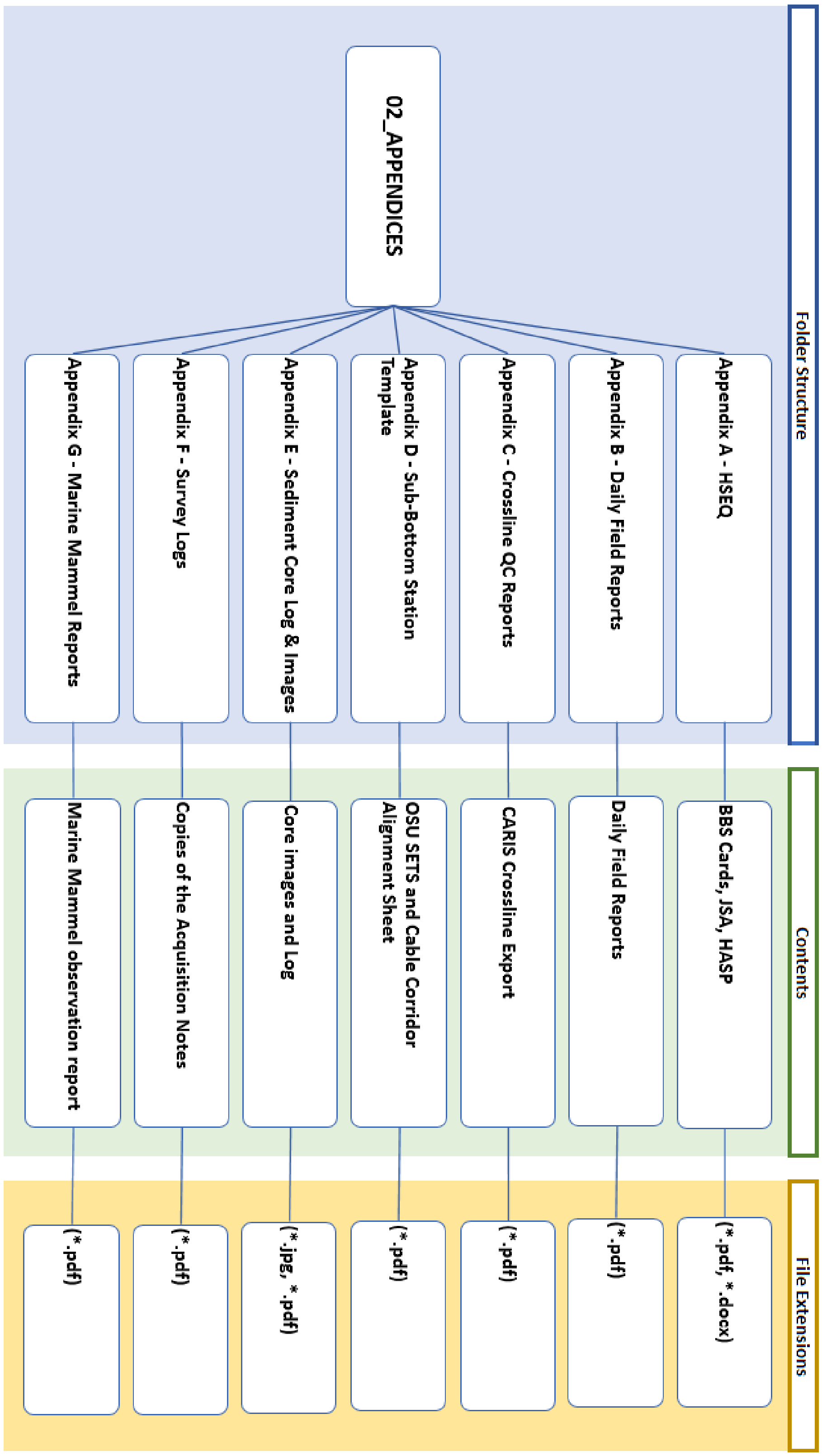
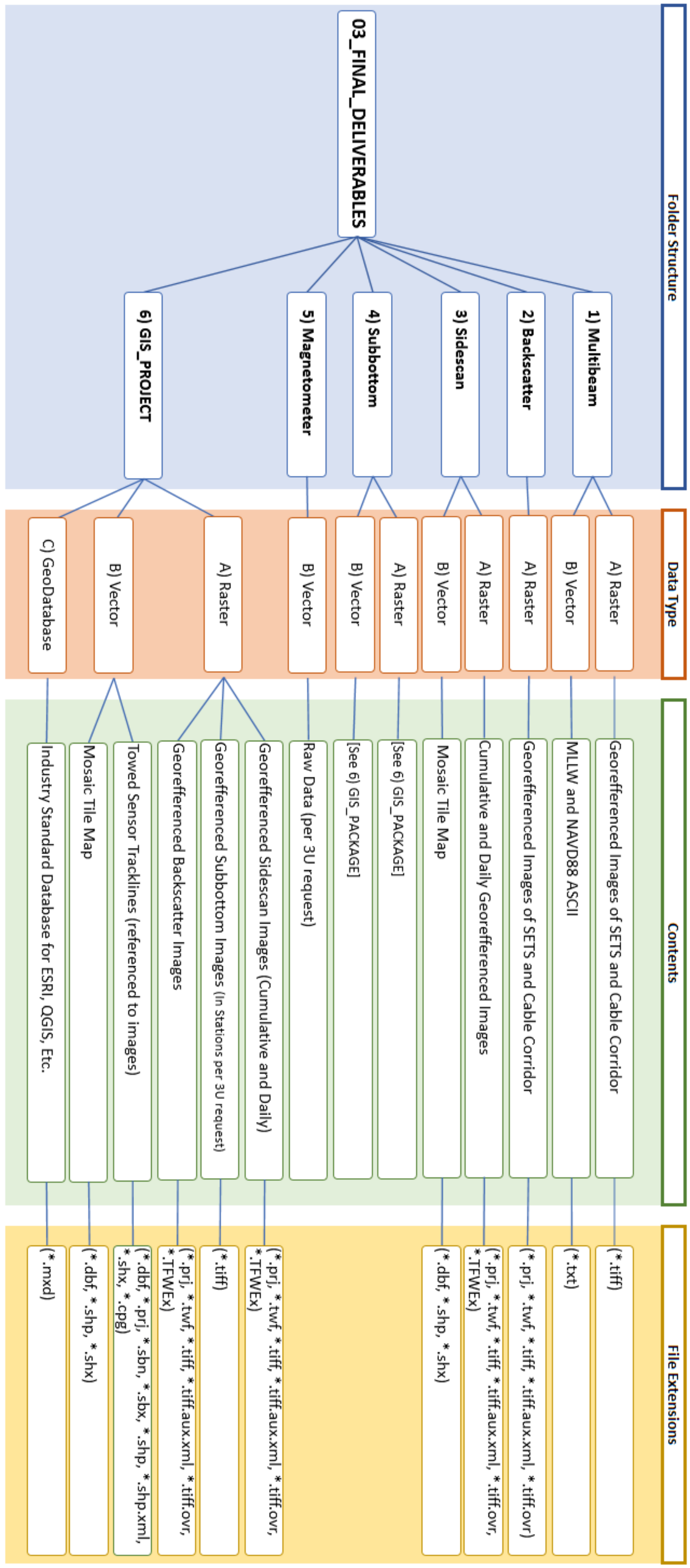
9 DELIVERABLES

The following digital deliverables were provided during acquisition and/or are included with this report:

- HSEQ Packet (APPENDIX A)
- Daily Field Reports (APPENDIX B)
- Multibeam Crossline QC Report (APPENDIX C)
- Sub-bottom Station Template (
- APPENDIX D)
- Sediment Core Log (APPENDIX E)
- Sediment sample Images (APPENDIX E)
- Survey Logs / Field Notes in PDF format (APPENDIX F)
- Marine Mammal Observer Reports (APPENDIX G)
- Raster (Georeferenced images)
    - 0.5m and 1.0m Multibeam Data
    - 0.5m Backscatter Data
    - 0.5m Side scan Sonar Data
- Vector (Points files)
    - 0.5m and 1.0m gridded Multibeam mean elevation. Format: E,N,Z
    - Raw magnetometer readings. Format: CSV
- Raw Daily Acquisition Data
    - Multibeam Sonar
    - Backscatter Intensity
    - Side scan Sonar
    - Sub-bottom Profiler
    - Magnetometer
    - Navigation. (Including Vessel Track lines)
    - Sound Velocity Casts
- GIS package
    - Side Scan, Sub-bottom, Backscatter data.
    - Sub-bottom images referenced to track lines

9.1 DATA PACKAGE ORGANIZATION




Folder Structure
Data Type
Contents
File Extensions
03_FINAL_DELIVERABLES
1) Multibeam
2) Backscatter
3) Sidescan
4) Subbottom
5) Magnetometer
6) GIS_PROJECT
A) Raster
B) Vector
A) Raster
A) Raster
B) Vector
A) Raster
B) Vector
B) Vector
A) Raster
B) Vector
C) GeoDatabase
Georefferenced Images of SETS and Cable Corridor
MLLW and NAVD88 ASCII
Georefferenced Images of SETS and Cable Corridor
Cumulative and Daily Georefferenced Images
Mosaic Tile Map
[See 6) GIS_PACKAGE]
[See 6) GIS_PACKAGE]
Raw Data (per 3U request)
Georefferenced Sidescan Images (Cumulative and Daily)
Georefferenced Subbottom Images (In Stations per 3U request)
Georefferenced Backscatter Images
Towed Sensor Tracklines (referenced to images)
Mosaic Tile Map
Industry Standard Database for ESRI, QGIS, Etc.
(*.tiff)
(*.txt)
(*.prj, *.twf, *.tiff, *.tiff.aux.xml, *.tiff.ovr)
(*.prj, *.twf, *.tiff, *.tiff.aux.xml, *.tiff.ovr, *.TFWEx)
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(*.prj, *.twf, *.tiff, *.tiff.aux.xml, *.tiff.ovr, *.TFWEx)
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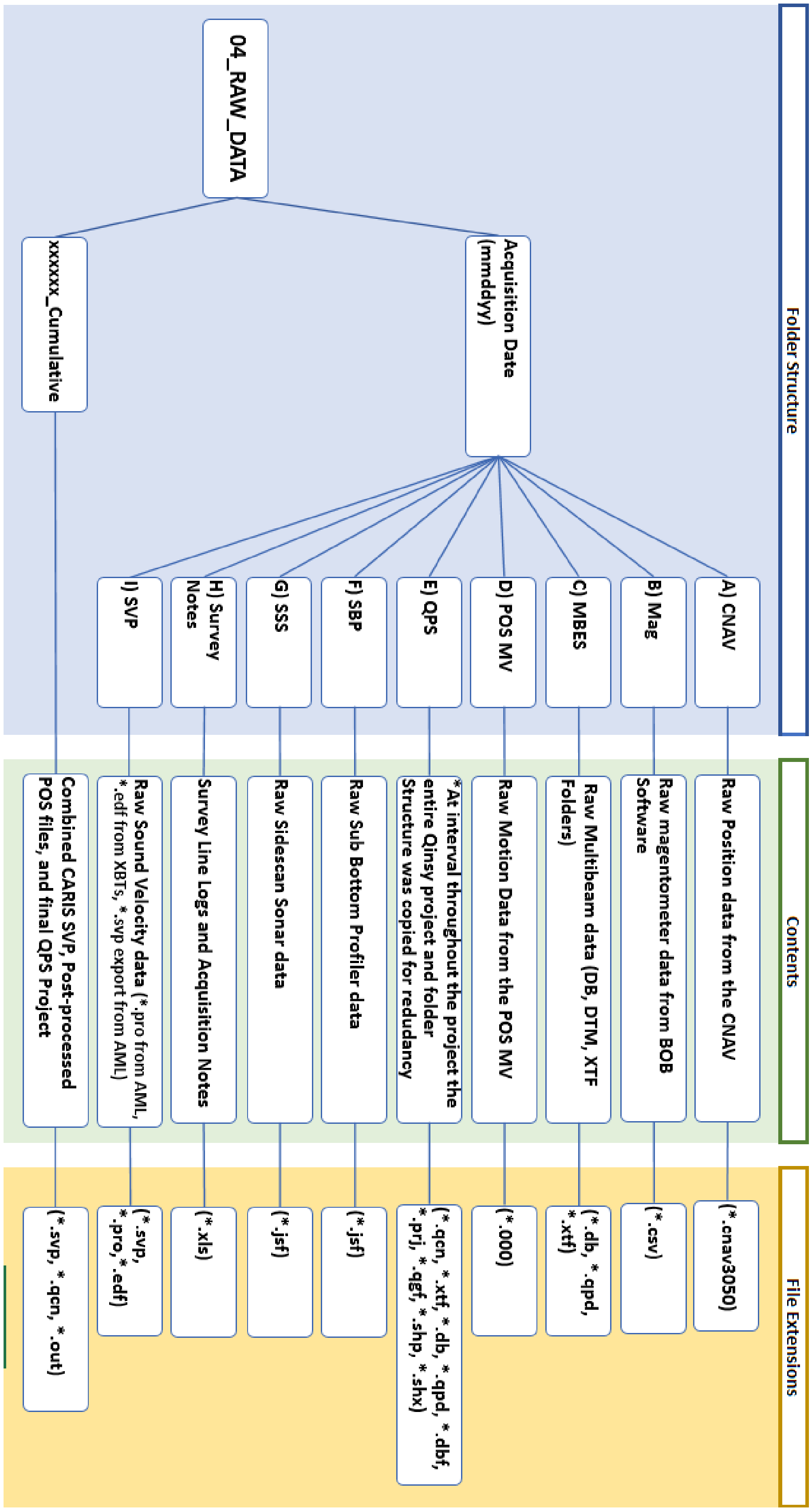
(*.mxd)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xxxxxx_Cumulative
A) CNAV
B) Mag
C) MBES
D) POS MV
E) QPS
F) SBP
G) SSS
H) Survey Notes
I) SVP
Raw Position data from the CNAV
Raw magentometer data from BOB Software
Raw Multibeam data (DB, DTM, XTF Folders)
Raw Motion Data from the POS MV
*At interval throughout the project the entire Qinsy project and folder Structure was copied for redudancy
Raw Sub Bottom Profiler data
Raw Sidescan Sonar data
Survey Line Logs and Acquisition Notes
Raw Sound Velocity data (*.pro from AML, *.edf from XBTs, *.svp export from AML)
Combined CARIS SVP, Post-processed POS files, and final QPS Project
(*.cnav3050)
(*.csv)
(*.db, *.qpd, *.xtf)
(*.000)
(*.qcn, *.xtf, *.db, *.qpd, *.dbf, *.prj, *.qgf, *.shp, *.shx)
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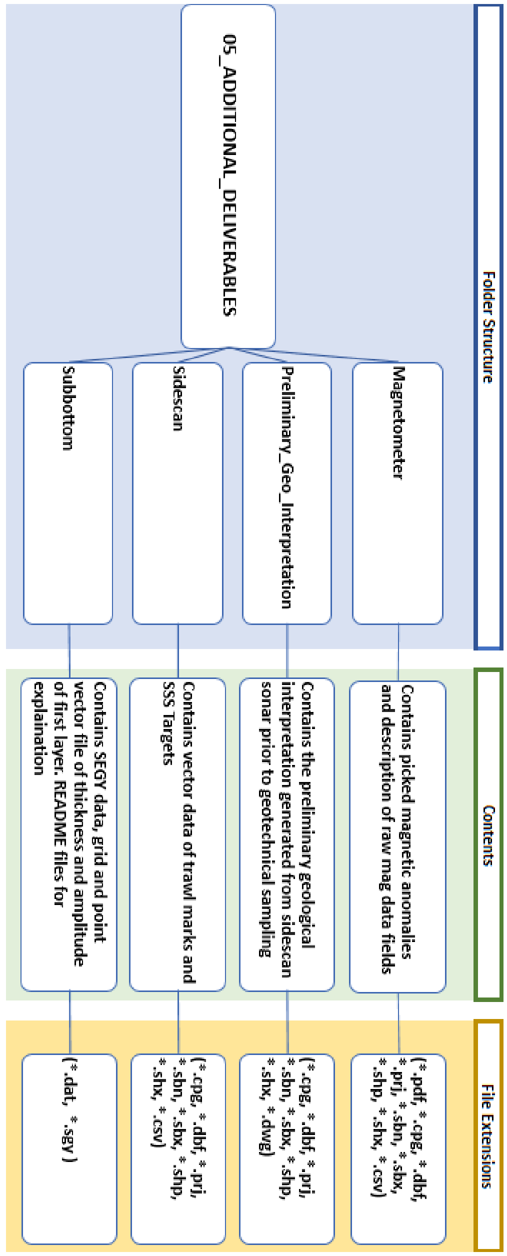
(*.svp, *.qcn, *.out)


Folder Structure
Contents
File Extensions
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Magnetometer
Preliminary_Geo_Interpretation
Sidescan
Subbottom
Contains picked magnetic anomalies and description of raw mag data fields
Contains the preliminary geological interpretation generated from sidescan sonar prior to geotechnical sampling
Contains vector data of trawl marks and SSS Targets
Contains SEGY data, grid and point vector file of thickness and amplitude of first layer. README files for explaination
(*.pdf, *.cpg, *.dbf, *.prj, *.sbn, *.sbx, *.shp, *.shx, *.csv)
(*.cpg, *.dbf, *.prj, *.sbn, *.sbx, *.shp, *.shx, *.dwg)
(*.cpg, *.dbf, *.prj, *.sbn, *.sbx, *.shp, *.shx, *.csv)
(*.dat, *.sgy)

9.2 FILE NAMING CONVENTION

The file naming conventions for the final deliverables are discussed below:

Backscatter: See Figure 30.

Magnetometer: See Figure 31. Additional field (at end) was used in some cases to represent the additional attributes for QC files (ie. Altitude, Total Gradient, Port/ Starboard Gradient etc.).

Multibeam: See Figure 30.

Side Scan: See Figure 32.

Sub-bottom: See Section 8.6 GIS Package. The project structure and organization system are thoroughly described.

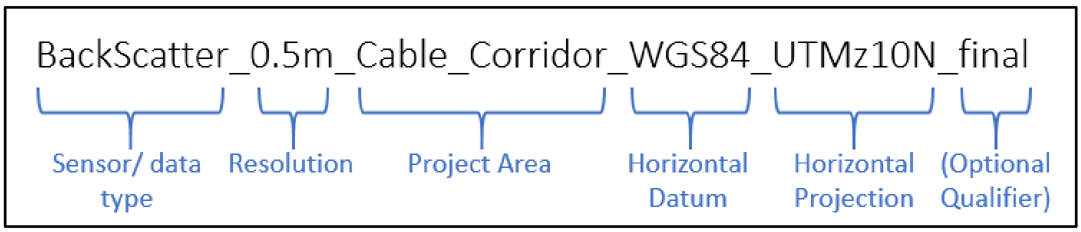


Figure 30. Bckscatter and Multibeam file naming convention.

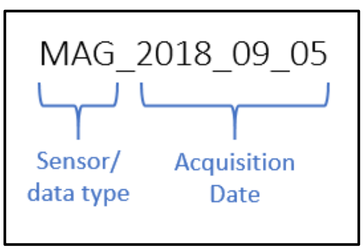


Figure 31. Magnetometer data file naming convention.

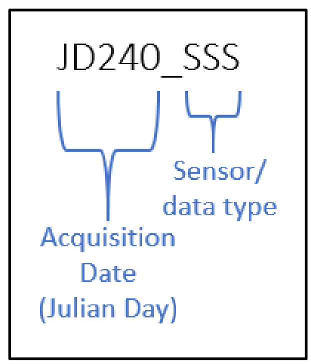


Figure 32. SSS data file naming convention.

PacWave: HDD Path

On the Pacific Ocean, near Waldport, Oregon

<u>DATA REPORT:</u>

Results of Geophysical Exploration

By: Siemens & Associates
Bend, Oregon

Prepared for: Oregon State University
Corvallis, Oregon

PacWave
TESTING WAVE ENERGY FOR THE FUTURE

December 28, 2018

Dan Hellin
Operations & Logistics Manager
PacWave
College of Earth, Ocean and Atmospheric Sciences
370 Strand Hall
Corvallis, Oregon, 97331

RE: PacWave Marine Geophysical & Geotechnical Services: HDD Path
On the Pacific Ocean, near Waldport, Oregon

Hello Dan,

Siemens & Associates is pleased to present the results of the geophysical exploration. The geophysical interpretation of the results considers local geology and incorporates the benefit of using multiple methods.

Data were gathered and processed for two geophysical methods in the marine environment: Electrical Resistivity (ER) and Seismic Refraction Microtremor (ReMi). The results are presented to describe continuous, 2D profiles. The interpretation is simplified in context with a general understanding of the area's geologic history and suggest the possibility of encountering a variety of material types with the most consistent conditions occurring at depths greater than 80 feet below the seabed. The interpretation of the geophysical results can be enhanced by correlation with direct exploration to confirm the findings.

Siemens & Associates expresses sincere appreciation for the opportunity to conduct this exploration and as new challenges, discoveries and questions arise, we are standing by to offer our assistance.

Prepared by,
Siemens & Associates

J. Andrew "Andy" Siemens, P.E., G.E.
Principal
siemens@bendcable.com
541.385.6500 (office)
541.480.2527 (cell)

CONTENTS

1. Introduction

1.1. Purpose

Siemens & Associates (SA) have completed marine based geophysical services to support geotechnical evaluations associated with the HDD path extending from the shore out into the Pacific Ocean. The exploration provides insight regarding seabed conditions and extends similar exploration previously completed on the beach.

1.2. Methods

Two marine geophysical methods were used:

- Electrical Resistivity (ER) in 2D
- Seismic Refraction Microtremor (ReMi) in 2D

Details concerning the procedures, the equipment used, and results are presented later in this report.

1.3. Project Description

SA understands that details regarding the HDD plan are not finalized although the general path is set and includes up to five routes extending from Driftwood Beach State Recreation Site. These paths are currently designed to extend roughly 4000 feet out to sea on a northwest heading. Bore diameter, method, curvature, and depth information has not been provided. SA assumes that decisions regarding such details of design are likely to be partially driven by the results of this exploration.

1.4. Scope

Working under an agreement with Oregon State University (OSU), the SA team completed geophysical measurement bounding the zone of interest. Guidelines for the work were outlined in the proposal prepared by SA dated July 13, 2017. The original scope was agreed upon and documented under an agreement executed on October 25, 2017 (OSU Project # 1991-17), and includes amendments #1, #2, and #3 dated June 15, September, 18 and October 8, 2018, respectively. The field work was performed on September 15 through 18. The completed scope is summarized as follows:

- Consultation with the design and management team
- Planning, preparation for, and scheduling services
- Basic surface reconnaissance and review of readily available geologic resources
- Geophysical data acquisition along HDD1 and HDD5
- Bathymetry data acquisition and delivery throughout HDD corridor and beyond

- Geophysical data processing and QC
- Special processing of previous geophysical data for correlation
- Consultation with outside geology resources
- Preparation of this data report

1.5. Location

The project is located west of Driftwood Beach State Recreation Site roughly two miles north of Waldport, Oregon. The HDD corridor includes the western portion of the recreation site and extends out into the Pacific Ocean to roughly the 10-meter depth mark and possibly farther.

1.6. Limitations

This report has been prepared for the exclusive use of OSU (and consultants of their choosing) for specific application to the project known as PacWave Marine Geophysical and Geotechnical Services. This report has been prepared in accordance with generally accepted geophysical practice consistent with similar work done near Waldport, Oregon, by geophysical practitioners operating in the surf transition zone at this time. No other warranty, express or implied is made.

The information presented is based on data obtained from the marine explorations described in Section 3 of this report. The explorations indicate geophysical conditions only at specific locations and times, and only to the depths penetrated. They do not necessarily reflect variations that may exist between exploration locations and the subsurface at other locations may differ from conditions interpreted at these explored locations. Also, the passage of time may result in a change in conditions. If any changes in the nature, design, or location of the project are implemented, the information contained in this report should not be considered valid unless the changes are reviewed by SA to address the implications and benefit of enhancing the work as necessary. SA is not responsible for any claims, damages, or liability associated with outside interpretation of these results, or for the reuse of the information presented in this report for other projects.

2. Executive Summary

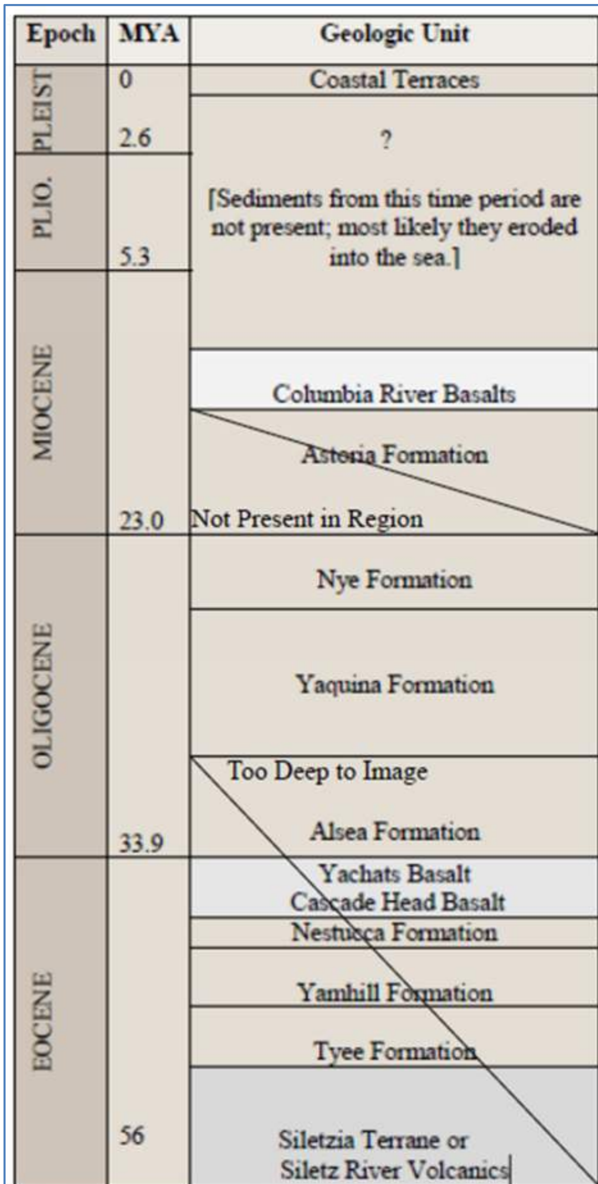
SA have completed marine based geophysical services to support geotechnical evaluations associated with the HDD path extending from the shore out into the Pacific Ocean.

The results developed from the geophysical methods are presented as “tomograms”; a word derived from the Greek “tomo” meaning to cut or slice. Data were collected to illustrate subsurface conditions through the agreed upon routes and the lines were positioned as near to the previously completed terrestrial explorations as physically possible given constraints offered by sea conditions and associated safety concerns when operating near the surf transition zone. Figure 101 (Site Plan: Marine

Geophysical Surveys - HDD) illustrates the location of each line. The tomograms are annotated to communicate our interpretation of the various types of geomaterials discovered by each geophysical method. SA is not aware of any geotechnical information (such as borings) that is available to confirm the interpretation.

2.1. Geologic Setting

The project site lies along the Pacific shoreline of Oregon, approximately two miles north of the mouth of the Alsea River and the town of Waldport. The site lies west of the relatively steep, north-south-trending Coast Range, on the coastal margin near Driftwood Beach State Recreation Site (Driftwood). The shoreline at Driftwood consists of a relatively flat parking area on a terrace surface approximately 40 feet above the active shoreline. The shoreline is characterized by relatively steep bluffs formed by wave-cut erosion at the toe of the slope. Based on our literature review and site reconnaissance, the units encountered at the site, from youngest to oldest, consist of Holocene (recent) surficial deposits of unconsolidated fine to medium-grained dune and beach sand, recent alluvium; Pleistocene marine terrace deposits; and Tertiary siltstone, claystone, and sandstone. The recent dune deposits are principally located in the periphery of the parking lot and to areas north, south, and east. The base of the dune sand may exhibit some consolidation. In addition to the recent dune sand deposits along the uplands, active shoreline processes are reworking the older, fine to medium grained terrace sand. Other recent deposits observed near the site include stream alluvium at the mouths of small drainages located north and south of the site. The alluvium consists of sand, gravel, and



Modified from Schlicker and others, 1973, and Orr and Orr, 2012.
Numeric ages from Walker and others, 2012.
MYA = Million years ago

cobbles composed predominantly of erosionally-resistant basalt. The thickness of the recent (Holocene) deposits varies between zero and tens of feet-thick.

Flat-lying marine terrace deposits underlie the unconsolidated recent deposits in the project vicinity. These semi-consolidated terrace soils are remnants of older beach deposits. The marine terrace deposits are exposed in the shoreline bluffs along most of the Lincoln County shoreline, including the project area. The semi-consolidated Pleistocene marine terrace deposits form steep bluffs along the shoreline and extend inland as much as a mile. The terrace deposits directly overlie the wave-cut benches formed on westward-tilted, Tertiary marine siltstone, sandstone, and marine clasts of the two formations exposed in the region; the Yaquina and Nye formations. The base of the marine terrace deposit may contain a lag deposit of coarse sand, gravel, and cobbles that formed as the shoreline transgressed to the east, prior to the deposition of the Pleistocene beach deposit. The Pleistocene marine terrace deposits range in thickness between 0 and 50 feet or more (Schlicker, et. al., 1973).

Tertiary (middle to late Oligocene), marine siltstone, and sandstone (Nye, Yaquina, and Alsea Formations) underlie the marine terrace deposit. The contact between the Yaquina/Nye Fm. and the Plio-Pleistocene terrace deposit has an approximate 40 MA year unconformity with the underlying Yaquina/Nye bedded sandstones, siltstones, and biogenic clasts inclined westward at dips ranging between 5 and 30 degrees, based on exposures along the Alsea River embayment and east of the project site. Thicknesses of individual beds of siltstone versus sandstone are unknown at the project site as this unit is not exposed at the surface in the project vicinity. The thickness and extent of these units is extremely variable laterally within the formations. The erosional contact between the Plio-Pleistocene terrace deposits and the underlying Oligocene siltstone and sandstone is regionally flat, however locally may be irregular due to variable erosional resistance variability between the materials composing the formations, as well as by downcutting of small streams in the young weakly consolidated material. Additionally, due to the unfavorable dip towards the west and active shoreline erosion, bedding plane failures (landslides) within the local sedimentary rocks exists and displaces the overlying Plio-Pleistocene through Holocene-aged deposits. The thickness of the Tertiary marine Alsea Formation ranges in thickness between 150 and 3,500 feet (Snavely, et. al., 1975).

In addition to the sedimentary units, regionally there are significant volcanic flows associated with the Columbia River Flood Basalts (CRBs). These flows occurred between the marine terraces and the Yaquina/Nye formations. The flows originate in Central Oregon and follow topographic lows in the region, and cause an inversion of topography. This is exposed north of Driftwood at Seal Rock where there is a contact between the CRBs and the Yaquina formation below it. The CRBs would only be present in a region that had a stream discharging into the ocean, such as the Alsea into the Yachats bay south of the job site, or any other major depressions in the topography. These flows often produce prominent outcrops in the form of headlands and sea stacks, as observed at Seal Rock.

There is some indication from the local geology of the headlands composed of CRBs that the surface flows may have "dove" subsurface. This would occur only in regions of very weak sediments with a low density, such as dunes and beach sand. This is caused by the much higher density lava flowing over less dense sediment and the flow essentially "sinks" into the material until it reaches a more resistant material, such as underlying rock, and follow that material's topography.

The units outlined in the above section are representative at the inferred units in the region. This inference is based on the stratigraphy of Seal Rock and other cliff-terrace outcrops north and south of Driftwood. This inference is made with high confidence as the sedimentary units that are outlined are on either lateral boundary in outcrop to both the north and south.

2.2. Conditions Encountered

Based on geophysical interpretations, the stratification is simplified as follows:

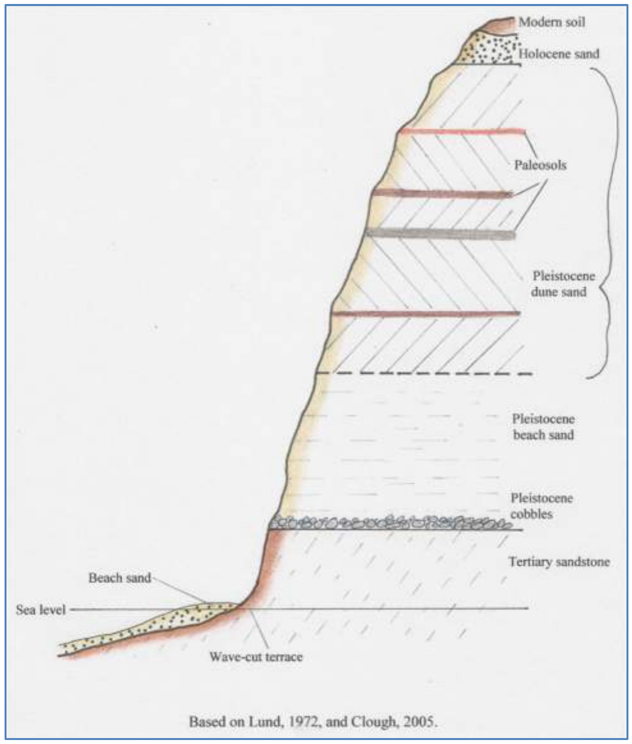
- Layer 1: Unconsolidated Sediments:

  Primarily beach sands are comprised of well sorted medium grained, moderate to well-rounded quartz, and other sediments collecting on the seabed. The sediment fines upward in layers eroded and deposited by wave action on the beach and shallow marine environments. There is a moderate amount of biogenic clasts; predominantly shells that vary in size and are generally fractured by wave action on the sediment surface.

- Layer 2: Terrace Deposits:

  Weak to moderately lithified and consolidated beach sand, compositionally similar to Layer 1, but much older. This layer is also deposited in several subsets of layers all compositionally variable dependent on water depth of deposition. This unit is likely deposited on top of a wave cut platform of more erosion resistant rock. These terraces are exposed by wave-cut cliffs regionally.

  The figure to the right shows a simplified stratigraphic column of what a marine terrace may look like in outcrop in the Seal Rock area (taken from "Geology of the Seal Rock Area" by Maxine Centala').

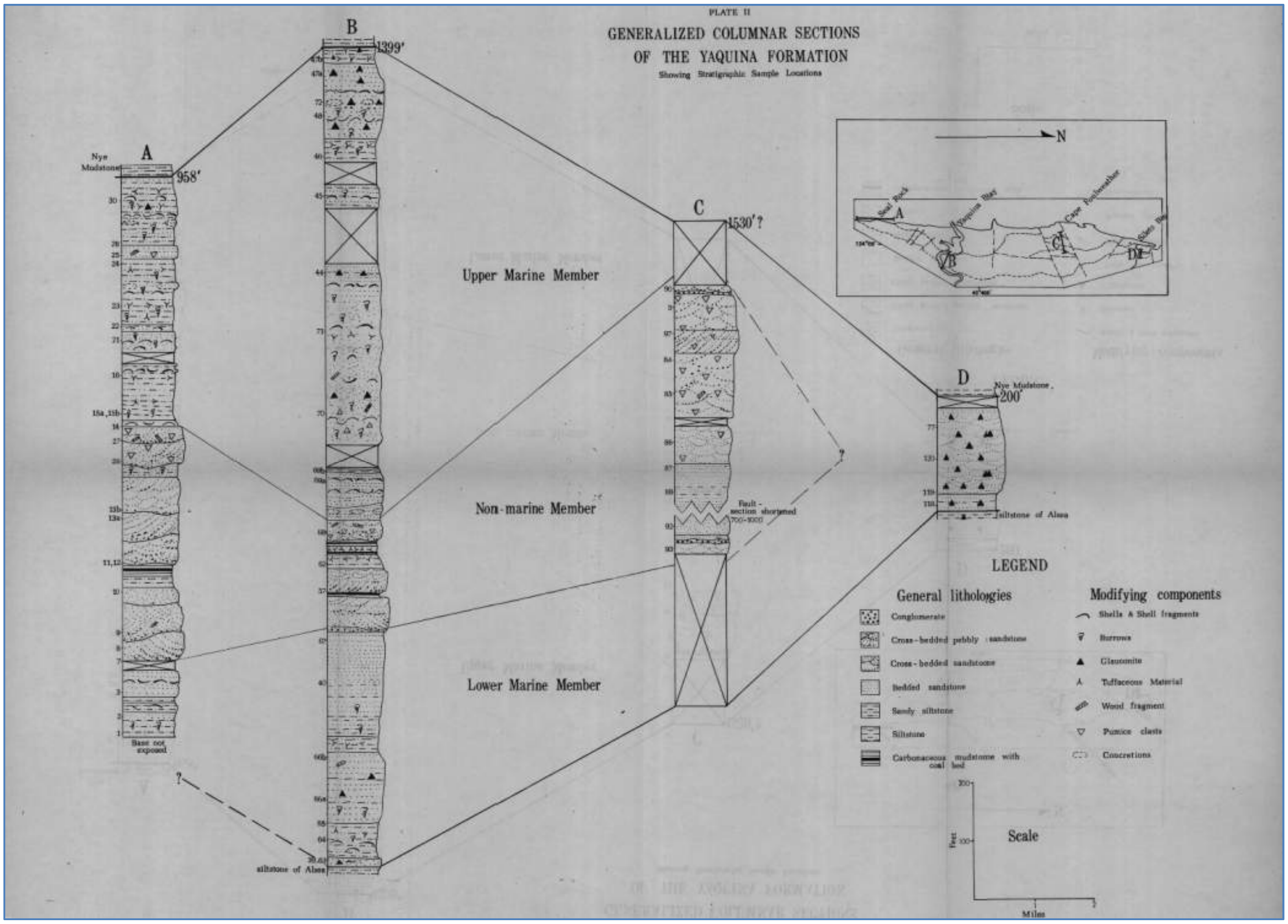


- Layer 3: Sedimentary Rocks including the Nye, Yaquina, and Alsea Formations:

  Yaquina and Nye formations are likely present in the work site. The Nye formation overlays the Yaquina formation and is dominated by well sorted, well rounded sandstone that is moderately consolidated. If present, it would be only a few feet thick or less, and relatively homogenous.

  The Yaquina formation is the lower most unit in the scope of the data. A detailed stratigraphic column of the unit is displayed in the figure below. Note that the stratigraphic column is only a generalization and is not derived from observations on the site; the actual materials found will vary locally. The stratigraphic column (From Goodwin 1972) is only intended to serve as a description of what materials and the order of stacking that is likely to be found.

  The Yaquina is broken into three general pieces. The oldest is shallow marine sediments, varying from beach sand to silt sized particles, and forming a moderate to well-consolidated sandstone. The middle age materials were deposited by rivers and can contain cobbles to silt sized particles, as well as organics such as wood. This layer is the most variable regionally as shown between the three columns below. The youngest and most substantial deposit in the unit, and the portion that is most likely on site, is shell rich sandstone, moderately to heavily consolidated. Column A is best representative of the geology that is expected to appear in Layer 3 through the HDD corridor.



Note:

The assemblage of local geologic knowledge "Geology of the Seal Rock Area" prepared by Maxine Centala (2013) is available on-line at www.sealrockor.com/Geology.html and is recommended for review to gain an improved understanding of the history that drives the possible conditions to be encountered through the HDD corridor.

3. Geophysical Data Acquisition: Marine

The geophysical methods were designed to explore the geotechnical conditions to depths of 100 feet and beyond. The use of multiple methods improves the confidence of the interpretation as each method offers particular strength (and weakness) and the combined results provide complimentary information that is more valuable than any of the methods individually.

In this section, the geophysical methods, equipment, challenges, and data quality are described.

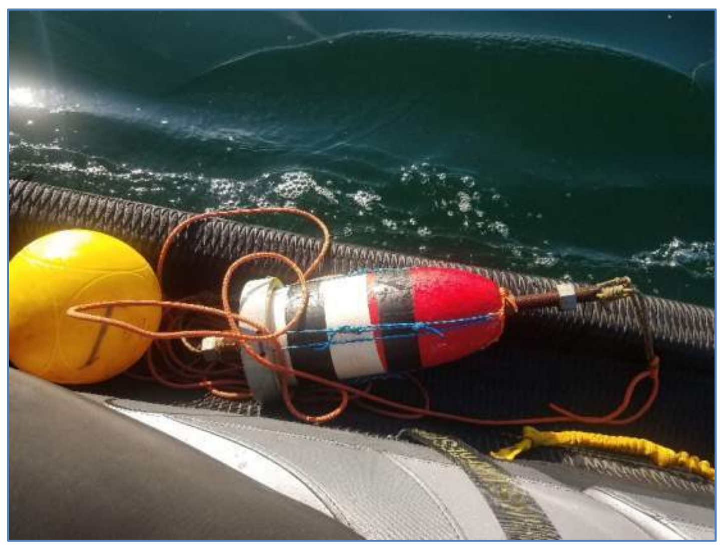
3.1. Geophysical Methods and Equipment

3.1.1. Electrical Resistivity (ER)

How it works: Two-dimensional (2D) electrical resistivity tomography is a geophysical method to illustrate the electrical characteristics of the subsurface by taking measurements on land or in a marine setting. These measurements are then interpreted to provide a 2D electrical resistivity tomogram which is, in turn, related to the likely distribution of geologic or cultural features known to offer similar electrical properties. Measurement in an electrical survey involves injecting DC current though two current-carrying electrodes and measuring the resulting voltage difference at two or more potential electrodes. The apparent resistivity is calculated using the value of the injected current, the voltage measured, and a geometric factor related to the arrangement of the four electrodes.

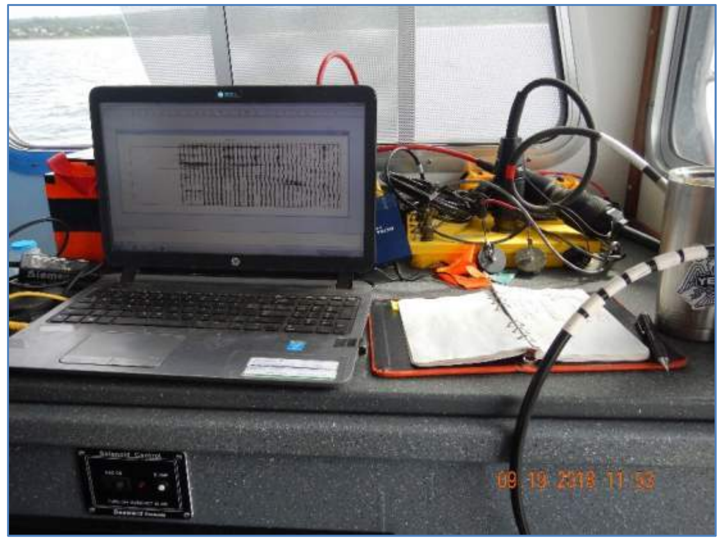
The investigation depth of any measurement is related to the spacing between the electrodes that inject current. Therefore, sampling at different depths can be done by changing the spacing between the electrodes. Measurements are repeated along a survey line with various combinations of electrodes and spacing to produce an apparent resistivity cross-section (tomogram). In this case, SA used the Dipole-Dipole array with electrode spacing of 3 m along a specially manufactured marine resistivity cable built with 56 stainless steel electrodes. The cable was deployed to rest on the seabed and stabilized with steel weights positioned near the first and last electrodes. Each measurement sequence was designed for a data collection that required about 30 minutes and at the end of the sequence, the cable was slid forward approximately 2/3 of its length for the position of the next measure sequence providing for a data overlap equal to 1/3 of the cable length.

3.1.2. Seismic Refraction Microtremor (ReMi)



The refraction microtremor, known as ReMi is a passive, surface-wave analysis method for obtaining near surface shear-wave velocity models to constrain strength and position of shallow geologic boundaries. These analyses provide information about land and marine soil, and rock properties that are very difficult to obtain through alternative methods. SA recorded passive ambient vibrations (background noise) augmented by an active seismic source (Thumper) operated from a jet-ski near the array.

On land, surface wave analysis is performed using Rayleigh waves because they can be detected on an air-ground interface (earth surface) using geophones. However, the Scholte wave, which is a similar type of seismic surface wave propagating along the interface between a fluid layer and an underlying solid, dominate in marine work. Hence, the Scholte wave is capitalized in marine work and measured with hydrophones set at the water-seabed interface to record ambient vibrations. Both the hydrophones and geophones measure the vertical component of the surface wave (Scholte or Rayleigh) and the results are considered a reasonable estimate of the vertical distance (depth) to layers distinguished by velocity contrast below the receivers.



How it works: The ReMi analysis develops the shear-wave velocity/depth profile using an engineering seismograph, low frequency receivers (geophones or hydrophones) and straight-line array aperture (Louie, 2001). Ambient surface wave energy is recorded using relatively long sample window (30 seconds) recording the ambient wavefield. At this site, quality low frequency signals were consistently recorded although the records contain significant frequencies related to ocean swell, vessel engine vibrations, and more. Higher frequency input was provided using "Thumper," a proprietary marine source that was operated from a jet-ski along the hydrophone array.

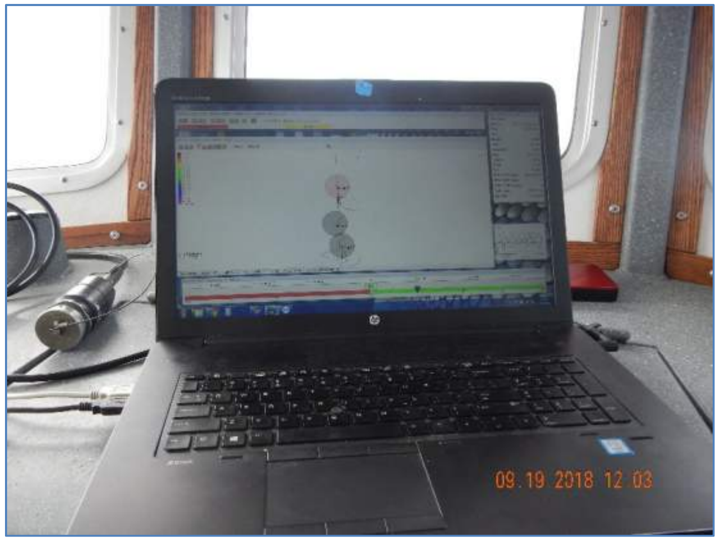
The microtremor records are transformed as a simple, two-dimensional slowness-frequency (p-f) plot where the ray parameter "p" is the horizontal component of slowness (inverse velocity) along the array and "f" is the corresponding frequency (inverse of period). The p-f analysis produces a record of the total spectral power in all records from the site, which plots within the chosen p-f axes. The trend within these axes, where a coherent phase has significant power is "picked." Then the slowness-frequency picks are transformed to a typical period-velocity diagram for dispersion. Picking the points to be entered into the dispersion curve is done manually along the low velocity envelope appearing in the p-f image.

Marine measurements were completed using a string of 36, 8 Hz. hydrophones built into a marine cable. Receiver spacing was set at 10 feet. Extended line length was accomplished by sliding the hydrophone array along the seabed leaving a 12 receiver overlap at each position.

Data were recorded using a networked pair of DAQ 4 seismographs manufactured by Seismic Source in Ponca City, Oklahoma, USA, connected to an HP laptop computer.

3.2. Horizontal and Vertical Control

Survey route coordinates were provided by 3U Technologies and these data were interpreted and utilized by Solmar Hydro for navigation and route survey control. Solmar mobilized a Trimble R8-3 RTK-GNSS (real-time kinematic global navigation satellite system) receiver, an SBG Systems Eclipse 2-A attitude and heading reference system (AHRS), and a Teledyne Odom CV100 singe-beam echo sounder (SBES) to complete the hydrographic survey.



Xylem Hypack hydrographic surveying software was used for data acquisition. Data were correlated with the NOAA Tides and Currents tide gauge at the NOAA terminal. This correlation provides a basis for converting the recorded NAVD88 datum to other datum formats if required.

The equipment provided real-time positioning along the survey routes with sub-meter accuracy. Bathymetry is judged to offer an accuracy on the order of 1/10th of a foot.

3.3. Ancillary Operations

3.3.1. Vessel

Vessel support was provided by Solmar Hydro, Inc. who mobilized a 29-foot, aluminum hull vessel with twin 200 HP outboards. The vessel was equipped for hydrographic survey and provided an excellent platform for data acquisition and navigation.

Support to extend the survey into the surf zone was provided by Ossies Surf Shop, Newport, Oregon, who mobilized to the site on a jet ski. The jet ski was launched from Waldport and met the SA survey team on site.

3.4. Summary of Challenges

3.4.1. Operations

Several weeks prior to the scheduled survey, the client requested a plan to modify the scope that included extended survey line length and bathymetry measurement throughout the HDD corridor. SA accommodated the request and adapted the data collection operation accordingly. Specifically, the original plan to draw the geophysical cables toward the shoreline using a long retrieval winch stationed at Driftwood was abandoned. Cable positions were determined using the vessel navigation system rather than distance measured with the retrieval winch. As it turned out, this change was favorable given the prevailing tide, weather, and sometimes rough seas at the time of the survey.

Although the weather was reasonably favorable in the mornings, wind, wave, and swell gained intensity in the early afternoon. As a result, the available survey time that included avoiding difficult weather was shortened. To complete the survey given the shortened schedule, SA altered the data collection methods to speed the collection sequences to fit the available time.

The transition surf zone was more difficult to safely approach than anticipated. This led to a larger than anticipated information gap between the terrestrial geophysical results completed in 2017 and the marine exploration even though marine data collection started near the surf at high tide. The jet ski was used to limit the information gap by handing the weighted end of the geophysical cable to the jet ski that was able to safely extend the cable directly into the surf as far as the cable length allowed. The survey vessel maintained a safe position just outside of breaking waves as the jet ski maneuvered into the surf.

3.4.2. Data Quality and Interpretation Challenges

In general, the recorded data are judged to be of moderate quality compared to the results from the terrestrial survey and of very good quality given the challenging survey environment. Data quality were compromised by several factors including shortened survey time as described and the dynamics of the surf transition zone. The shortened schedule required a reduction in the quantity of data collected (particularly in redundant collection) which condenses the data available for scrutinization during processing. The dynamics of the ocean promotes movement of the bottom cables even though they are heavily weighted and drawn tight during each slide to the new position. Cable movement causes noisy data and this promoted challenges for processing both ER and ReMi data.

Even so, it is the opinion of SA that the results provide an effective overall look at subsurface conditions through the north and south boundaries of the HDD offshore corridor and the reasonable correlation between the stratigraphy illustrated by independent geophysical methods leads to greater confidence in the findings than would be had by only one method.

4. Processing and Interpretation

4.1. General

During the data gather, partial interpretation was completed in the field for quality control purposes and to assist in setting and confirming proper data acquisition parameters. The instruments were continuously monitored through the data acquisition phase.

The interpretation for each line is presented in this section and the locations of the lines are shown graphically on Figure 101. Results for each method along each line are presented in appendices to this report. ER and ReMi tomograms are presented using the same horizontal and vertical scales and horizontal zero coordinate to assist in correlation. ReMi results are also presented on a scale of 1 inch = 400 feet horizontal and 1 inch = 50 feet vertical to incorporate the terrestrial results measured along the same HDD lines in 2017. The apparent resistivity scaling factors do not correlate well between the marine and terrestrial surveys and although attempted by SA, no benefit was found by providing a similar correlation between marine and terrestrial ER results.

In the opinion of SA, the 2D S-wave (ReMi) tomograms are the most robust and plausible description of the conditions encountered. While the ER results are similar, visual review of the ER tomograms are more challenging to interpret.

It is worthy to emphasize that the geophysical results are presented in 2D yet the data collection is influenced by a 3D environment. Unless the geology is simple, like a flat stack of pancakes, the various geophysical methods cannot be expected to match perfectly. In addition, geophysical interpretations are often compared to direct observation of conditions discovered in geotechnical drill holes. Note that the drill hole is a 1D description of the subsurface and represents a very small sampling, unlike the geophysical approach. Correlation and conflict are expected, and both must be considered in context with the factors that influence data quality, complication of the subsurface and the geophysical parameters measured.

A description of the data processing, interpretation methods and results are presented in the following sections.

4.2. Electrical Resistivity (ER)

Important factors which affect the resistivity of different geological material are:

- Porosity
- Moisture content
- Dissolved electrolytes
- Temperature (resistivity decreases with increasing temperature)

Each dataset was filtered to remove spikes, noisy, and mis-fit data through a systematic progression to produce plausible inversion models without excessive iteration. As discussed, data were noisy due to various reasons and this led to filtering (removal) of nearly 50% of the data collected. This level of filtering is high although not uncommon in a difficult saltwater marine environment. The remaining data still provides a sampling through depth well beyond 100 feet. The best resolution is within the upper 50 feet or so and fewer data are available to resolve deeper strata. For this reason and the effect of merging overlapping data sets, the ER tomograms are blocky and illustrate stratification that is more complicated than reality.

4.2.1. ER Processing and Presentation

The data sets were processed using AGI Earth Imager Software and Res2D INV by Geotomo Software, Malaysia. After many iterations and trials with various algorithms and review of the results, SA selected the images developed with the AGI software as the most plausible description of the conditions encountered. The tomograms are graphically scaled 1 inch = 300 feet horizontal and 1 inch = 50 feet vertical. The temperature and conductivity of the water layer was measured onsite and utilized in the data processing: water conductivity = 0.27 Ohm-m, Temperature = 14.9^0 C.

4.2.2. Considerations in ER Interpretation

Lines 1 and 2 on HDD-1 and HDD5, respectively: The results present similar findings along each line that roughly correlate with stratification developed using the ReMi method. The tomograms are blocky and effective interpretation requires a broad simplification to knit layers together and close the gaps where data were filtered in the processing stage and not recorded due to the length of the overlapping measurement. Considering this simplification, the ER results clearly show at least three layers to differentiate geologic boundaries below the seabed.

Unconsolidated Sediments

In general, the apparent resistivity increases with depth and the lowest resistivity is interpreted to be associated with conductive, unconsolidated sediments of the seabed. The layer resistivity ranges from about 0.1 to 0.3 Ohm-m. Layer thickness ranges from 10 to about 40 feet. This layer is likely composed of fine-grained materials that include silts and sands like beach deposits although probably finer.

Terrace Deposits

Below the unconsolidated layer, the apparent resistivity increases and through the range of about 0.3 to 0.45 Ohm-m, SA interprets the results to be indicative of terrace deposits. The texture and consolidation of this layer is expected to vary as the layer is composed of materials cut, reworked, and then deposited with its origins being a variety of soil and rock types including beach sand, cobbles, and boulders of the CRBt and remnants of local sedimentary rocks.

Sedimentary Rocks (undifferentiated)

The highest apparent resistivity, occurring at depths below the seabed ranging from about 40 to 60 feet (possibly greater) are interpreted to represent undifferentiated sedimentary rock. Apparent resistivity is not an indicator of the strength of geologic materials and in this case, it appears that the electrical contrast at this boundary is not distinct. Since there are a variety of local formations that could have similar electrical properties because they have similar origin and texture, it is the opinion of SA that distinct sedimentary units are not defined by the electrical method. Further, the transition from the overlying terrace deposits to the sedimentary units is also not distinguished in these tomograms.

Based on geologic research, the CRB (like that present ~1500 feet north of HDD-1) could occur within this and other layers. To evaluate this potential, SA collected submerged sample of this basalt from the surf zone at Seal Rock State Park and tested the apparent resistivity in the laboratory with the specimens submerged in seawater. The results indicate an apparent resistivity that ranged from 1.1 to 1.4 Ohm-m. Apparent resistivity in this range was not measured within the upper layer and although unconformable, it is remotely possible that apparent resistivity on the order of 1 Ohm-m could be indicative of isolated basalt features.

4.3. Refraction Micro-tremor (ReMi)

ReMi data were procured along the same routes as ER. The models are of particular value as the shear wave velocity is directly related to the strength of a geologic material. The models were produced by Dr. Satish Pullammanappallil, Ph.D. of SubTerraSeis, LLC, using Geogiga SubsurfacePlus 8.3 software. The 2D models illustrate the trend in the subsurface in terms of shear-wave velocity that correspond closely with trends in the ER although the fit is not perfect.

Shear-wave velocity, V_s is used to determine the shear modulus, G, of soil or rock:

$G = \rho\ (V_s^2)$: a valuable measure of soil stiffness and rock strength

Where ρ = mass density (i.e. total unit weight / gravitational acceleration constant, 32.2 ft/s^2)

The ReMi derived V_s is interpreted from small strain measurements produced by non-destructive surface waves (Scholte waves) with strain on the order of 10^{-4} %. Shear modulus (G) derived from shear-wave velocity measured insitu using surface wave methods is commonly referred to as the small-strain shear modulus G_{max}.

4.3.1. ReMi Processing and Presentation

Dr. Pullammanappallil, Ph.D. created the 2D profiles using a series of 1D shear-wave depth profiles along each line typically using 12 to 24 channels per analysis progressing through the data with two channel increments (channels 1 to 12, 3 to 14, 5 to 16 and so on). As many as 36 channels were used to constrain the deepest parts of the models. The data were noisy due to surf, vessel motor frequencies, swell, and possibly other factors. Dr. Pullammanappallil applied various filtering techniques during the data processing effort.

The ReMi tomograms are presented on the same scale as ER for correlation and SA developed a second presentation with a horizontal scale of 1 inch = 400 feet and added the results of the terrestrial ReMi surveys along the same HDD lines. This presentation is useful and illustrates consistency in the depth to the fastest velocity and diminishing thickness of the upper, unconsolidated sediment to the east. The thickness of the intermediate layer interpreted as terrace deposits is greater through the terrestrial interval due to the nature of the environment of the unit's deposition. The terrace is dominated by beach sand and sand dunes, and was predominately shallow ocean and subaerial when deposited. When deposition was occurring in the unit, it was much thicker inland and tapered down in thickness moving east into deeper water.

4.3.2. Considerations in ReMi Interpretation

Lines 1 and 2 on HDD-1 and HDD5, respectively: The results present similar findings along each line that roughly correlate with stratification developed using the ER method. The tomograms illustrate progressively increasing velocity with depth with a few velocity reversals and irregular transitions to the various layers.

Unconsolidated Sediments

Through the upper layers, shear-wave velocities as low as ~200 f/s are interpreted and represent very weak sediment through many shallow intervals. The lowest velocity up to about 500 f/s are representative of the unconsolidated layer and based on this range, thickness varies from 10 to nearly 35 feet.

Terrace Deposits

This intermediate layer is interpreted to be represented by S-wave velocity in the range of about 500 to 1200 f/s, possibly a bit higher in areas. As discussed, the terrace deposit is anticipated to include a variety of material types including variable degree of consolidation. As a result, S-wave velocity cannot be directly related to any specific material type although geologic materials with S-wave velocity in this range offer moderate to moderately high strength. Due to the heterogeneity inherent to a terrace deposit, these characteristics are likely to change significantly over short distances and the irregularity of the ReMi tomograms support that conclusion. Terrace deposit thickness through the marine ReMi survey varies from about 10 to 30 feet.

Sedimentary Rocks (undifferentiated)

S-wave velocity on the order of 1200 f/s and higher are interpreted to represent strong, more homogeneous geology typical of the various sedimentary units described in the geologic literature available to SA. The highest velocity region (>2200 f/s) is interpreted to represent the most homogeneous of the sedimentary layers. The tomograms illustrate much greater variability within the velocity zone 1200 to 2200 f/s, probably due to surficial erosion, weathering, and other disturbance. Depth to the top of the sedimentary layer varies from about 45 to 65 feet with the top of the highest velocity rock ranging from 45 to 90 feet.

Although unlikely, there is a possibility of basalt inclusions within these higher velocity regions. As described earlier, the CRB deposition associated with the nearby Seal Rock area could extend into the HDD corridor and fill ancient depressions or displaced weak materials present at the time of deposition. Fresh, non-weathered, and lightly fractured/jointed basalt typically offers S-wave velocity greater than 2500 f/s and these velocities (and higher) are interpreted at depth. This occurrence would be unconformable and is considered a possibility, although remote.

ReMi is a volume averaging method and hence, it is challenging to resolve small variations within high velocity layers. Also, the resolving power decreases with depth and thus variations (particularly velocity reversal) are less likely to be imaged within the deep, higher velocity layers.

4.3.3. Seismic Site Classification (ASCE 7)

Seismic Site Classification in accordance with ASCE 7 was calculated from data along each of the 2D ReMi lines. The average shear wave velocities through the upper 100 feet (Vs100) which defines the seismic site classification ranges from Site Class E to C and is dominated by Site Class D. A summary of the calculated values of Vs100 are as follows:

- RM-1 on HDD-1: Vs100 range: 584 to 1071 f/s, average: 821 f/s (Site Class E to D)
- RM-2 on HDD-5: Vs100 range: 578 to 1289, average: 945 f/s (Site Class E to C)

5. References

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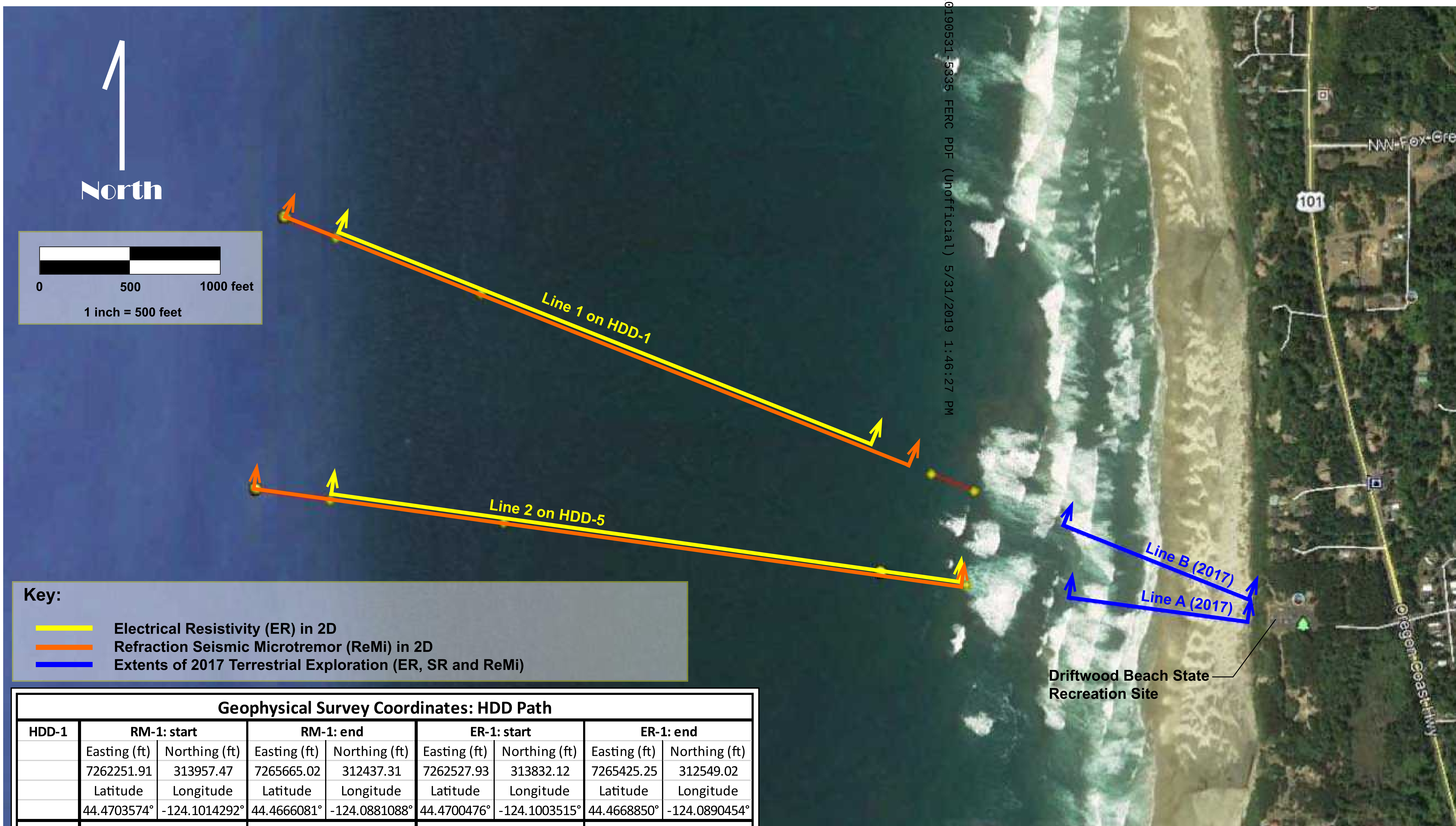
6. Graphical Presentation of Results

The interpretations are presented in 2D with the locations of the various lines illustrated on Figure 101.

6.1. Figure 101: Site Plan: Marine Geophysical Surveys - HDD



Geophysical Survey Coordinates: HDD Path

HDD-1	**RM-1: start**		**RM-1: end**		**ER-1: start**		**ER-1: end**	
	Easting (ft)	Northing (ft)	Easting (ft)	Northing (ft)	Easting (ft)	Northing (ft)	Easting (ft)	Northing (ft)
	7262251.91	313957.47	7265665.02	312437.31	7262527.93	313832.12	7265425.25	312549.02
	Latitude	Longitude	Latitude	Longitude	Latitude	Longitude	Latitude	Longitude
	44.4703574°	-124.1014292°	44.4666081°	-124.0881088°	44.4700476°	-124.1003515°	44.4668850°	-124.0890454°
HDD-5	**RM-2: start**		**RM-2: end**		**ER-2: start**		**ER-2: end**	
	Easting (ft)	Northing (ft)	Easting (ft)	Northing (ft)	Easting (ft)	Northing (ft)	Easting (ft)	Northing (ft)
	7262025.36	312474.27	7265799.64	311815.77	7262436.13	312397.12	7265749.64	311825.77
	Latitude	Longitude	Latitude	Longitude	Latitude	Longitude	Latitude	Longitude
	44.4662652°	-124.1020429°	44.4649212°	-124.0874880°	44.4661040°	-124.1004579°	44.4649425°	-124.0876810°

Site Plan: Marine Geophysical Surveys - HDD

Figure: 101

PacWave: HDD Path

On the Pacific Ocean, near Waldport, Oregon

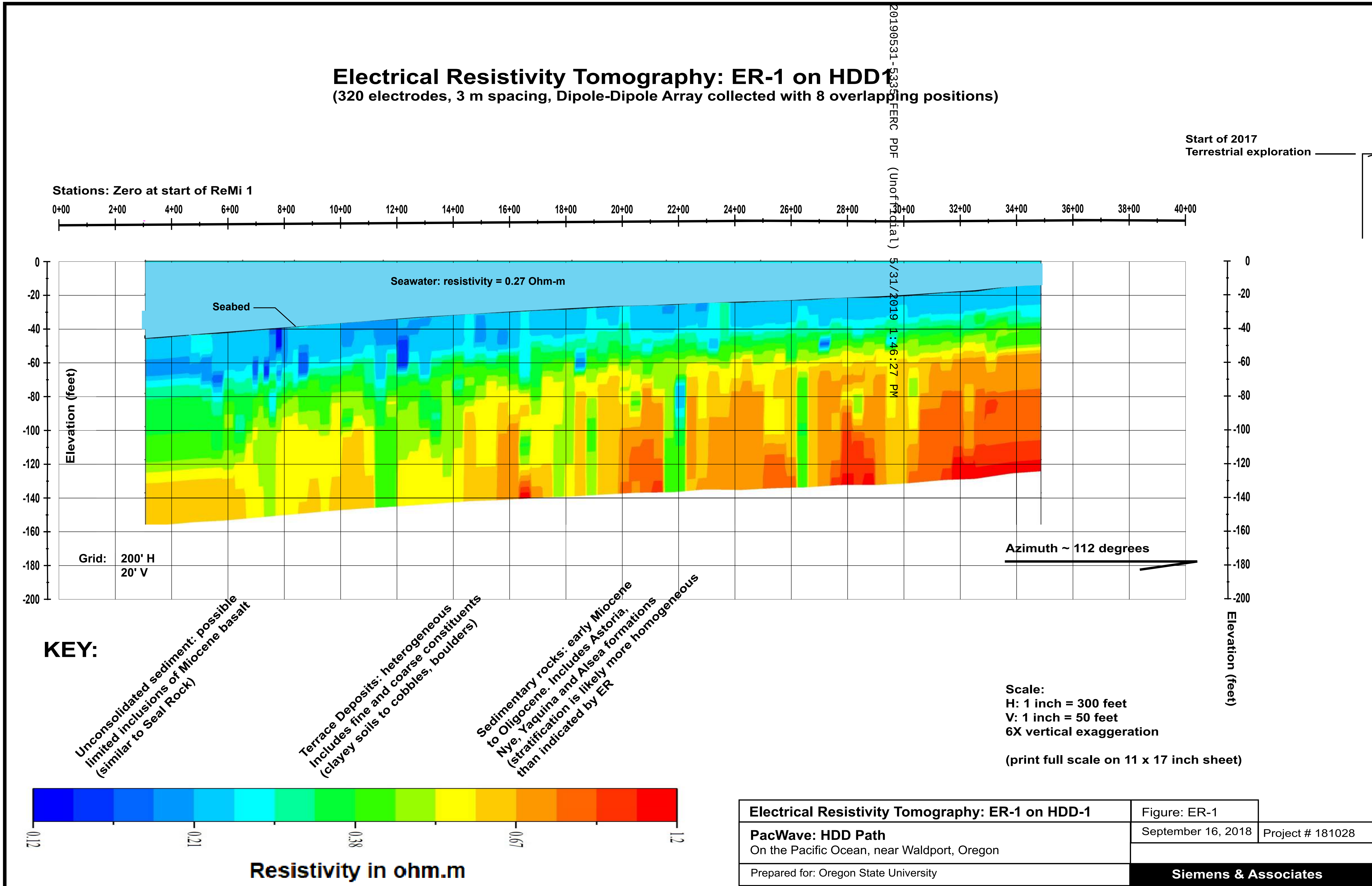
September 18, 2018

Project # 181028

Prepared for: Oregon State University

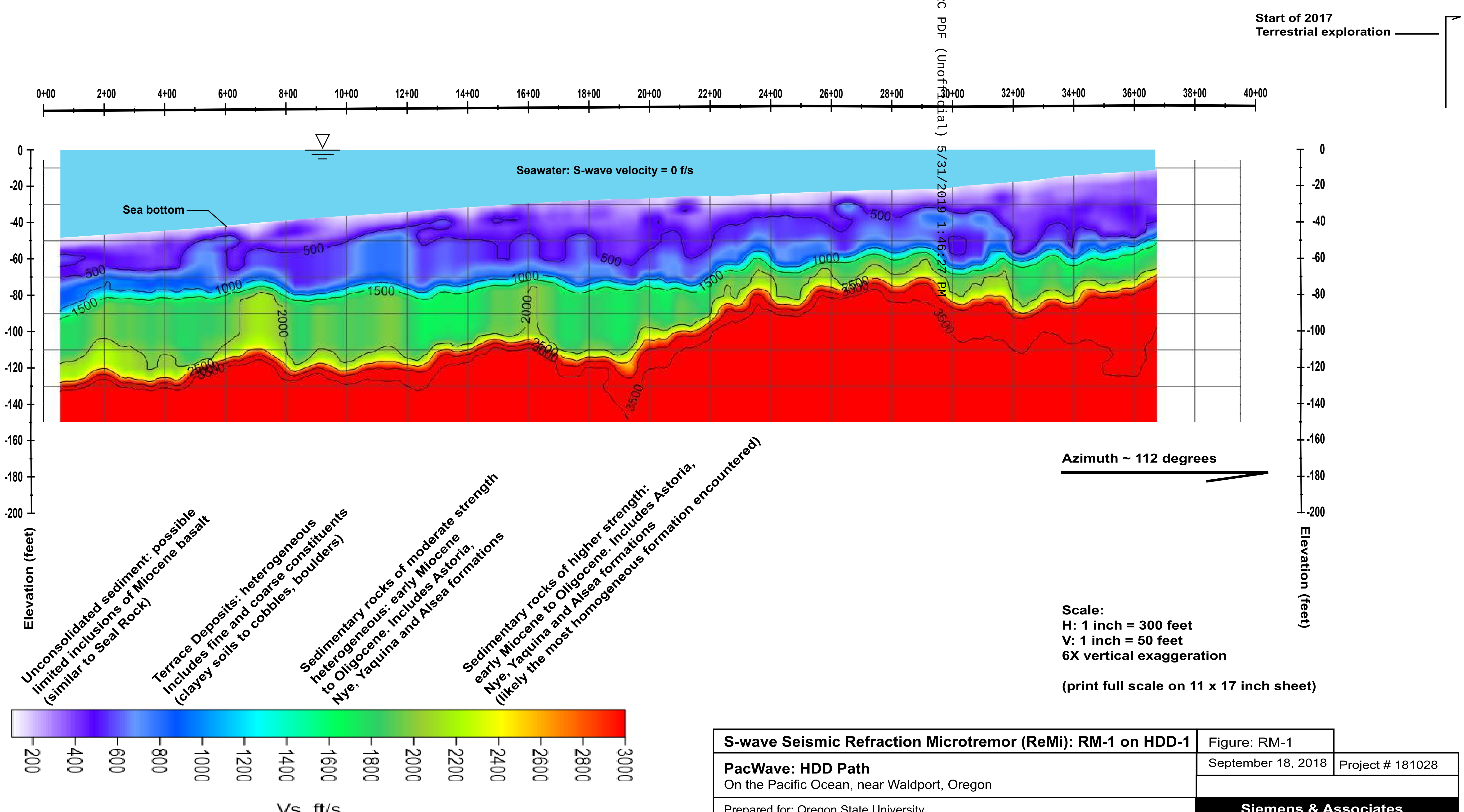
Siemens & Associates

6.2. Results: ER and ReMi, Line 1 on HDD-1


Electrical Resistivity Tomography: ER-1 on HDD1
(320 electrodes, 3 m spacing, Dipole-Dipole Array collected with 8 overlapping positions)
Start of 2017
Terrestrial exploration
Stations: Zero at start of ReMi 1
0+00
2+00
4+00
6+00
8+00
10+00
12+00
14+00
16+00
18+00
20+00
22+00
24+00
26+00
28+00
30+00
32+00
34+00
36+00
38+00
40+00
Seawater: resistivity = 0.27 Ohm-m
Seabed
Elevation (feet)
0
-20
-40
-60
-80
-100
-120
-140
-160
-180
-200
Grid: 200' H
20' V
Azimuth ~ 112 degrees
KEY:
Unconsolidated sediment: possible limited inclusions of Miocene basalt (similar to Seal Rock)
Terrace Deposits: heterogeneous Includes fine and coarse constituents (clayey soils to cobbles, boulders)
Sedimentary rocks: early Miocene to Oligocene. Includes Astoria, Nye, Yaquina and Alsea formations (stratification is likely more homogeneous than indicated by ER
Scale:
H: 1 inch = 300 feet
V: 1 inch = 50 feet
6X vertical exaggeration
(print full scale on 11 x 17 inch sheet)
0.12
0.21
0.38
0.67
1.2
Resistivity in ohm.m
Electrical Resistivity Tomography: ER-1 on HDD-1
Figure: ER-1
PacWave: HDD Path
On the Pacific Ocean, near Waldport, Oregon
September 16, 2018
Project # 181028
Prepared for: Oregon State University
Siemens & Associates

S-wave velocity: Seismic Refraction Microtremor: RM-1 on HDD1

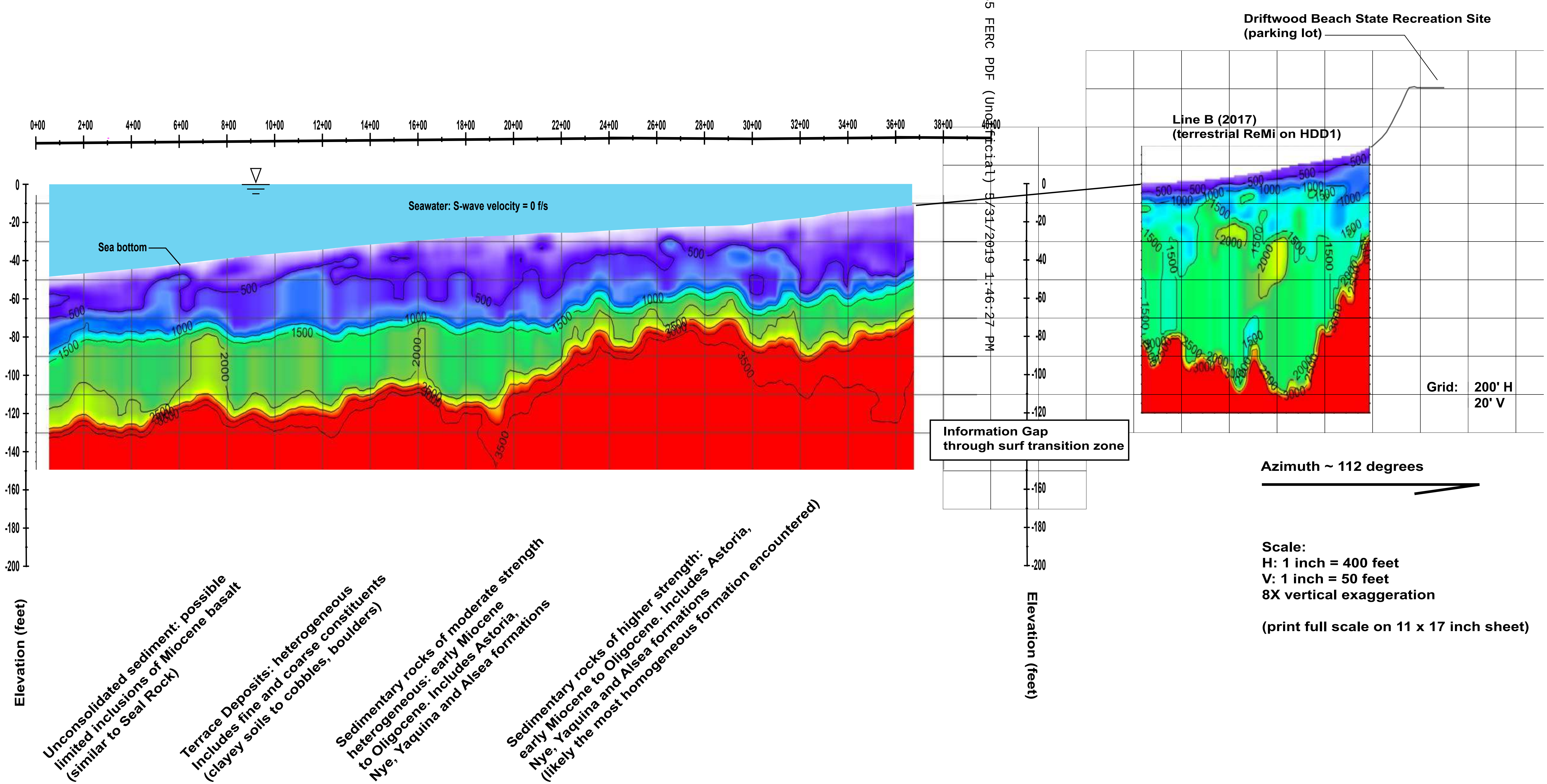
(374, 10 Hz. hydrophones on 10 foot spacing, recording bottom conditions at 14 overlapping positions)

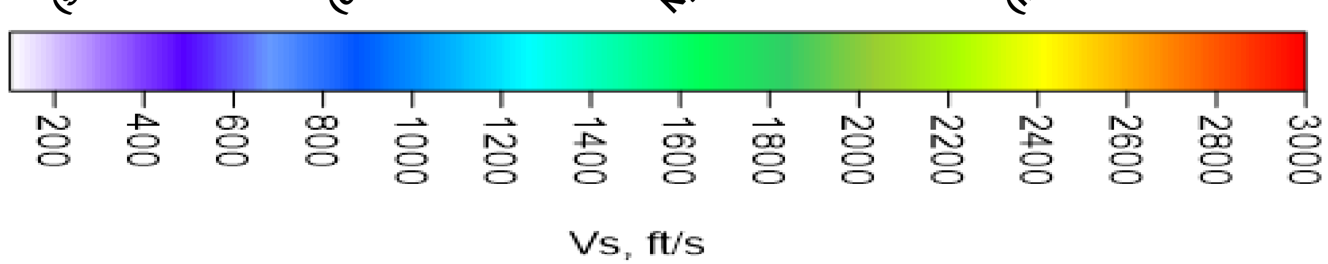


S-wave Seismic Refraction Microtremor (ReMi): RM-1 on HDD-1	Figure: RM-1	
PacWave: HDD Path On the Pacific Ocean, near Waldport, Oregon	September 18, 2018	Project # 181028
Prepared for: Oregon State University	**Siemens & Associates**	

S-wave velocity: Seismic Refraction Microtremor: RM-1 on HDD1

(374, 10 Hz. hydrophones on 10 foot spacing, recording bottom conditions at 14 overlapping positions)

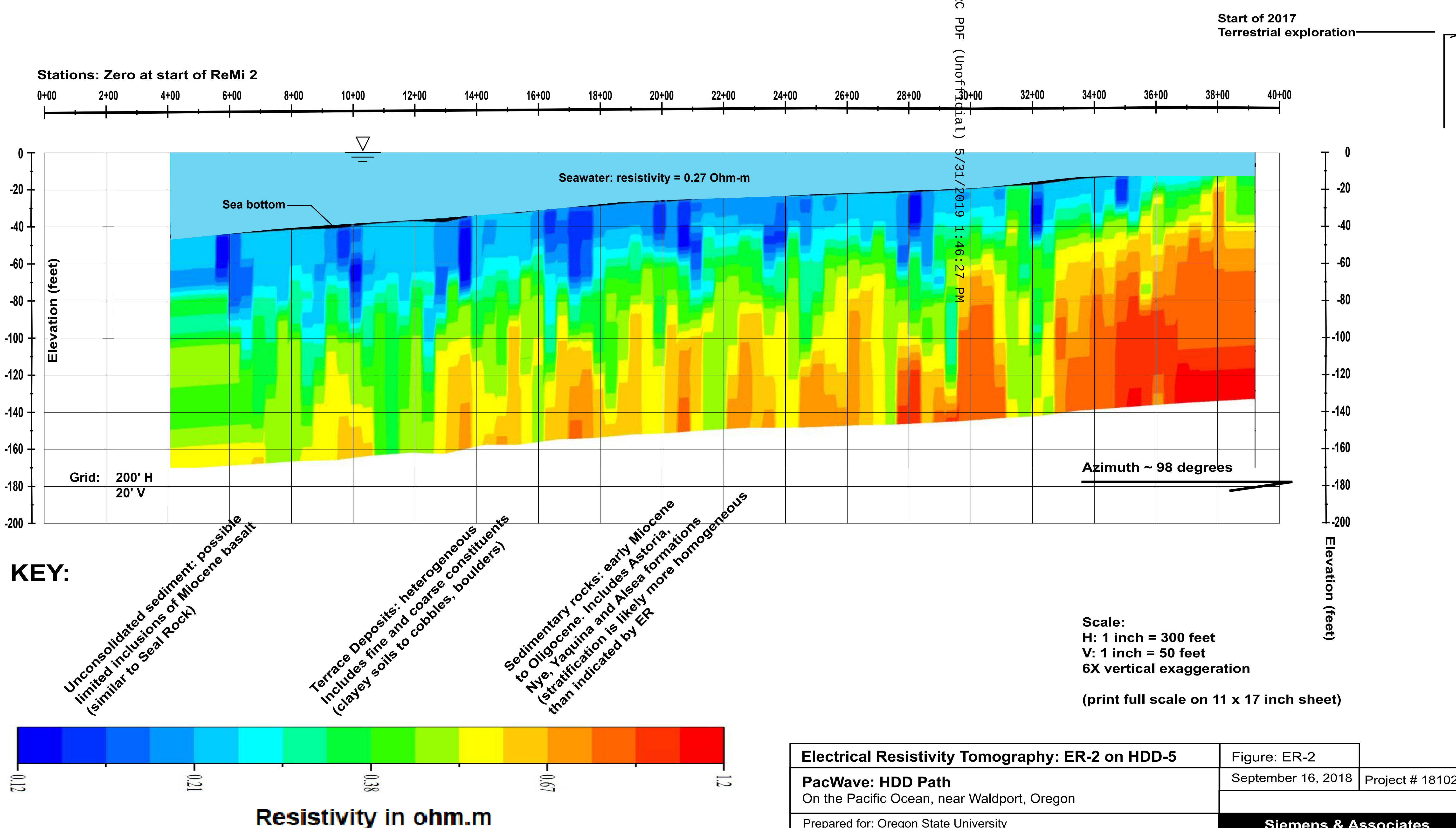




S-wave Seismic Refraction Microtremor (ReMi): RM-1 on HDD-1	Figure: RM-1s	
PacWave: HDD Path On the Pacific Ocean, near Waldport, Oregon	September 18, 2018	Project # 181028
Prepared for: Oregon State University	**Siemens & Associates**	

6.3. Results: ER and ReMi, Line 2 on HDD-5

Electrical Resistivity Tomography: ER-2 on HDD5
(356 electrodes, 3 m spacing, Dipole-Dipole Array collected with 9 overlapping positions)



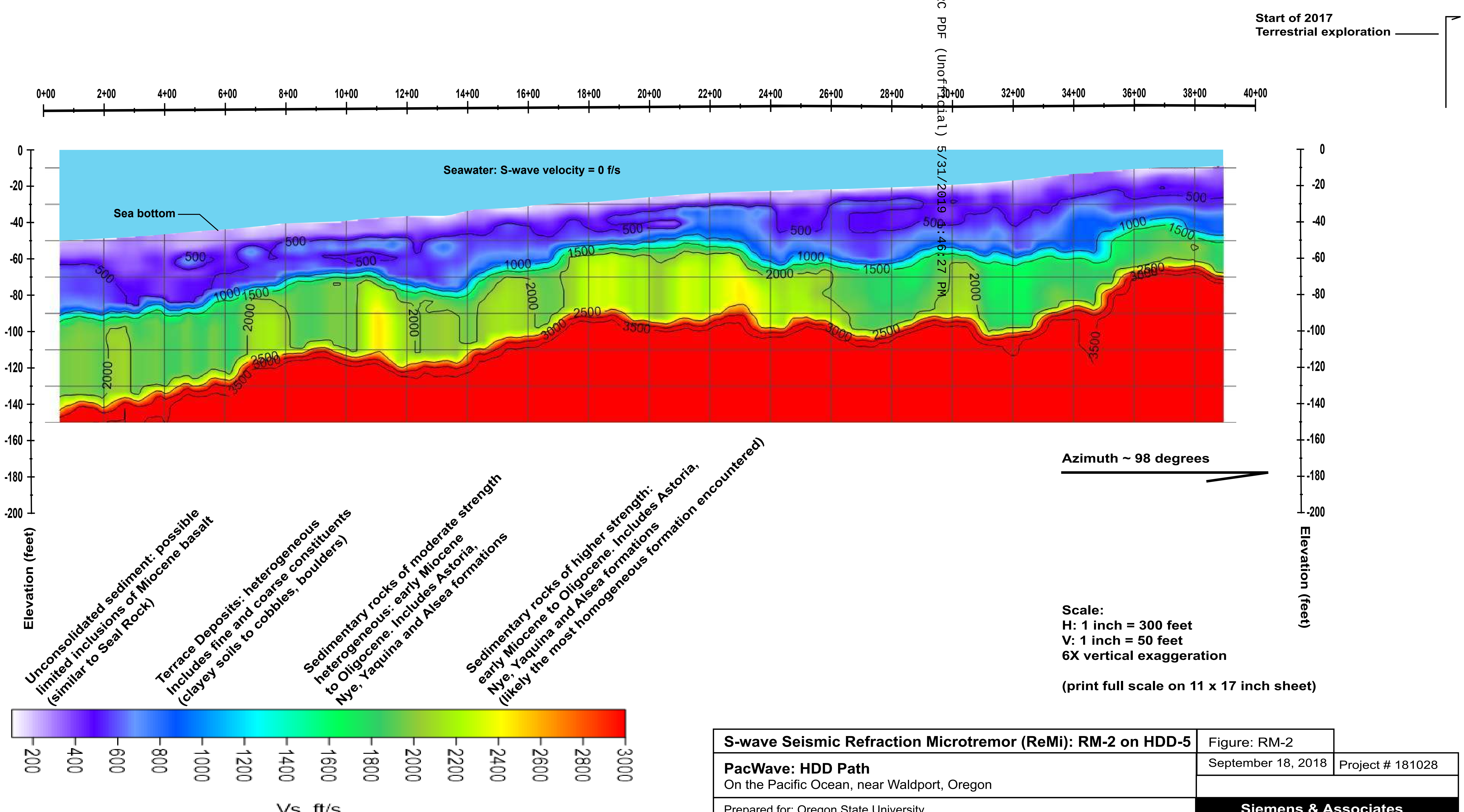
Scale:
H: 1 inch = 300 feet
V: 1 inch = 50 feet
6X vertical exaggeration

(print full scale on 11 x 17 inch sheet)

Electrical Resistivity Tomography: ER-2 on HDD-5	Figure: ER-2	
PacWave: HDD Path On the Pacific Ocean, near Waldport, Oregon	September 16, 2018	Project # 181028
Prepared for: Oregon State University	**Siemens & Associates**	

S-wave velocity: Seismic Refraction Microtremor: RM-2 on HDD5

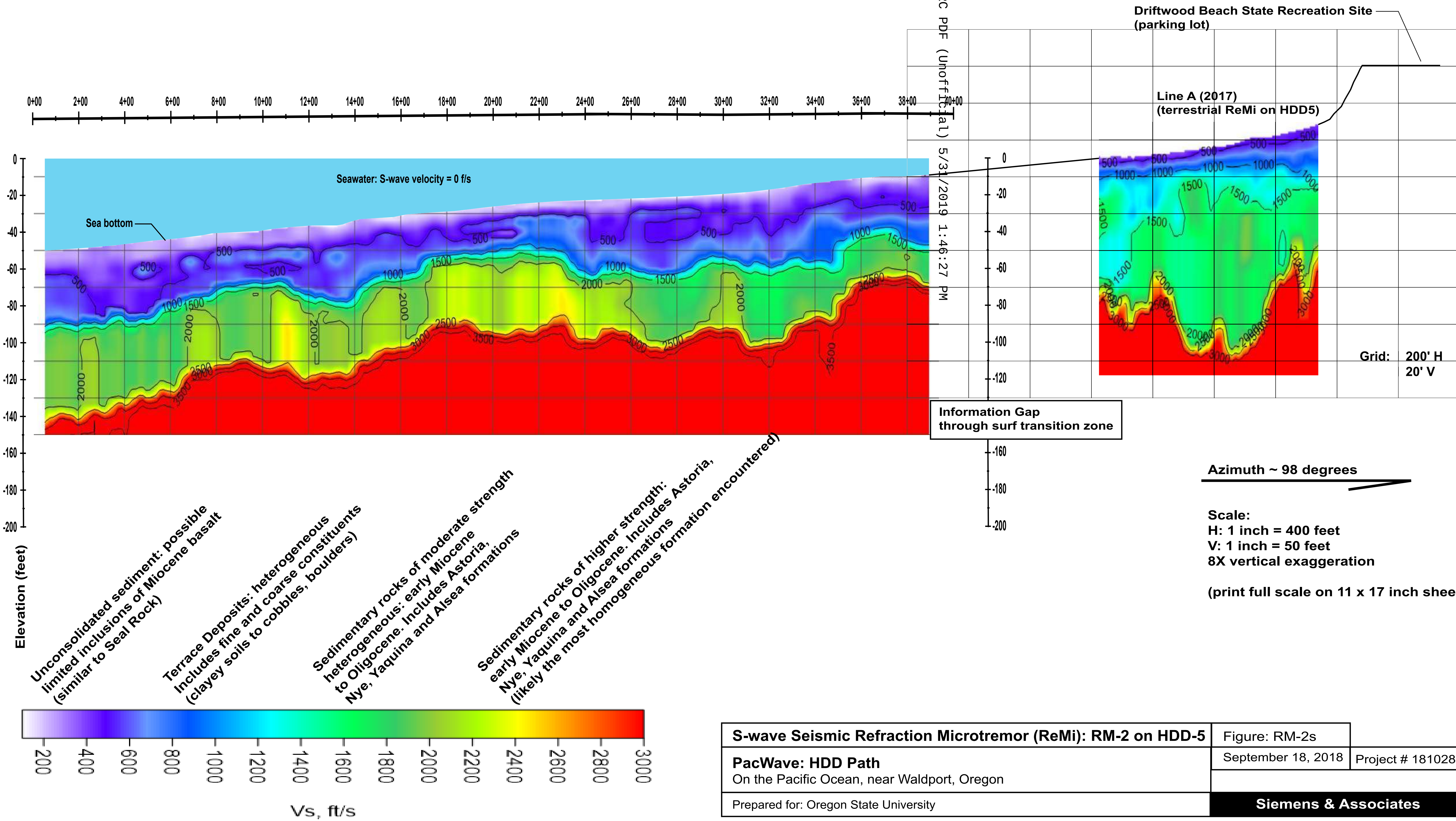
(396, 10 Hz. hydrophones on 10 foot spacing, recording bottom conditions at 15 overlapping positions)



S-wave Seismic Refraction Microtremor (ReMi): RM-2 on HDD-5	Figure: RM-2	
PacWave: HDD Path On the Pacific Ocean, near Waldport, Oregon	September 18, 2018	Project # 181028
Prepared for: Oregon State University	**Siemens & Associates**	

S-wave velocity: Seismic Refraction Microtremor: RM-2 on HDD5

(396, 10 Hz. hydrophones on 10 foot spacing, recording bottom conditions at 15 overlapping positions)



S-wave Seismic Refraction Microtremor (ReMi): RM-2 on HDD-5	Figure: RM-2s
PacWave: HDD Path On the Pacific Ocean, near Waldport, Oregon	September 18, 2018 / Project # 181028
Prepared for: Oregon State University	**Siemens & Associates**

PacWave
TESTING WAVE ENERGY FOR THE FUTURE

Technical Services for Terrestrial Seismic Survey and Evaluation

DATA REPORT:

Results of Geophysical Exploration

Prepared by: Siemens & Associates, Bend, Oregon
Prepared for: Oregon State University, Corvallis, Oregon

May 28, 2019

Dan Hellin
Operations & Logistics Manager
PacWave
College of Earth, Ocean and Atmospheric Sciences
370 Strand Hall
Corvallis, Oregon, 97331

RE: Technical Services for Terrestrial Seismic Survey and Evaluation: PacWave
Seal Rock, Oregon

Hello Dan,

Siemens & Associates (SA) is pleased to present the results of this geophysical exploration. The geophysical interpretation considers local geology and incorporates the benefit of using multiple methods. This report presents the third geophysical exploration prepared by SA for PacWave and the most comprehensive evaluation of the prevailing geology and associations with HDD. These correlations and considerations are judged to be applicable to both the terrestrial and marine HDDs planned for PacWave.

Data were gathered and processed for three geophysical methods in the terrestrial environment: Electrical Resistivity (ER), Seismic Refraction (SR), and Linear Microtremor (LM). The results are presented to describe continuous, 2D profiles through most of the alignment. The interpretation is simplified in context with a general understanding of the area's geologic history and suggest the possibility of encountering a variety of material types with the most consistent conditions occurring through the sedimentary bedrock. SA recommends enhancing and confirming the geophysical findings using traditional geotechnical exploration.

Siemens & Associates expresses sincere appreciation for the opportunity to conduct this exploration and as new challenges, discoveries and questions arise, we are standing by to offer our assistance.

Prepared by,
Siemens & Associates

REGISTERED PROFESSIONAL ENGINEER 16,377 OREGON JAN. 19, 1993 J. ANDREW SIEMENS

J. Andrew "Andy" Siemens, P.E., G.E.
Principal
siemens@bendcable.com
541.385.6500 (office)
541.480.2527 (cell)

CONTENTS

1. Introduction

1.1. Purpose

Siemens & Associates (SA) have completed geophysical services to support geotechnical evaluations associated with terrestrial HDD (horizontal directional drilling). Geophysical exploration methods were selected as a first approach since the surface terrain is complicated by heavy brush and wetlands limiting drill rig access to much of the route. The results provide a basis for addressing feasibility and planning as well as targets for continued exploration using conventional geotechnical methods.

1.2. Methods

Three geophysical methods were used:

- Electrical Resistivity (ER) in 2D
- Seismic Refraction (SR) in 2D
- Linear Microtremor Shear-wave (LM) in 2D

Details concerning the procedures, the equipment used, and results are presented later in this report.

1.3. Project Description

It is understood that the transmission and communication lines from the off-shore test facility are to be routed through an approximately 2000 foot HDD extending from the landing at Driftwood Beach State Recreation Site (Driftwood) to the property recently acquired for the Utility Connection and Monitoring Facility (UCMF) located south and east of Driftwood. Only the general route has been defined as details like the number of HDDs, diameter, and depth are not available at this time.

1.4. Scope

Working under contract with Oregon State University (OSU), the SA team completed geophysical measurement along the HDD path generating results along most of the path excluding sections occupied by private landowners. Guidelines for the work were outlined in the agreement executed on March 9, 2019, prepared by OSU. The completed scope is summarized as follows:

- Consultation with the design team
- Preparation of a detailed workplan
- Brush clearing to provide access
- ER, SR, and LM surveys along the proposed HDD path

- Basic surface reconnaissance including elevation surveys of each line
- Establishment of permanent control points along the HDD path and at UCMF
- Geophysical data processing and quality control
- Area geologic reconnaissance and research
- Interpretation of the findings
- Preparation of this report

The line location and number sequence were developed through mutual agreement between SA and the design team. The lines are designated by letter that continues the sequence established on previous similar explorations for this project.

1.5. Location

The project is located along a corridor extending southeast from Driftwood to the property known as UCFM located immediately east of Highway 101 on NW Wenger Lane. Specific exploration points and the HDD path are identified in this report by Figure 103 (Site Plan: Geophysical Exploration).

1.6. Limitations

This report has been prepared for the exclusive use of OSU for specific application to the project known as Technical Services for Terrestrial Seismic Survey and Evaluation: PacWave. This report has been prepared in accordance with generally accepted geophysical practice consistent with similar work done near Seal Rock, Oregon, by geophysical practitioners at this time. No other warranty, express, or implied is made.

The information presented is based on data obtained from the field explorations described in Section 3 of this report. The explorations indicate geophysical conditions only at specific locations and times, and only to the depths penetrated. They do not necessarily reflect variations that may exist between exploration locations. The subsurface at other locations may differ from conditions interpreted at these explored locations. Also, the passage of time may result in a change in conditions. If any changes in the nature, design, or location of the project are implemented, the information contained in this report should not be considered valid unless the changes are reviewed by SA to address the implications and benefit of enhancing the work as necessary. SA is not responsible for any claims, damages, or liability associated with outside interpretation of these results, or for the reuse of the information presented in this report for other projects.

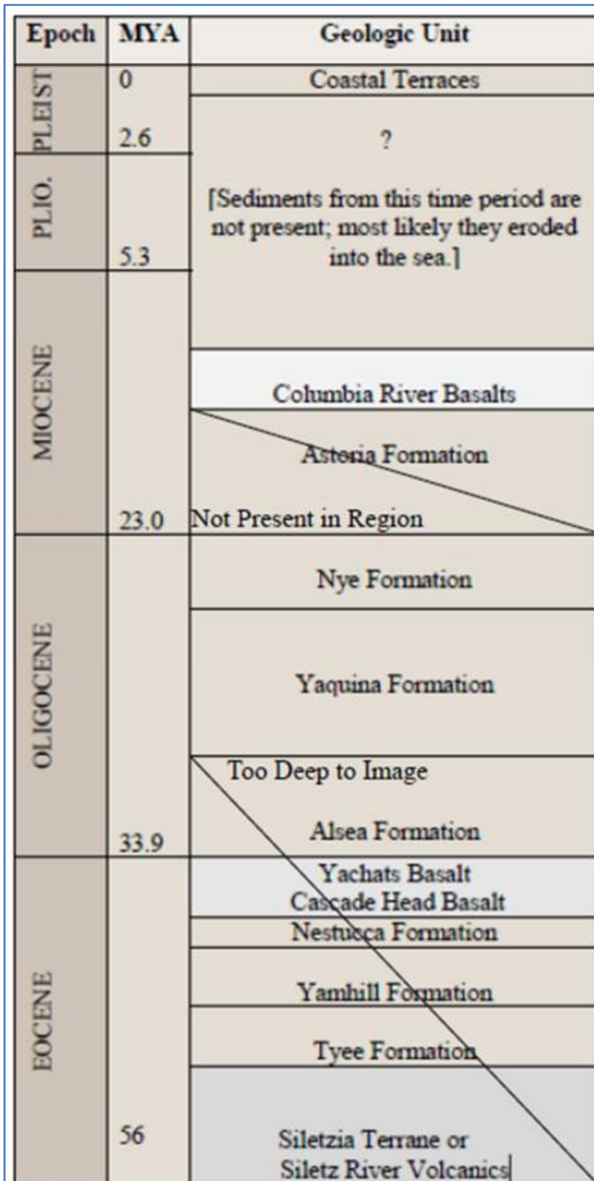
2. Conditions Encountered

The results developed from the geophysical methods are presented as tomograms; a word derived from the Greek "tomo" meaning to cut or slice. The tomograms are annotated to communicate our interpretation of the various types of geomaterials discovered by each geophysical method. SA is not aware of any geotechnical information (such as borings) that is available to confirm the interpretation.

2.1. Geologic Setting

The project site lies along the Pacific shoreline of Oregon, approximately two miles north of the mouth of the Alsea River and the town of Waldport. The site lies west of the relatively steep, north-south-trending Coast Range, on the coastal margin near Driftwood Beach State Recreation Site (Driftwood). The shoreline at Driftwood consists of a relatively flat parking area on a terrace surface approximately 40 feet above the active shoreline. The shoreline is characterized by steep bluffs formed by wave-cut erosion at the toe of the slope.

Based on our literature review and site reconnaissance, the units encountered at the site, from youngest to oldest, consist of Holocene (recent) surficial deposits of unconsolidated fine to medium-grained dune and beach sand, recent alluvium and peat / fine-grained lake deposits; Pleistocene marine terrace deposits; and Tertiary (middle to late Oligocene aged) mudstone, siltstone, claystone, and sandstone.



Modified from Schlicker and others, 1973, and Orr and Orr, 2012.
Numeric ages from Walker and others, 2012.
MYA = Million years ago

The recent dune deposits are principally located in the periphery of the parking lot and to areas north, south, and east. The base of the dune sand may exhibit some consolidation. In addition to the recent dune sand deposits along the uplands, active shoreline processes are reworking the older, fine to medium grained terrace sand. Other recent deposits observed near the site include stream alluvium at the mouths of small drainages located north and south of the site. The alluvium consists of sand, gravel, cobbles and boulders composed predominantly of erosionally-resistant basalt. The thickness of the recent (Holocene) deposits varies between zero and tens of feet. East of the dune deposits is a marsh that is interpreted as a drained back-dune pond. Deposits in this area likely include soft, organic-rich silts and fine sands.

Flat-lying marine terrace deposits underlie the unconsolidated recent deposits in the project vicinity. These semi-consolidated terrace soils are remnants of older beach deposits. The marine terrace deposits are exposed in the shoreline bluffs along most of the Lincoln County shoreline, including the project area. The semi-consolidated Pleistocene marine terrace deposits form steep bluffs along the shoreline and extend inland as much as a mile. The Pleistocene marine terrace deposits range in thickness between 0 and 50 feet or more (Schlicker, et. al., 1973; Oregon Water Resources water well records). The terrace deposits directly overlie the wave-cut benches formed on westward-tilted, Tertiary marine siltstone, sandstone, and marine clasts of the two formations exposed in the region; the Yaquina and Nye formations.

The base of the marine terrace deposit may contain a lag deposit of coarse sand, gravel, and cobbles that formed as the shoreline transgressed to the east, prior to the deposition of the Pleistocene beach deposit. These deposits were not observed in the project area but are exposed along the beach to the north at Seal Rock. Deposits in this area were measured at up to 2 feet thick (Photograph 1). These gravels were also reported in water well records from the Seal Rock area but were not recorded south of the project area. Gravel fan deposits at the mouth of the drainages north and south of Driftwood indicate the presence of some gravel deposits above the sedimentary bedrock contact within the project area. These Pleistocene deposits also contain rare large woody debris that was likely driftwood rafted in on ocean currents. This driftwood can be in excess of two feet in diameter and may be present throughout these deposits (Photograph 1).

Photograph 1. The outcrop exposes the contact between the underlying Yaquina Formation and recent deposits. Note the approximately 2 foot thick gravel lens immediately above the bedrock and the large (up to 2 foot diameter) woody debris in the overlying sandy terrace deposits.

Tertiary (middle to late Oligocene), marine siltstone, and sandstone (Nye, Yaquina, and Alsea Formations) underlie the marine terrace deposit. The contact between the Yaquina/Nye Formation and the Plio-Pleistocene terrace deposit has an approximate 40 MA year unconformity with the underlying Yaquina/Nye bedded sandstones and siltstones. These formations are regionally inclined westward at dips ranging between 5 and 30 degrees, based on exposures along the Alsea River embayment and east of the project site. Measured bedding dips ranged from 14 to 17 degrees. Thicknesses of individual beds of siltstone versus sandstone are unknown at the project site as this unit is not exposed at the surface in the project vicinity with the exception of an incised channel at the outlet to the marsh south of Driftwood. Siltstone is exposed in the creek channel at this location immediately beneath terrace and dune deposits (Photograph 2).

Photograph 2. This is a view west along the outlet stream for the marsh on Driftwood. The red arrow points to exposed siltstone in the lower portion of the channel. The yellow arrow points to the overlying beach dune deposits.

The erosional contact between the Plio-Pleistocene terrace deposits and the underlying Oligocene siltstone and sandstone is overall relatively flat, however locally may be irregular due to erosional resistance variability between the materials composing the formations, as well as by downcutting of small streams in the young, weakly consolidated material. A potential bedrock low is present along seismic profile I. Additionally, due to the unfavorable dip towards the west and active shoreline erosion, bedding plane failures (landslides) within the local sedimentary rocks exists and displaces the overlying Plio-Pleistocene through Holocene-aged deposits.

In addition to the sedimentary units, regionally there are significant volcanic flows associated with the Columbia River Flood Basalts (CRBs). These flows occurred between the marine terraces and the Yaquina/Nye Formations. The flows originate in eastern Oregon and follow topographic lows in the region, and cause an inversion of topography. This is exposed north of Driftwood at Seal Rock where there is a contact between the CRBs and the Yaquina Formation below it. The CRBs would only be present in a region that had a stream discharging into the ocean, such as the Alsea into the Yachats bay south of the job site, or any other major depressions in the topography. These flows often produce prominent outcrops in the form of headlands and sea stacks, as observed at Seal Rock. They are also the source of basaltic gravels present at the base of the terrace deposits.

2.2. Stratification

Based on geophysical interpretations, the stratification is simplified as follows:

- Layer 1: Unconsolidated Sediments

  Primarily beach sands are comprised of well sorted medium grained, moderate to well-rounded quartz, and other sediments collecting on the seabed. The sediment fines upward in layers eroded and deposited by wave action on the beach and shallow marine environments. There is a moderate amount of biogenic clasts; predominantly shells that vary in size and are generally fractured by wave action on the sediment surface. As noted above, these deposits may contain large woody debris rafted in during storm events. Based on the geophysical results, these deposits may be in excess of 50 feet thick.

  East of the beach sand deposits within Driftwood and along the HDD alignment are organic-rich silts and fine sands associated with a drained back dune lake. This area is currently a marsh with groundwater present at approximately ground surface. The thickness of these deposits is likely less than 25 feet thick.

- Layer 2: Terrace Deposits

  Weak to moderately lithified and consolidated beach sand, compositionally similar to Layer 1, but much older. This layer is also deposited in several subsets of layers all compositionally variable dependent on water depth of deposition. This unit is likely deposited on top of a wave cut platform of more erosion resistant rock. These terraces are exposed by wave-cut cliffs regionally. As noted above, basal gravel lenses are present within these terrace deposits immediately above the bedrock. While not directly observed or defined by geophysics, gravel fan deposits are present at the mouth of the marsh outlet, indicating some gravels are present in the vicinity of the project area (Photograph 1).

  Exposures of these deposits are present in numerous road cuts along US 101 both north and south of the site. These deposits are cut nearly vertical and up to 20 feet high (Photograph 3). These vertical cuts reflect a degree of cementation / lithification of these older deposits. Water well logs in the area indicate that these deposits can be in excess of 50 feet thick and are anticipated to be moderately dense to dense. Based on the seismic profiles, the terrace deposits are anticipated to be less than 50 feet thick along most of the HDD alignment. These terrace deposits may also underlie the marsh / lake bottom deposits within Driftwood.

Information regarding groundwater conditions within the terrace deposits was not readily available. Seeps or springs were not observed in roadcuts but were present along the beach fronts at the contact with the underlying bedrock. Groundwater is anticipated to be present in the lower portions of this unit.

Photograph 3. These terrace deposits are exposed along US101 south of the HDD alignment. This cut is nearly 20 feet high and subvertical.

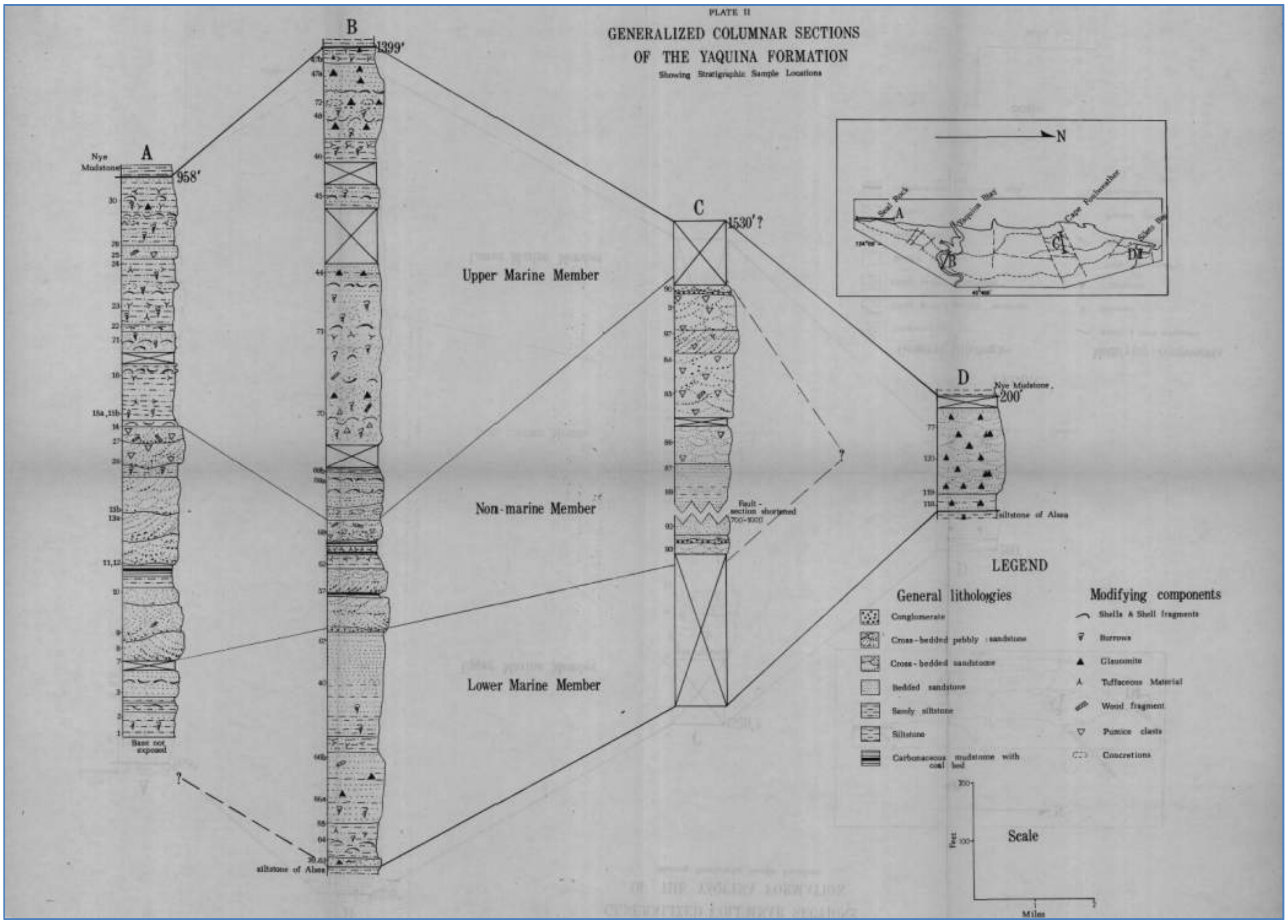
- Layer 3: Sedimentary Rocks including the Nye, Yaquina, and Alsea Formations

  Yaquina and Nye Formations are likely present beneath the work site. The Nye Formation overlays the Yaquina Formation and is primarily a very weak mudstone associated with deeper marine sediments. The contact between the Nye Formation and upper Yaquina Formation is transitional and difficult to identify in outcrop and geophysical contrast. The siltstone observed along the base of the incised stream outlet channel for the marsh south of the Driftwood parking lot may be the Nye Formation or upper Yaquina Formation.

The Yaquina Formation is the oldest unit beneath the project area. A detailed stratigraphic column of the unit is displayed in the figure below. Note that the stratigraphic column is only a generalization and is not derived from observations on the site; the actual materials found will vary locally. The stratigraphic column (from Goodwin 1972) is only intended to serve as a description of what bedrock formations are present at depth.

The Yaquina Formation is broken into three general pieces. The oldest is shallow marine sediments, varying from beach sand to silt sized particles, and forming a moderate to well-consolidated sandstone. The middle age materials were deposited by rivers and can contain cobbles to silt sized particles, as well as organics such as wood. This layer is the most variable regionally as shown between the three columns below. The youngest and most substantial deposit in the unit, and the portion that is most likely on site, is a weak siltstone with interbeds of shell rich sandstone. In outcrops north and south of Driftwood, this unit has widely spaced fractures.

Bedrock along the HDD alignment is most likely mudstone / siltstone representing the lower portion of the Nye Formation or upper Yaquina Formation. The siltstone of the upper Yaquina Formation is anticipated to be over 400 feet thick beneath the site. Water well records indicate this siltstone has low permeability. Column A below is best representative of the geology that is expected to appear in Layer 3 through the HDD corridor.



Note:

The assemblage of local geologic knowledge "Geology of the Seal Rock Area" prepared by Maxine Centala (2013) is available on-line at www.sealrockor.com/Geology.html and is recommended for review to gain an improved understanding of the history that drives the possible conditions to be encountered through the HDD corridor.

2.3. Geologic Impacts along the HDD Alignment

As discussed above, there are several anticipated subsurface conditions that could impact construction of pipelines installed using HDD methods. These hazards and their associated project risks are summarized in Table 1.

Table 1

Geologic Condition	Location	HDD Implication	Mitigation Considerations
Granular dune and terrace deposits	• Dune deposits at the northern end • Terrace deposits along the southern half of the alignment	• Granular soils can be highly erodible, particularly with multiple HDD drives as successive passes can loosen soils.	• Install casing from the surface to bedrock contact at end of HDD profiles. • Reduce the number of HDD drives by installing a larger carrier pipe.
Large woody debris in dune, terrace deposits	• Present along the entire alignment	• Woody debris can be difficult to penetrate with drill rig.	• Install casing from the surface to bedrock contact at end of HDD profiles. • Include this hazard in the specifications.
Basalt gravels in the terrace deposits	• Potential for gravel deposits along the entire alignment above the bedrock contact. • Higher potential for basalt gravels in bedrock low along seismic line I.	• Gravels can be difficult to penetrate and cause delays.	• Install casing from the surface to bedrock contact at end of HDD profiles. • Include this hazard in the specifications.
Variable bedrock weathering and strength	• Along the entire alignment.	• Weathering and strength variations can impact drilling rates and production.	• Conduct additional subsurface explorations to characterize strength and weathering to be included in contract documents.

3. Geophysical Data Acquisition: Terrestrial

The geophysical methods were designed to explore the geotechnical conditions to depths of 100 feet and beyond. The use of multiple methods improves the confidence of the interpretation as each method offers strength (and weakness) and the combined results provide complimentary information that is more valuable than any of the methods individually.

In this section, the geophysical methods, equipment, challenges, and data quality are described.

Geophysical Methods and Equipment

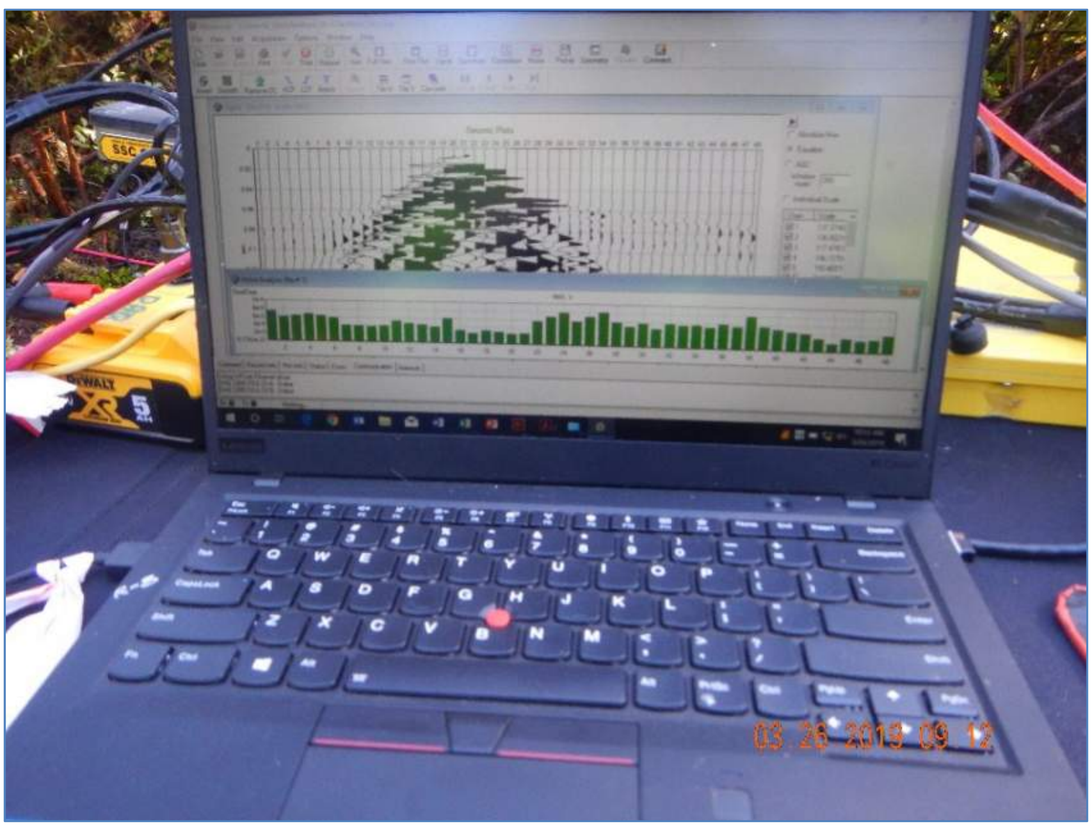
3.1.1. Electrical Resistivity (ER)

How it works: Two-dimensional (2D) electrical resistivity tomography is a geophysical method to illustrate the electrical characteristics of the subsurface by taking measurements on land or in a marine setting. These measurements are then interpreted to provide a 2D electrical resistivity tomogram which is, in turn, related to the likely distribution of geologic or cultural features known to offer similar electrical properties. Measurement in an electrical survey involves injecting DC current though two current-carrying electrodes and measuring the resulting voltage difference at two or more potential electrodes. The apparent resistivity is calculated using the value of the injected current, the voltage measured, and a geometric factor related to the arrangement of the four electrodes.

The investigation depth of any measurement is related to the spacing between the electrodes that inject current. Therefore, sampling at different depths can be done by changing the spacing between the electrodes. Measurements are repeated along a survey line with various combinations of electrodes and spacing to produce an apparent resistivity cross-section (tomogram). In this case, SA used the Dipole-Dipole array with electrode spacing of either 4 or 6.25 m. Electrode pins were 20 inch long, 3/8 inch diameter stainless rods fully embedded into mineral earth and wetted with a saline solution to reduce contact resistance.

3.1.2. Seismic Refraction (SR)

Seismic refraction (SR) is an active seismic method utilizing geophone receivers set along a straight-line gathering data from signals induced by a small explosive charge (8-gauge, 400 grain black powder shell detonated using a Betsy Seisgun). Data were processed using forward modeling software developed by Geogiga known as DW Tomo 8.3. The models developed are plausible and illustrate a reasonably uniform although sometimes complicated top of rock profile. Lower P-wave velocity through the upper layers is related to unconsolidated materials while heavily consolidated materials and rock are illustrated by higher P-wave velocity. P-wave velocity reversals with depth are present in the shallow



geology. These reversals combined with a shallow water table complicate processing and interpretation.

How it works: When the explosive charge is triggered, the receivers are activated, and the wavelet energy is recorded. The P-wave is the fastest of the various seismic waves that are generated and only the time of the first arrival wave at the receiver is considered in the SR method. These first arrivals are picked for each shot at each receiver. As the energy travels through the ground, the waves are refracted and the arrival time, combined with distance from the source is related to both the velocity and distance to the layers promoting refraction. This distance is not necessarily vertical depth; rather the nearest refractor and the image can be skewed when oriented along a dipping refractor.

Data were recorded using a networked pair of DAQ 4 seismographs manufactured by Seismic Source in Ponca City, Oklahoma, USA, connected to an IBM laptop computer. Lines were composed of 48 to 96 receivers on 10 foot spacing with shot intervals of 30 feet.

3.1.3. Linear Microtremor S-wave (LM)

The linear microtremor method, referred to as LM is a passive, surface-wave analysis technique for obtaining near surface shear-wave velocity models to constrain strength and position of shallow geologic boundaries. These analyses provide information about land

and marine soil, and rock properties that are very difficult to obtain through alternative methods. SA recorded passive ambient vibrations (background noise) augmented by an active, un-timed seismic source (plate and hammer) operated along the array to induce higher frequency, rapidly attenuating energy.

On land, surface wave analysis is performed using Rayleigh waves because they can be detected on an air-ground interface (earth surface) using geophones. The low frequency geophones measure the vertical component of the surface wave (Rayleigh) and the results are considered a reasonable estimate of the vertical distance (depth) to layers distinguished by velocity contrast below the receivers.

How it works: The LM analysis develops the shear-wave velocity/depth profile using an engineering seismograph, low frequency receivers (geophones or hydrophones) and straight-line array aperture (Louie, 2001). Ambient surface wave energy is recorded using relatively long sample window (30 seconds) recording the ambient wavefield. At this site, quality low frequency signals were consistently recorded.

The microtremor records are transformed as a simple, two-dimensional slowness-frequency (p-f) plot where the ray parameter "p" is the horizontal component of slowness (inverse velocity) along the array and "f" is the corresponding frequency (inverse of period). The p-f analysis produces a record of the total spectral power in all records from the site, which plots within the chosen p-f axes. The trend within these axes, where a coherent phase has significant power is "picked." Then the slowness-frequency picks are transformed to a typical period-velocity diagram for dispersion. Picking the points to be entered into the dispersion curve is done manually along the low velocity envelope appearing in the p-f image.

The terrestrial records were completed using arrays composed of 48 and 96, 4.5 Hz. geophones. Receiver spacing was set at 10 feet. Extended line length was accomplished by overlapping the receivers on Line H and data are interpolated between the receiver gap on Line G.

3.2. Horizontal and Vertical Control

Coordinates describing the general HDD route were provided by OSU and these data were interpreted and utilized by SA to establish the exploration extents. The beginning and end-points of the geophysical lines were initially established using hand-held GPS (Garmin 755t). As geophysical operations progressed, SA set temporary lath and hubs marking select positions along each geophysical line. The SA crew measured the elevations along the lines with reference to these temporary benchmarks using a theodolite (Nikon NT-1) and grade rod.

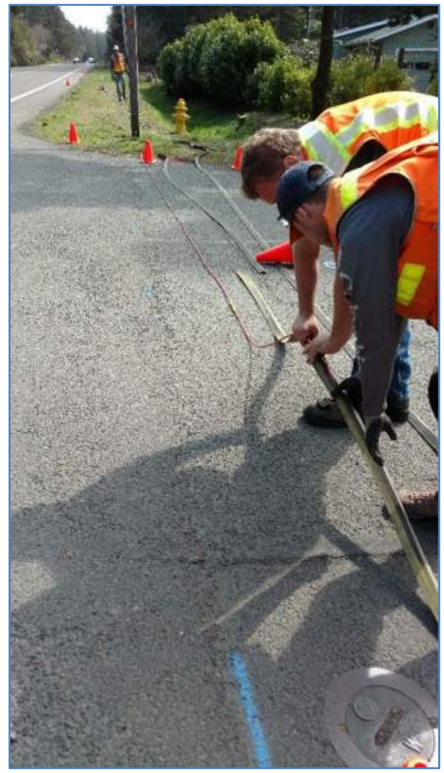
Following the collection of the geophysical data, surveyor John Thompson, PLS, of John Thompson & Associates, Inc., visited the site to determine precise location and elevation of the temporary benchmarks set by SA using RTK methods. The elevation profiles were then converted to match Oregon State Plane Datum (International Foot) and this is the basis for elevations presented on the geophysical results.

3.3. Ancillary Operations

3.3.1. Brush clearing for access:

Lines G and I included clearing of light to heavy undergrowth along the survey routes. These operations were conducted several days prior to geophysical data acquisition. The effort was completed by the SA crew equipped with both hand and power tools including a Sthil 560 brush cutter designed specifically for the task.

3.3.2. Traffic Control:



Operations for Line H along Highway 101 were complicated by traffic both along the highway and intersecting roads. Safe operating conditions were maintained by positioning the survey line as far west as practical, setting a row of traffic cones along the working area and posting signs to alert drivers approaching the survey. A rubber road mat was used at intersections to allow traffic to cross the geophysical cables without interrupting operations. An SA crew member was posted at each of these intersections to slow and direct vehicles as they approached the crossing. The precautions were successful and no adverse traffic incidents were experienced.

3.4. Summary of Challenges

3.4.1. Operations

Few difficulties were experienced. The heavy brush presented a challenging clearing task and negotiations through the wetland were difficult due to soft ground and surprisingly deep streams. Soft ground conditions also presented challenges for effective geophone plants which the SA crew enhanced by digging to solid earth and at many locations, extensions were added to the geophone spikes to improve coupling.

Traffic noise slowed the P-wave acquisition along Highway 101 as it was necessary to wait for gaps in the traffic to detonate the source. Shot stacking was done to compensate for noisy conditions when necessary.

The HDD path is below private property as it approaches Highway 101 from the north and again as the path approaches the UCMF on the east side of Highway 101. Surface geophysical survey through these areas would have required trespass, substantial brush clearing, and associated landowner permission. The SA team and client agreed that attempting to acquire this permission was not in the project’s best interest. Rather, exploration was conducted along the Highway 101 right of way which crosses and is near the HDD path through these zones.

Further, operations were not conducted on the east side of Highway 101 as originally planned. SA made a field decision to limit operations to the wider right of way along the west side of Highway 101 as a safety precaution since only a narrow strip was available on the east and traffic control with flaggers was beyond the scope.

3.4.2. Data Quality and Interpretation Challenges

The recorded data are judged to be of excellent quality. Few cultural features appear to be available to influence the ER signal. P-wave first arrivals were almost always very clear and easy to pick and a strong wide range in frequency of ambient vibrations were available to enhance the linear microtremor (LM) records.

Due to these favorable factors, it is the opinion of SA that the results provide an effective look at subsurface conditions through the HDD path. Although the different geophysical methods respond in their own way to the conditions encountered, similarity exists and this leads to greater confidence in the findings than would be had by only one method.

4. Processing and Interpretation

4.1. General

During the data gather, partial interpretation was completed in the field for quality control purposes and to assist in setting and confirming proper data acquisition parameters. The instruments were continuously monitored through the data acquisition phase.

The interpretation for each line is presented in this section and the locations of the lines are shown graphically on Figure 103. Results for each method along each line are presented in appendices to this report. ER, SR, and LM tomograms are presented on the same page using the same horizontal and vertical scales and horizontal zero coordinate to assist in correlation.

In the opinion of SA, the 2D S-wave (LM) tomograms and ER results are the most robust and plausible description of the conditions encountered. As discussed later, ER results are presented with several resistivity scales to illustrate subtle variations through the low resistivity bedrock layer.

It is worthy to emphasize that the geophysical results are presented in 2D yet the data collection is influenced by a 3D environment. Unless the geology is simple, like a flat stack of pancakes, the various geophysical methods cannot be expected to match perfectly. In addition, geophysical interpretations are often compared to direct observation of conditions discovered in geotechnical drill holes. Note that the drill hole is a 1D description of the subsurface and represents a very small sampling, unlike the geophysical approach. Correlation and conflict are expected, and both must be considered in context with the factors that influence data quality, complication of the subsurface, and the geophysical parameters measured.

A description of the data processing, interpretation methods and results are presented in the following sections.

4.2. Electrical Resistivity (ER)

Important factors which affect the resistivity of different geological material are:

- Porosity
- Moisture content
- Dissolved electrolytes (including saltwater intrusion)
- Temperature (resistivity decreases with increasing temperature)

Each dataset was filtered to remove spikes, noisy, and misfit data through a systematic progression to produce plausible inversion models without excessive iteration. The level of filtering was modest, and most data points were used in the final inversion.

4.2.1. ER Processing and Presentation

The data sets were processed using AGI Earth Imager Software and Res2D INV by Geotomo Software, Malaysia. After many iterations and trials with various algorithms and review of the results, SA selected the images developed with the AGI software as the most plausible description of the conditions encountered.

4.2.2. Considerations in ER Interpretation

<u>Lines G through I</u>

The results present similar findings along each line that correlate reasonably well with stratification developed using the other methods. Line G intersects a layer of beach sand with relatively high resistivity not encountered on the other lines. To maintain easy comparison of findings, SA presents each ER line on a scale that includes the high resistivity associated with the beach sand as a common scale. Alternate scales are also presented to better illustrate the electrical contrasts encountered on Lines H and I. Of interest, is the scale compressed to 20 Ohm-m that highlights the subtle, low resistivity contrasts associated with the sedimentary bedrock anticipated to dominate the HDD path. These subtle contrasts are interpreted to be indicative of either heterogeneity within the bedrock that are not well defined by the other methods or variations in pore-water characteristics which could be altered by saltwater intrusion.

<u>Unconsolidated Sediments</u>

As discussed, the highest apparent resistivity (up to about 5000 Ohm-m) is associated with unsaturated, poorly-graded beach and dune sand. This high resistivity layer is defined only through the beginning of Line G leading south from Driftwood toward the wetland. The unconsolidated layer is present along the remainder of the alignment within a range of about 100 to 500 Ohm-m.

<u>Terrace Deposits</u>

Below the unconsolidated layer, the apparent resistivity illustrates a slight decrease to define the boundaries of the terrace deposit. Rough interpretation suggests the terrace to be defined within apparent resistivity ranging from about 100 down to about 30 Ohm-m. The distinction between the terrace deposit and underlying rock, in terms of apparent resistivity, varies and this is likely due to the variability in texture and lithification of the terrace deposit at this transition (see geologic description of Section 2.2).

Sedimentary Rocks (undifferentiated)

The sedimentary bedrock is defined by ER as a low resistivity layer with subtle electrical contrast within the unit. Geologic research indicates the rock type to be mudstone, siltstone, and possibly sandstone. The sedimentary bedrock apparent resistivity is relatively low owing to its fine-grained texture combined with the likely saturated condition. The apparent resistivity tomograms are presented in several ways to visualize the electrical contrast within each. This subtle electrical contrast could be indicative of several features including heterogeneity and possible saltwater intrusion that could be quite variable. These are uncertainties inherent to the ER method and confirmation must be provided by other geophysical methods and/or direct exploration.

4.3. P-wave Seismic Refraction (SR)

Lines G through I

Refraction data were recorded along each line and the data were excellent. Challenging factors associated with data processing include a layered soil overburden that includes saturated soil.

The shallow water table below the wetland on Line G promotes P-wave velocity related to the saturated condition (essentially the speed of a compression wave traveling through water) and can be many times faster than the velocity of the same wave through the same soil if it were not saturated. Hence, the P-wave is a poor measure of soil strength when soils are saturated. SA suspects that organics within the shallow soil horizon throughout the wetlands and possibly beyond promote some gas within the soil column such that the soil layer is not 100% saturated in all areas. In the opinion of SA, this is the reason that low velocity (less than about 5000 f/s) occurs within the wetland even though the water table is at or near the surface.

In some areas, the unconsolidated zone appears to be layered or otherwise complicated such that stronger, faster layers are bedded at depths above weaker, slower layers. This causes problems with the refraction method since the fastest raypaths return to the receivers from shallow depth and deeper geology is not sampled by the first arrival waves. The P-wave raypath tends to propagate along the shallow boundary of the higher velocity layer. SA suggests that in some cases apparent irregularities in the velocity distribution are caused by these effects and layer interface boundaries are probably complicated. In general, the transition from unconsolidated materials to sound rock is represented by a P-wave velocity on the order of 6000 to 7000 f/s. Weaker rock layers could be similar to saturated soil velocity (about 5000 f/s) and are not distinguished by the refraction method.

4.3.1. SR Processing and Presentation

Data processing was completed using Geogiga DW Tomo 8.3 software developed by Geogiga Technology Corp. Calgary, Alberta, Canada. The software utilizes a robust grid ray tracing and regularized inversion with constraints in topography and elevation along the seismic array as input for calculations. The software is suitable for strong elevation and lateral velocity variation. Data sets included a moderately dense shot pattern (shots centered at 3X the receiver spacing) and this lead to the generation of robust P-wave velocity models based on many first arrivals. Dr. Satish Pullammanappallil, Ph.D. of SubTerraSeis, LLC lead the data processing effort. To develop input geometry, SA measured the vertical locations along the line using a theodolite. Horizontal location was measured along the ground with reference to receivers and shot points using the seismic take-out cable.

4.3.2. Considerations in SR Interpretation

Unconsolidated Sediments

As discussed, the shallow water table and variations within plays an important role in the behavior of velocities related to P-wave refraction. The character of the unconsolidated layer is difficult to constrain due the effect of saturation as saturated weak soils could offer P-waver velocity similar unsaturated strong soils.

Terrace Deposits

Similar to the unconsolidated layer, the velocity of saturated, weaker zones within the terrace deposit could be similar to unconsolidated sediments. Also, variations within this unit include partially lithified regions that could offer P-wave velocity similar to the underlying bedrock. These factors combine to add uncertainty in delineating the boundaries of the terrace deposit.

Sedimentary Rocks (undifferentiated)

The depth to the higher velocity, lower elevation sedimentary layer is reasonably well defined and correlates well with other geophysical methods. The upper rock layer is less defined and includes velocity reversals on Lines G and H. Shallow, high P-wave velocity anomaly are also calculated in unexpected areas and these anomalies are not defined by the other geophysical methods which raises some suspicion regarding validity. SA has no plausible explanation regarding the shallow, high P-wave anomalies although the data clearly support the results of the calculation.

The P-wave tomograms define flat lying, linear features through the sedimentary bedrock (best defined on Lines G and H) and this characteristic is likely due to alternating strength of thinly bedded layers; a structure common to sedimentary rocks.

4.4. S-wave Linear Microtremor (LM)

LM data were procured along the same routes as ER and SR and the models are of value as the shear wave velocity is directly related to the strength of a geologic material and is not influenced by saturation as water has no shear strength. The models were produced by Dr. Satish Pullammanappallil, Ph.D. of SubTerraSeis, LLC, using Geogiga SubsurfacePlus 8.3 software. The 2D models illustrate the trend in the subsurface in terms of shear-wave velocity that correspond closely with trends in both ER and SR and since each method responds to the geology differently, the fit is not perfect.

Shear-wave velocity, V_s is used to determine the shear modulus, G, of soil or rock:

$G = \rho (V_s^2)$: a valuable measure of soil stiffness and rock strength

Where ρ = mass density (i.e. total unit weight / gravitational acceleration constant, 32.2 ft/s^2)

The LM derived V_s is interpreted from small strain measurements produced by non-destructive surface waves (Rayleigh waves) with strain on the order of 10^{-4} %. Shear modulus (G) derived from shear-wave velocity measured insitu using surface wave methods is commonly referred to as the small-strain shear modulus G_{max}.

4.4.1. LM Processing and Presentation

Dr. Pullammanappallil, Ph.D. created the 2D profiles using a series of 1D shear-wave depth profiles along each line typically using 12 to 24 channels per analysis progressing through the data with single channel increments (channels 1 to 12, 2 to 13, 3 to 14, and so on). As many as 36 channels were used to constrain the deepest parts of the models. The data were strong due to vibrations related to nearby traffic, ocean waves, and other unidentified sources.

The LM tomograms are presented on the same scale and same page as ER and SR for correlation.

4.4.2. Considerations in LM Interpretation

Lines G though I

The results present similar findings along each line that roughly correlate with stratification developed from the ER and SR methods. The tomograms illustrate progressively increasing velocity with depth, no significant velocity reversals, and suggest both abrupt and gradual/irregular transitions to the various layers. The LM method is judged to be the most effective at defining top of rock and clearly illustrates distinct layers defined by S-wave velocity contrast.

Unconsolidated Sediments

Through the upper layers, only a few zones offer S-wave velocity less than 600 f/s representing weak soils and these include a thin layer through the wetland along Line G. The lower reaches of the unconsolidated zone are judged to be associated with S-wave on the order of 800 to 1000 f/s and given this definition, the thickness of the unconsolidated soils range from about 5 to 45 feet.

Terrace Deposits

This intermediate layer is interpreted to be represented by S-wave velocity in the range of about 600 to 1200 f/s, possibly a bit higher in areas. As discussed, the terrace deposit is anticipated to include a variety of material types including variable degree of consolidation and lithification. As a result, S-wave velocity is not necessarily directly related to any specific material type although geologic materials with S-wave velocity in this range offer moderate to moderately high strength. Due to the heterogeneity inherent to a terrace deposit, these characteristics are likely to change significantly over short distances although the LM interpretation does not illustrate this characteristic as well as the other methods. Terrace deposit thickness through the terrestrial LM survey varies from about 5 to 50 feet.

Sedimentary Rocks (undifferentiated)

S-wave velocity on the order of 1200 f/s and higher is interpreted to represent strong, and sometimes heterogeneous geology typical of the shallow sedimentary units described in the geologic literature available to SA. The highest velocity region (>2500 f/s) is interpreted to represent the most homogeneous of the sedimentary layers. The tomograms illustrate slight variability within the velocity zone 1200 to 2500 f/s (supported by both ER and SR), probably due to surficial erosion, weathering, and other disturbance within the upper sedimentary unit. Depth to the top of the sedimentary layer varies from about 15 to 50 feet with the top of the highest velocity rock ranging from 60 to 150 feet.

Although unlikely, there is a possibility of basalt inclusions within these higher velocity regions. As described earlier, the CRB deposition associated with the nearby Seal Rock area could extend into the HDD corridor and fill ancient depressions or displaced weak materials present at the time of deposition. Fresh, non-weathered, and lightly fractured/jointed basalt typically offers S-wave velocity greater than 2500 f/s and these velocities (and higher) are interpreted at depth. This occurrence would be unconformable and is considered a possibility although remote.

LM is a volume averaging method and hence, it is challenging to resolve small variations within high velocity layers. Also, the resolving power decreases with depth and thus variations (particularly velocity reversal) are less likely to be imaged within the deep, higher velocity layers.

4.4.3. Seismic Site Classification (ASCE 7)

4.4.4. Seismic Site Classification in accordance with ASCE 7 was calculated from data along each of the 2D LM lines. The average shear wave velocities through the upper 100 feet (Vs100) which defines the seismic site classification ranges from 966 f/s (Line H) to 2093 f/s (Line G) defining Site Class D. At UCMF Site Class C dominates with an average of 1588 f/s.

5. Conclusions and Recommendations

5.1. Conclusions

Based on the results of the geophysical exploration, SA concludes that the proposed HDD is feasible and favorable conditions for maintaining a stable boring are available within the sedimentary layers encountered. Table 1 (page 15) identifies various geologic conditions related to HDD planning in context with the prevailing geology. These (and probably others) must be considered in planning and preparing specifications.

Stratification appears reasonably consistent along the HDD path and the 2D results indicate no reason to suspect that the alignment crosses unknown geologic faults or other geologic hazard.

5.2. Recommendations

SA recommends that the geophysical findings be verified by direct exploration using conventional methods (drilling and sampling) at select locations. During our geologic reconnaissance, appropriate locations were identified that consider both the geophysical results and practicality of mobilizing drilling equipment. These locations are identified as follows:

- Driftwood parking lot
- Highway 101 at the approximate 600-foot mark on Line H (adjacent NW Terrace Street)
- Along Line I at the approximate the 100-foot mark at UCMF

Few geotechnical borings are required due to the existence of the long geophysical traverses that effectively cover most of the alignment which is fortunate as most of the alignment offers difficult drill rig access considering both terrain and permitting. The objective of a geotechnical exploration is to confirm stratigraphy and material characteristics and procure sample for testing. Material properties that will be of interest in HDD design and planning include dynamic testing of the unconsolidated layer (N-value), unit weight, rock strength and groundwater table.

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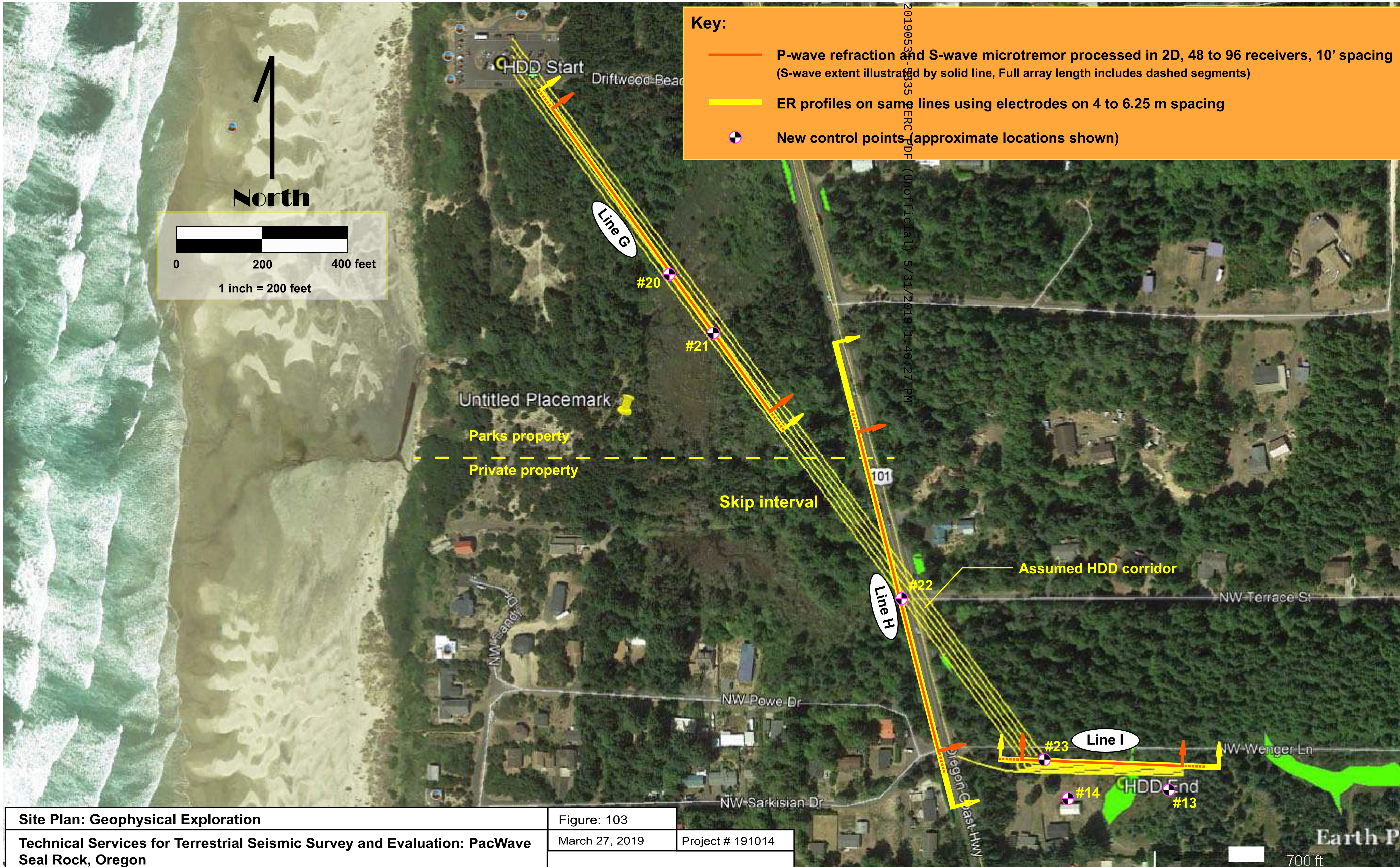
7. Graphical Presentation of Results

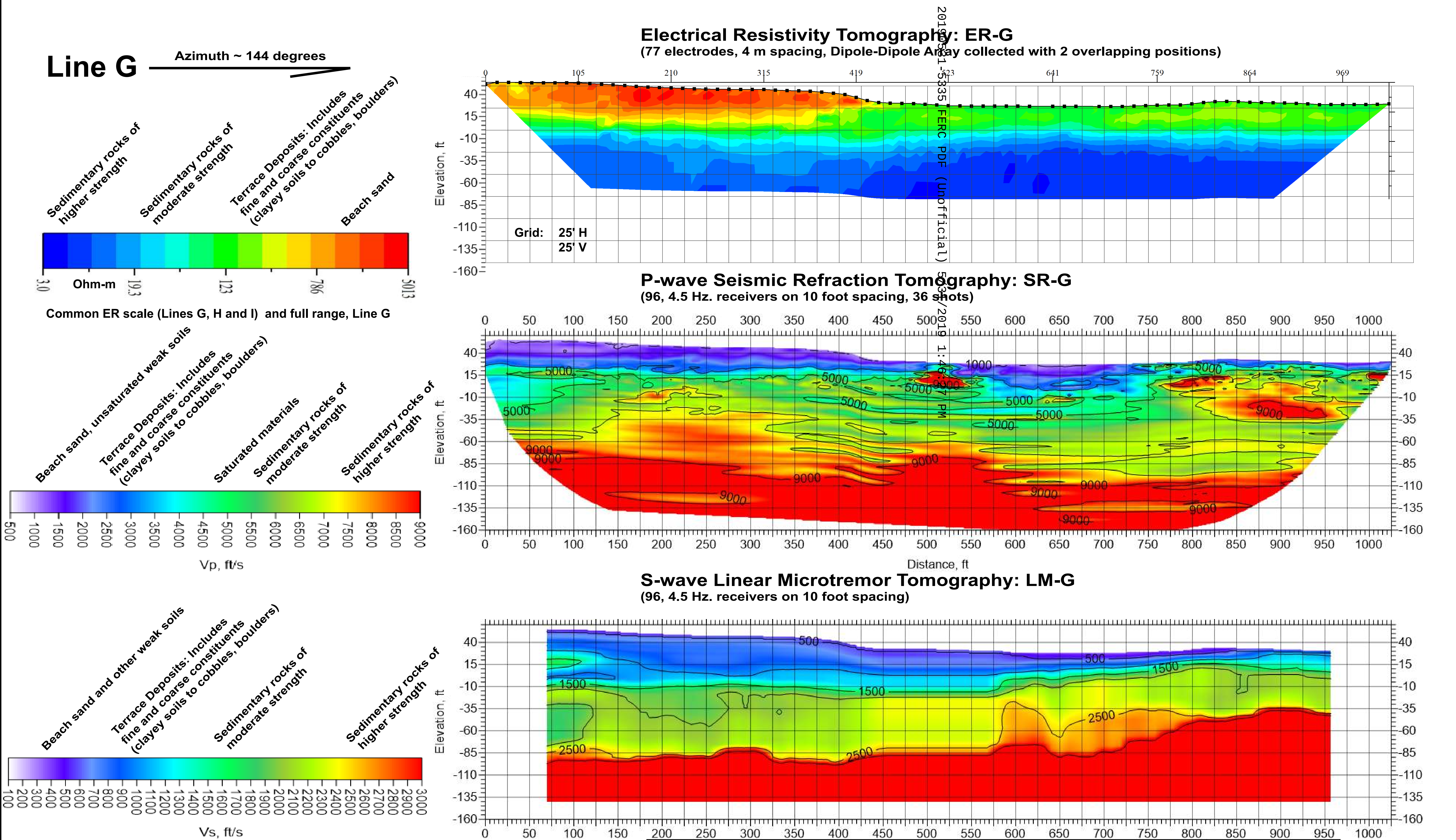
The interpretations are presented in 2D with the locations of the various lines illustrated on Figure 103.

7.1. Figure 103: Site Plan: Terrestrial Geophysical Surveys



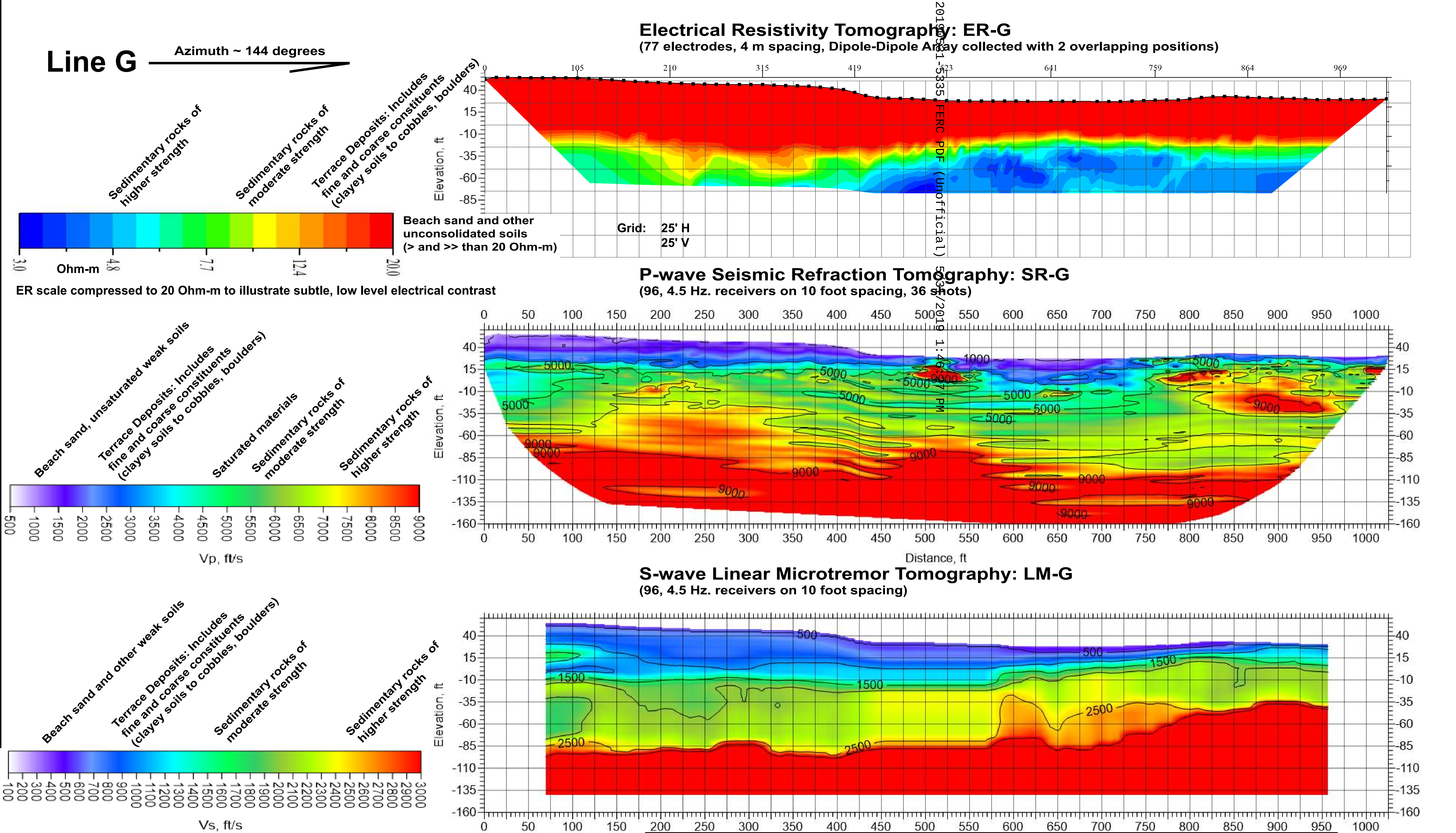
Site Plan: Geophysical Exploration	Figure: 103	
Technical Services for Terrestrial Seismic Survey and Evaluation: PacWave Seal Rock, Oregon	March 27, 2019	Project # 191014
Prepared for: Oregon State University	Siemens & Associates	

7.2. Results: Line G



Scale:
H: 1 inch = 100 feet
V: 1 inch = 100 feet

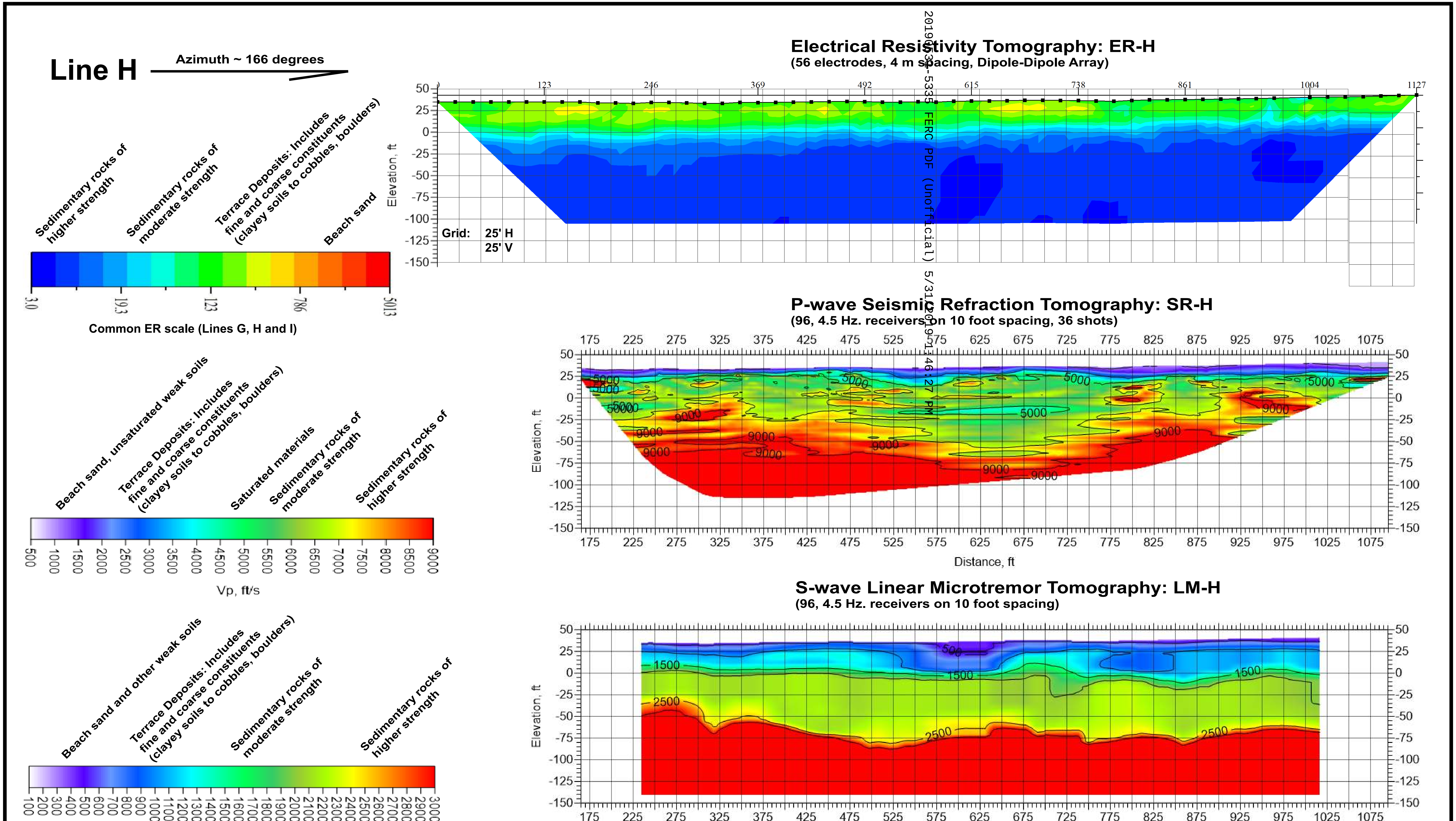
Geophysical Results: Line G	Figure: G-1	
Technical Services for Terrestrial Seismic Survey and Evaluation: PacWave Seal Rock, Oregon	March 27, 2019	Project # 191014
Prepared for: Oregon State University	**Siemens & Associates**	



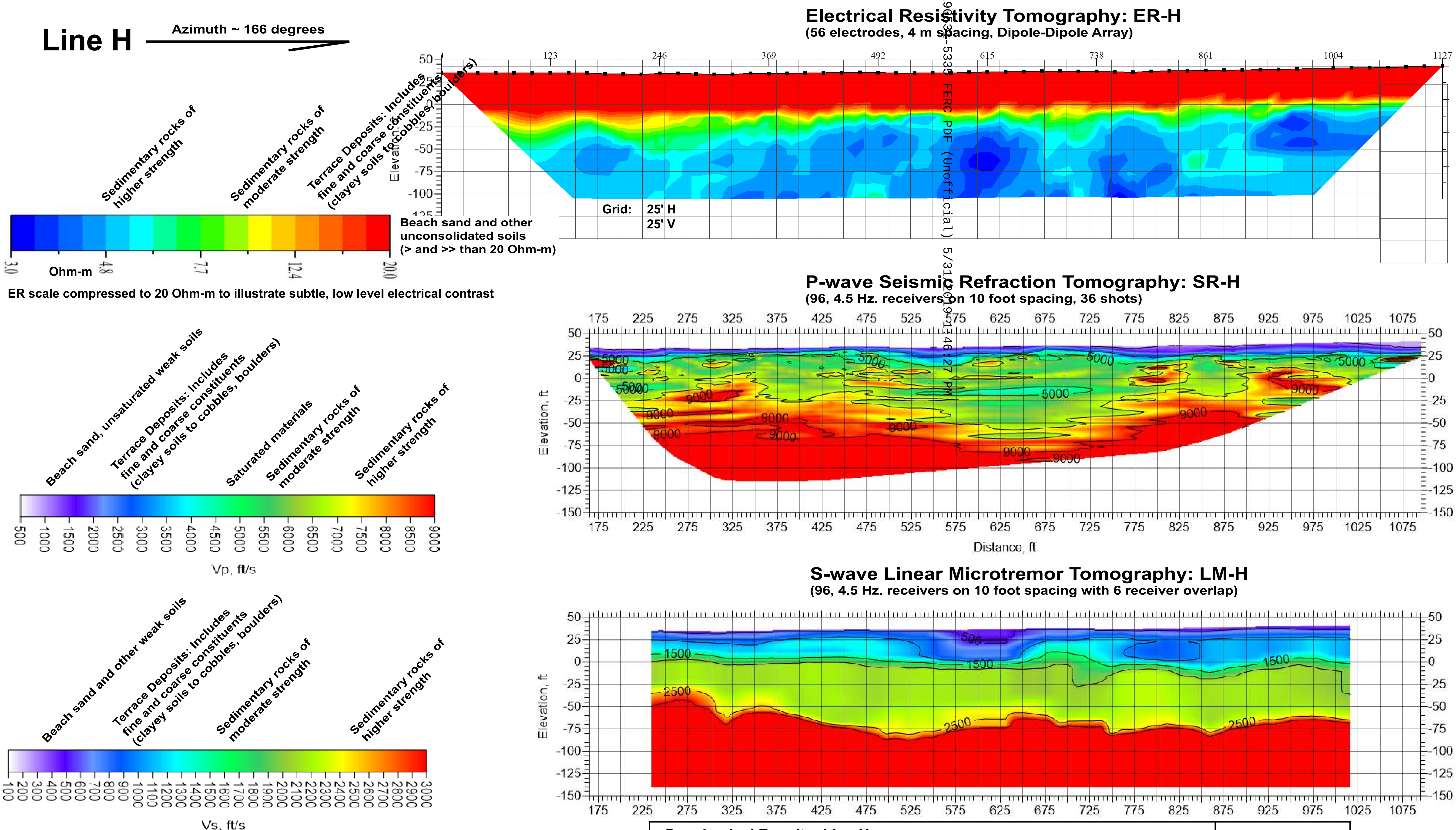
Geophysical Results: Line G	Figure: G-2	
Technical Services for Terrestrial Seismic Survey and Evaluation: PacWave Seal Rock, Oregon	March 27, 2019	Project # 191014
Prepared for: Oregon State University	Siemens & Associates	

Scale:
H: 1 inch = 100 feet
V: 1 inch = 100 feet

7.3. Results: Line H

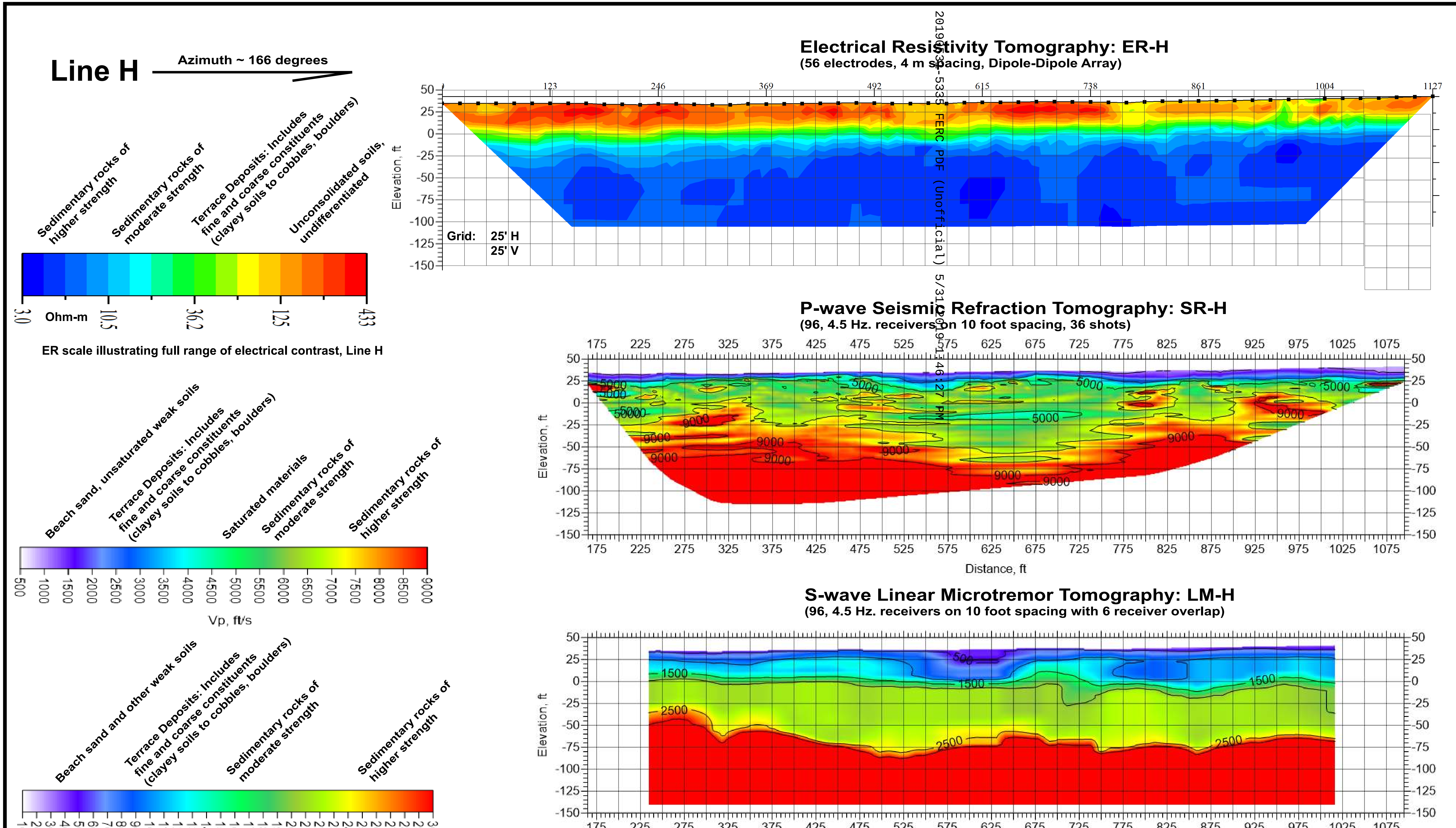


Geophysical Results: Line H	Figure: H-1	
Technical Services for Terrestrial Seismic Survey and Evaluation: PacWave Seal Rock, Oregon	March 27, 2019	Project # 191014
Prepared for: Oregon State University	Siemens & Associates	



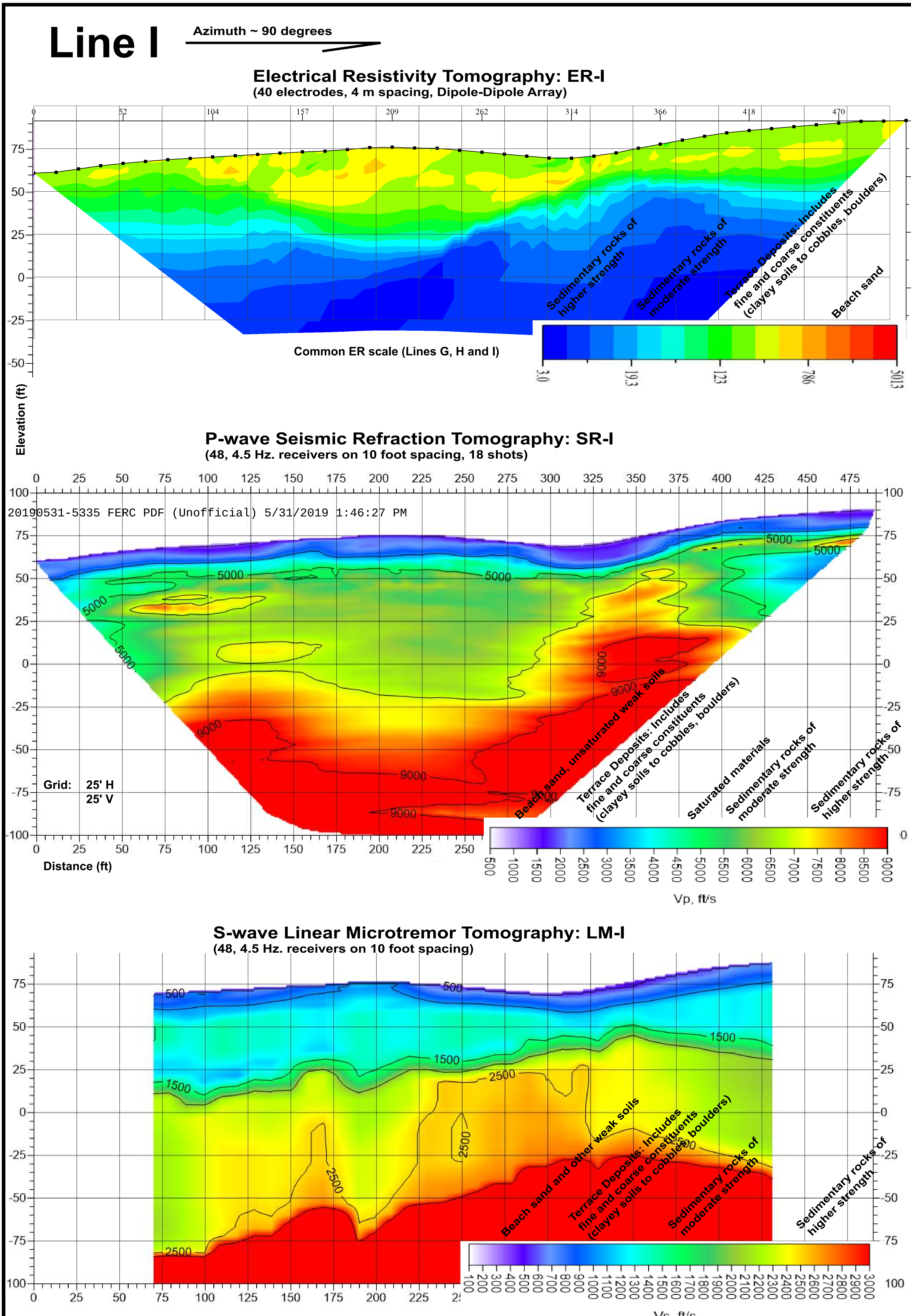
Scale:
H: 1 inch = 100 feet
V: 1 inch = 100 feet

Geophysical Results: Line H	Figure: H-2	
Technical Services for Terrestrial Seismic Survey and Evaluation: PacWave Seal Rock, Oregon	March 27, 2019	Project # 191014
Prepared for: Oregon State University	Siemens & Associates	



Geophysical Results: Line H	Figure: H-3	
Technical Services for Terrestrial Seismic Survey and Evaluation: PacWave Seal Rock, Oregon	March 27, 2019	Project # 191014
Prepared for: Oregon State University	Siemens & Associates	

7.4. Results: Line I



Scale:
H: 1 inch = 50 feet
V: 1 inch = 50 feet

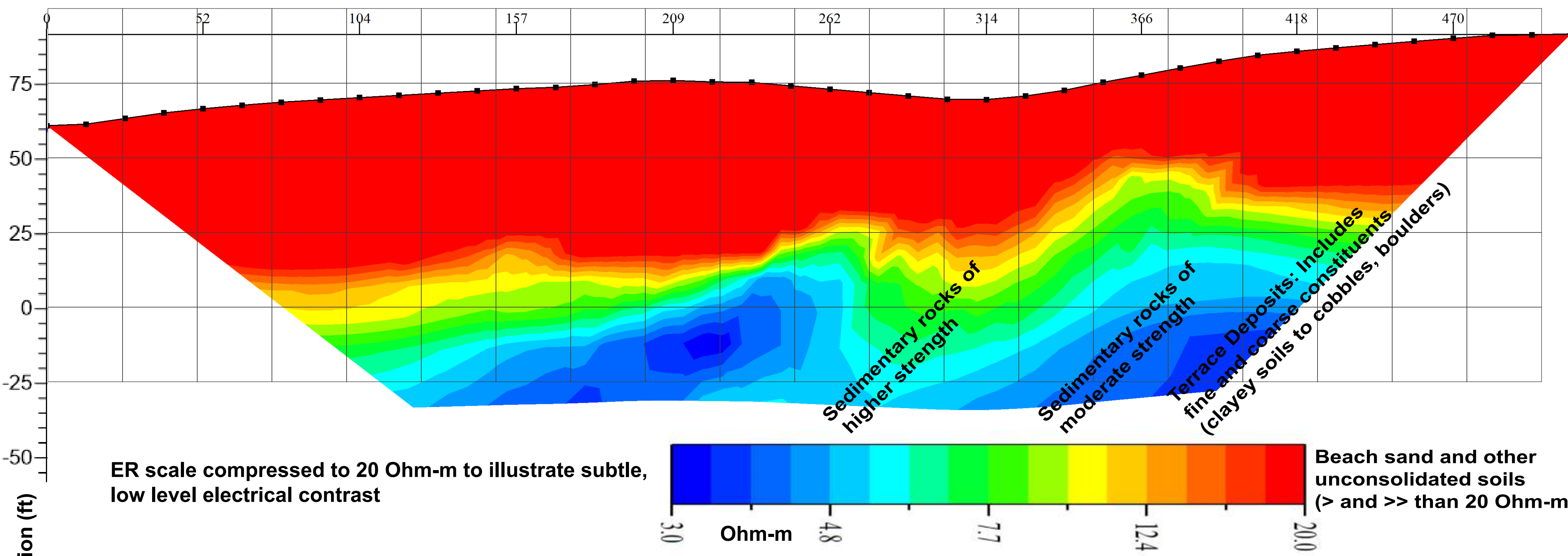
Geophysical Results: Line I	Figure: I-1	
Technical Services for Terrestrial Seismic Survey and Evaluation: PacWave Seal Rock, Oregon	March 27, 2019	Project # 191014
Prepared for: Oregon State University	Siemens & Associates	

Line I

Azimuth ~ 90 degrees

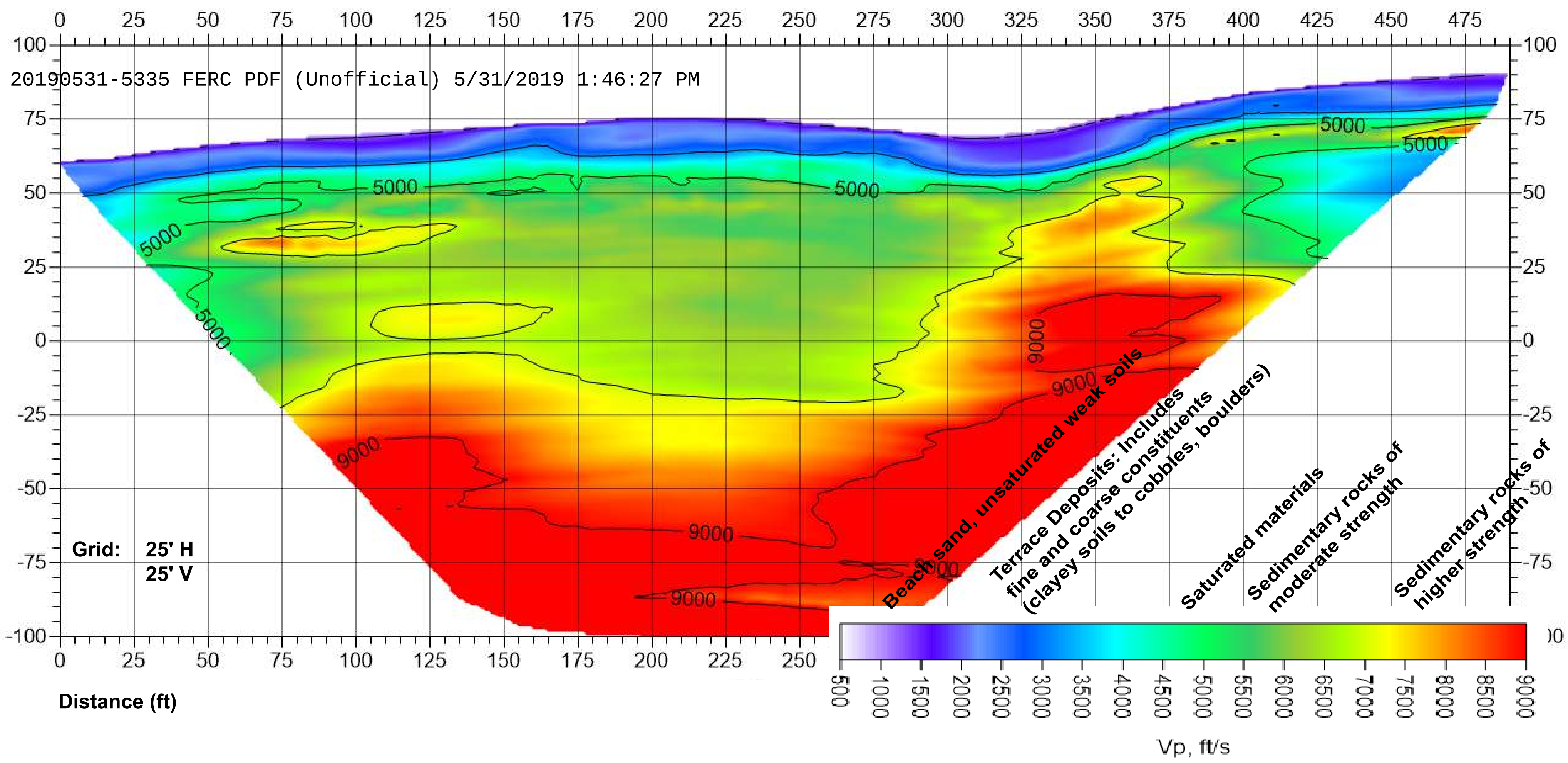
Electrical Resistivity Tomography: ER-I

(40 electrodes, 4 m spacing, Dipole-Dipole Array)



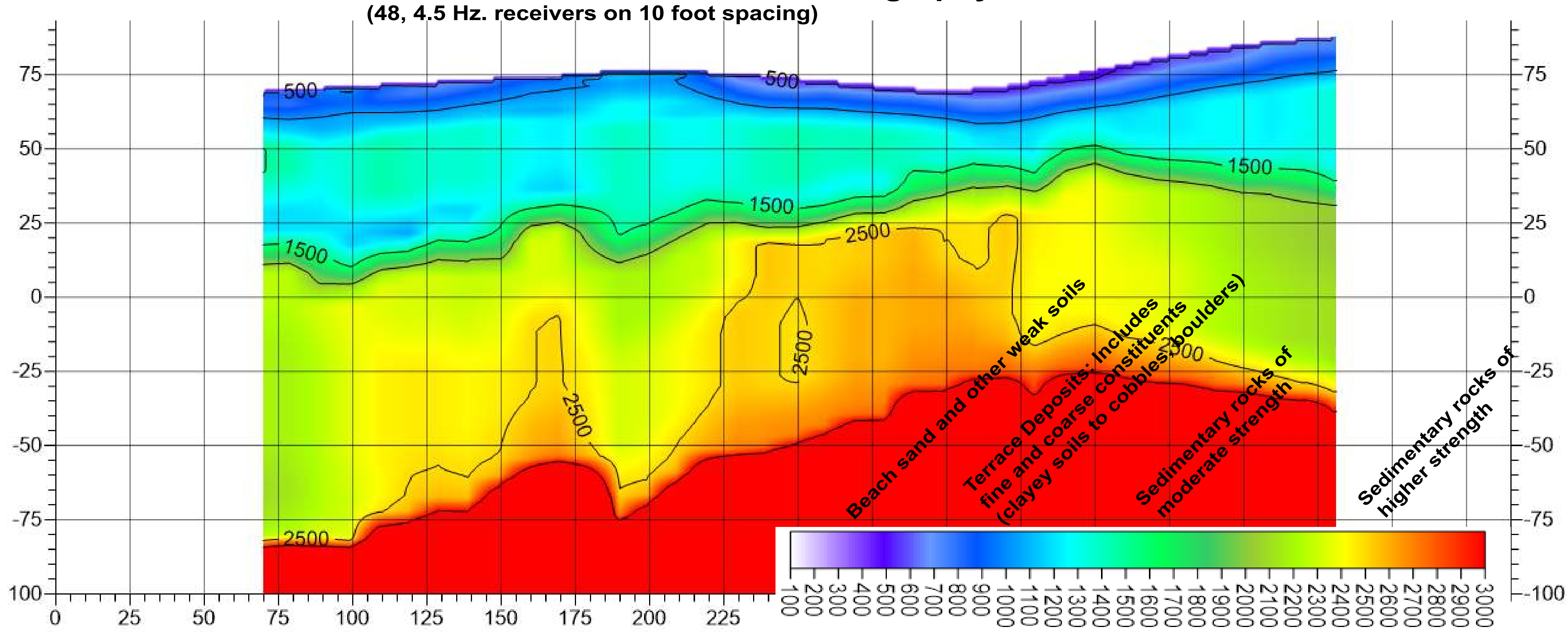
P-wave Seismic Refraction Tomography: SR-I

(48, 4.5 Hz. receivers on 10 foot spacing, 18 shots)



S-wave Linear Microtremor Tomography: LM-I

(48, 4.5 Hz. receivers on 10 foot spacing)



Scale:
H: 1 inch = 50 feet
V: 1 inch = 50 feet

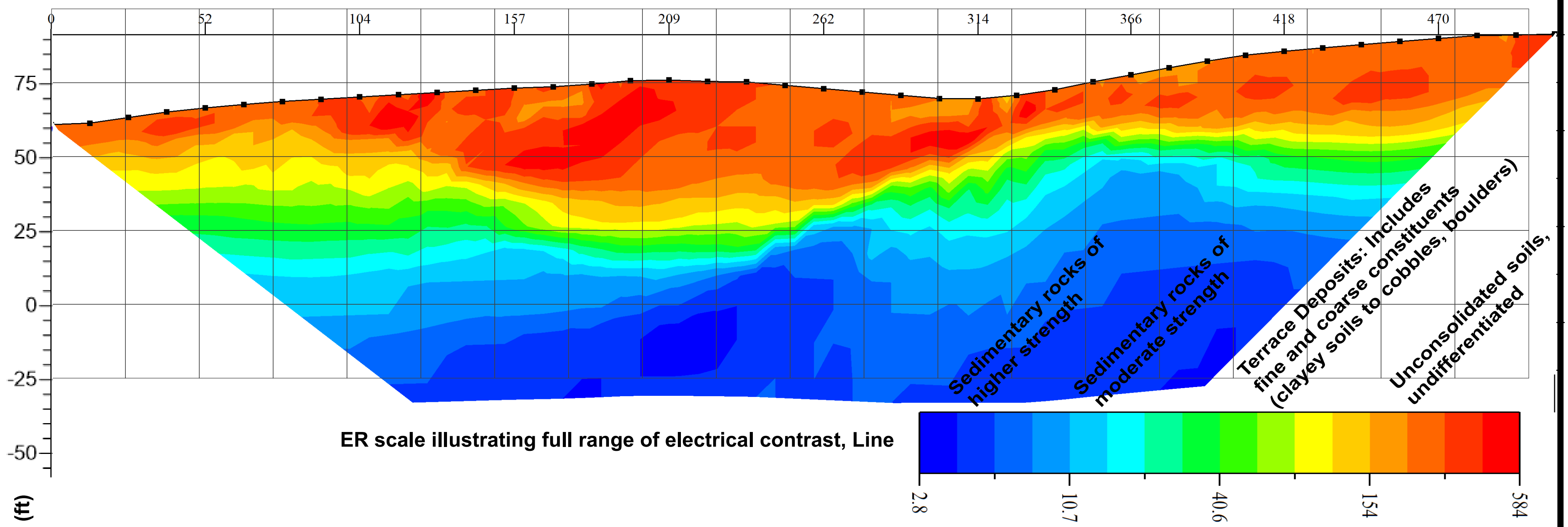
Geophysical Results: Line I	Figure: I-2	
Technical Services for Terrestrial Seismic Survey and Evaluation: PacWave Seal Rock, Oregon	March 27, 2019	Project # 191014
Prepared for: Oregon State University	**Siemens & Associates**	

Line I

Azimuth ~ 90 degrees

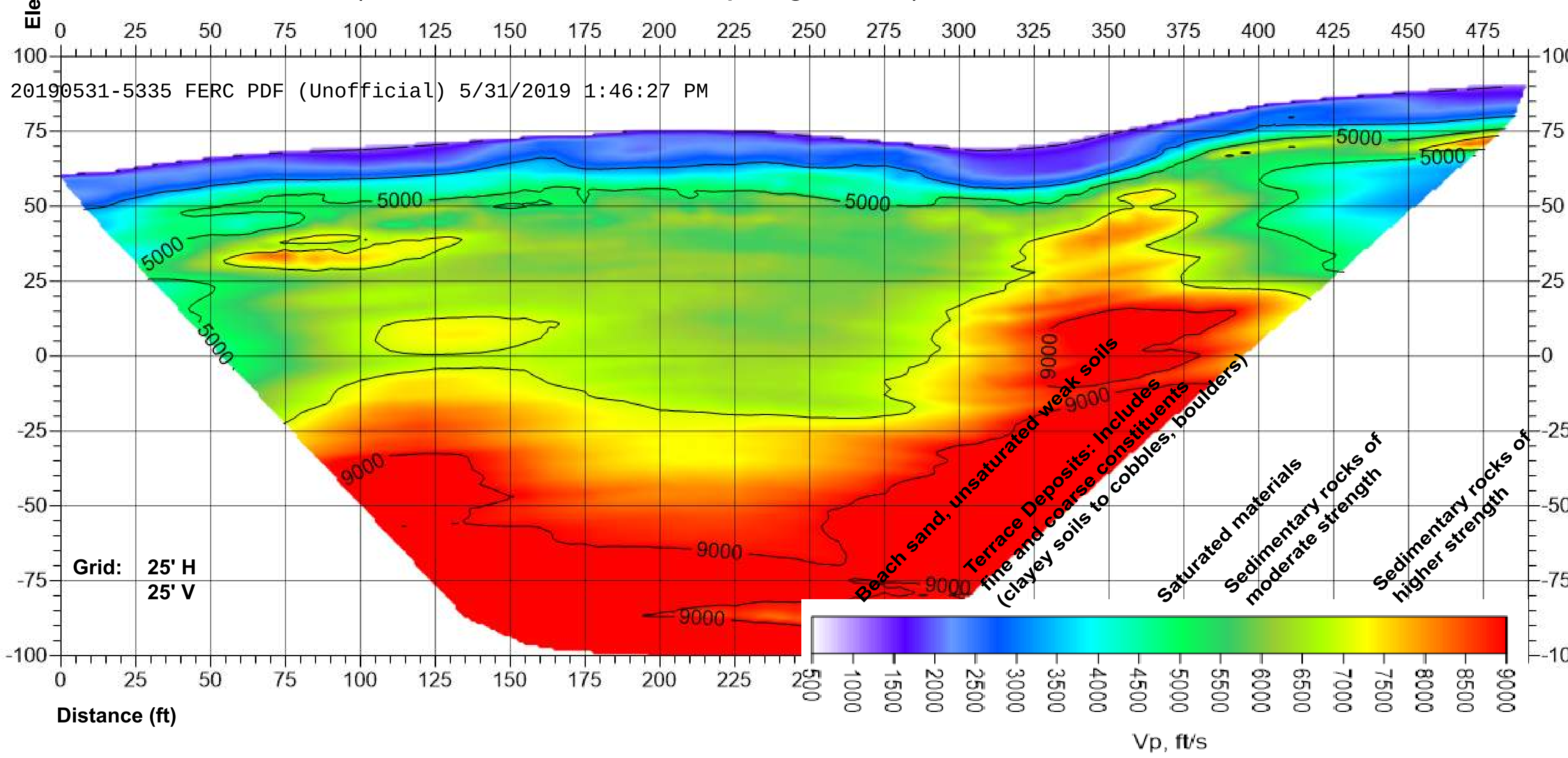
Electrical Resistivity Tomography: ER-I

(40 electrodes, 4 m spacing, Dipole-Dipole Array)



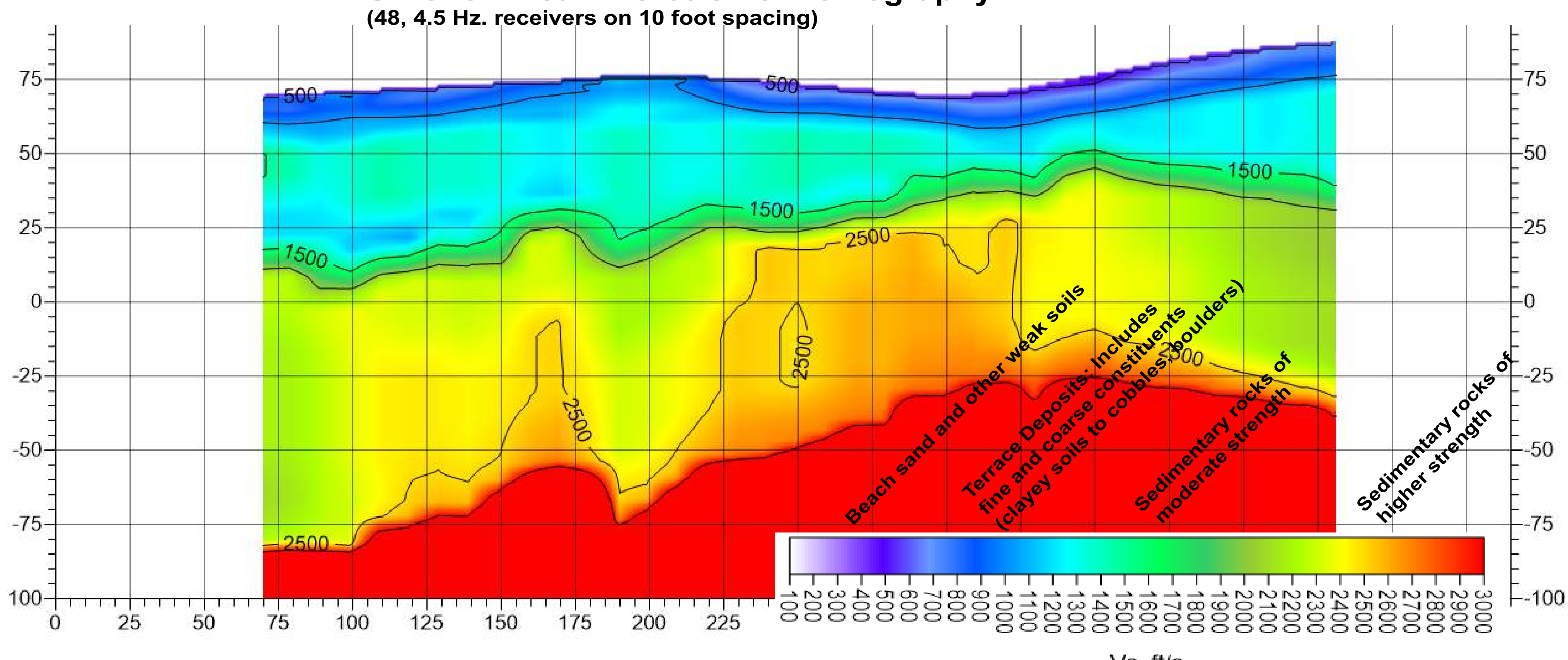
P-wave Seismic Refraction Tomography: SR-I

(48, 4.5 Hz. receivers on 10 foot spacing, 18 shots)



S-wave Linear Microtremor Tomography: LM-I

(48, 4.5 Hz. receivers on 10 foot spacing)



Scale:
H: 1 inch = 50 feet
V: 1 inch = 50 feet

Geophysical Results: Line I	Figure: I-3	
Technical Services for Terrestrial Seismic Survey and Evaluation: PacWave Seal Rock, Oregon	March 27, 2019	Project # 191014
Prepared for: Oregon State University	**Siemens & Associates**	

Pacific Marine Energy Center South Energy Test Site

Near Waldport, Oregon

DATA REPORT:

Results of Geophysical Exploration

By: Siemens & Associates
Bend, Oregon

Prepared for: Oregon State University

July 24, 2017

Mr. Dan Hellin, Assistant Director for Test Operations
Northwest National Marine Renewable Energy Center
Oregon State University
350 Batcheller Hall
Corvallis, Oregon 97331

RE: Pacific Marine Energy Center South Energy Test Site: Geophysical Exploration
Near Waldport, Oregon

Hello Dan,

Siemens & Associates is pleased to present the results of the geophysical exploration.
The geophysical interpretations incorporate the results of an area geologic reconnaissance which strongly influences our interpretation. A draft of this document has been reviewed by OSU and 3U Technologies and comments have been incorporated.

Data were gathered and processed for three geophysical methods: Electrical Resistivity (ER), Seismic Refraction (SR) and Seismic Refraction Microtremor (ReMi). The results are presented to describe continuous, 2D profiles. The interpretations suggest a complicated system of sediments and sedimentary rock through the proposed HDD alignment currently at ~ 50 foot depth. Through this zone, heterogeneous materials of variable strength are expected to dominate. The more homogeneous Alsea Formation is interpreted at lower elevations.

The independent geophysical methods describe similar geologic features in terms of thickness and character of stratification. As described in the report, several factors are judged to be responsible for apparent discrepancies and the results must be interpreted with care.

Siemens & Associates expresses sincere appreciation for the opportunity to conduct this exploration and as new challenges, discoveries and questions arise, we are standing by to offer our assistance.

Prepared by,
Siemens & Associates

J. Andrew "Andy" Siemens, P.E., G.E.
Principal
siemens@bendcable.com
541.385.6500 (office)
541.480.2527 (cell)

CONTENTS

1. Introduction

1.1. Purpose

Siemens & Associates (SA), in conjunction with Optim and John Thompson Associates (JTA), have completed terrestrial geophysical services to support geotechnical evaluations associated with improvements proposed at Driftwood Beach State Recreation Site. The information is intended to provide a first look at geotechnical conditions that can be related to the distribution and strength of shallow, unconsolidated soil and sediment as well as depth to hard rock.

1.2. Methods

Three geophysical methods were used:

- Electrical Resistivity (ER) in 2D
- Seismic Refraction (SR) in 2D
- Seismic Refraction Microtremor (ReMi) in 2D

Details concerning the procedures, the equipment used and results are presented later in this report.

1.3. Project Description

It is understood that Driftwood Beach State Recreation Site is proposed as the entry point for a series of horizontal direction drillings (HDDs) that will extend west below the surf zone providing conduits for communication, control and power distribution to the grid from the test site to be located at sea. The HDDs will extend roughly 3500 feet beyond the west end of the parking lot and will extend to depths approaching 50 feet. Currently, five HDDs are scheduled with diameters on the order of 5 inches.

1.4. Scope

Working under contract with OSU, the SA team completed geophysical measurement throughout the terrestrial portion of the HDD corridor using three independent geophysical methods. Guidelines for the work were outlined in the agreement executed on March 20, 2017, prepared by OSU Capital Planning and Facilities Services. The original work scope as described in the agreement was modified to facilitate permitting and resulted in a an extra mobilization, 18% additional ER survey, 50% additional SR survey and 20% additional ReMi survey in order to limit the need to clear vegetation through the originally proposed geophysical routes. The completed scope is summarized as follows:

- ER, SR and ReMi surveys on four different lines
- SR only, on two additional lines
- Geologic reconnaissance

- Onsite mapping and establishment of permanent survey monuments
- Survey data including locations of geophysical traverses uploaded to GIS database

1.5. Location

The project is located on the Pacific Ocean within the property lines of Driftwood Beach State Recreation Site managed by Oregon Parks and Recreation Department. Twenty four hour access to the site is provided off Highway 101 about two miles north of Waldport, Oregon. Specifically, the project is at Latitude 44.464313°N and Longitude -124.080387°W.

1.6. Limitations

This report has been prepared for the exclusive use of OSU for specific application to the project known as Pacific Marine Energy Center South Energy Test Site. This report has been prepared in accordance with generally accepted geophysical practice consistent with similar work done near Waldport, Oregon, by geophysical practitioners at this time. No other warranty, express or implied, is made.

The information contained in this report is based on data obtained from the field explorations described in Section 4 of this report. The explorations indicate geophysical conditions only at specific locations and times, and only to the depths penetrated. They do not necessarily reflect variations that may exist between exploration locations. The subsurface at other locations may differ from conditions interpreted at these explored locations. Also, the passage of time may result in a change in conditions. If any changes in the nature, design or location of the project are implemented, the information contained in this report should not be considered valid unless the changes are reviewed by SA to address the implications and benefit of enhancing the work as necessary. SA is not responsible for any claims, damages or liability associated with outside interpretation of these results, or for the reuse of the information presented in this report for other projects.

2. Geologic Setting

The project site lies along the Pacific shoreline of Oregon, approximately two miles north of the mouth of the Alsea River and the town of Waldport. The site lies west of the relatively steep, north-south-trending Coast Range, on the coastal margin at Driftwood Beach State Recreation Site. The shoreline area at the project site consists of a relatively flat parking area on a terrace surface approximately 30 feet above the active shoreline. In the vicinity of the site, the shoreline is characterized by a relatively steep, 20- to 40-foot high, steep bluff formed by wave-cut erosion at the toe of the slope. At the project area, the slope from the parking area to the beach is relatively subdued and modified with paths and minor fill.

Based on our literature review and site reconnaissance, the units encountered at the site, from youngest to oldest, consist of Holocene (recent) surficial deposits of unconsolidated fine- to medium-grained dune and beach sand, recent alluvium; Pleistocene marine terrace deposits; and Tertiary siltstone, claystone, and fine sandstone. The recent dune deposits are principally located in the periphery of the parking lot and to areas north, south, and east. The base of the dune sand may exhibit some consolidation. In addition to the recent dune sand deposits along the uplands, active shoreline processes are reworking the older, fine to medium grained terrace sand. Other recent deposits observed near the site include stream alluvium at the mouths of small drainages located north and south of the site. The alluvium consists of sand, gravel and cobbles composed predominantly of erosionally-resistant basalt. The thickness of the recent (Holocene) deposits varies between 0 and tens of feet-thick.

Flat-lying marine terrace deposits underlie the unconsolidated recent deposits in the project vicinity. These semi-consolidated terrace soils are remnants of older beach deposits. The marine terrace deposits are exposed in the shoreline bluffs along most of the Lincoln County shoreline, including the project area. The semi-consolidated, Pleistocene marine terrace deposits form steep bluffs along the shoreline and extend inland as much as a mile. The terrace deposits directly overlie the wave-cut benches formed on westward-tilted, Tertiary marine siltstone and fine sandstone of the Alsea Formation. The base of the marine terrace deposit may contain a lag deposit of coarse sand, gravel and cobbles that formed as a lag deposit at the shoreline transgressed to the east, prior to the deposition of the Pleistocene beach deposit. The Pleistocene marine terrace deposits range in thickness between 0 and 50 feet or more (Schlicker, et. al., 1973).

Tertiary (middle to late Oligocene), dark gray, marine siltstone and fine sandstone (Alsea Formation) underlie the marine terrace deposit. The contact between the Alsea Fm. and the Plio-Pleistocene terrace deposit is unconformable, with the underlying Alsea interbedded claystone, siltstone and fine sandstone inclined westward at dips ranging between 5 and 30 degrees, based on exposures along the Alsea River embayment and east of the project site. Thicknesses of individual interbeds of siltstone versus fine sandstone are unknown at the project site as this unit is not exposed at the surface in the project vicinity. The erosional contact between the Plio-Pleistocene terrace deposits and the underlying Oligocene siltstone and sandstone is regionally flat, however locally may be irregular due to variable erosional resistance between the siltstone, claystone and sandstone. Additionally, due to the unfavorable dip towards the west and active shoreline erosion, bedding plane failures (landslides) within the Alsea Formation exists and displaces the overlying Plio-Pleistocene through Holocene-aged deposits. The thickness of the Tertiary marine Alsea Formation ranges in thickness between 150 and 3,500 feet (Snavely, et. al., 1975).

3. Executive Summary: Conditions Encountered

The data from the various geophysical methods are processed to present the results as "tomograms"; a word derived from the Greek "tomo" meaning to cut or slice. Data were collected to illustrate subsurface conditions a distance of roughly 1200 feet along the westerly route of the proposed HDD corridor as illustrated by Figure 100 (Geophysical Exploration Plan). The tomograms are annotated to communicate our interpretation of the various types of soil and rock believed to be identified by each geophysical method.

As described in the previous section (Geologic Setting), the SA team has identified three distinct strata that dominate the materials to be encountered through this section of the HDD corridor. Stratification is simplified as follows:

- Beach Sand: The recent beach sand consists of unconsolidated, cohesionless, fine- to medium-grained sand derived from the reworking of the older, underlying marine terrace deposits. The sand ranges in density between loose and medium dense, and ranges in moisture between moist and saturated. The thickness of the beach sand varies between approximately 10 and 30 feet in the study area. Geophysical properties are summarized as follows:
    - ER: Wide variations in electrical properties were encountered mostly due to variable moisture content and moisture characteristics. When saturated by salt water, the sand offers a very low electrical resistivity, on the order of 1 Ohm-m. At higher elevations, the sand is moist and the connate water is fresh; the apparent electrical resistivity is on the order of 1,000 Ohm-m. This variation within the same strata promotes difficulty distinguishing the beach sand based on electrical resistivity alone.
    - SR: Unsaturated P-wave velocity was only measured through the higher elevations of the parking lot. Here the beach sand is characterized by P-wave velocity ranging from about 500 to 2000 f/s. In the saturated environment, the P-wave velocity will be similar to the compression wave propagation speed through water: about 4700 f/s.
    - ReMi: S-wave velocity is considered to be an excellent means of distinguishing the extents of the beach sand and the contact with stronger, underlying units. S-wave velocity is valid in both the saturated and unsaturated environment and SA interprets the S-wave velocity of the beach sand to vary from about 300 f/s to around 1000 f/s with these velocities identifying loose to dense characteristics, respectively.
- Marine Terrace Deposits: The Pleistocene terrace deposits consist of orange-brown, fine to medium-grained sand, with abundant organic fragments. Scattered, thin (1- to 2-inch) seams of sandy silt exist within the unit. Previous borings performed in this unit exhibit densities ranging between medium dense and dense. Subsurface information for the proximal area is sparse, however based on observations from the field, the terrace deposit ranges in thickness between 25 and 35 feet in the vicinity of the parking lot and to between 20 and 50 feet in the near shore area investigated in this study. Geophysical properties are summarized as follows:

- ER: Again, the ER interpretation is challenged by a wide range of electrical resistivity mostly driven by the character of the connate water. However, within each ER tomogram, electrical contrast exists to help define the upper and lower boundary of the marine terrace deposits.
- SR: P-wave refraction is an ineffective method to define the character and thickness of this stratum. SA suggests that this is due to numerous, thin layers offering variable P-wave velocity. When a high velocity layer is situated at a higher elevation than a lower velocity layer, the first arrival P-waves are carried by the higher elevation layer and the lower layers are not sampled properly. Thus, limited sampling of the marine terrace has been accomplished by SR. This blind zone leads to problems associated with defining the marine terrace thickness and position of lower strata.
- ReMi: The ReMi method provides clear definition of the marine terrace layers and identifies numerous velocity reversals, heterogeneity and a reasonable estimate regarding thickness, and strength. SA interprets S-wave velocity ranging from about 800 f/s to roughly 2200 f/s represent the marine terrace. This suggests a wide range of strength and texture.

- Tertiary Alsea Formation: The fine grained marine Alsea Formation is an indurated, interbedded, gray, siltstone, claystone, and fine sandstone. Based on previous explorations within this formation elsewhere in the region, the Alsea is hard/very dense and exhibits refusal standard penetration tests (SPTs). As described above, the top of the Alsea is a former shoreline and may exhibit an undulating erosional surface due to the variability in erosional resistance between the siltstone and sandstone interbeds. The thickness of the individual interbeds of siltstone and sandstone are unknown at the site, but outcrop evidence suggests a range between inches and tens of feet. Geophysical properties are summarized as follows:
  - ER: The ER results suggest that the Alsea Formation offers a low resistivity layer and the formation is well defined in both the saltwater and freshwater environment. The Resistivity varies widely based on the character of the connate water. In the higher elevations a strong electrical contrast exists that defines the depth to the Alsea that closely correlates with the depth defined by both SR and ReMi.
  - SR: Where thick deposits of the marine terrace deposits exist, the SR method is not considered to be an effective geophysical method to reliably define the depth and P-wave velocity of the Alsea.
  - ReMi: In each tomogram, the Alsea is clearly defined by an increase in S-wave velocity. SA interprets an S-wave velocity on the order of 2200 f/s and higher to represent the Alsea Formation. The contact with the overlying marine terrace is typically abrupt and S-wave velocity as high as about 3800 f/s are interpreted.

4. Geophysical Data Acquisition: Terrestrial

The three geophysical methods were designed to explore the geotechnical conditions to depths of 100 feet and beyond. Data were procured in a manner to extend the exploration as far west as possible by scheduling operations to coincide with low tide. In order to facilitate permitting with Oregon Parks and Recreation Department, the lines on the beach were terminated below the parking lot to prevent the need to clear vegetation. Exploration was continued at the higher elevation of the parking lot with the survey locations selected to avoid vegetation removal and limit damage to the parking lot pavement. Line locations are illustrated by Figure 100 (Geophysical Exploration Plan).

In this section, the geophysical methods, equipment, challenges, and quality are described.

4.1. Geophysical Methods and Equipment

4.1.1. Electrical Resistivity (ER)

How it works: Two-dimensional (2D) electrical resistivity tomography is a geophysical method to illustrate the electrical characteristics of the subsurface by taking measurements on land or in a marine setting. These measurements are then interpreted to provide a 2D electrical resistivity profile which is, in turn, related to the likely distribution of geologic or cultural features known to offer similar electrical properties. Measurement in an electrical survey involves injecting DC current though two current-carrying electrodes and measuring the resulting voltage difference at two or more potential electrodes. The apparent resistivity is calculated using the value of the injected current, the voltage measured and a geometric factor related to

the arrangement of the four electrodes.

The investigation depth of any particular measurement is related to the spacing between the electrodes that inject current. Therefore, sampling at different depths can be done by changing the spacing between the electrodes. Measurements are repeated along a survey line with various combinations of electrodes and spacing to produce an apparent resistivity cross-section (tomogram). In this case, SA used both Wenner and Dipole-Dipole arrays with electrode spacing ranging from 3 to 4 m along overlapping lines composed of 56 electrode take-outs built into the cable.

ER lines were set to coincide with low tide and continue from the surf zone to the toe of the brushy slope west of the parking lot. Additional lines were extended north to south both near the toe and crest of slope near the west end of the parking lot. Line length varies from 540 feet to 1141 feet with depth of exploration as great as 160 feet. Figure 100 (Geophysical Exploration Plan) illustrates the location of each line.

Electrical resistivity data were recorded using an R-8 SuperSting manufactured by Advanced Geosciences, Inc., Austin, Texas, USA. The instrument is an eight channel, automated system capable of completing over 1600 measurements in about one hour. For this project, the measurement sequence was configured for a high density data set and data were subsequently filtered during the processing stage.

4.1.2. Seismic Refraction (SR)

Seismic refraction (SR) is an active seismic method utilizing geophone receivers set along a straight line gathering data from signals induced by a small explosive charge (8 gauge, 400 grain black powder shell detonated using a Betsy Seisgun). Data were processed using forward modeling software developed by Optim known as SeisOpt@2D; the models developed are considered questionable due to velocity reversal "blind zones" as described in Section 5. SR provides a 2D profile illustrating P-wave velocity with depth. Lower P-wave velocity is related to unconsolidated materials while heavily consolidated materials and rock are illustrated by higher P-wave velocity.

How it works: When the explosive charge detonates, the receivers are triggered and the wavelet energy is recorded. The P-wave is the fastest of the various seismic waves that are generated and only the time of the first arrival wave form at the receiver is considered in the SR method. These "first arrivals" are picked for each record. As the energy travels through the ground, the waves are refracted and the arrival time, combined with distance from the source is related to both the velocity and distance to the layers promoting refraction. This distance is not necessarily vertical depth; rather the nearest refractor and the image can be skewed when oriented along a dipping refractor.

In this case, the soils on the beach are saturated promoting P-wave travel through and velocity measurement of the fluid rather than the soil. This means that P-wave velocity lower than about 4700 f/s (speed through water) will not be measured by seismic refraction.

Data were recorded using a networked pair of DAQ III seismographs manufactured by Seismic Source in Ponca City, Oklahoma, USA, connected to a HP laptop computer.

4.1.3. Seismic Refraction Microtremor (ReMi)

The refraction microtremor, known as ReMi is a passive, surface-wave analysis method for obtaining near surface shear-wave velocity models to constrain strength and position of shallow geologic boundaries. These analyses provide information about land and marine soil and rock properties that are very difficult to obtain through alternative methods. SA recorded passive ambient vibrations (background noise) augmented by an active seismic source (un-timed plate and hammer) operated near the array.

On land, surface wave analysis is performed using Rayleigh waves because they can be detected on an air-ground interface (earth surface) using geophones. However, the Scholte wave, which is a similar type of seismic surface wave propagating along the interface between a fluid layer and an underlying solid (the seabed), dominate in marine work. Hence, the Scholte wave is capitalized in marine work and measured with hydrophones set at the water-seabed interface to record ambient vibrations. Both hydrophones and geophones measure the vertical component of the surface wave (Scholte or Rayleigh) and the results are considered a reasonable estimate of the vertical distance (depth) to layers below the receivers.

How it works: The ReMi analysis develops the shear-wave velocity/depth profile using an engineering seismograph, low frequency receivers (geophones or hydrophones) and straight line array aperture (Louie, 2001). Ambient surface wave energy is recorded using relatively long sample window (30 seconds) recording the ambient wavefield. At this site, quality low frequency signals were consistently recorded from waves crashing on the beach, nearby highway traffic (trucks) and SA enhanced the mid-range frequency (about 15 Hz. to 50 Hz.) using a plate and hammer.

The microtremor records are transformed as a simple, two-dimensional slowness-frequency (p-f) plot where the ray parameter “p” is the horizontal component of slowness (inverse velocity) along the array and “f” is the corresponding frequency (inverse of period). The p-f analysis produces a record of the total spectral power in all records from the site, which plots within the chosen p-f axes. The trend within these axes, where a coherent phase has significant power is “picked”. Then the slowness-frequency picks are transformed to a typical period-velocity diagram for dispersion. Picking the points to be entered into the dispersion curve is done manually along the low velocity envelope appearing in the p-f image.

Terrestrial measurements were completed using 8 Hz. vertical receivers (geophones) using the same arrays configured for SR. Receiver overlap of 12 channels were used to provide continuous records through the long arrays of Lines A and B.

Data were recorded using a pair of networked DAQ III seismographs manufactured by Seismic Source in Ponca City, Oklahoma, USA, connected to an HP laptop computer.

4.2. Horizontal and Vertical Control

The horizontal and vertical locations were recorded by JTA as the geophysical operations were in progress. JTA worked alongside the geophysical crew each day of operations and provided staking to locate the lines in accordance with data illustrating the anticipated orientation of the HDD corridor. The North American Vertical Datum of 1988 is the basis for the elevations presented by the geophysical tomograms and details regarding the onsite survey including tabulations of the measured coordinates and a scaled site plan are presented in Section 8 of this report. Coordinates have also been uploaded to ArcGIS, a GIS database for future reference. Details regarding the GIS database and upload data formats are described in Section 9 of this report. Figure 100 (Geophysical Exploration Plan) is a rough, visual illustration of the line locations and not intended to reflect the accuracy of the JTA survey.

4.3. Ancillary Operations

4.3.1. Traffic Control

At the start of each workday, SA established a safe corridor to maintain public awareness. When operations moved to the parking lot, the west end of the lot was closed to traffic. The plan consisted of signage and cones and a few cars that where within the closed area were allowed to exit across the survey cables that were protected by a rubber road mat that allowed traffic to travel directly over the survey cables as operations were underway.

4.4. Summary of Challenges

4.4.1. Operations

Several difficulties were experienced with the most severe related to the rapid flood tide experienced on the first day of operations and associated strong wave breaks that displaced the initial setting of the ER cable along Line A. The crew needed to adjust operations including changing the planned sequence for the SR survey on Line B and re-doing the ER on Line A at a later time. Also, at the higher elevations of the parking lot, the sand was quite resistive and significant difficulty was experienced in achieving proper contact resistance at the electrode pins. The pins were watered with a saline solution and driven deep to mitigate this condition. Along Line D, both Dipole-Dipole and Wenner electrode configurations were used and the Wenner data proved to be more robust due to a stronger signal and was used in the final data processing.

4.4.2. Data Quality and Interpretation Challenges

In general, the recorded data are judged to be of moderate to high quality. The lines were laid out to optimize definition of the subsurface throughout the upper 100 feet, roughly twice the anticipated depth of the HDDs through this zone. The results provide an outstanding first look at subsurface conditions including a solid understanding of the relative strength, character and position of the various layers encountered. A summary of the engineer's judgment regarding quality and confidence in the results presented by each geophysical line is as follows:

ER-1, ER-2, SR-5, SR-6 and RM-1 through RM-4: High quality/confidence

SR-4: Good quality, challenged by some velocity reversal, not severe

ER-3, ER-4, SR-1 and SR-2, SR-3: Moderate quality, challenged by high contact resistance at the electrode pins (ER) and velocity reversal (SR)

5. Processing

5.1. General

During the data gather, partial interpretation was completed in the field for quality control purposes and to assist in setting and confirming proper data acquisition parameters.

The interpretation for each line is presented as appendix to this report with the general locations shown graphically on Figure 100 (Geophysical Exploration Plan).

It is worthy to emphasize that the geophysical results are presented in 2D yet the data collection is influenced by a 3D environment. Unless the geology is simple, like a flat stack of pancakes, the various geophysical methods cannot be expected to match perfectly. In addition, geophysical interpretations are often compared to direct observation of conditions discovered in geotechnical drill holes. Note that the drill hole is a 1D representation of the subsurface and represents a very small sampling, unlike the geophysical approach. Correlation and conflict are expected and both must be considered in context with the complication of the subsurface and the various factors influencing the measurements.

A description of the data processing, interpretation methods and results are presented as follows:

5.2. Electrical Resistivity (ER)

Important factors which affect the resistivity of different geological material are:

- Porosity
- Moisture content
- Dissolved electrolytes
- Temperature (resistivity decreases with increasing temperature)

- Water conductivity (in marine environments)

5.2.1. Processing

The AGI, R-8 SuperSting stores field measurements to proprietary data files with a .stg extension. Each dataset was filtered to remove spikes and noisy data through a systematic progression to produce inversion models with acceptable RMS error data fit without excessive iteration, which tends to produce artificial anomaly. Geometry (elevation data) was included in the processing. The data sets from overlapping measurements were combined for processing using AGI Earth Imager and Res2DINV by Geotomo Software. In the end, SA selected the inversion produced by Earth Imager; however, the two software packages produced similar findings.

5.2.2. Presentation and Interpretation

At this site, electrical contrast ranges from less than 10 Ohm meters near the ocean and is roughly 4 orders of magnitude near the parking lot. This presents a challenge in presenting the results since using a common resistivity scale for each of the tomograms effectively masks important characteristics. The difficulty was resolved by changing the resistivity presentation scale to match the range illustrated by the data measured along each line.

Since different resistivity scales are used, it is difficult to correlate similarities from line to line. Nevertheless, the ER results tend to illustrate stratification boundaries that generally are supported by the results of the other geophysical methods.

A common horizontal and vertical scale of 1 inch = 50 feet was selected for presentation of each line and the long lines A and B are presented with a horizontal scale of 1 inch = 100 feet while the shorter lines C and D offer a horizontal scale of 1 inch = 50 feet to better illustrate the findings.

5.2.3. Seismic Refraction (SR)

Refraction data were recorded along each line and the data were excellent. Lines A, B and C were challenged by several factors. First, the soils were either saturated from the surface or the water table was very shallow. This promotes P-wave velocity related to the saturated condition (essentially the speed of a compression wave traveling through water) and can be many times faster than the velocity of the same wave through the same soil if it were not saturated. Hence, the P-wave is a poor measure of soil strength when saturated. Second, the sediments appear to be layered such that stronger, faster layers are bedded at depths above weaker, slower layers. This causes problems with the refraction method since the fastest raypaths return to the receivers from shallow depth and deep geology is not sampled as thoroughly.

5.2.4. Processing

SA processed the refraction data using software known as SeisOpt@2D, version 6.0, developed by Optim. The process uses a forward modeling and nonlinear optimization procedure capable of resolving features to about one-half of the receiver spacing generating results using only geometry, source and receiver locations, and first arrival times. Many models were generated for each line to determine the best fit for various possibilities of raypaths refracting to each receiver from each shot. The primary variable (and unknown) is the depth to the refractor and in this is case, SA judges that the refractors are a complicated system of layers offering velocity reversals challenging the normal precision of the refraction method. This is particularly true for Lines A, B and C, and less of an issue with the remaining lines that are at higher elevations.

The raypath hitplots are presented to illustrate the path of the refracting waves for the models that were selected. These plots clearly show that the P-wave velocity through the interior regions of Lines A, B and C is not well constrained. This is a classic example of when the refraction seismic method is not the most effective geophysical technique for the given geology.

5.2.5. Presentation and Interpretation

The geology described by the 2D refraction surveys defines a strong layer with an elevation that ranges as deep as about -80 feet to as shallow as about -20 feet. This interpretation is judged to be suspect due to the velocity reversal “blind zone” as discussed. In the opinion of SA, the 2D ReMi interpretations are probably a better estimate for depth to hard, strong layers and a much better description of the strength of the shallow, saturated soils and the lateral variability.

A common vertical scale of 1 inch = 50 feet was selected for presentation of the Lines A, B, C and D, and a horizontal scale of 1 inch = 30 feet was used for the short lines E and F to better illustrate the findings. A common velocity range was used for each velocity tomogram.

5.3. Refraction Micro-tremor (ReMi)

A two-dimensional shear-wave model was produced along each of the geophysical traverses for Lines A through D. The models are of particular value as the shear wave velocity is directly related to the strength of a geologic material and is not influenced by saturation since water has no shear strength. The models were produced by Dr. Satish Pullammanappallil, Ph.D. of Optim, Reno, Nevada, USA using SeisOpt ReMi software. The 2D models illustrate the trend in the subsurface in terms of shear-wave velocity that correspond closely with trends in the ER and, in some cases, SR adding confidence in the interpretation.

Shear-wave velocity, V_s is used to determine the shear modulus, G, of soil or rock:

$G = \rho (V_s^2)$: a valuable measure of soil stiffness and rock strength.

Where ρ = mass density (i.e. total unit weight / gravitational acceleration constant, 32.2 ft/s^2).

The ReMi derived V_s from small strain measurements produced by non-destructive surface waves (Rayleigh waves) with strain on the order of 10^{-4} %. Shear modulus (G) derived from shear-wave velocity measured insitu using surface wave methods is commonly referred to as the small-strain shear modulus G_{max}.

The shear-wave velocities observed in the 2D ReMi profile illustrates numerous velocity reversals in the shallow layers and a clear, typically abrupt transition to hard, strong material at elevations ranging from about -100 feet to as shallow as -20 feet or so. The data for ReMi analysis are robust and SA judges the 2D ReMi profile to be a valid estimate of the prevailing geology. Overall, the ReMi appears to define complicated, disconnected layers of variable strength underlain by competent, hard strata.

5.3.1. Processing

Dr. Pullammanappallil, Ph.D. took the lead on processing the ReMi datasets. He created a series of 1D shear-wave depth profiles along each line using 12 to 24 channels per analysis progressing through the data one channel at a time (channels 1 to 12, 2 to 13, 3 to 14 and so on). As many as 24 channels were used to constrain the deepest parts of the models; however, even the 12 channel analysis offered data constraining depth of exploration approaching 70 feet.

5.3.2. Presentation and Interpretation

The 2D ReMi data is presented using a template similar to the ER and SR with common horizontal and vertical scales.

5.3.3. Seismic Site Classification (ASCE 7)

Seismic Site Classification in accordance with ASCE 7 was also calculated from data along each of the 2D ReMi lines. Site Class C dominates with the average V100 well above 1200 f/s.

6. References

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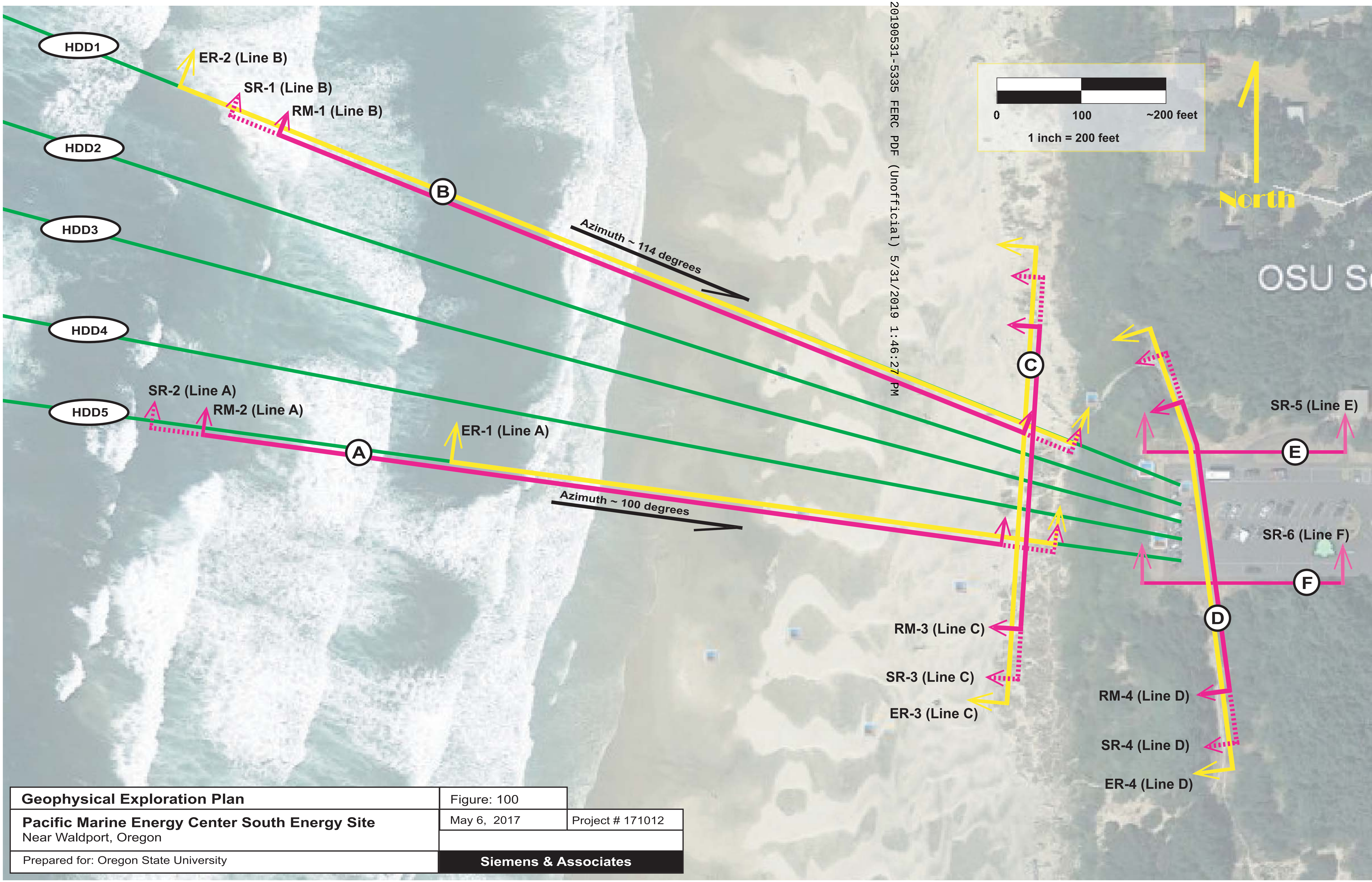
7. Graphical Presentation of Results

The interpretations are presented in 2D with the location of each line illustrated on Figure 100 (Geophysical Exploration Plan).

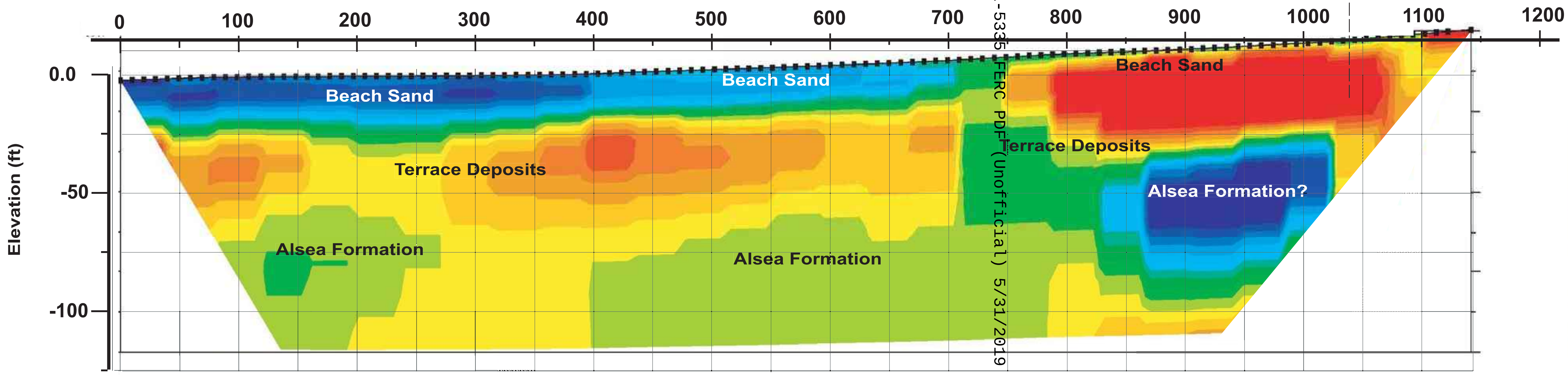
7.1. Figure 100: Geophysical Exploration Plan

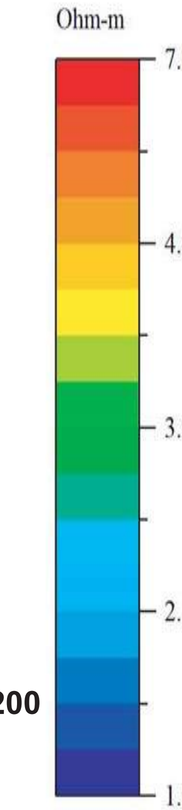


Geophysical Exploration Plan	Figure: 100	
Pacific Marine Energy Center South Energy Site Near Waldport, Oregon	May 6, 2017	Project # 171012
Prepared for: Oregon State University	**Siemens & Associates**	

7.2. Results on Line A: ER, SR and ReMi

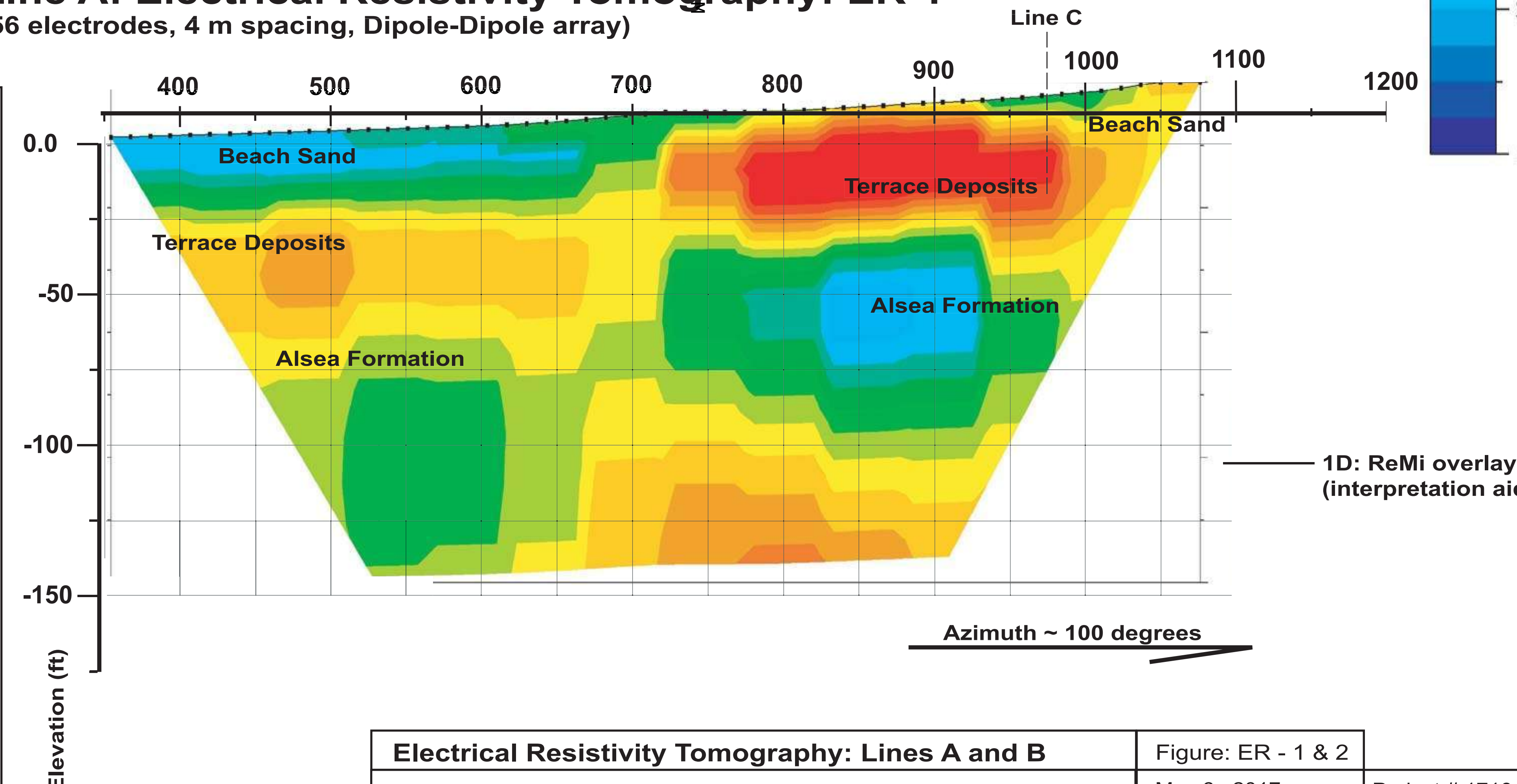
Line B: Electrical Resistivity Tomography: ER-2
(Three overlapping arrays of 56 electrodes - merged, 3 m spacing: Dipole-Dipole array)





Line A: Electrical Resistivity Tomography: ER-1
(56 electrodes, 4 m spacing, Dipole-Dipole array)

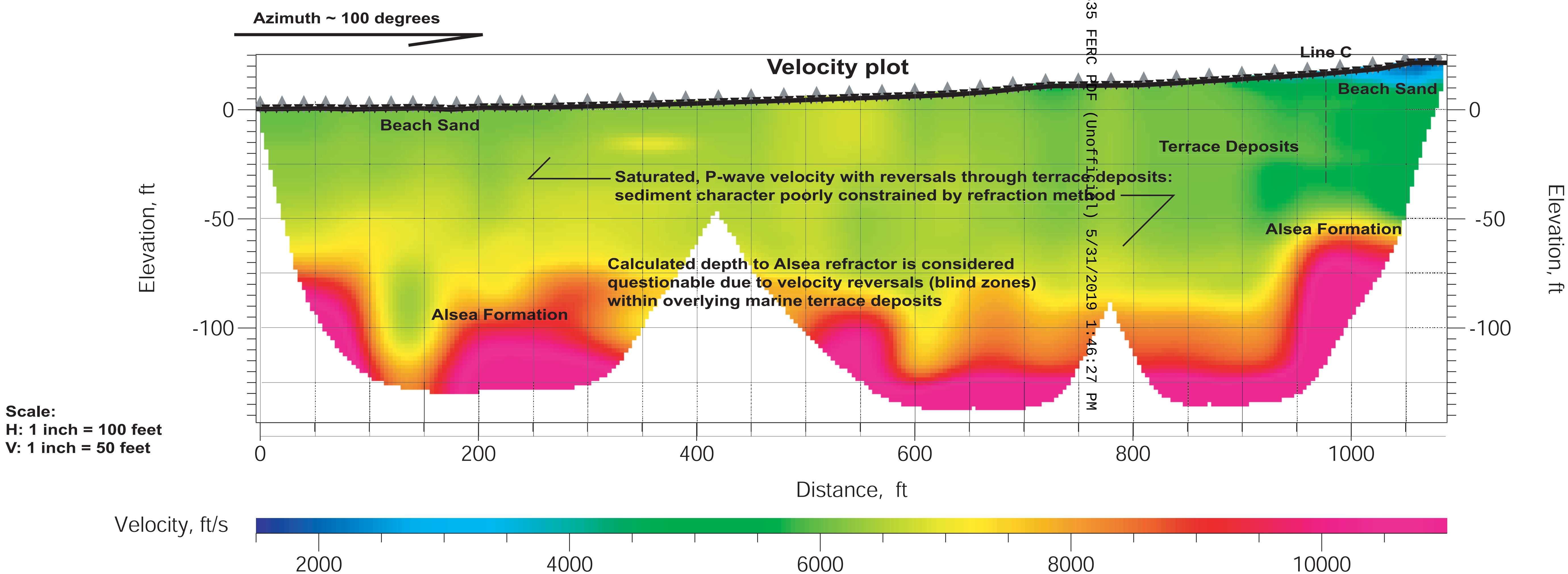
Scale:
H: 1 inch = 100 feet
V: 1 inch = 50 feet

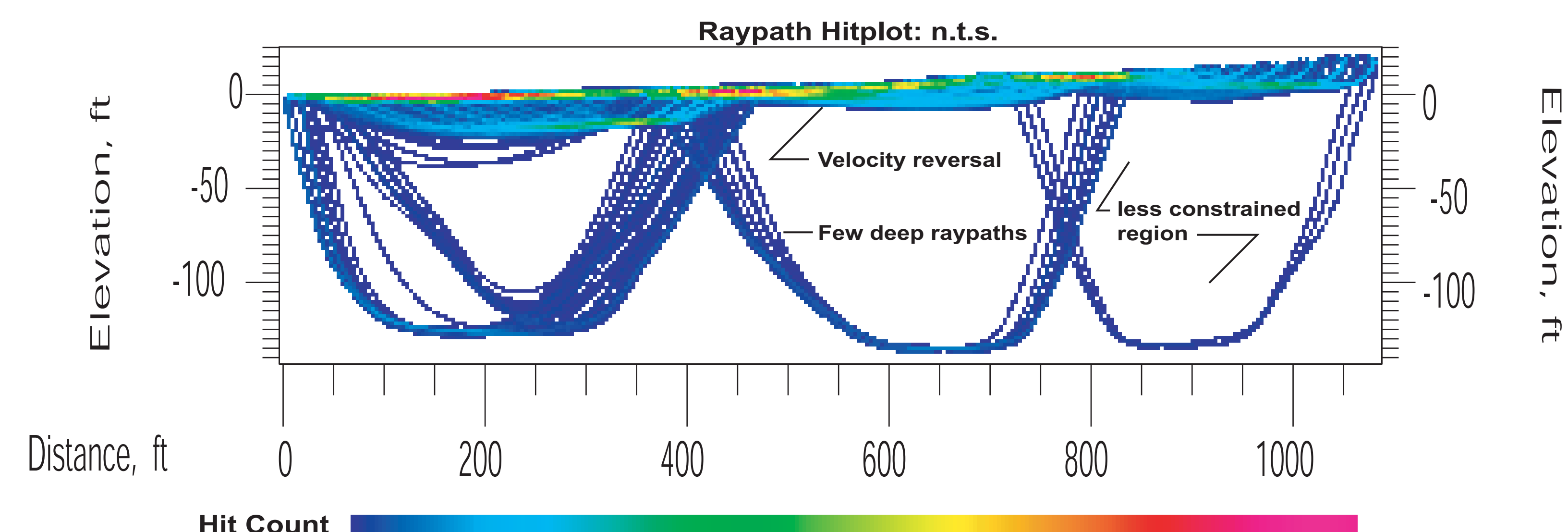


Electrical Resistivity Tomography: Lines A and B	Figure: ER - 1 & 2	
Pacific Marine Energy Center South Energy Site Near Waldport, Oregon	May 6, 2017	Project # 171012
Prepared for: Oregon State University	**Siemens & Associates**	

Line A: P-wave Seismic Refraction Tomography: SR-2

(two 48 receiver spreads and one 36 receiver spread on 10 foot spacing, 12 receiver overlap, 8 Hz. receivers: shots on 20 to 30 foot spacing)



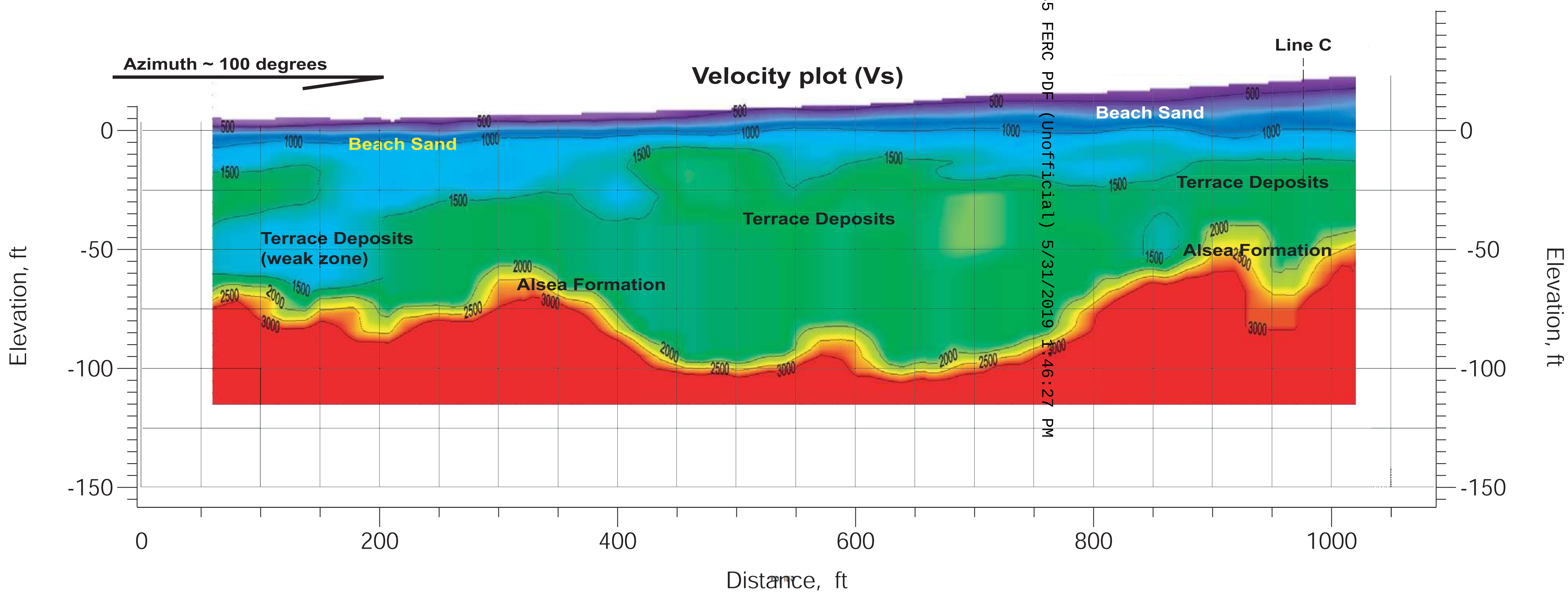


P-wave Seismic Refraction Tomography: SR-2	Figure: SR-2	
Pacific Marine Energy Center South Energy Site Near Waldport, Oregon	April 29, 2017	Project # 171012
Prepared for: Oregon State University	**Siemens & Associates**	

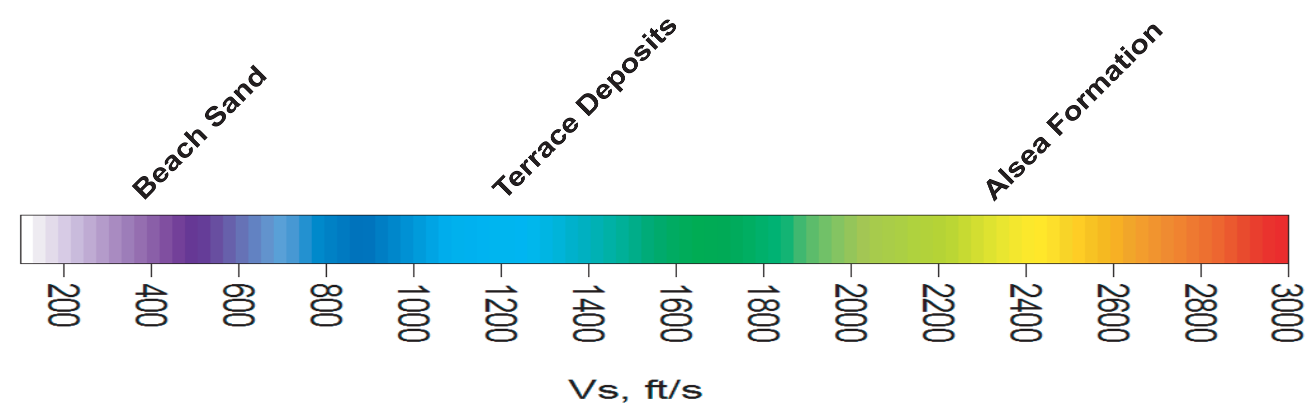
Line A: S-wave Seismic Refraction Microtremor (ReMi): RM-2

(two 48 receiver spreads and one 36 receiver spread on 10 foot spacing, 12 receiver overlap, 8 Hz. receivers)

SeisOpt ®ReMi ™



Scale:
H: 1 inch = 100 feet
V: 1 inch = 50 feet

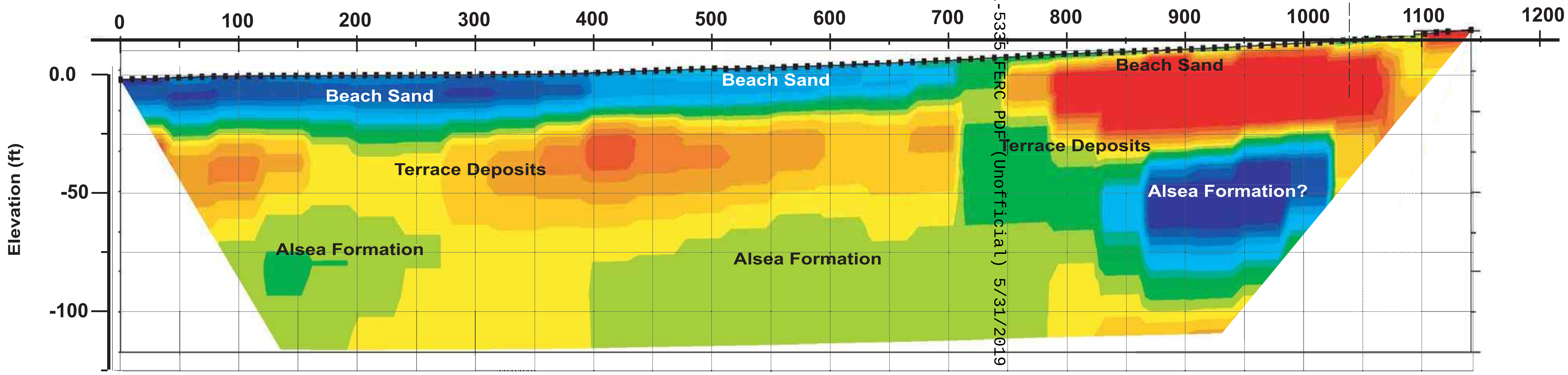


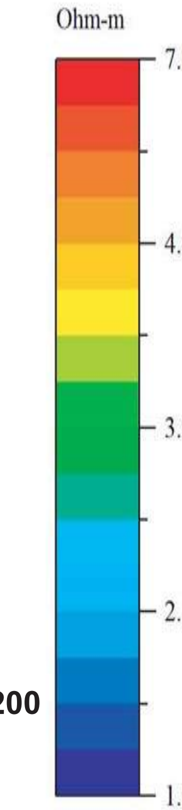
Seismic Refraction Microtremor (ReMi): RM-2	Figure: RM-2	
Pacific Marine Energy Center South Energy Site Near Waldport, Oregon	April 29, 2017	Project # 171012
Prepared for: Oregon State University	**Siemens & Associates**	

7.3. Results on Line B: ER, SR and ReMi

Line B: Electrical Resistivity Tomography: ER-2

(Three overlapping arrays of 56 electrodes - merged, 3 m spacing: Dipole-Dipole array)

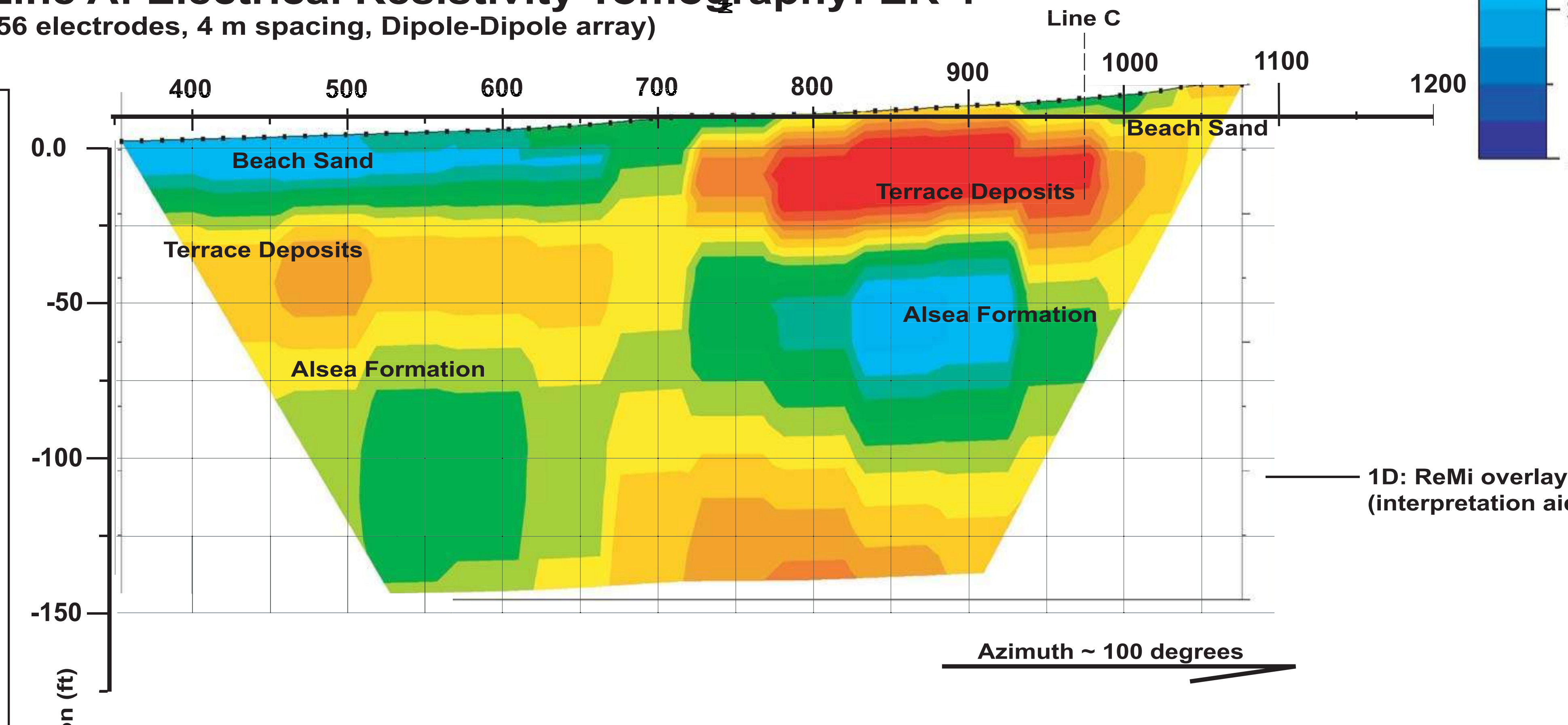




Line A: Electrical Resistivity Tomography: ER-1

(56 electrodes, 4 m spacing, Dipole-Dipole array)

Scale:
H: 1 inch = 100 feet
V: 1 inch = 50 feet

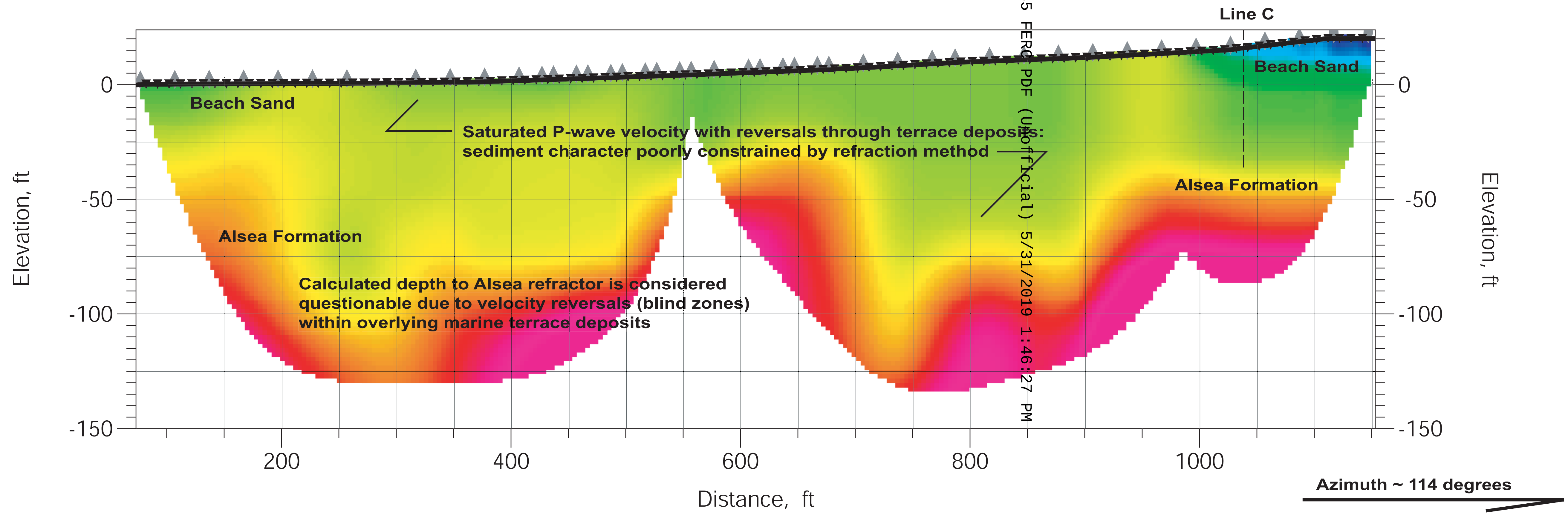


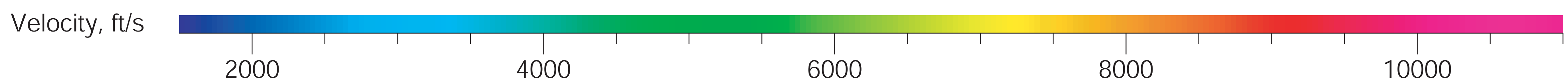
Elevation (ft)

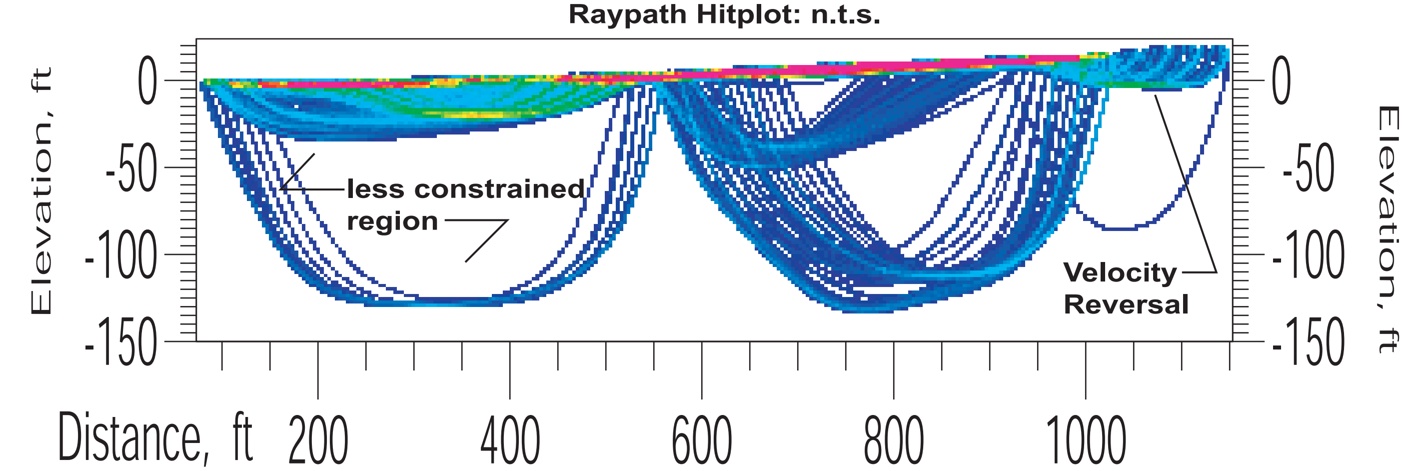
Electrical Resistivity Tomography: Lines A and B	Figure: ER - 1 & 2	
Pacific Marine Energy Center South Energy Site Near Waldport, Oregon	May 6, 2017	Project # 171012
Prepared for: Oregon State University	**Siemens & Associates**	

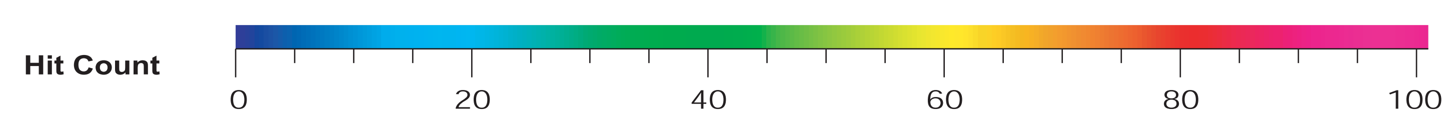
Line B: P-wave Seismic Refraction Tomography: SR-1

(two 48 receiver spreads and two 24 receiver spreads on 10 foot spacing, 12 receiver overlap, 8 Hz. receivers: shots on 30 foot spacing)









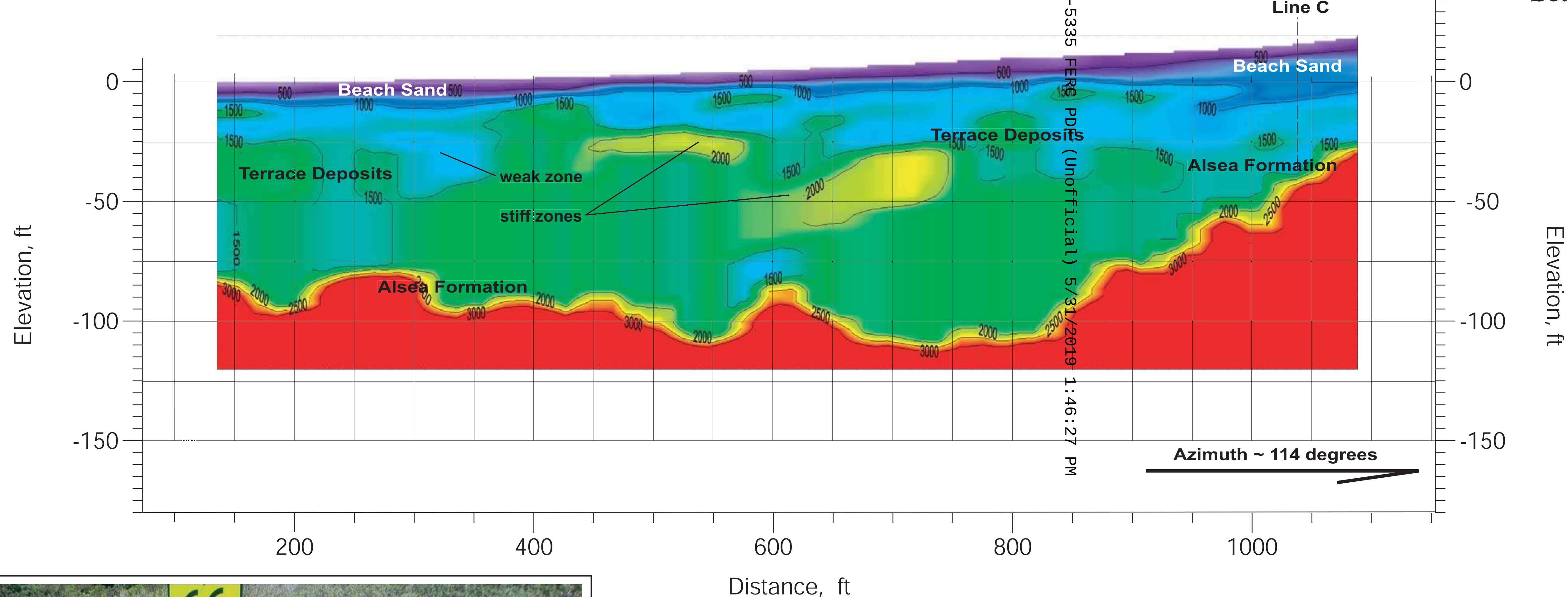
Scale:
H: 1 inch = 100 feet
V: 1 inch = 50 feet

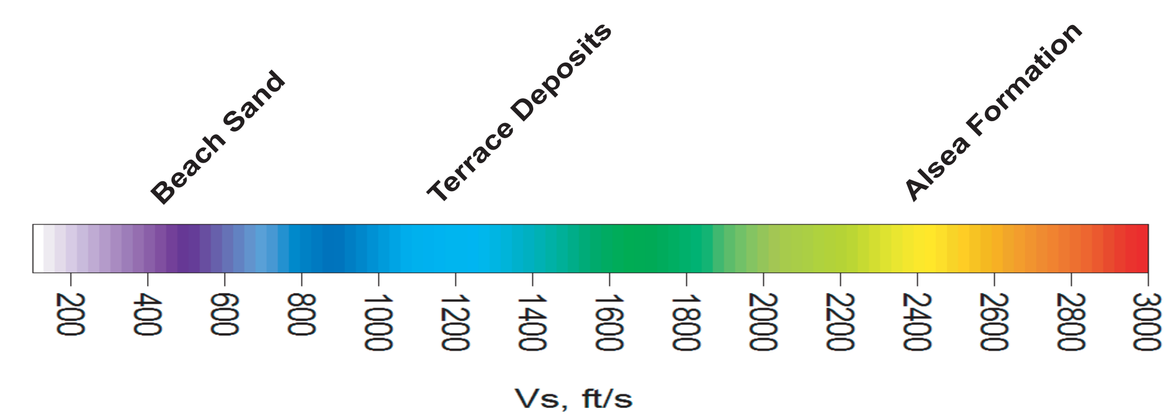
P-wave Seismic Refraction Tomography: SR-1 on Line B	Figure: SR-1	
Pacific Marine Energy Center South Energy Site Near Waldport, Oregon	April 27, 2017	Project # 171012
Prepared for: Oregon State University	**Siemens & Associates**	

Line B: S-wave Seismic Refraction Microtremor (ReMi: RM-1

(two 48 receiver spreads and two 24 receiver spreads on 10 foot spacing, 12 receiver overlap)

SeisOpt® ReMi™





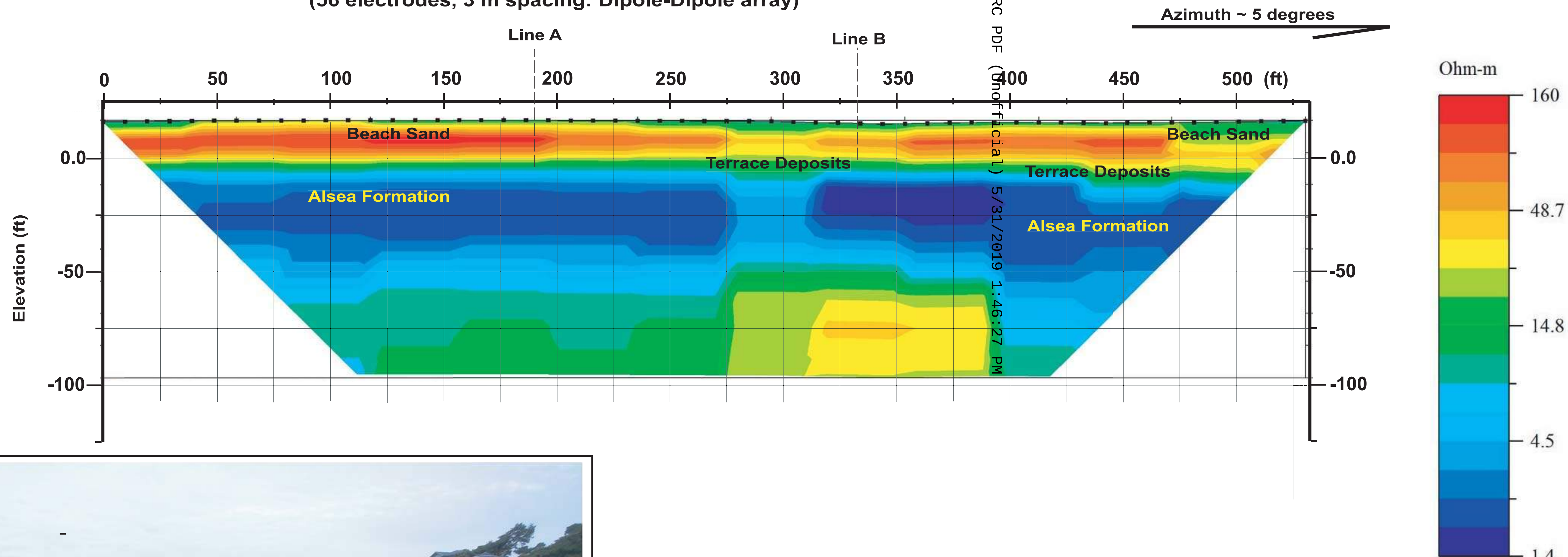
Scale:
H: 1 inch = 100 feet
V: 1 inch = 50 feet

Seismic Refraction Micrtotremor (ReMi): RM-1	Figure: RM-1	
Pacific Marine Energy Center South Energy Site Near Waldport, Oregon	April 27, 2017	Project # 171012
Prepared for: Oregon State University	**Siemens & Associates**	

7.4. Results on Line C: ER, SR and ReMi

Line C: Electrical Resistivity Tomography: ER-3

(56 electrodes, 3 m spacing: Dipole-Dipole array)

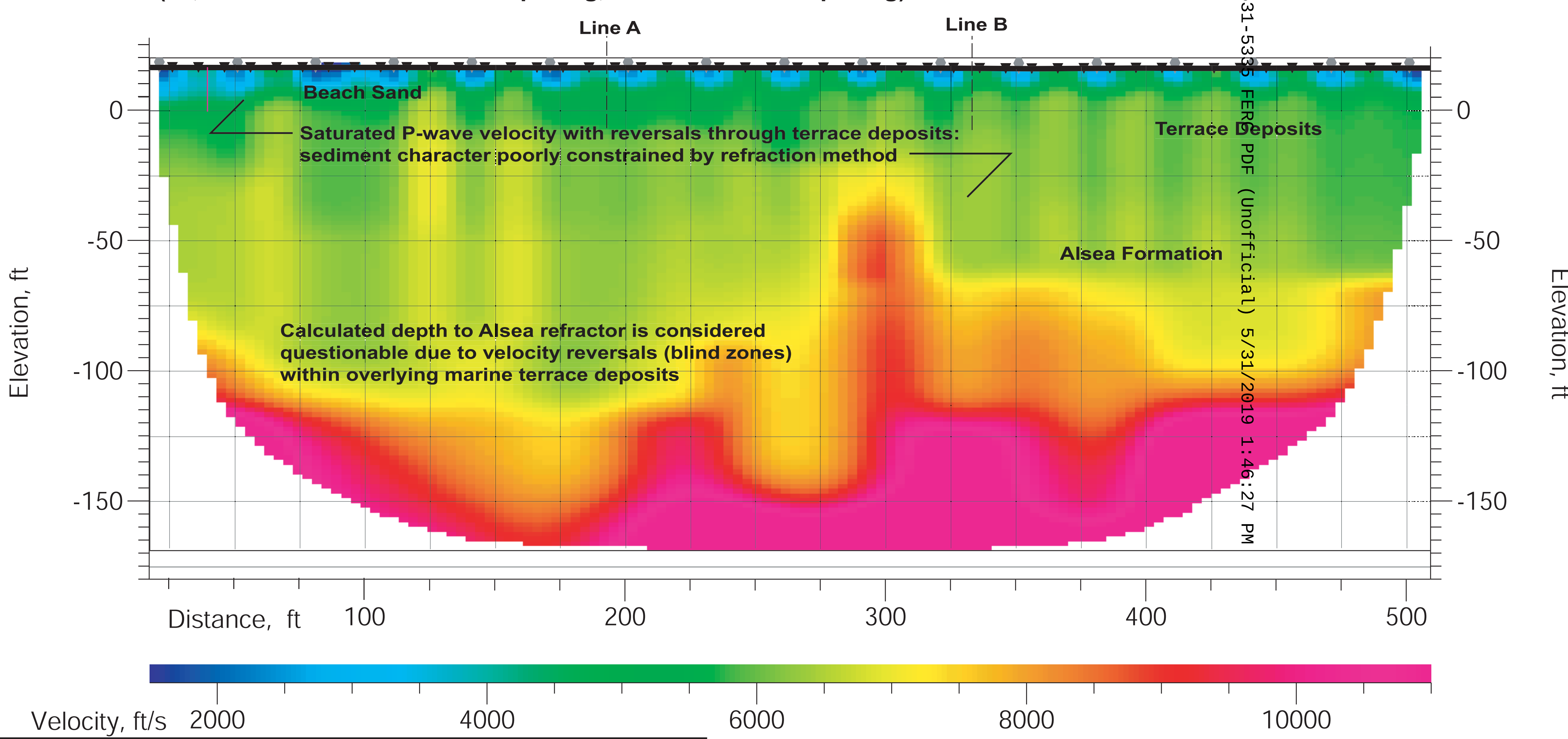


Scale:
H: 1 inch = 50 feet
V: 1 inch = 50 feet

Electrical Resistivity Tomography: Line C	Figure: ER-3	
Pacific Marine Energy Center South Energy Site Near Waldport, Oregon	April 29, 2017	Project # 171012
Prepared for: Oregon State University	**Siemens & Associates**	

Line C: P-wave Seismic Refraction Tomography: SR-3

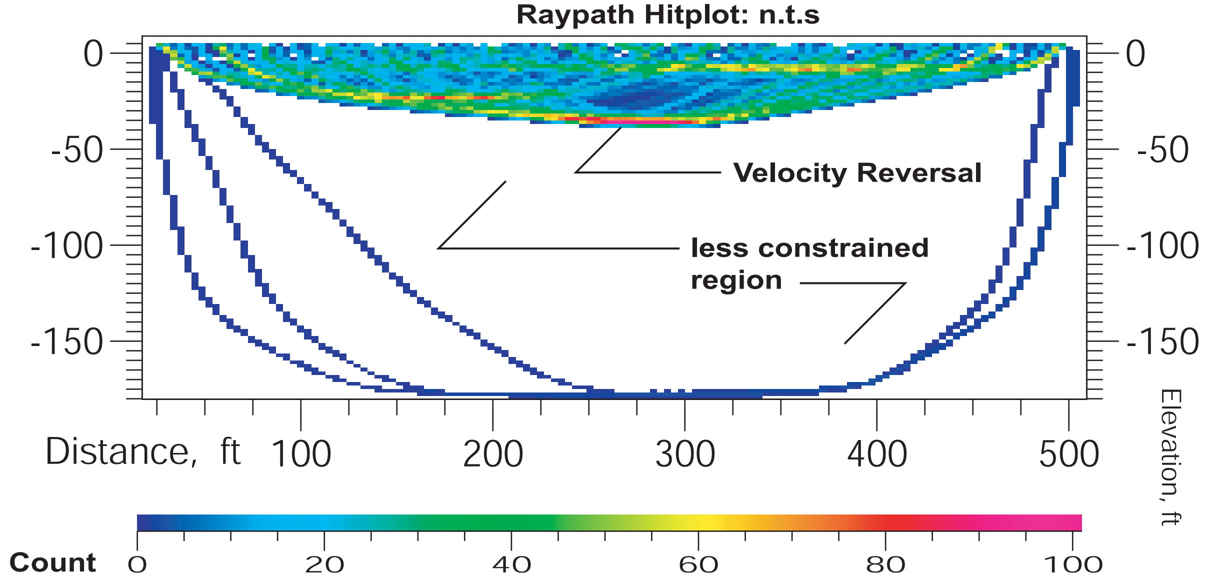
(48, 8 Hz. receivers on 10 foot spacing, shots on 30 foot spacing)



Azimuth ~ 5 degrees

Scale:
H: 1 inch = 50 feet
V: 1 inch = 50 feet

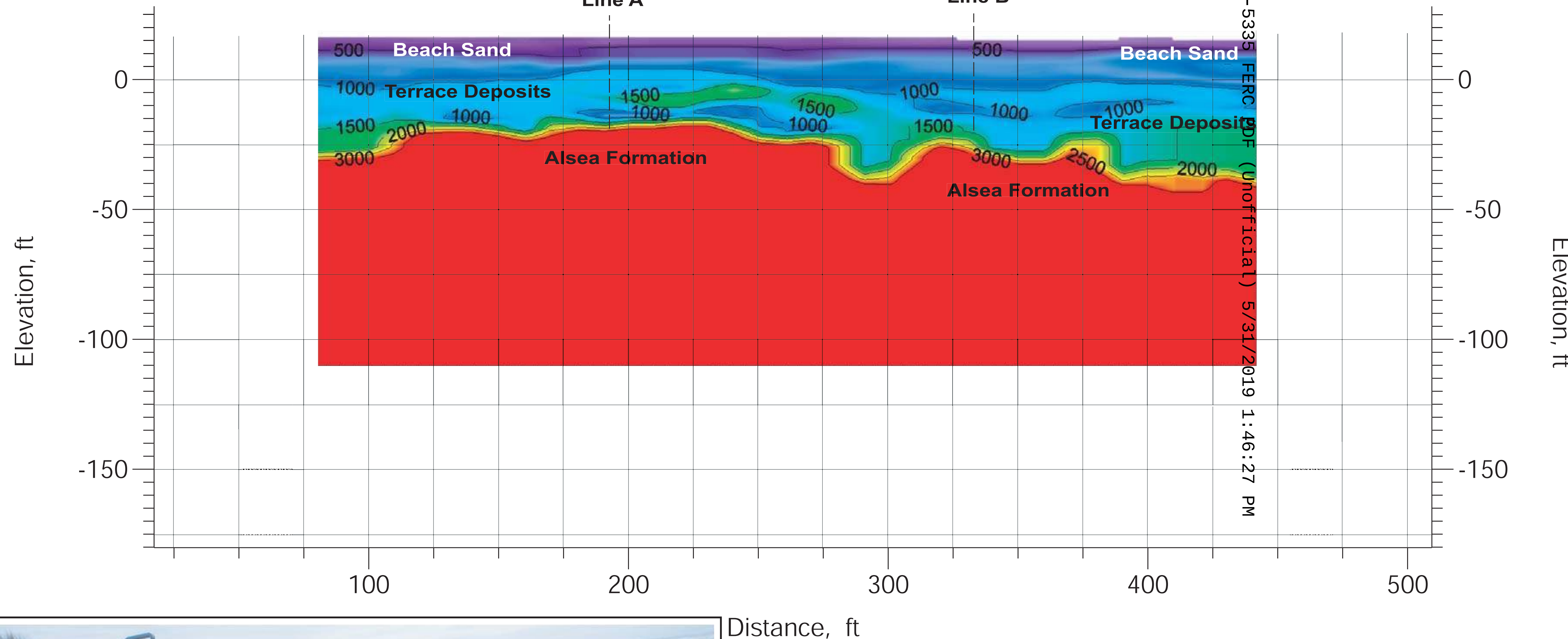
Raypath Hitplot: n.t.s



P-wave Seismic Refraction Tomography: SR-3 on Line C	Figure: SR-3	
Pacific Marine Energy Center South Energy Site Near Waldport, Oregon	April 28, 2017	Project # 171012
Prepared for: Oregon State University	**Siemens & Associates**	

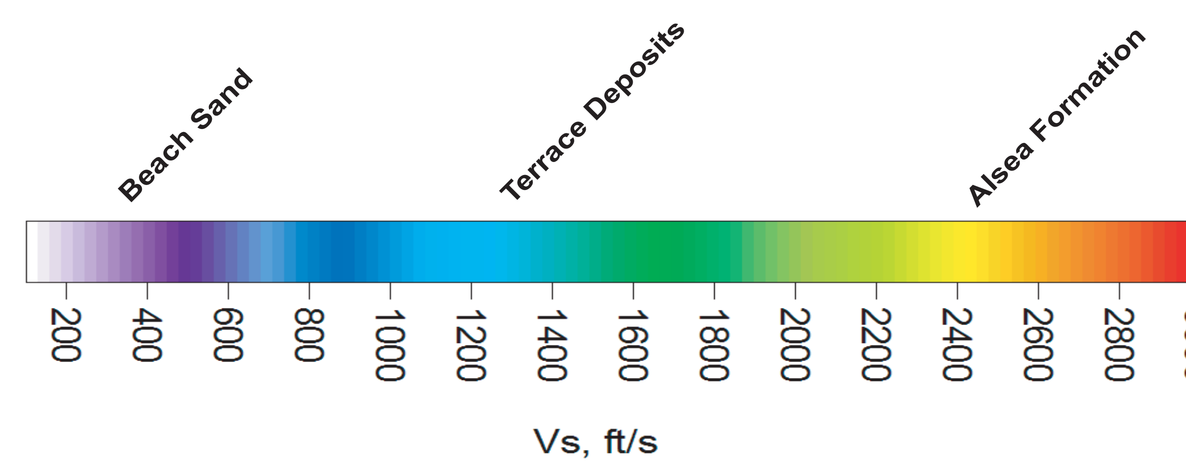
Line C: S-wave Seismic Refraction Microtremor (ReMi): RM-3
(48, 8 Hz. receivers on 10 foot spacing)

SeisOpt® ReMi™



Azimuth ~ 5 degrees

Scale:
H: 1 inch = 50 feet
V: 1 inch = 50 feet

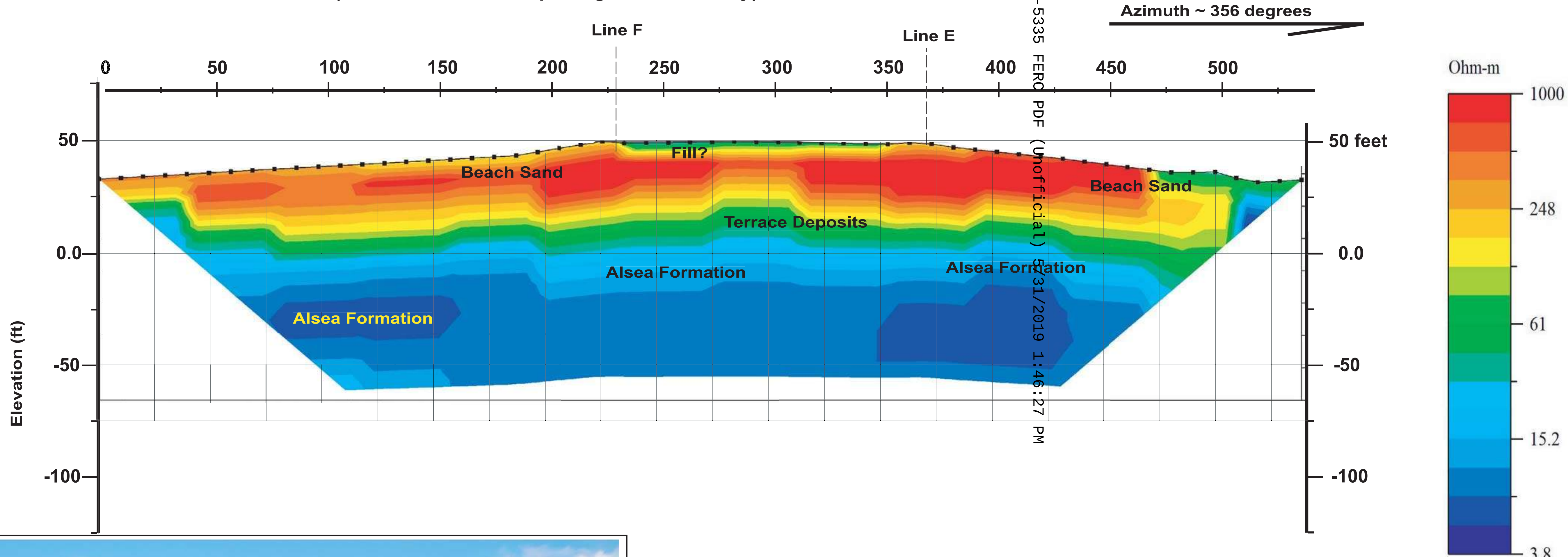


S-wave Seismic Refraction Microtremor (ReMi): RM-3	Figure: RM-3	
Pacific Marine Energy Center South Energy Site Near Waldport, Oregon	April 29, 2017	Project # 171012
Prepared for: Oregon State University	**Siemens & Associates**	

7.5. Results on Line D: ER, SR and ReMi

Line D: Electrical Resistivity Tomography: ER-4

(56 electrodes, 3 m spacing: Wenner array)

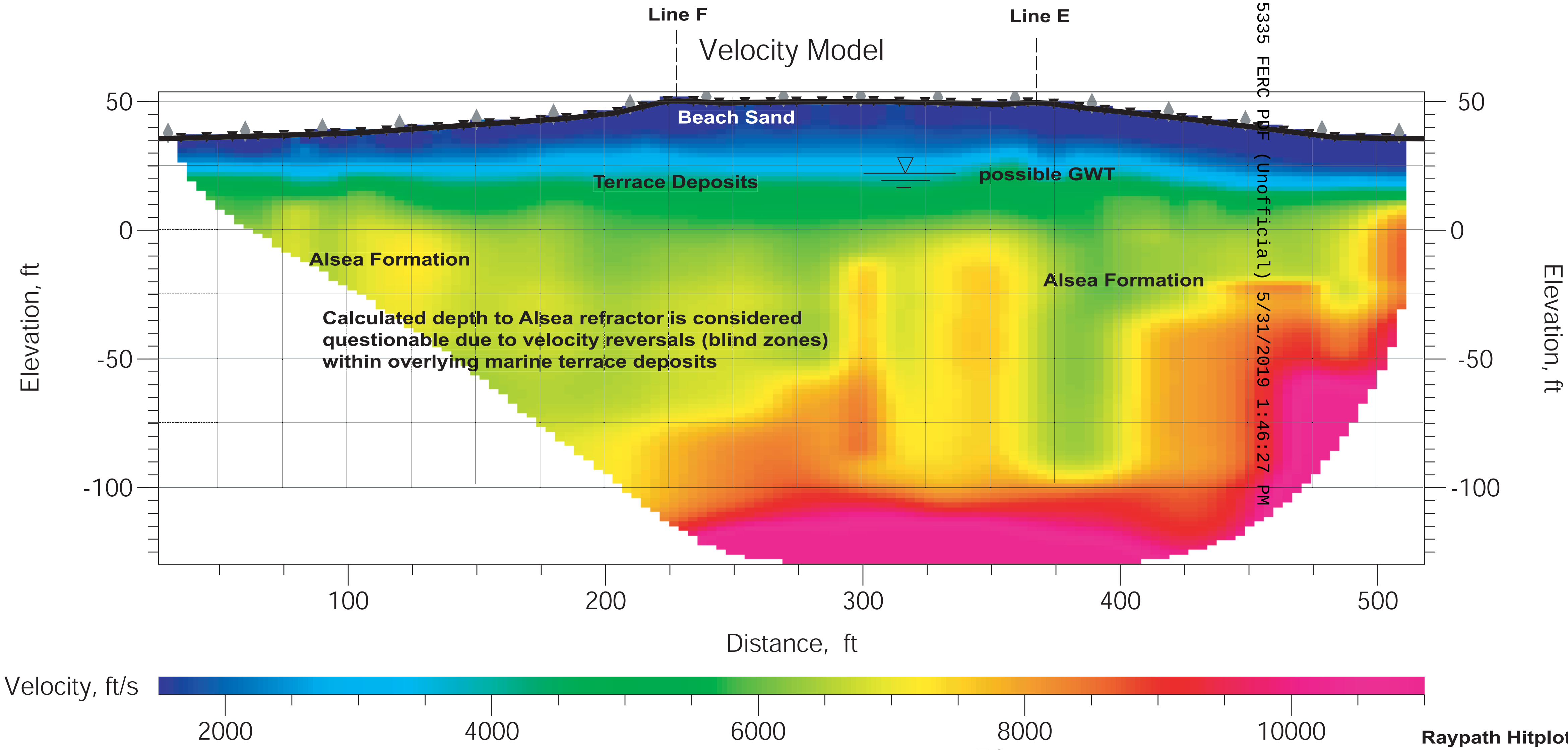


Scale:
H: 1 inch = 50 feet
V: 1 inch = 50 feet

Electrical Resistivity Tomography: Line D	Figure: ER-4	
Pacific Marine Energy Center South Energy Site Near Waldport, Oregon	May 6, 2017	Project # 171012
Prepared for: Oregon State University	**Siemens & Associates**	

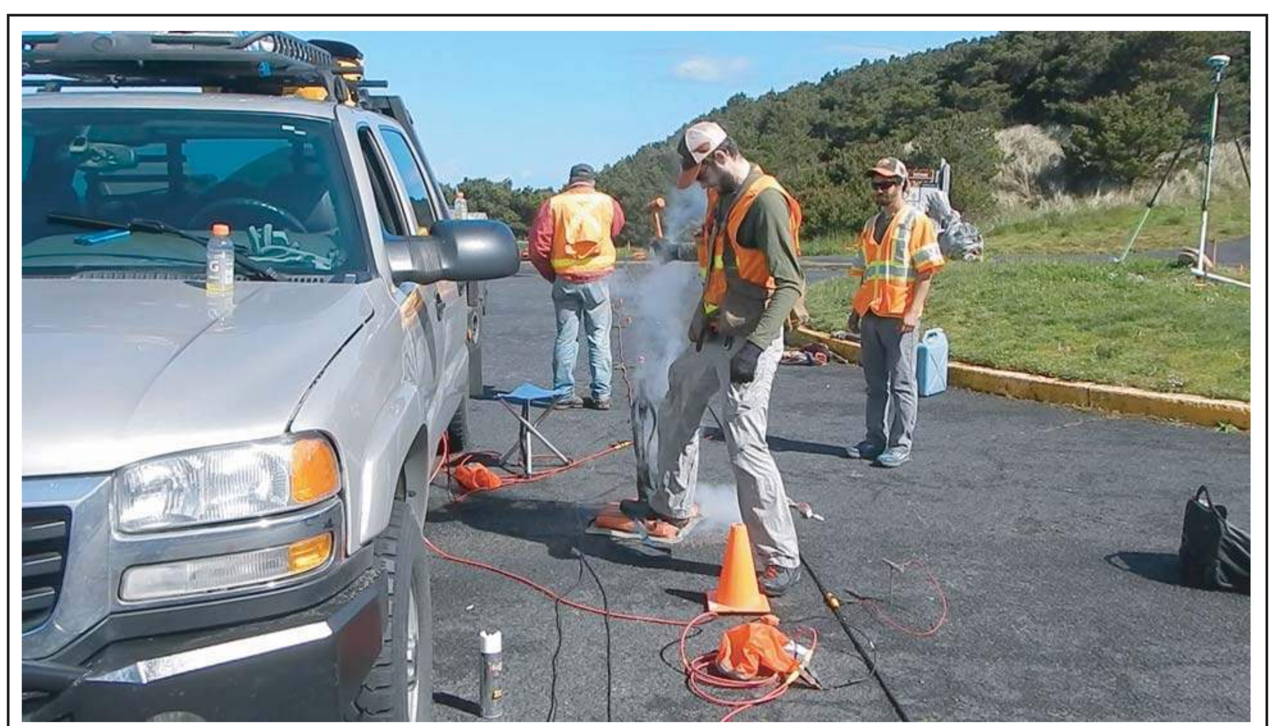
Line D: P-wave Seismic Refraction Tomography: SR-4

(48, 8 Hz. receivers on 10 foot spacing, shots on 30 foot spacing)

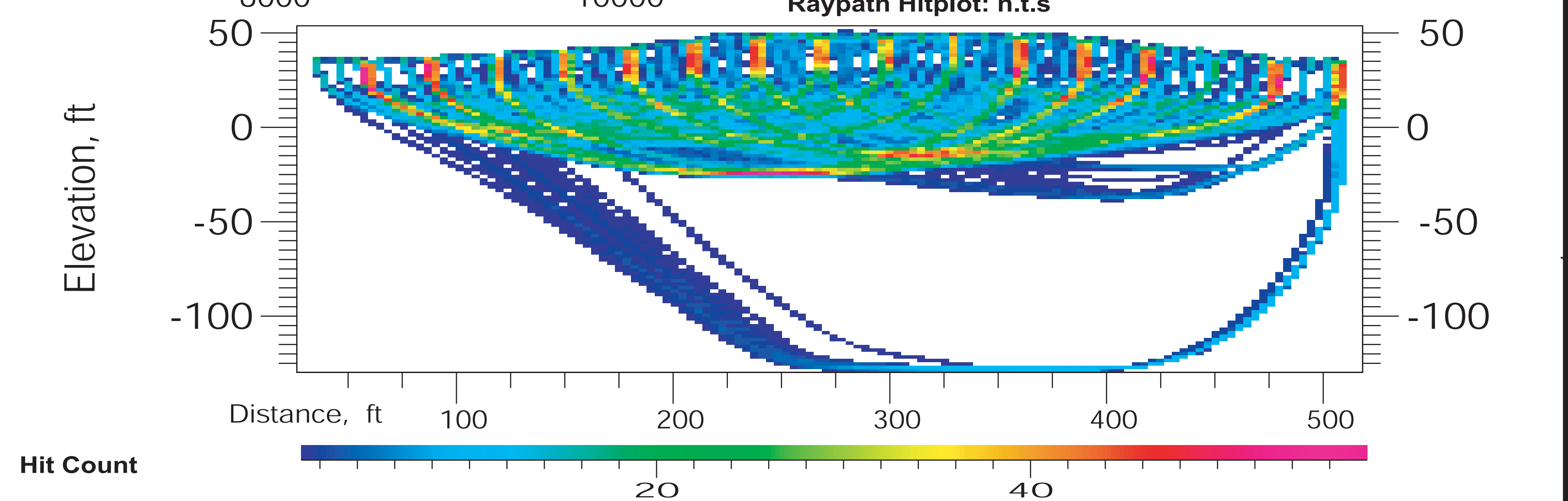


Azimuth ~ 356 degrees

Scale:
H: 1 inch = 50 feet
V: 1 inch = 50 feet



Raypath Hitplot: n.t.s

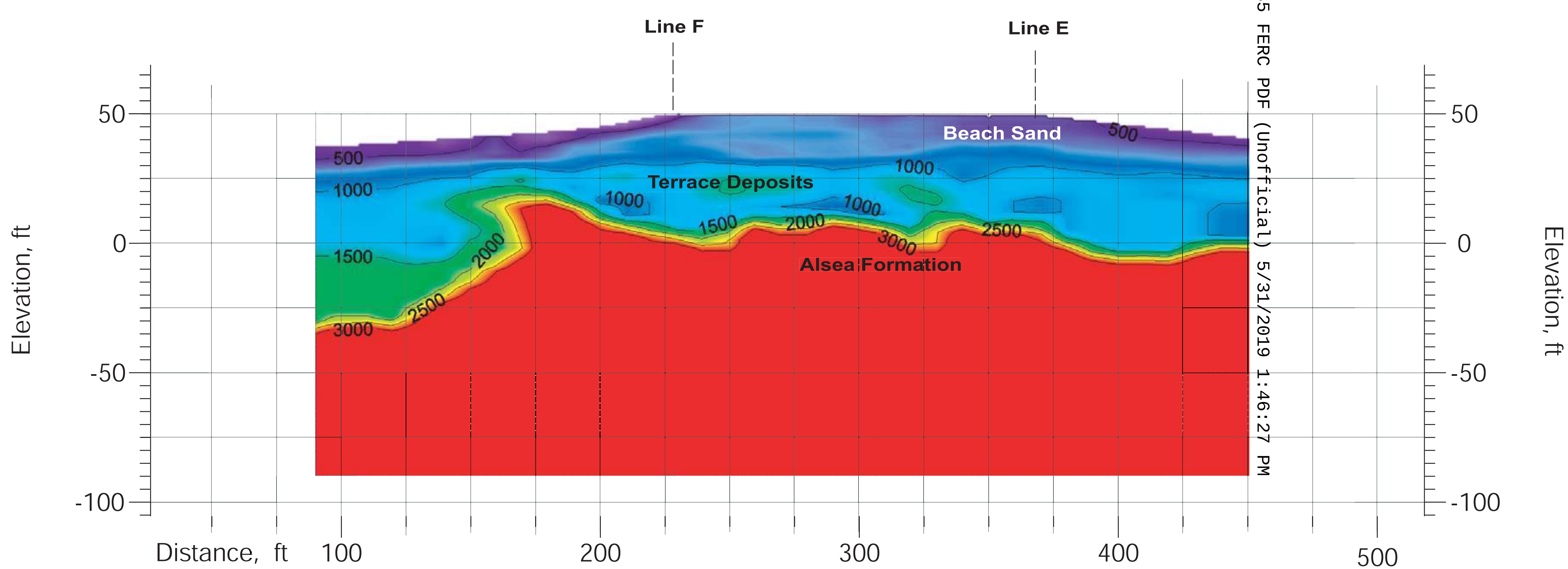


P-wave Seismic Refraction Tomography: SR-4 on Line D	Figure: SR-4	
Pacific Marine Energy Center South Energy Site Near Waldport, Oregon	May 6, 2017	Project # 171012
Prepared for: Oregon State University	**Siemens & Associates**	

Line D: S-wave Seismic Refraction Microtremor: RM-4

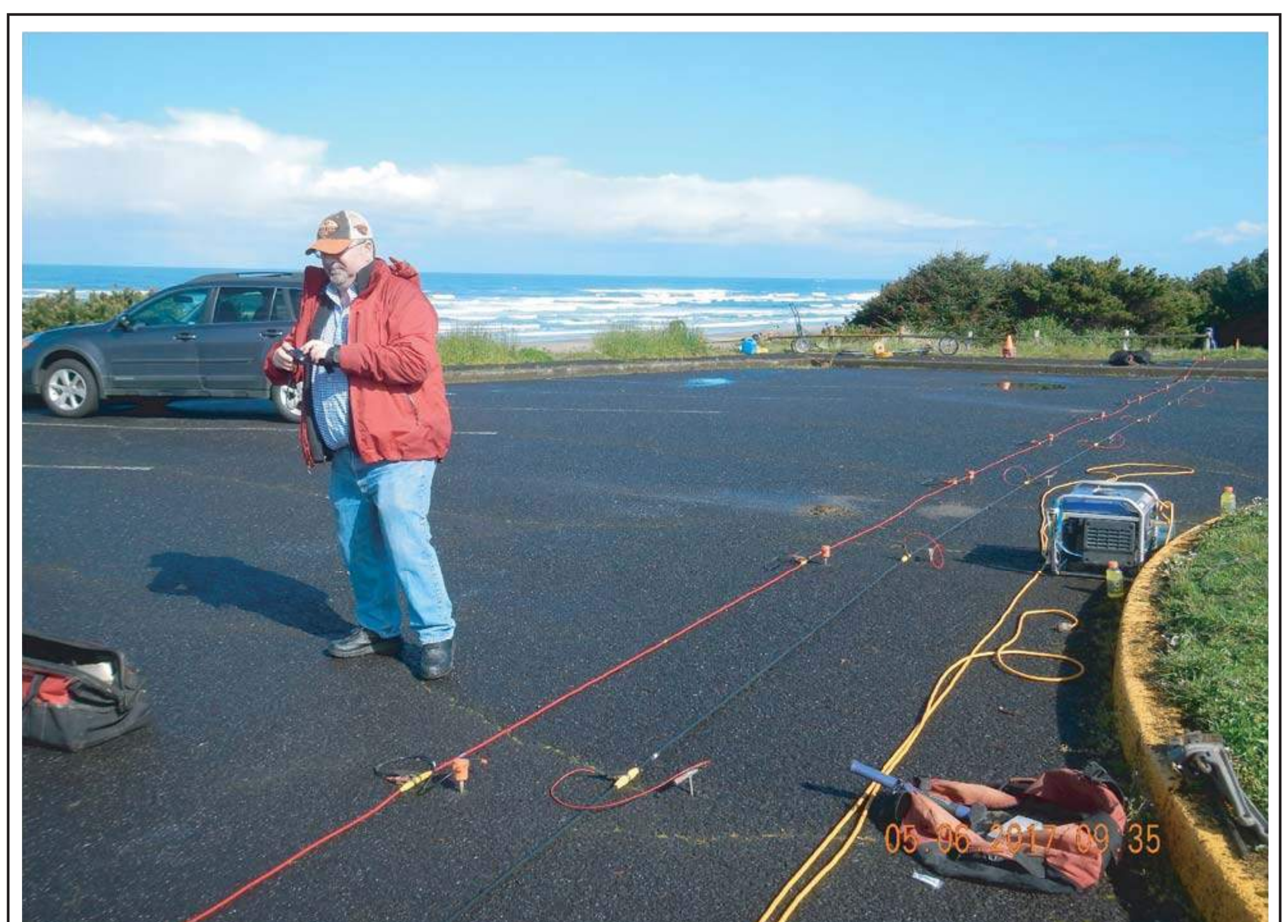
(48, 8 Hz. receivers on 10 foot spacing)

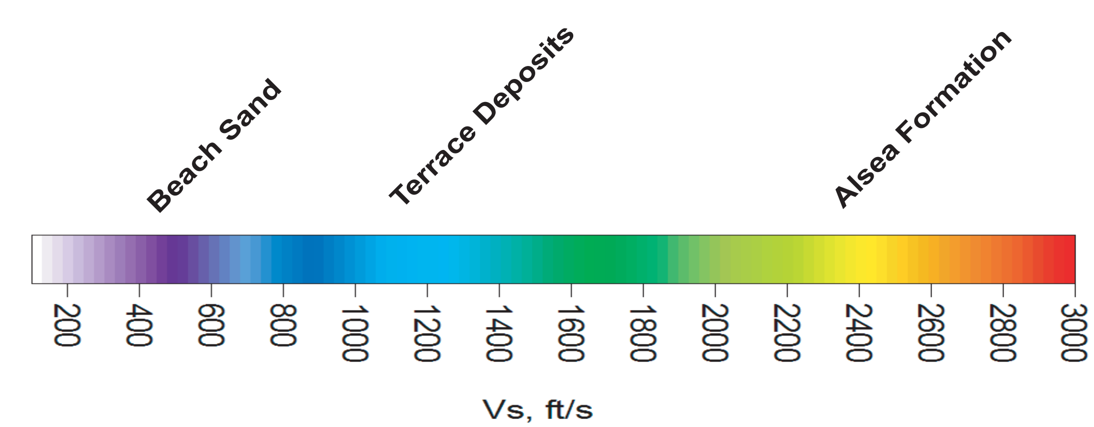
SeisOpt® ReMi™



Azimuth ~ 356 degrees

Scale:
H: 1 inch = 50 feet
V: 1 inch = 50 feet



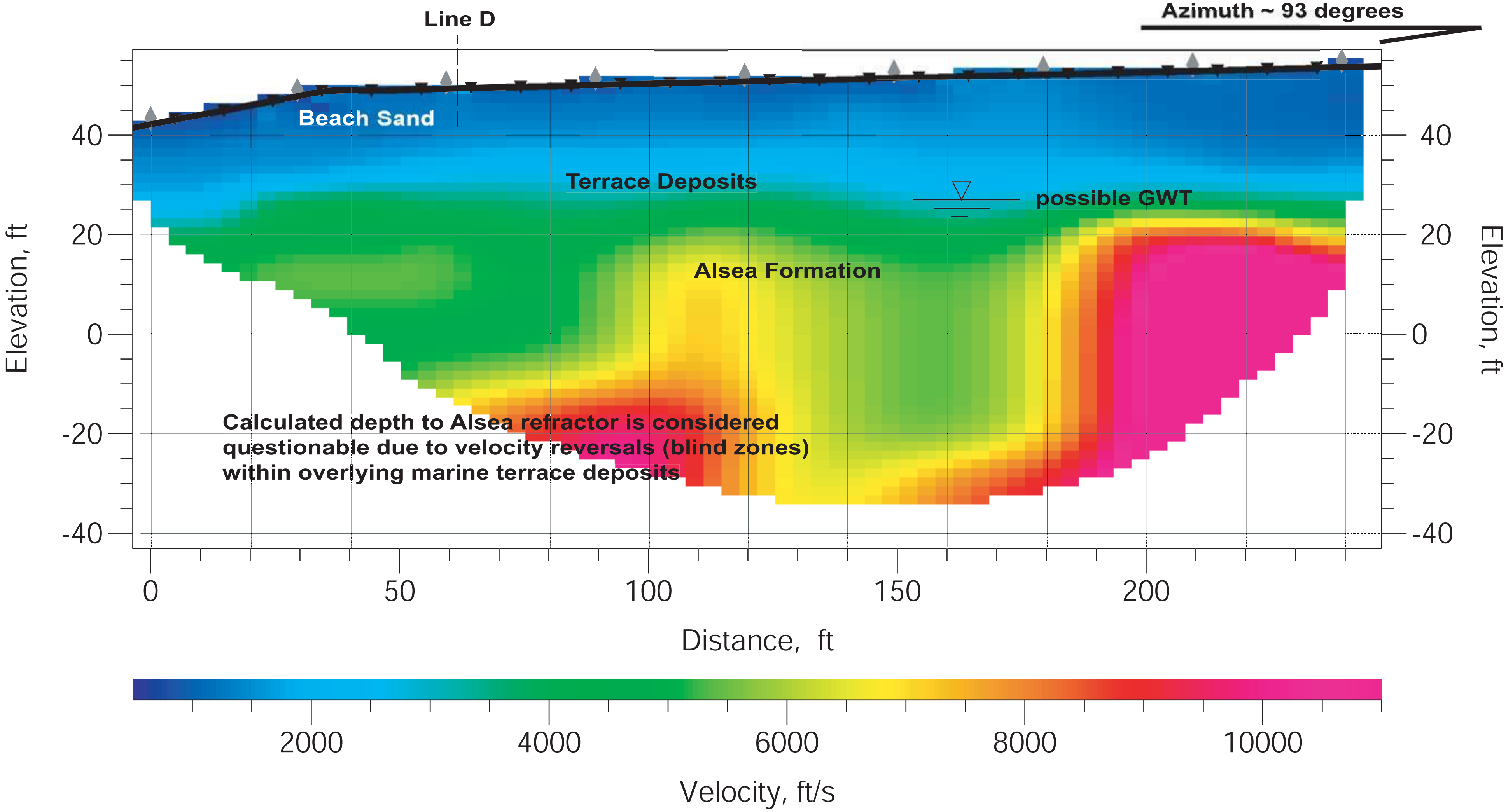


S-wave Seismic Refraction Microtremor (ReMi): RM-4	Figure: RM-4	
Pacific Marine Energy Center South Energy Site Near Waldport, Oregon	May 6, 2017	Project # 171012
Prepared for: Oregon State University	**Siemens & Associates**	

7.6. Results on Line E: SR only

Line E: P-wave Seismic Refraction Tomography: SR-5

(24, 8 Hz. receivers on 10 foot spacing, shots on 30 foot spacing)



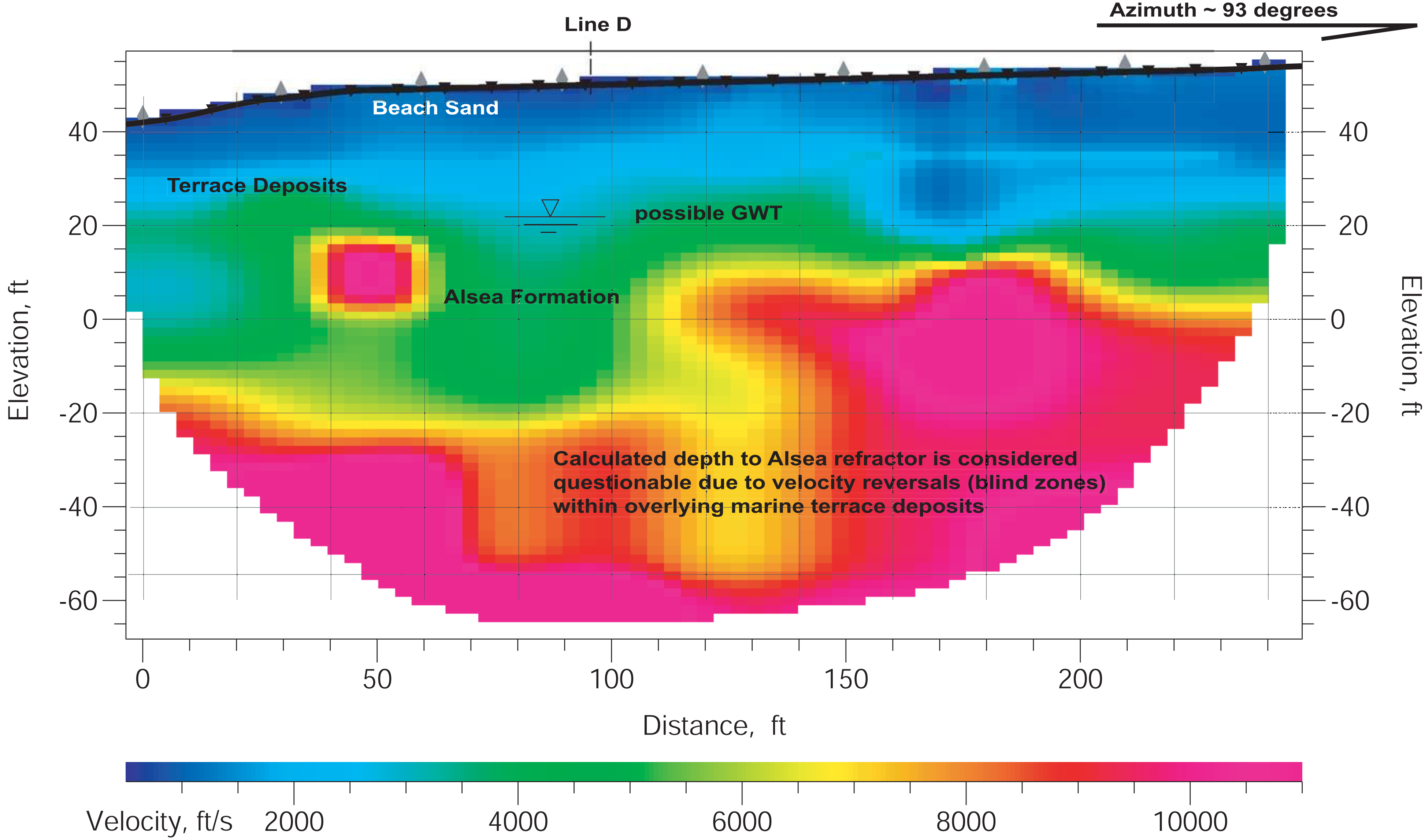
Scale:
H: 1 inch = 30 feet
V: 1 inch = 30 feet

P-wave Seismic Refraction Tomography: SR-5 on Line E	Figure: SR-5	
Pacific Marine Energy Center South Energy Site Near Waldport, Oregon	May 6, 2017	Project # 171012
Prepared for: Oregon State University	**Siemens & Associates**	

7.7. Results on Line F: SR only

Line F: P-wave Seismic Refraction Tomography: SR-6

(24, 8 Hz. receivers on 10 foot spacing, shots on 30 foot spacing)



Scale:
H: 1 inch = 30 feet
V: 1 inch = 30 feet

P-wave Seismic Refraction Tomography: SR-6 on Line F	Figure: SR-6	
Pacific Marine Energy Center South Energy Site Near Waldport, Oregon	May 6, 2017	Project # 171012
Prepared for: Oregon State University	**Siemens & Associates**	

8. Land Survey Records: John Thompson and Associates, Inc. (JTA)

8.1. Control

Three survey control points were set in the Driftwood Beach State Recreation Site parking area. JTA selected 5/8 inch iron rods and 1-1/2 inch aluminum caps for monument construction because of their durability. These control points can be used throughout the lifecycle of the project.

8.2. Reference

This project is referenced to NAD 83(2011) Epoch 2010.00 and NAVD 88. This is the current reference frame supported by the National Geodetic Survey (NGS). Using the current NGS datum simplifies the establishment of on-site survey control. NGS also computes Oregon State Plane North Zone (3601) coordinates on their Data Sheets. The CAD deliverables use this reference frame and the project units are international feet.

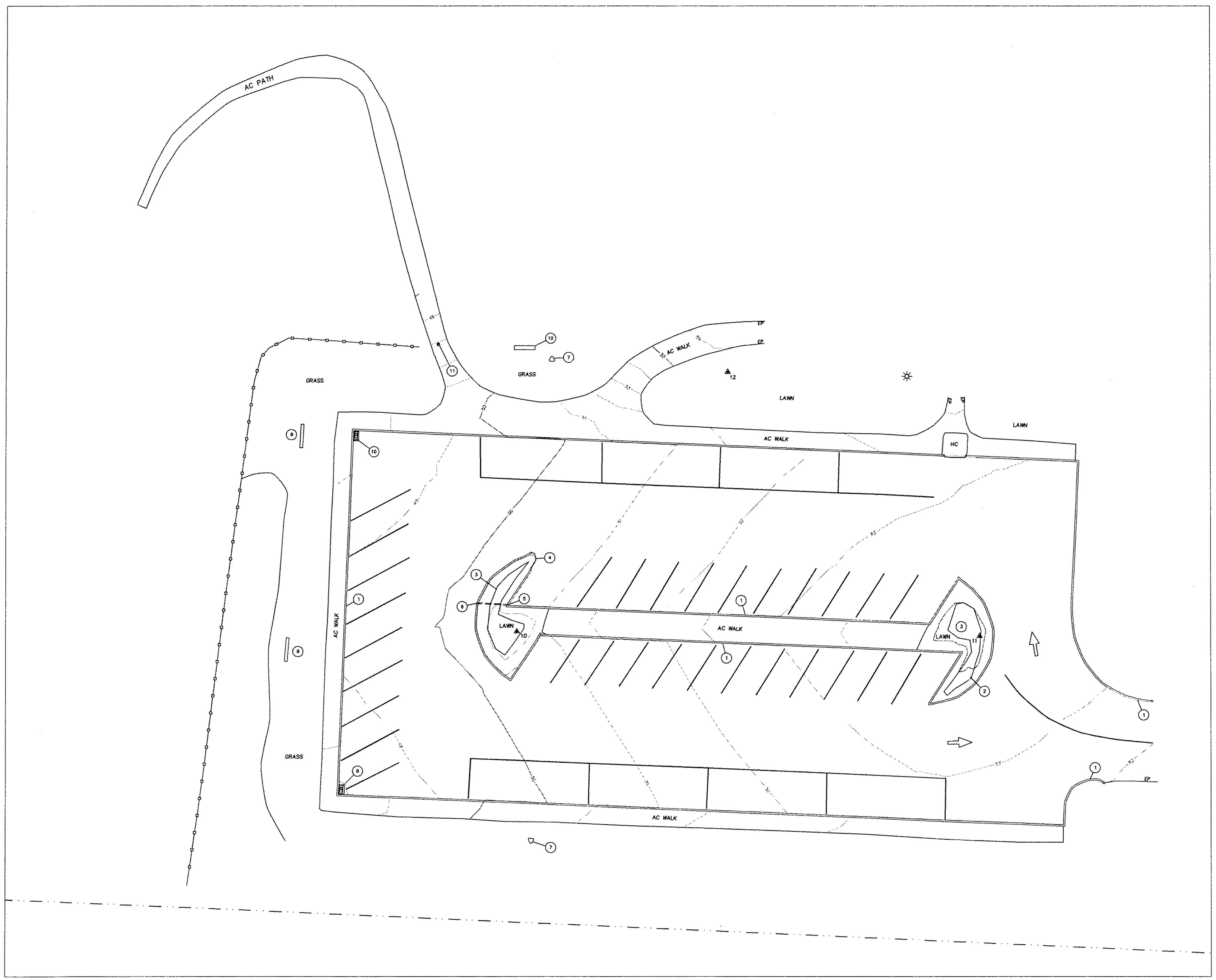
8.3. Mapping Products

JTA created two mapping products for this project. The first is the topographic map of the parking area of Driftwood Beach State Recreation Site. This map and digital terrain model will aid the design engineers in the development of the boring equipment staging plan and can be used to document the existing condition of the parking area which will be useful if repairs to the parking area are needed after construction. The second mapping product illustrates the geophysical survey line geometry in plan dimension. This map is used for both for the on-shore and off-shore phases of this site exploration. The line geometry is the basis of sampling for the on-shore study. The survey coordinates along Lines A and Line B are useful to integrate similar explorations and associated overlap when similar data are gathered during the marine survey of the HDD route.

The mapping products are delivered in several formats. The CAD drawings were created using Autodesk Civil 3D. The drawing files will include the survey point data, 3D breakline data and a digital terrain model (DTM) of the existing ground surface conditions. JTA compiled an ASCII file of the survey data points and LandXML files for the survey point data and the existing ground DTM. These files can be imported into various engineering or GIS programs used by project stakeholders. Also provided were PDF files generated from the CAD drawing files.

XREF INDEX:

T.13S. R.12W. W.M.
SEC. 01



NORTH
SCALE: 1"=20'
0 10 20 40

LEGEND

- BOLLARD
- LIGHT POLE (TAPER METAL BASE.)
- SIGN AS NOTED
- STORM CATCH BASIN
- SURVEY BENCH MARK / CONTROL POINT

LEGEND

- EP — EDGE OF PAVEMENT
- HC — HANDICAP RAMP AC SURFACE POOR CONDITION

LEGEND

- FENCE WOOD HT=3.0 FT. (TYP.) CONDITION VARIES
- PARCEL BOUNDARY LINES APPROXIMATE, SEE NOTE 3

NOTES

1. THE COORDINATES SHOWN ARE BASED ON THE OREGON STATE PLANE NORTH ZONE (3601). THE PROJECT IS REFERENCED VERTICALLY TO NATIONAL GEODETIC SURVEY MARK V 79 (PID QE1300) BY STATIC GPS OBSERVATIONS.

   LINEAR UNITS: INTERNATIONAL FEET
   HORIZONTAL DATUM: NAD 83(2011)(EPOCH: 2010.0000)
   PROJECT COMBINED FACTOR (GROUND TO GRID): 0.99997084

   VERTICAL DATUM: NAVD88 (GEOID 12B)

2. CONTOUR INTERVAL IS 1 FOOT.

3. THE PRORERTY LINES SHOWN ARE BASED ON DATA PROVIDED BY CLIENT AND ARE APPROXIMATE ONLY. BOUNDARY DETERMINATION AND RESOLUTION ARE OUTSIDE THE SCOPE OF THIS PROJECT.

UTILITY STATEMENT

THE UNDERGROUND UTILITIES SHOWN ARE BASED ON SURVEYED UTILITY LOCATE MARKINGS AND EXISTING DRAWINGS. THE SURVEYOR MAKES NO GUARANTEE THAT THE UNDERGROUND UTILITIES SHOWN COMPRISE ALL SUCH UTILITIES IN THE AREA, EITHER IN SERVICE OR ABANDONED. THE SURVEYOR FURTHER DOES NOT WARRANT THAT THE UNDERGROUND UTILITIES SHOWN ARE IN THE EXACT LOCATION INDICATED ALTHOUGH HE DOES CERTIFY THAT THEY ARE LOCATED AS ACCURATELY AS POSSIBLE FROM INFORMATION AVAILABLE. THE SURVEYOR HAS NOT PHYSICALLY LOCATED THE UNDERGROUND UTILITIES.

EXISTING FEATURES

(1) CURB (TYP.)
(2) LANDSCAPE FEATURE, DRIFTWOOD WITH SIGN "ONE WAY"
(3) LANDSCAPE FEATURE, DRIFTWOOD
(4) DAMAGED CURBING
(5) STORM DRAINAGE PIPE STEEL, 4-IN. DIA. I.E.=50.59' (IN)
(6) STORM DRAINAGE PIPE STEEL, 4-IN. DIA. I.E.=50.32' (OUT)
(7) POSSIBLE LIGHT POLE BASE, NO POLE BASE, PLATED, NOT IN USE
(8) STORM CATCHBASIN, WATER FILLED NO INVERTS VISIBLE, GRATE EL.=47.96'
(9) BENCH WOOD
(10) STORM CATCHBASIN, WATER FILLED NO INVERTS VISIBLE, GRATE EL.=48.03'
(11) BOLLARD, CONCRETE DIA.=8-IN. HT.=3.4 FT. W/SIGN: "MOTOR VEHICLES PROHIBITED"
(12) SIGN 6"x6" WOOD POST W/SIGNS "DRIFTWOOD" & MULTIPLE PLACARDS

SURVEY CONTROL DATA TABLE

POINT	NORTHING	EASTING	ELEVATION	DESCRIPTION
10	311507.8949	7267656.6567	52.87	5/8" IRON ROD W/2-1/2" ALUM. CAP MARKED "JTA INC. CONTROL POINT 10 2017"
11	311506.3886	7267812.3870	55.41	5/8" IRON ROD W/2-1/2" ALUM. CAP MARKED "JTA INC. CONTROL POINT 11 2017"
12	311595.0785	7267727.6627	57.34	5/8" IRON ROD W/2-1/2" ALUM. CAP MARKED "JTA INC. CONTROL POINT 12 2017"

UNITS: INTERNATIONAL FEET

[DATE: 7/22/2017 8:02 PM] [AUTHOR: admin] [PLOTTER: HP LJ 5000DN Universal Printing PCL 6.pc3] [STYLE: DEA-STD-STB.stb]
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JOHN THOMPSON & ASSOCIATES, INC.
P.O. BOX 683 BEND, OREGON 97709
PHONE: (541)312-9421
JPT@JTASURVEY.COM

07-22-2017
REGISTERED PROFESSIONAL LAND SURVEYOR
OREGON
JANUARY 12, 1999
JOHN P. THOMPSON
49220
RENEWS 06-30-2018

REVISIONS

NO.	BY	DATE	REMARKS

SHEET INFO

DRAWN	JPT
CHECKED	JPT
APPROVED	JAS
LAST EDIT	06/26/2017
PLOT DATE	07/22/2017
SUBMITTAL	

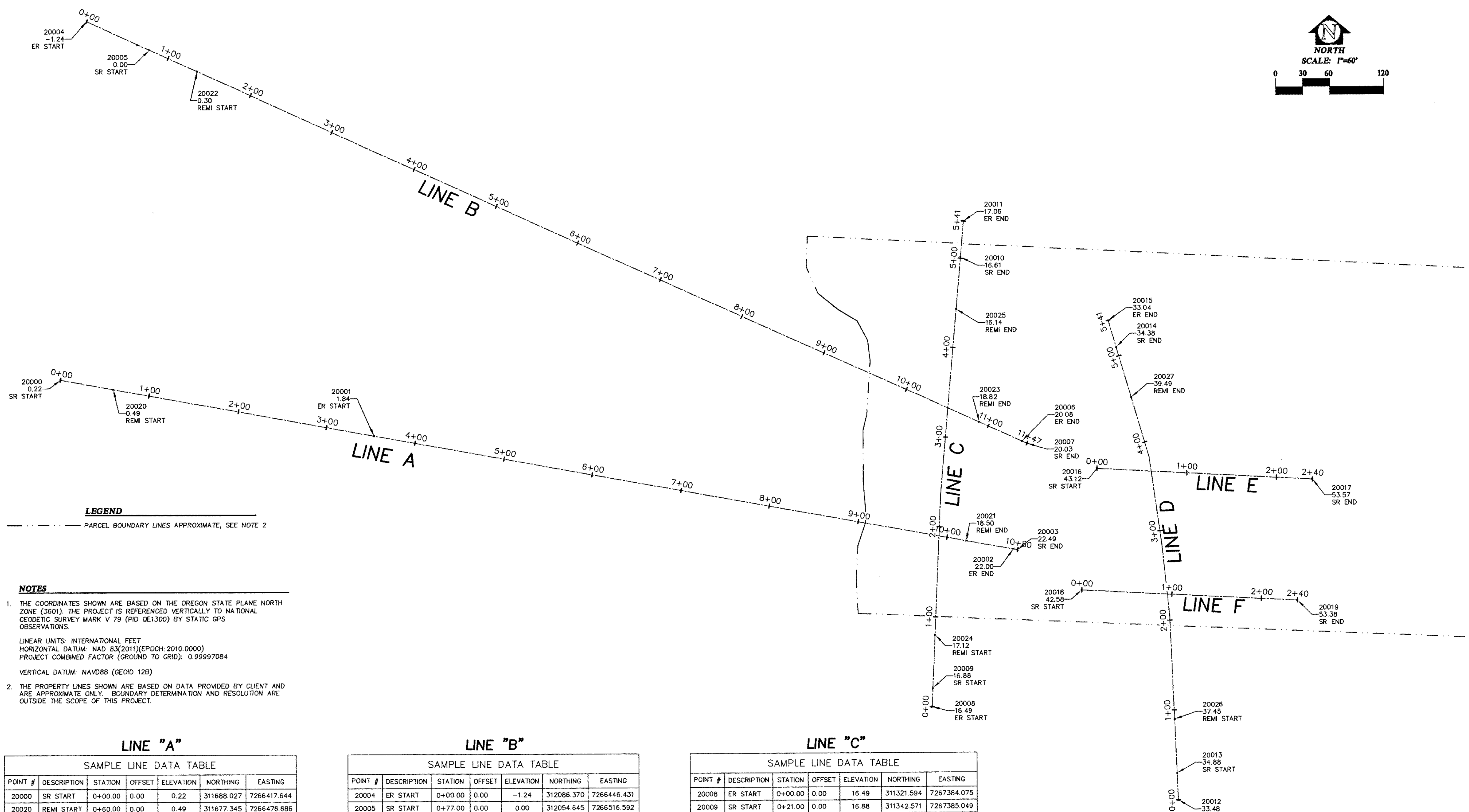
PACIFIC MARINE ENERGY CENTER SOUTH ENERGY TEST SITE:
GEOPHYSICAL EXPLORATION
DRIFTWOOD BEACH STATE RECREATION SITE

SCALE 1"=20'
PROJECT NUMBER SIEM0001
DRAWING FILE NAME SIEM1DWPARKING

SHEET NUMBER
1
OF 2 SHEETS

XREF INDEX:

T.13S. R.12W. W.M.
SEC. 01



LEGEND

— · · — · · — PARCEL BOUNDARY LINES APPROXIMATE, SEE NOTE 2

NOTES

1. THE COORDINATES SHOWN ARE BASED ON THE OREGON STATE PLANE NORTH ZONE (3601). THE PROJECT IS REFERENCED VERTICALLY TO NATIONAL GEODETIC SURVEY MARK V 79 (PID QE1300) BY STATIC GPS OBSERVATIONS.

   LINEAR UNITS: INTERNATIONAL FEET
   HORIZONTAL DATUM: NAD 83(2011)(EPOCH: 2010.0000)
   PROJECT COMBINED FACTOR (GROUND TO GRID): 0.99997084

   VERTICAL DATUM: NAVD88 (GEOID 12B)

2. THE PROPERTY LINES SHOWN ARE BASED ON DATA PROVIDED BY CLIENT AND ARE APPROXIMATE ONLY. BOUNDARY DETERMINATION AND RESOLUTION ARE OUTSIDE THE SCOPE OF THIS PROJECT.

LINE "A"

SAMPLE LINE DATA TABLE

POINT #	DESCRIPTION	STATION	OFFSET	ELEVATION	NORTHING	EASTING
20000	SR START	0+00.00	0.00	0.22	311688.027	7266417.644
20020	REMI START	0+60.00	0.00	0.49	311677.345	7266476.686
20001	ER START	3+54.00	0.00	1.84	311625.004	7266765.989
20021	REMI END	10+22.00	0.00	18.50	311506.080	7267423.318
20002	ER END	10+75.00	0.00	22.00	311496.644	7267475.471
20003	SR END	10+80.00	0.00	22.49	311495.754	7267480.391

LINE "B"

SAMPLE LINE DATA TABLE

POINT #	DESCRIPTION	STATION	OFFSET	ELEVATION	NORTHING	EASTING
20004	ER START	0+00.00	0.00	-1.24	312086.370	7266446.431
20005	SR START	0+77.00	0.00	0.00	312054.645	7266516.592
20022	REMI START	1+35.00	0.00	0.30	312030.749	7266569.440
20023	REMI END	10+89.00	0.00	18.82	311637.691	7267438.705
20006	ER END	11+41.00	0.00	20.08	311616.266	7267486.086
20007	SR END	11+47.00	0.00	20.03	311613.794	7267491.553

LINE "C"

SAMPLE LINE DATA TABLE

POINT #	DESCRIPTION	STATION	OFFSET	ELEVATION	NORTHING	EASTING
20008	ER START	0+00.00	0.00	16.49	311321.594	7267384.075
20009	SR START	0+21.00	0.00	16.88	311342.571	7267385.049
20024	REMI START	0+80.00	0.00	17.12	311401.508	7267387.787
20025	REMI END	4+43.00	0.00	16.14	311763.508	7267413.566
20010	SR END	5+01.12	0.00	16.61	311821.391	7267418.773
20011	ER END	5+41.47	0.00	17.06	311861.579	7267422.389

LINE "D"

SAMPLE LINE DATA TABLE

POINT #	DESCRIPTION	STATION	OFFSET	ELEVATION	NORTHING	EASTING
20012	ER START	0+00.00	0.00	33.48	311216.431	7267656.667
20013	SR START	0+30.00	0.00	34.88	311246.407	7267655.467
20026	REMI START	0+90.00	0.00	37.45	311306.359	7267653.068
20027	REMI END	4+52.00	0.00	39.49	311664.180	7267607.614
20014	SR END	5+10.19	0.00	34.38	311720.063	7267591.376
20015	ER END	5+41.19	0.00	33.04	311749.832	7267582.726

LINE "E"

SAMPLE LINE DATA TABLE

POINT #	DESCRIPTION	STATION	OFFSET	ELEVATION	NORTHING	EASTING
20016	SR START	0+00.00	0.00	43.12	311585.277	7267568.981
20017	SR END	2+40.00	0.00	53.57	311572.158	7267808.622

LINE "F"

SAMPLE LINE DATA TABLE

POINT #	DESCRIPTION	STATION	OFFSET	ELEVATION	NORTHING	EASTING
20018	SR START	0+00.00	0.00	42.58	311450.548	7267551.208
20019	SR END	2+40.00	0.00	53.38	311437.988	7267790.879

[DATE: 7/22/2017 8:05 PM] [AUTHOR: admin] [PLOTTER: HP LJ 5000DN Universal Printing PCL 6.pc3] [STYLE: 0EA-STD-STB.stb]
[PATH: L:\PDrive_Recover\Projects\SIEM0001-Waldport\Dwg_Deliverables\SIEM1GEOLAYOUT3.dwg] [LAYOUT: SHEET2]

JOHN THOMPSON & ASSOCIATES, INC.
P.O. BOX 683 BEND, OREGON 97709
PHONE: (541)312-9421
JPT@JTASURVEY.COM

07-22-2017
REGISTERED PROFESSIONAL LAND SURVEYOR
OREGON
JANUARY 12, 1999
JOHN P. THOMPSON
49220
RENEWS 06-30-2018

REVISIONS			
NO.	BY	DATE	REMARKS

SHEET INFO	
DRAWN	JPT
CHECKED	JPT
APPROVED	JAS
LAST EDIT	06/26/2017
PLOT DATE	07/22/2017
SUBMITTAL	

PACIFIC MARINE ENERGY CENTER SOUTH ENERGY SITE:
GEOPHYSICAL EXPLORATION
GEOPHYSICAL SAMPLE LINE GEOMETRY

PROJECT NUMBER: SIEM0001
DRAWING FILE NAME: SIEM1GEOLAYOUT3
SCALE: 1"=60'

SHEET NUMBER 2 OF 2 SHEETS

9. GIS Database Records: Rhine-Cross Group

9.1. Summary

The mapping and geophysical sample line geometry represented in the Autodesk Civil 3D drawings was converted to .dxf files that can be accessed by non-CAD users utilizing the Global Mapper Software. The data can aid stakeholders in the future planning and decision making process.

In addition, the processes results used for the generation of the geophysical tomograms were provided to the client in text delimited format. The deliverable included georeferenced beginning and endpoints for each line and tabulated points describing the x-distance and elevation along the traverse associated with a value relative to the physical property measured, including, P-wave velocity (f/s), S-wave velocity (f/s) and apparent electrical resistivity (Ohm-m).

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APPENDIX N

NMFS MMPA Letter of Concurrence Dated May 30, 2019

UNITED STATES DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
NATIONAL MARINE FISHERIES SERVICE
Silver Spring, MD 20910

MAY 30 2019

Burke Hales
Chief Scientist
College of Earth, Ocean, and Atmospheric Sciences
Oregon State University
104 CEOAS Admin Bldg
Corvallis, Oregon 97331-5503

May 30, 2019

Dear Mr. Hales,

On April 10, 2019, the College of Earth, Ocean, and Atmospheric Sciences at Oregon State University (OSU) submitted a letter to NMFS regarding the PacWave Project (the Project). The letter concluded that the installation and operation of the Project is not expected to result in the incidental take of marine mammals and thus an incidental take authorization (ITA), pursuant to sec 101(a)(5) of the Marine Mammal Protection Act (MMPA), is not warranted for the specified activities.

PacWave would be a grid-connected wave energy test facility located in the Pacific Ocean, approximately six nautical miles off the coast of Newport, Oregon, and would occupy an area of approximately two square nautical miles (1,695 acres). The purpose of the project would be to research and test up to 20 wave energy converters (WECs) to advance the development of marine renewable energy technologies. The Project would provide facilities for developers of WEC technology to conduct full-scale, open-ocean testing of WECs, thereby reducing the time and costs associated with siting individual grid-connected projects. When operational, PacWave could generate up to 20 megawatts that would travel through four individually buried subsea cables running from the test site to a terrestrial cable connection point at Driftwood Beach State Recreation Site in Seal Rock, Lincoln County, Oregon. The portion of the OCS where the test site would be located is federal land administered by the Bureau of Ocean Energy Management (BOEM). The subsea cables would cross Oregon's territorial seas.

OSU has not yet determined the exact WEC design that will ultimately be used for the Project. The WEC design types that may be used for the Project include the following:

- Point absorbers: floating or submerged structures with components at or near the ocean surface that capture energy from the motion of waves, which drives a generator.
- Attenuators: structures that respond to the curvature of the waves rather than the wave height. These WECs may consist of a series of semi-submerged sections linked by enclosed hinged joints. As waves pass along the length of the WEC, the sections move relative to one another. The wave-induced motion of the sections is captured and used to drive a generator.

- Oscillating water columns: structures that are partially submerged and hollow (i.e., open to the sea below the water line), enclosing a column of air above the water. Waves cause the water under the device to rise and fall, which in turn compresses and decompresses the air column above. This air is forced in and out through a turbine, which usually has the ability to rotate regardless of the direction of the airflow (i.e., a bi-directional turbine).
- Hybrids: WEC types that utilize use two or more of the above-listed technology types.

The WEC design type(s) that may be operated, as described in the list above, would not have the potential to entrap or entrain marine mammals. The only WEC design that could otherwise have the potential to entrain or entrap marine mammals would be an "overtopping-type device", which converts wave energy into potential energy by forcing water up to a higher level and then gravity fed through a turbine. However, OSU has determined this type of WEC will not be included in the PacWave project. Therefore, the potential for take of marine mammals as a result of entrapment or entrainment in operational WECs is considered so low as to be discountable.

During the operational phase of the Project, sound is expected to be generated by the moving components of the WECs, mooring components (e.g., chain noise) and water flowing past and splashing against Project structures. It is difficult to model or predict the sounds of operational WECs due to the variety and complexity of differing sound sources within the WEC array. However, based on underwater sound monitoring, the operational sounds of a similar experimental wave energy project (the Newport North Energy Test Site, located just north of the site of the PacWave project) were within the range of ambient conditions and did not exceed 120 dB re 1 μPa. We expect that sound from operational WECs would be similar to those at the Newport North Energy Test Site. Even if sound levels of operational WECs at PacWave slightly exceeded those monitored at the Newport North Energy Test Site, we believe any reactions by marine mammals to these aspects of the operational Project would be minor and short term. Marine mammals may perceive noise from these Project components and may respond briefly, but based on the expected sound levels and the fact that marine mammals would be expected to avoid the sound source (which will be stationary) before that source reaches a level that would result in harassment, we believe the potential for this response to rise to the level of take to be so low as to be discountable.

During the operational phase of the project, WECs will be connected to anchors on the seafloor by mooring lines which would consist of types commonly used in the marine industry, such as chain, steel wire, or synthetic materials. The mooring lines would be more substantial than those typically used for fishing or crab pot lines (which represent an entanglement risk for large whales). The potential for entanglement is unlikely due to the moorings' size and mass regardless of the mooring configuration. The WECs are also expected to create substantial tension on the mooring lines; this tension would reduce the potential for entanglement. Power generated by WECs would be transferred via "umbilical cables" to a subsea connector located on the seafloor at each test berth; these umbilical cables would descend from the WECs to the seabed and would also be substantially taut and relatively rigid. It is likely the umbilical cables and mooring lines would act more as structures in the water than as lines that are commonly associated with fisheries. For the reasons described above, entanglement of marine mammals in mooring lines and cables associated with the Project is considered so low as to be discountable.

During operation of the Project, OSU will implement the following monitoring measures:

- Require WEC testing clients to keep their equipment in good working order to minimize sound due to faulty or poorly maintained equipment;
- Implement an Acoustics Monitoring Plan[1] to quantify sound levels using field measurements and validated sound propagation models. Based on monitoring results, implement specified measures to mitigate for potential adverse effect;
- Minimize construction activities during key gray whale migration periods, to the extent possible;
- Avoid use of Dynamic Positioning vessels to the maximum extent practicable during Phase B gray whale migration (April 1 – June 15);
- Make opportunistic visual observations of pinnipeds in the portions of the test site which are being visited to for operations, maintenance, or environmental monitoring work;
- In addition, to monitor for potential fishing gear entangled in WECs, OSU would:
  - Conduct opportunistic visual observations from the water surface during all visits to the Project test site, and at least once per quarter each year for the duration of the project;
  - Annually, following the peak storm season and the period of maximum activity for the Dungeness crab fishery (mid-March through mid-June, or, the earliest possible time after that period that avoids jeopardizing human safety, property or the environment), conduct surface surveys of active WECs; and
  - Conduct annual subsurface surveys of moorings and anchor systems using remotely operated vehicles (ROVs) or other appropriate technologies, with approval by NMFS.

In consideration of the planned activity as described in OSU's letter, we have concurred with OSU's conclusion[2] that the likelihood of marine mammal take resulting from the planned activities is so low as to be discountable; therefore, we agree that an ITA is not warranted for these activities. In the event of unanticipated incidental take of a marine mammal as result of the PacWave project, OSU should contact our office immediately to provide notification of the incident and to work through the necessary steps to ensure MMPA compliance moving forward, which could include submitting a request for an ITA.

Please contact Jordan Carduner if you have any questions at (301) 427-8483.

Sincerely,

Jolie Harrison, Chief
Permits and Conservation Division
Office of Protected Resources

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[1] The Acoustic Monitoring Plan is included as Appendix H to the Environmental Assessment prepared by the Federal Energy Regulatory Commission (FERC).

[2] Please note that our concurrence with OSU's conclusions does not constitute any statement regarding the applicability and/or appropriateness of the planned mitigation and monitoring measures towards a finding of "least practicable adverse impact" under the MMPA.

APPENDIX O

Archaeological Assessment of Submerged Cultural Resources in the PacWave South Project Area

ARCHAEOLOGICAL ASSESSMENT OF SUBMERGED CULTURAL RESOURCES IN THE PACWAVE SOUTH PROJECT AREA

CONTACT: DAN HELLIN, OPERATIONS & LOGISTICS MANAGER, PACWAVE
541-737-5452 DAN.HELLIN@OREGONSTATE.EDU

PRINCIPLE INVESTIGATOR: DR. LOREN G. DAVIS, DAVIS GEOARCHAEOLOGICAL RESEARCH

INTRODUCTION

Oregon State University (OSU) is proposing to install and operate a grid-connected wave energy test facility off the coast of Newport, Oregon. This proposed project is called PacWave South and has an area of potential effects (APE) that extends in a northwesterly direction away from Oregon's modern coast (Figure 1). The proposed project will involve the burial of electrical transmission lines in seafloor sediments and will include a vertical APE of ~3.5 meters (~10') below the seafloor[1]. This proposed development action will intersect areas of Oregon's continental shelf that were previously exposed as terrestrial landscapes during periods of lower sea level that occurred between ~10,000-2,000 calendar years before present (cal BP). While we do not currently know if and where precontact archaeological sites are held in Oregon's now-submerged ancient coastal landscape, we do know that the PacWave South APE overlaps with portions of Oregon's ancient coastal landscape that were available for occupation by contemporaneous past human populations.

This report describes the archaeological record that is relevant to this project, presents the results of paleolandscape and offshore site potential modeling within the APE, and provides an archaeological assessment of the APE based on an evaluation of geophysical datasets and marine cores collected from predetermined sample areas.

Archaeological Context of the New World Pacific Coast

The earliest archaeological record of the New World Pacific coast dates to the Bølling-Ållerød interval (~15,000–12,900 cal BP) in the South American sites of Quebrada Jaguay, Quebrada Tacahuay, Huaca Prieta, and Monte Verde (Keefer et al. 1998; Sandweiss et al. 1998; Dillehay 1989; Dillehay et al. 2009, 2012). These sites show the use of a very limited set of marine resources, including anchovy, drum fish, crustaceans, some mollusks, and seaweeds, which is atypical to the post-Younger Dryas period pattern of marine zone use that generally includes a much broader resource base with a diverse set of shellfish and fish species. The discovery of cordage in these South American sites may point to the earliest use of fishing nets in the New World, an application of a specialized technology, to be sure. The Monte Verde-II component shows a more limited use of marine resources but notably includes the remains of seaweed that were procured from the Pacific Ocean, which is considered to indicate a deep traditional ecological knowledge of marine environments and their products (Dillehay et al. 2009). The Younger Dryas period (12,900–11,500 cal BP) includes the Quebrada Tacahuay of Peru and the Richard's Ridge site of Mexico

[1] The planned subsea cable burial depth is 3 to 6 feet below the seafloor.

that demonstrate clear but divergent orientations to marine resource exploitation, along with the more pericoastal sites in British Columbia including K1 Cave and Gaadu Din Cave, and Oregon's Indian Sands site (Fedje et al. 2004; Fedje and Mathewes 2005; Davis et al. 2004; Davis 2006, 2008). Whereas the Quebrada Tacahuay site shows a more specialized use of the marine environment, probably involving the use of nets to capture anchovy (which may also reflect a task-specific pattern in an otherwise richer marine setting), Richard's Ridge includes the remains of a broad range of invertebrate and fish species along with a well-developed non-fluted/non-Paleoindian foliate projectile point industry that was probably used to hunt marine mammals and sea turtles.

The search for late Pleistocene-aged sites along Oregon's coast began in earnest in the late 1990s and began to bear fruit a few years later, represented by the works of Punke (2001), Punke and Davis (2006) Davis et al. (2004), Hall et al. (2005), and Davis (2006). Research into coastal Oregon's earliest archaeological record has often employed geoarchaeological perspectives, particularly in efforts to model late Quaternary paleolandscape changes and their effects on the preservation and visibility of late Pleistocene-aged archaeological sites. Efforts to model Oregon's changing coastal landscape initially began with global eustatic-based reconstructions of sea level (Punke 2001; Davis et al. 2009; Jenevein 2010; ICF International et al. 2013) but now incorporate newly available glacioisostatic adjustment models (Clark et al. 2014) to calculate local relative sea level histories for parts of Oregon's continental shelf. These relative sea level curves are combined with GIS-based landscape models that first model the probable distribution of coastal stream networks based on publically available bathymetric datasets, and then add gridded data layers that calculate relative environmental productivity values and heuristic grid values to model the potential attractiveness of different parts of the coastal landscape.

Archaeological evidence for late Pleistocene-aged occupation of coastal Oregon is currently limited to two sites: Indian Sands and Devils Kitchen. Indian Sands is located on Oregon's southern coast near the town of Brookings and contains a stratified series of repeated cultural occupations in a cumulic soil developed in the top of a late Pleistocene-aged sand dune (Davis et al. 2004; Davis 2006, 2008). The earliest component at Indian Sands includes 808 pieces of debitage and 12 tools, including cores, utilitarian biface fragments, lanceolate projectile point base fragments, unifaces, and modified flakes (Davis and Willis 2011). The site's earliest component also included 56 pieces of fire cracked rock, one of which included an adhering piece of wood charcoal that returned a calibrated radiocarbon age of 12,312 cal BP (Davis et al. 2004). Undisturbed aeolian sediments accumulated throughout the early to middle Holocene and buried this late Pleistocene occupation. Excavations conducted at the Devils Kitchen site, located near the town of Bandon, revealed a record of repeated cultural occupation along an inland coastal stream and dune field. Hall et al. (2005) and Davis et al. (2006) report evidence that humans occupied the site sometime between ca. 12,800-6700 cal BP. More recent excavations at the site uncovered lithic debitage and wood charcoal in an alluvial floodplain deposit that aggraded between ca. 13,440 and 12,630 cal BP (Curteman 2015).

Geoarchaeological and archaeological approaches are jointly applied to understand the late Quaternary history of landscape evolution and site formation along Oregon's coast. Results of studies by Hall and Radosevitch (1995), Punke (2006), and Punke and Davis (2006) employed mechanical coring and trenching that showed how Oregon's coastal environments often experienced rapid sedimentation in response to post-glacial marine transgression, burying terminal Pleistocene-aged terrestrial deposits to depths up 30 meters below the modern surface. A larger number of Oregon's late Pleistocene to early Holocene-aged sites are known from uplifted headlands that received far less sedimentation over time, but which retain intact archaeological components within paleosols at some localities (Davis et al. 2008).

In 2013, Davis Geoarchaeological Research completed a GIS-based evaluation of paleocoastal landscapes and archaeological site potential for the Pacific outer continental shelf (POCS) zones of Washington, Oregon, and California as part of a larger Bureau of Ocean Management (BOEM) funded project (ICF International et al. 2013). This evaluation currently forms the primary basis for BOEM's cultural resource assessment on the POCS. Beginning in 2016, with funds provided by the BOEM and the National Oceanographic and Atmospheric Administration, author Davis has collaborated with archaeologists Todd Braje and Alexander Nyers, marine geologists Jillian Maloney and Neal Driscoll, and others to conduct a more intensive evaluation of a GIS-based site location predictive model. Since 2017, this team has conducted multiple geophysical surveys that led to the discovery of an extensive network of submerged alluvial channel and floodplain features buried beneath a thin mantle of marine sediments offshore of Oregon's central coast (Davis et al. 2018) and in the summer of 2018, multiple marine cores were collected from key localities. The analysis and interpretation of these cores is forthcoming.

Geoarchaeological Context of the Project Area

The division between the Washington and Oregon coasts lies at the mouth of the Columbia River, which forms Oregon's northwestern border. Lacking influence from Late Wisconsinan ice sheet glaciers, Oregon's coastline is similar to Washington's western margin and is dominated by narrow beaches and high rocky headlands backed by abruptly rising Coast Range Mountains. Larger embayments caused by rising sea levels drowning river basins are few, represented by Tillamook Bay, Netarts Bay, Siletz Bay, Yaquina Bay, Alsea Bay, and Coos Bay. Coastal Washington, Oregon, and northern California lie to the east of the Cascadia Subduction Zone (CSZ), a shallow reverse fault marking the convergent boundary between the Juan de Fuca oceanic plate and the North American continental plate (Darienzo and Peterson 1990; McNeill et al. 1998). Subduction of the Juan de Fuca plate beneath the continent produces strain along part of the plate interface, the locked zone, which resists slip by frictional forces. Along the coast, strain accrues slowly between earthquakes causing gradual uplift of the land (0–5 millimeters [mm] per year) (Mitchell et al. 1994). When stresses caused by the subduction process overcome the frictional strength of the locked zone, slip on the plate interface releases elastic strain as an earthquake. Coastal regions that are raised between earthquake events suddenly subside downward during an earthquake, producing widespread coastal subsidence of as much as 2–3 meters (Witter et al. 2003). As the stress is reduced during a CSZ earthquake, the subducting Juan de Fuca plate becomes locked and begins to accumulate strain once again. The accumulation of interseismic strain along the CSZ causes the coastal margin of Washington, Oregon, and northern California to resume their various rates and motions of crustal deformation once again.

Although Oregon does not share the same degree of glacioisostatic effects that are seen farther north in Washington, British Columbia and Alaska (Clark et al. 2014), its coastal landscape experiences significant neotectonic deformation due to its proximity to the CSZ, which lies offshore of the outer continental shelf.

Small-scale, upper plate faults and folds associated with the CSZ also deform portions of the Oregon coast mainland (Goldfinger et al. 1992, 1997; McNeill et al. 2000). Active folds and faults on the inner continental shelf generally trend parallel and perpendicular to the coastline and deformation front, respectively (Goldfinger et al. 1992; Goldfinger 1994) and have a significant influence on the formation of raised marine terraces, headlands, estuaries, and bays (Kelsey 1990; Kelsey et al. 1996; McNeill et al. 1998; Kelsey et al. 2002; Witter et al. 2003). Many prominent embayments along the Oregon coast are associated with synclinal folding or lie on the downthrown sides of high-angle faults or are submerged river valleys (e.g., Yaquina Bay), while headlands and differentially uplifted marine terraces generally correlate with anticlines or the upthrown side of high-angle faults (Muhs et al. 1990; Kelsey 1990; Kelsey et al. 1996; McNeill et al. 1998). The local behaviors of upper plate faults cause greater or lesser amounts of uplift, producing rocky headlands, bays, and dune-infilled lowlands. Greater or lesser degrees of coseismic subsidence may occur in any given area due to the nature and behavior of local geologic structures during great CSZ earthquakes.

Assessing Cultural Resources on Oregon's Continental Shelf

Precontact coastal foragers undoubtedly used a range of natural resources that were distributed across Oregon's paleocoastal landscape and into areas of the modern North American coast. Marine transgression undoubtedly affected the position of these natural paleocoastal resources and the archaeological sites related to their use. As sea levels rose after the last glacial maximum (LGM) (i.e., the most recent time during the Last Glacial Period when ice sheets were at their greatest extent), landward (i.e., eastward) compression of the POCS coastal landscape forced precontact foragers to move farther and farther inland to stay above shifting shorelines and to access shifting resource areas. Precontact sites on the POCS may hold evidence of foraging activities related to the proximal location of different kinds of environmental zones at different points in time. For example, parts of the POCS paleolandscape that are farther inland at any point in time might hold sites related to interior resource use. In time, rising sea levels cause outer coast environments (e.g., estuarine, littoral) to shift inland.

Where site formation processes promote the development of stratified geological records and where precontact peoples continued using the same sites through time, we should expect to see situations where earlier archaeological components related to inland terrestrial and riverine resource use are buried by younger deposits bearing archaeological evidence of people using estuarine or littoral ecosystems at the same location. In this way, the vertical order of site functions recorded in stratified archaeological sequences should not only reflect the transgressive sequence of post-LGM environmental change but also the original lateral distribution of cultural activities in the coastal landscape. Archaeological evidence of this phenomenon has been reported from stratified sites found on Oregon's modern shoreline, examples of which include Neptune (Lyman and Ross 1988a; Ross 1976; Jenevein 2010), Devils Kitchen (Hall et al. 2005; Davis et al. 2006), and Indian Sands (Davis et al. 2004; Davis 2006; Davis 2008; Davis et al. 2008; Davis 2009a, 2009b; Davis and Willis 2011). At these three sites, older basal archaeological components contain higher quantities of lithic debitage and tools, and fire cracked rock; and lack marine shells. Younger overlying components include shell midden layers. Any precontact sites created on the paleolandscape of the POCS would be subject to the effects of marine inundation as rising sea levels advanced the shoreline of the Pacific Ocean farther to the east. Opinions vary on how marine inundation would have affected the formation and preservation of archaeological sites. Kraft et al. (1983) suggest that rapid marine transgression might quickly inundate sites on the continental shelf without significant erosive effects, whereas Inman (1983) argues that erosion should be widespread, and sites are unlikely to be preserved but in exceptional still-stand circumstances where protective ecological and geomorphic contexts associated with lagoons and terraces are created. In their previous review of POCS submerged site potential, Snethkamp et al. (1990: III–102) offer several insights:

> In general, the same classes of physiographic locations that have a high potential for site preservation on land offer the highest potential for preservation during and following the process of inundation. For example, sites that are buried by a protective covering of sediments are much less likely to have been impacted by wave erosion during inundation than are exposed sites. At least three factors affect the degree of wave erosion likely to impact a site: burial prior to inundation, the duration of exposure in the intertidal zone, and the intensity of wave energy. Burial of terrestrial sites is one of the best mechanisms for increasing the chances of survival during inundation. Sites that are most likely to become buried in a terrestrial setting occur in alluvial environments such as river floodplains and terraces. As a result, submerged riverine meander belts have been judged to be one of the most likely settings to contain preserved precontact sites on the continental shelf.

Alluvial burial of precontact sites on the POCS prior to marine transgression seems probable, given what we know about sedimentation histories from Oregon's coastal rivers and bays. Stratigraphic evidence from Alsea Bay, located on Oregon's central coast, shows about 55 meters of sediment accumulation occurred during the Holocene (Peterson et al. 1984). From 10,000 to 7,500 radiocarbon years before present (RYBP), sedimentation rates ranged between 4 and 7 mm/year. An average of 11 meters of sediment accumulated in the bay between 7,500 and 5,000 RYBP. After 5,000 RYBP, sedimentation rates in Alsea Bay fell to ca. 2.1 mm/year, reflecting a decline in the rate of eustatic sea-level rise and corresponding alluvial aggradation. To the north, stratigraphic records from Oregon's Tillamook Bay indicate that about 32 meters of sediment accumulated during the Holocene (Glenn 1978), with depositional rates at 20 mm/year seen before 7,000 RYBP and ca. 2 mm/year after 7,000 RYBP. Punke and Davis (2006) report details of Holocene depositional patterns from a 27-meter-long core recovered from the Sixes River valley, which is located on Oregon's southern coast, just north of Cape Blanco. Wood charcoal found at the base of the core in organic-bearing marsh sediments returned a radiocarbon age of 10,190 ± 60 RYBP. Kelsey et al. (2002) reported dated cores extending 7 meters into the Sixes River floodplain, which revealed a stratigraphic record spanning the last 6,000 radiocarbon years. Taken together, the Kelsey et al. (2002) and the Punke and Davis (2006) cores indicate that the Sixes River aggraded 21 meters of sediment between 10,190 and 6,000 RYBP, at a rate of 5 mm/year. After 6,000 RYBP, Sixes River sedimentation rates slowed considerably to 1 mm/year. Punke and Davis (2006: 336) state, "The rates and amount of sedimentation recorded at the Sixes River since the Late Pleistocene appear to be typical of Oregon coastal river valleys."

Coastal streams accumulate sediments in their lower reaches where sediment-laden river discharge meets an opposing influx of tidal waters or the stream enters a lower gradient, less constrained embayment. In such a context, the physical competency of coastal streams is greatly reduced, causing most of their sediment load to fall out of suspension or traction and become deposited. Past stream systems on the paleolandscapes of the POCS would also respond to marine transgression by accumulating sediment in their lower reaches. As marine transgression moved shorelines farther inland, this sedimentation zone would translate farther and farther upstream in advance of the littoral zone. The rate of co-transgressive riverine aggradation for any particular stream system is expected to maintain a steady-state with sea level rise: all other factors being equal, riverine systems will respond to high rates of marine transgression by accumulating greater amounts of sediment over shorter periods of time; periods of slow sea level rise will be matched by relatively lower rates of alluvial aggradation. Ultimately, we may find that the total amount of stream aggradation that occurred in such a co-transgressive relationship might be the same across the POCS; only the amount of time represented by the accumulation of riverine sediments might change from place to place.

Those parts of the POCS that lie outside of the influence of stream deposition, including open coastlines and adjacent headlands, are subject to different kinds of site formation processes before and after inundation. Numerous uplifted marine-cut terraces and coastal plains are seen along the modern coastlines of Washington, Oregon, and California. Based on the stratigraphy of several headland sites from the Oregon coast, Davis et al. (2008) describe different site formation scenarios that create distinct patterns of archaeological resolution in non-riverine coastal sites. At one end of the continuum, Davis et al. (2008) describe sites that are largely cut off from receiving significant quantities of sediment through time, and, as a result, appear as time-averaged archaeological deposits at or just beneath the surface. At the other extreme are sites bearing one or more cultural components that are entombed as discrete archaeological deposits within rapidly aggrading aeolian dunes. In terrestrial settings, the relative degree to which a coastal or headland site is buried and remains buried over time is expected to play an important role in determining whether it might survive any erosive effects of initial inundation. The accumulation of sediment over an archaeological component will offer a protective buffer against erosion, to some degree at least. Because open coastal and headland sites are associated with topographic projections, they may receive a much greater degree of erosional damage than sites buried in alluvial floodplains, which lie in topographically depressed portions of the landscape. Whether or not open coastal and headland sites could ever accumulate enough sediment to mediate the erosive effects of marine transgression is unknown; however, it seems reasonable to expect that the relative degree of burial prior to inundation could play a greater or lesser role in promoting site preservation in a context of rising sea levels. In sum, we expect that sites associated with riverine settings, including bays and estuaries, will have a far greater chance of surviving the erosional effects of coastline advance; sites located along the open coastline and on adjacent headlands will probably receive greater erosional effects as rising sea levels apply the full force of the Pacific Ocean's littoral zone.

Ultimately, marine transgression submerged nearly all parts of the POCS landscape that were once connected to the North American mainland. We might expect that surficial sites or shallow buried sites might have been destroyed as the highest energy portion of the Pacific littoral zone passed over the POCS paleolandscape; however, the erosional effects of the Pacific's wave actions are expected to be reduced through time, as archaeological sites become inundated and submerged beneath ever deeper waters. To this point, Snethkamp et al. (1990: III-105) offer several key insights:

> The subtidal zone includes all of the seafloor below the normal reach of high wave energy, and thus offers a mechanically stable environment for inundated sites. All of the continental shelf within the study area now is located within the subtidal zone. As sea level rose, the intertidal zone migrated landward, leaving behind a basal transgressive sand layer in the subtidal zone. Once having "arrived" in the subtidal zone, buried sites would be relatively safe from additional mechanical degradation. As is true of sites in the intertidal zone, burial beneath sediments prior to inundation would play a significant factor in the survival of sites in the subtidal zone. A considerable number and variety of precontact sites undoubtedly would have survived the transition from terrestrial to subtidal setting.

METHODS AND DATASETS

GIS Modeling

Our approach to predicting the location of submerged precontact sites within the PacWave South project APE rests heavily on basic assumptions about human behavior within coastal paleolandscapes: precontact foragers survived by using natural food resources that were differentially distributed within past landscapes, and, as a result, archaeological evidence of their survival might be held in proximity to the location of these natural resources. Accepting these assumptions, we might use information about the distribution of different resource patches projected to have once existed on the POCS as a proxy indicator of potential site locations. To do this we employed the GIS-based paleolandscape and precontact site potential models developed for BOEM (ICF International et al. 2013) in order to predict the distribution of submerged precontact sites in the PacWave South project APE.

Archaeological Records Search

A search for recorded precontact and historic period archaeological sites was made by reviewing the Oregon State Historic Preservation Office's online archaeological records database (https://maps.prd.state.or.us/shpo/archaeoview.html accessed in January, 2019). This search revealed that there are no known archaeological sites (including shipwrecks) within the project APE.

Geophysical Data

Sidescan sonar and magnetometry signal data were collected in 2014 and in 2018 throughout the PacWave South project APE (see Figure 2) and were examined to look for evidence of large precontact sites expressed at or near the surface of the seafloor, and for magnetic anomalies that might represent the remains of historic shipwrecks. Subbottom profiler data collected in support of the PacWave South project were examined for evidence of submerged and buried paleocoastal landscape features, submerged precontact archaeological sites, and submerged historical sites, including shipwrecks.

Davis reviewed the data from each of the subbottom profiler transects in order to identify potential buried terrestrial landform features, including floodplain surfaces, terraces, alluvial channels, as well as anomalous features that might represent buried and submerged archaeological sites (e.g., shell middens, structures, cultural features). Davis identified 27 locations distributed across the APE for potential sampling with marine cores in order to facilitate groundtruthing of the range of variation seen in subbottom profiler geophysical signatures in areas with possible archaeological interest. Marine cores were collected from nine of these locations (Figure 1).

Physical Coring and Archaeological Assessment of Cores

As described above, nine vibrocores (up to 2.5 m long with a diameter of ~7 cm) were collected in 2018 and 2019 from areas within the APE that appeared in the subbottom profiler data to hold potential burial landform features (e.g., buried surfaces, banks of alluvial channels) (Table 1, Figure 1). Loren Davis examined and water screened (through 1/8" mesh) the working halves of these cores at OSU's Marine and Geology Core Repository in December of 2018 and May of 2019 to search for any buried archaeological materials. The analytical halves for each of these cores were not screened and are currently stored at the OSU repository.

RESULTS

GIS Modeling

Figure 1 shows a reconstruction of continental shelf landscape under different sea level positions spanning the period between 10,000-2,000 cal BP. The PacWave South project APE appears to cross the modeled paths of several smaller stream channels. The PacWave South APE intersects a portion of Oregon's paleocoastal landscape that includes high, medium, and low site potential scores (Figure 1). Several areas within the APE retain high site potential grid scores. These high site potential areas may represent low gradient, south facing alluvial terraces within ancient riparian zones that might have been attractive to ancient coastal peoples.

Subbottom Profiler Data and Sediment Cores

Examination of the subbottom profiler data collected in the project area reveals several zones that appear to have downward trending and more intense reflectance traces that are positioned beneath a layer of unconsolidated sediment (Figures 2). These geophysical signatures were thought to potentially represent ancient pre-inundation terrestrial alluvial channel and adjacent floodplain features that were subsequently buried and submerged beneath postglacial marine transgression. Nine vibrocores were placed in predetermined target locations that were associated with subbottom profiler signatures that were hypothesized to represent submerged terrestrial features (Table 1). As seen in Figures 3-10, these hypothetical features are positioned within 1-3 meters below the sea floor.

Examination of these sediment cores primarily revealed fine sediments (sand to clay) with few to common fragments of driftwood and marine shells. Pebble to cobble gravels were found at the base of some cores. No archaeological materials were found in any of the examined cores. The sediments recovered in these shallow cores are most likely related to subtidal depositional environments and do not reflect submerged ancient terrestrial landscape deposits.

Table 1. Marine cores examined for archaeological materials. Depth is reported as meters below sea level (depth of sea floor below surface of ocean).

Core	Lat/Long	Depth (below MSL)	Length (cm)	Notes
A-01	44° 31.354' -124° 12.819’	62	115	No cultural materials
A-07	44° 31.609' -124° 12.864’	63	125	No cultural materials
A-08	44° 33.767' -124° 13.695’	71	60	No cultural materials
A-12	44 32.116' -124 13.283'	70	72	No cultural materials
A-17	44° 30.765' -124° 10.961'	52	25	No cultural materials
A-20	44° 30.541' -124° 10.306’	51	45	No cultural materials
A-21	44° 28.955' -124° 07.555’	42	250	No cultural materials
A-22	44° 28.629' -124° 07.053’	34	150	No cultural materials
A-24	44° 31.652' -124° 11.498'	55	40	No cultural materials

Summary and Recommendations

The PacWave South project APE does not contain any known recorded precontact period archaeological sites. No precontact cultural materials or site features were observed in the geophysical data nor were any cultural materials found in the nine marine cores. The PacWave South project area does not contain any recorded historic shipwrecks or any other historic sites. No historic shipwrecks or other historic period sites were observed in the sidescan sonar and subbottom profiler dataset, nor were historic artifacts found in the sediment cores.

Evaluation of the geophysical datasets did not reveal any anomalous patterns that might overtly signal the presence of precontact or historic period archaeological sites. Paleolandscape GIS modeling and offshore site potential modeling indicate that limited portions of the project area may intersect ancient coastal streams with environmental characteristics likely attractive to precontact coastal peoples. Geophysical traces of what appeared to be the ancient course of several buried alluvial channels were observed in subbottom profiler transects; Although marine coring did not reach deep enough to recover sediment from these geophysical traces, they lie below the APE depth. These data suggest that the PacWave South development project is not expected nor likely to negatively affect submerged and/or buried cultural resources within its project area boundaries.

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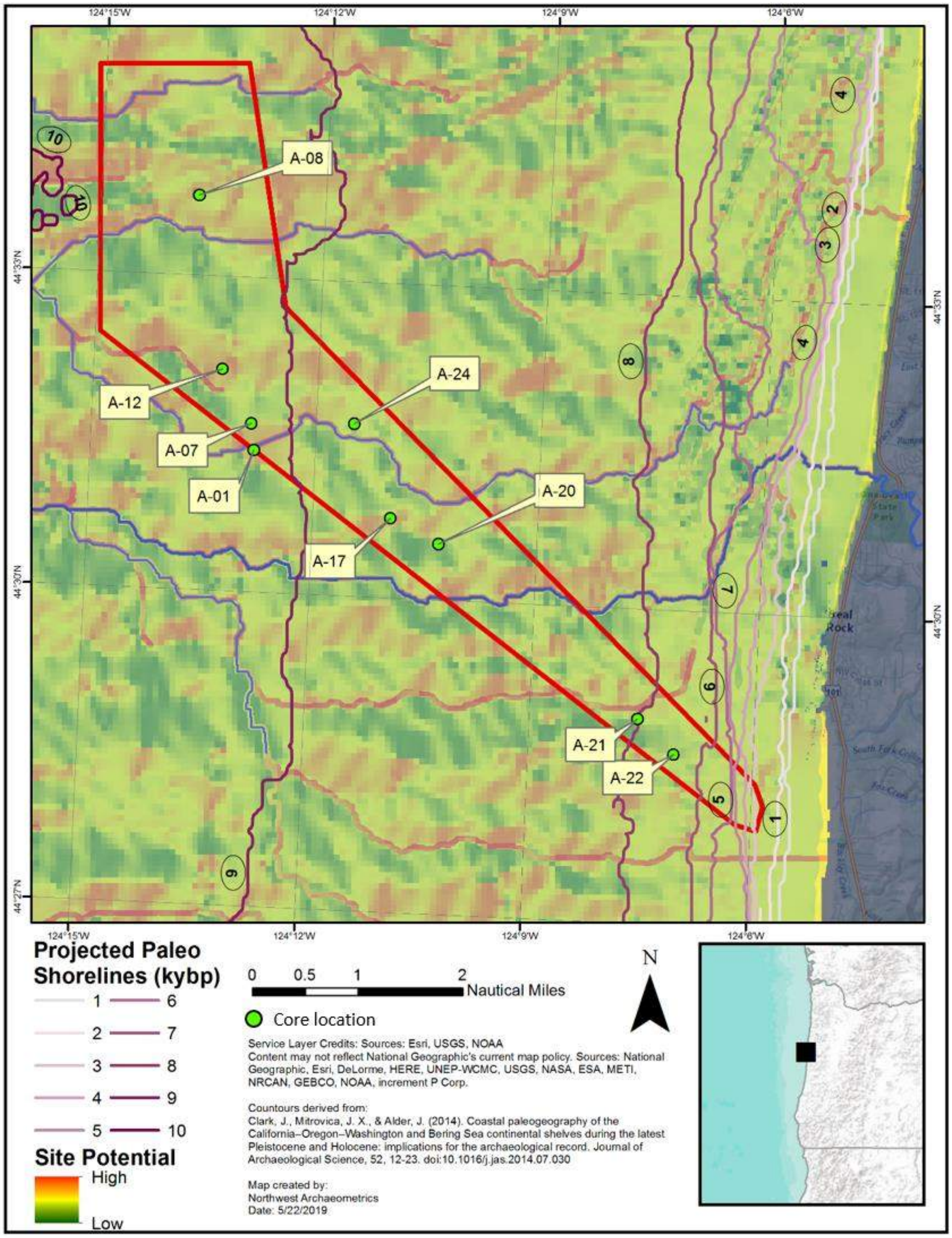

Figure 1. Site potential model with maximum extents of PacWave South offshore area of potential effect (APE) shown as red lined polygon. Site potential grid values are projected across study area: red represents high site potential, yellow represents moderate site potential, and green represents low site potential. Hypothetical alluvial channel/riparian courses are shown in red and purple west-trending lines. Relative sea level positions are shown at millennial scales by age within circle (e.g., 1 = 1,000 cal BP).

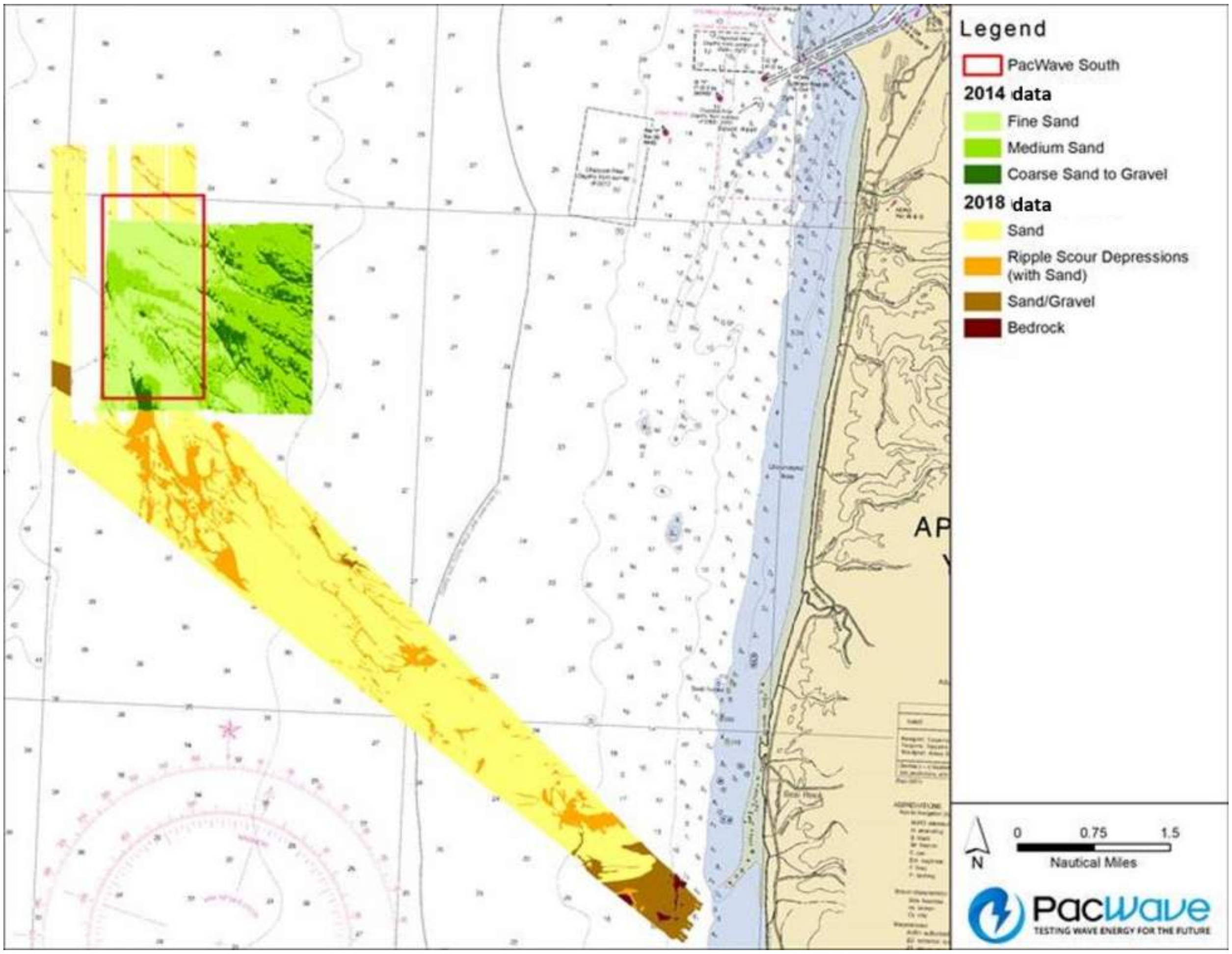

Figure 2. Sidescan sonar and magnetometry signal data collected in 2014 and in 2018 throughout the PacWave South project offshore APE.

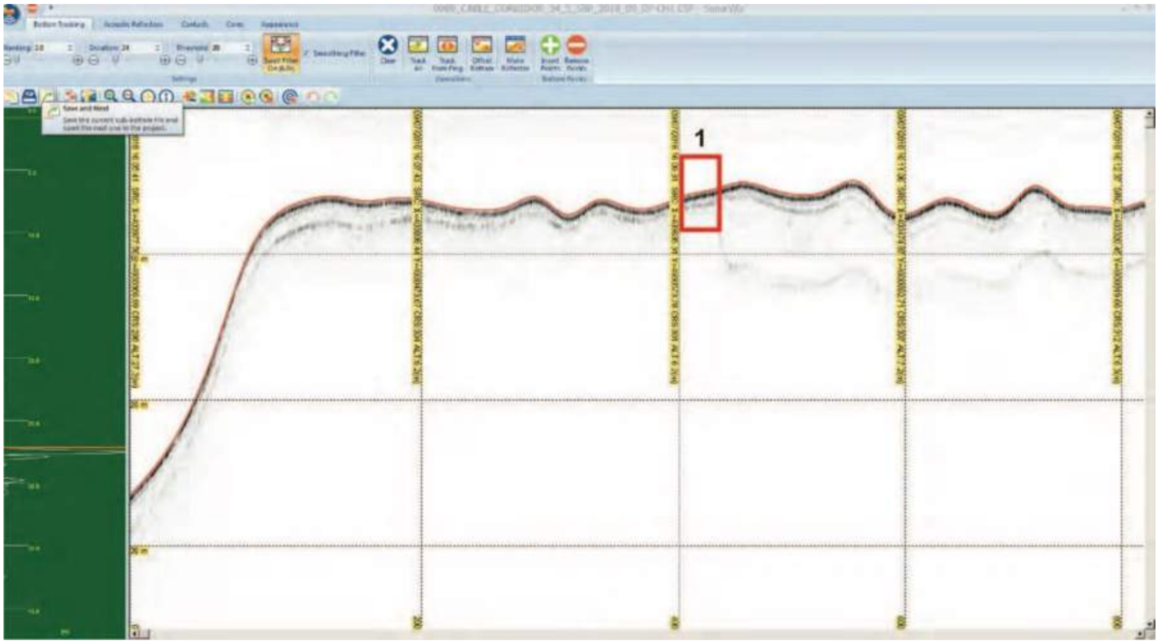

Figure 3. Subbottom profiler images in vicinity of archaeological core location A-01. X-axis gridlines are spaced at 200 m intervals. Y-axis gridlines are spaced at 10 m depth intervals.

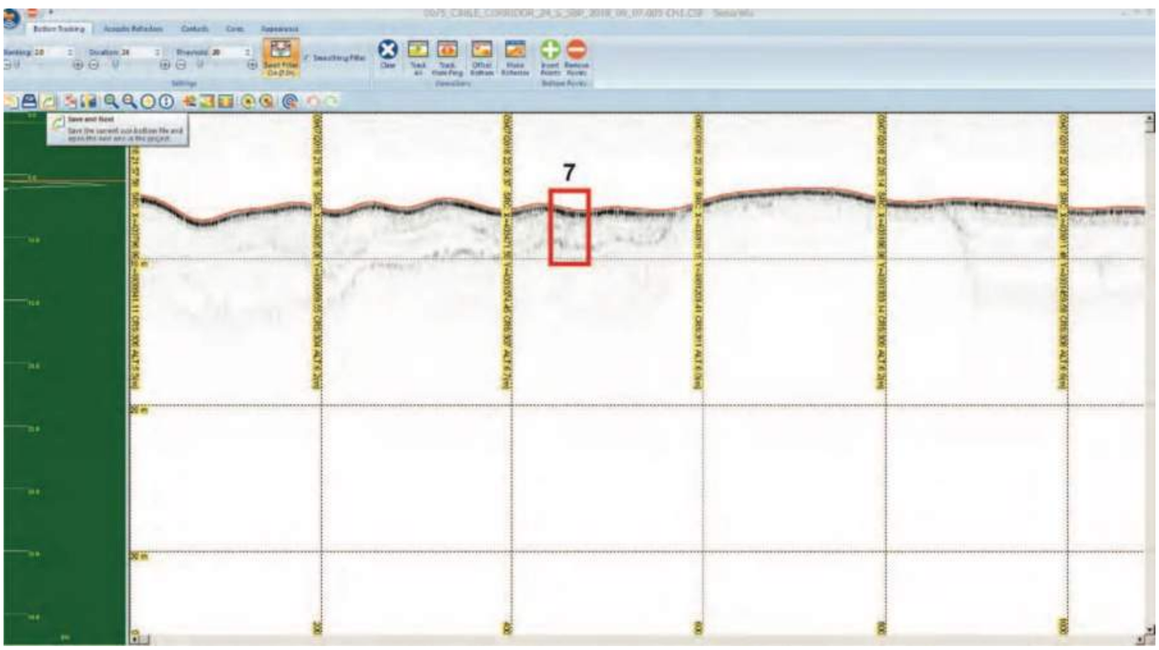

Figure 4. Subbottom profiler images in vicinity of archaeological core location A-07. X-axis gridlines are spaced at 200 m intervals. Y-axis gridlines are spaced at 10 m depth intervals.

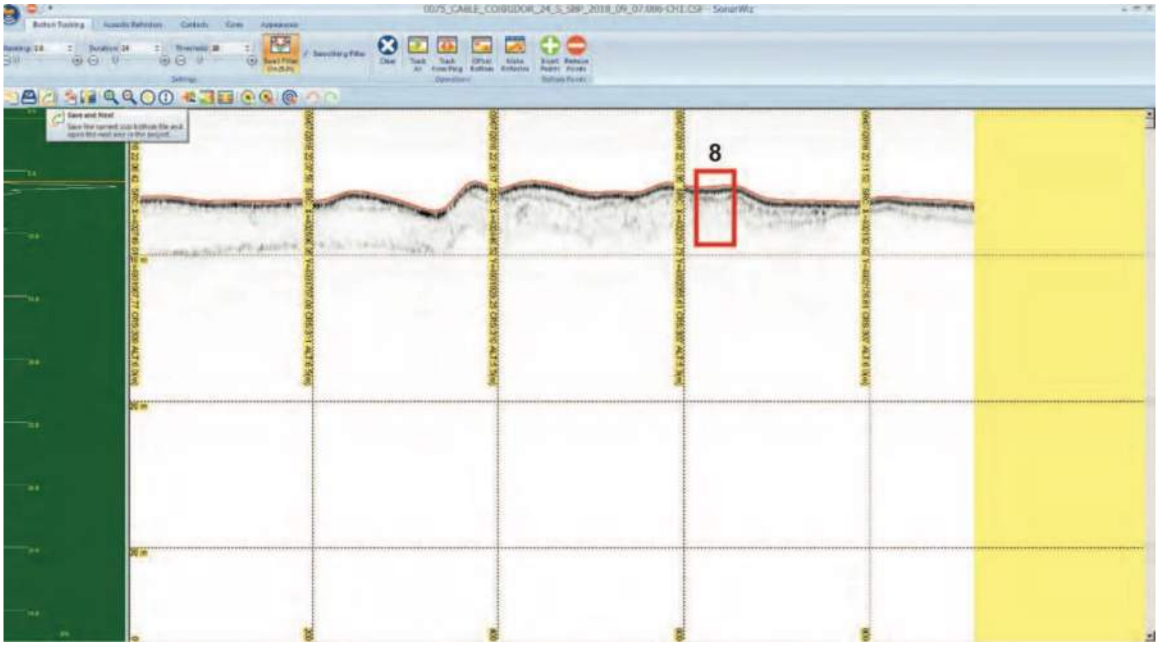

Figure 5. Subbottom profiler images in vicinity of archaeological core location A-08. X-axis gridlines are spaced at 200 m intervals. Y-axis gridlines are spaced at 10 m depth intervals.

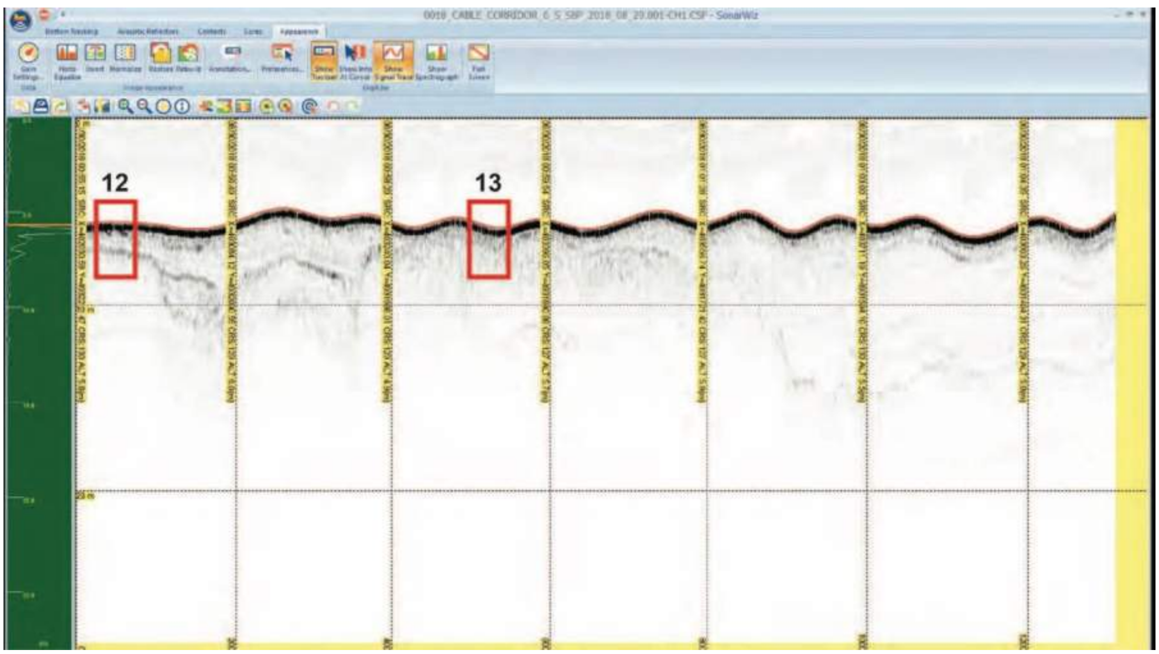

Figure 6. Subbottom profiler images in vicinity of archaeological core location A-12. X-axis gridlines are spaced at 200 m intervals. Y-axis gridlines are spaced at 10 m depth intervals.

0093_CABLE_CORRIDOR_11_S_SBP_2018_09_09.006-CH1.CSF - SonarWiz.png

Figure 7. Subbottom profiler images in vicinity of archaeological core location A-17. X-axis gridlines are spaced at 200 m intervals. Y-axis gridlines are spaced at 10 m depth intervals.

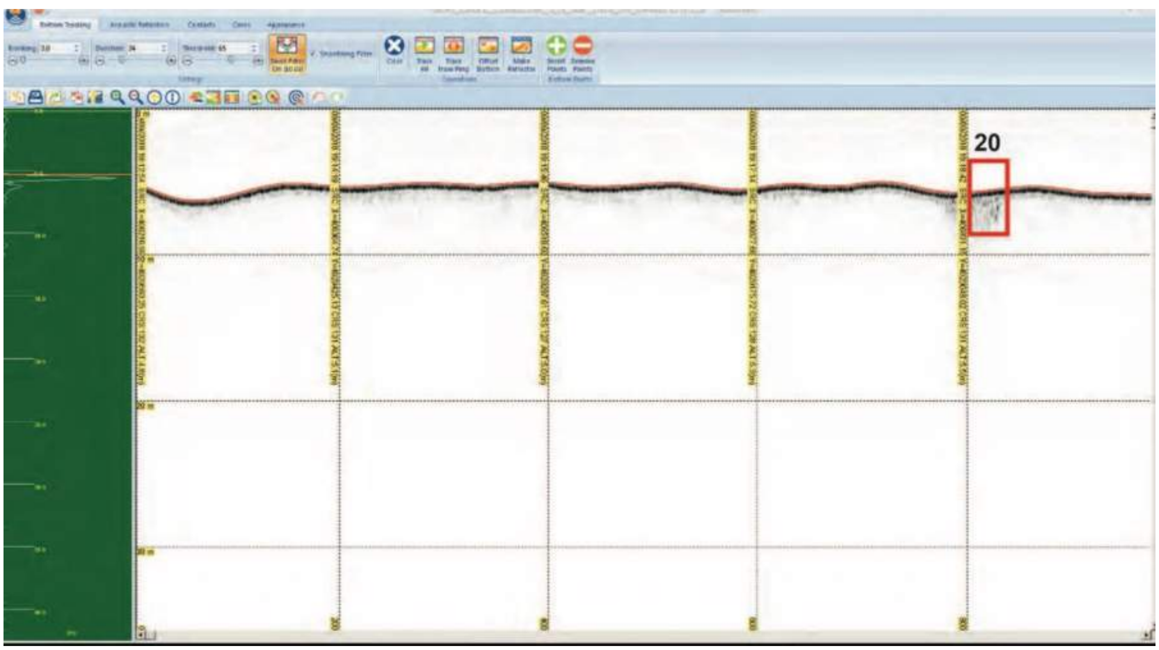

Figure 8. Subbottom profiler images in vicinity of archaeological core location A-20. X-axis gridlines are spaced at 200 m intervals. Y-axis gridlines are spaced at 10 m depth intervals.

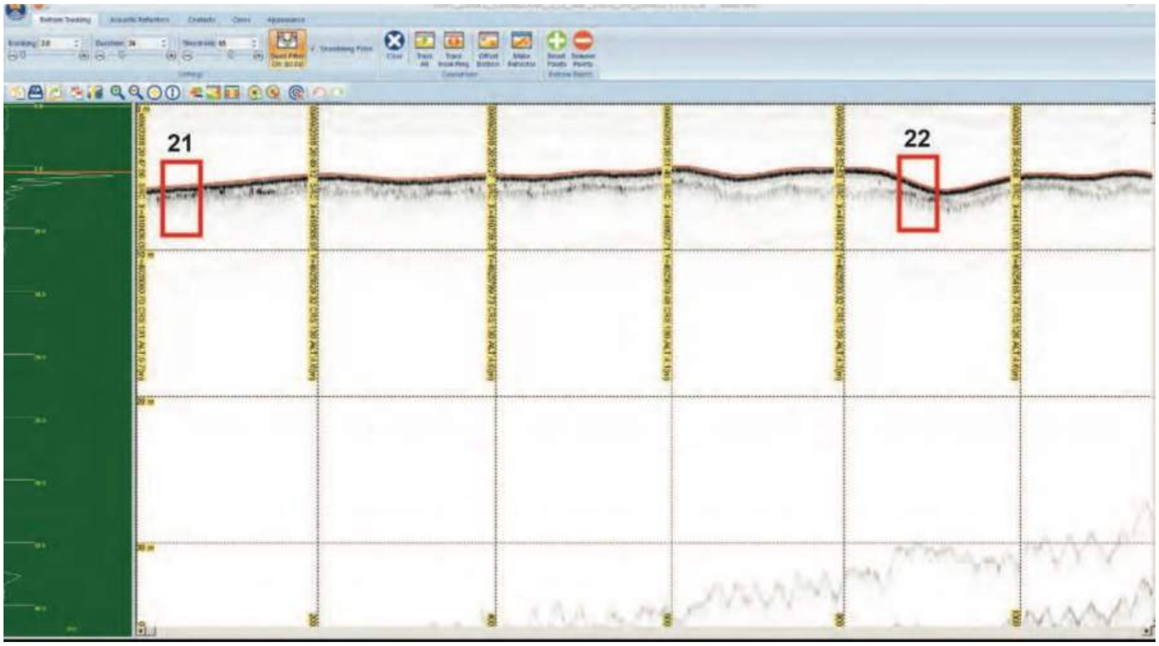

Figure 9. Subbottom profiler images in vicinity of archaeological core location A-21-22. X-axis gridlines are spaced at 200 m intervals. Y-axis gridlines are spaced at 10 m depth intervals.

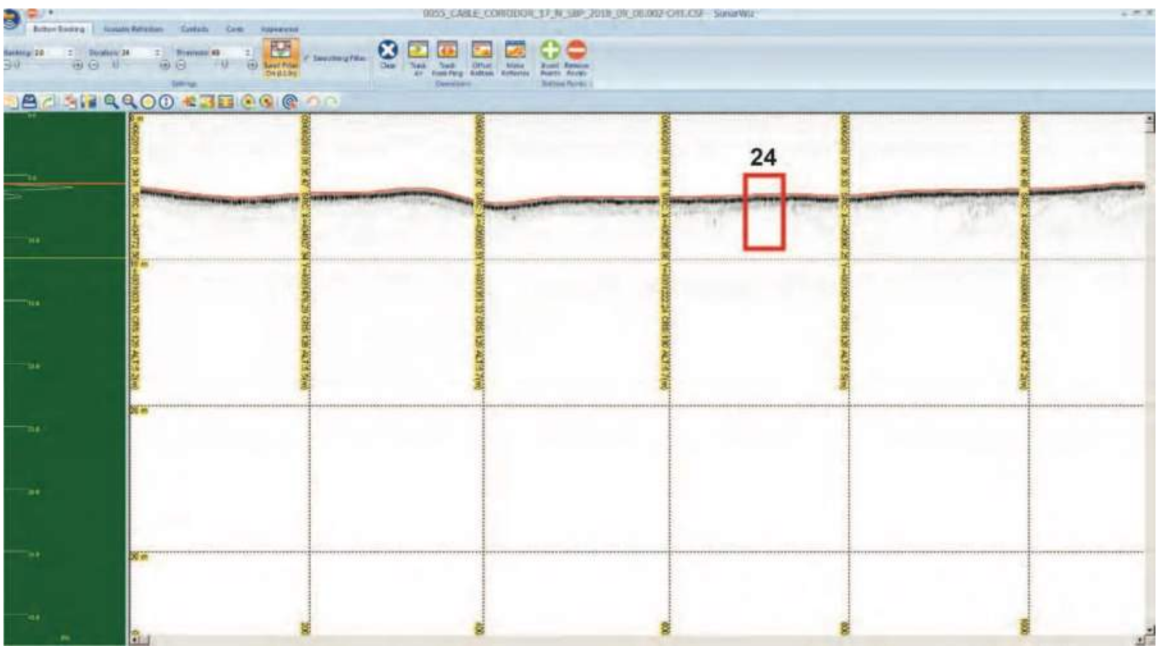

Figure 10. Subbottom profiler images in vicinity of archaeological core location A-24. X-axis gridlines are spaced at 200 m intervals. Y-axis gridlines are spaced at 10 m depth intervals.

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