MOTT MACDONALD

Coos Bay Offshore Wind Port Infrastructure Study

February 2022 – TotalEnergies SBE US

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Contents

Executive summary

The Coos Bay Offshore Wind Port Infrastructure Study was commissioned by TotalEnergies Simply Blue Energy US (TotalEnergies SBE US) to identify the constraints, opportunities, needs, and planning-level costs required to provide suitable port infrastructure for supporting a future floating offshore wind (FOW) industry in Southern Oregon. The study was funded in part by the Oregon State Lottery and administered by the Oregon Business Development Department. The state of Oregon has enacted legislation to plan for the development of up to 3GW of FOW energy by the year 2030, but there are no publicly available studies indicating whether an existing port facility in Oregon can support the industry. Of the existing ports near the Bureau of Ocean Energy Management (BOEM) Oregon Offshore Wind Planning Area, Coos Bay is the most suited for supporting FOW due to its deep draft navigation channel & lack of critical airdraft restrictions[1] (Porter & Philips, 2016). The capabilities and challenges associated with supporting FOW buildout from Coos Bay need to be investigated.

A FOW port must provide navigable access for support vessels, foundations, and integrated devices. Additionally, the port must have adequate marine terminal facilities to handle & store large FOW components, integrate turbines and/or foundations, and support O&M activities. The components and integrated devices are very large, and existing Oregon ports were not designed to accommodate the emerging FOW industry. Historically, the Port of Coos Bay has facilitated the export of logs, lumber, and woodchips produced within the region and the existing navigation channels & marine terminal infrastructure were primarily designed for serving the forest products industry.

Primary study findings (summarized below) are intended to objectively inform TotalEnergies SBE US on the technical feasibility and upgrades needed to support FOW buildout within Coos Bay.

Primary Study Findings

- With investments and appropriate stakeholder coordination, Coos Bay has the physical characteristics to support the FOW industry in Southern Oregon in a variety of functions including wind turbine generator (WTG) integration, marshalling activities, foundation fabrication and assembly, WTG manufacturing, and O&M.
- The key factors that make Coos Bay favorable for supporting FOW include its deep draft navigation channel and availability of waterfront acreage seaward of the bridges that cross over the bay.
- The width of the presently proposed navigation channel improvements by the US Army Corps of Engineers (USACE) can likely support the smaller size range of floating foundations (~200-250ft), but additional widening of the channel would be required to support larger foundations. The depths of the existing & proposed Coos Bay navigation channel are likely sufficient to support FOW buildout for 10-20MW WTGs, though towing may be limited to higher water levels.
- Planning-level costs were estimated for construction of an example facility at the Jordan Cove West site. For this example development (see Figure 2), investments needed to support integration include a new wharf, storage yard, and dredging. These investments were estimated to total $475 million, but may be in the range of $235-$950 million (-50% to +100%, per the Association for the Advancement of Cost Estimating's Class V level cost estimate) or higher.
- Coordination with stakeholders, including with the Federal Aviation Administration (FAA) and Coos County Airport District, on airspace restrictions is needed to confirm feasibility.

[1] Airdraft restrictions are present in Coos Bay (due to airport, bridges), which may constrain where certain FOW activities may occur, but they do not preclude the integration or transport of turbines from occurring within the bay.

Port infrastructure needed to support FOW includes both the onshore marine terminal (berth, wharf, and yard), and the in-water navigation facilities. To evaluate opportunities for supporting FOW in Coos Bay, the following conceptual engineering work was conducted:

- **Data Collection & Basis of Assessment**: Compiled site information. Study assumptions were coordinated with the TotalEnergies SBE US Team and relevant stakeholders (e.g. Port of Coos Bay & the FAA).
- **Navigation Assessment:** Evaluated the capability of existing navigation channels and other in-water areas within Coos Bay to support safe and efficient wind farm construction. Assessed the need for potential geometric or operational modifications to the existing & proposed channels.
- **Marine Terminal Assessment:** Conducted a preliminary screening assessment of potential development locations relative to different types of FOW activities to identify favorable development areas. Focus areas for each FOW activity were identified for further investigation. A gap analysis was conducted to assess the capability of existing facilities to accommodate integration activities, foundation assembly, component manufacturing, and O&M and to assess the need for upgrades or development of a new terminal.

A summary of the navigation & marine terminal infrastructure assessments is provided below:

Navigation Infrastructure: Existing federal navigation channels (FNCs) in Coos Bay consist of the Entrance Channel, which provides a navigable pathway from the Pacific Ocean into the sheltered waters of the bay, and the Inner Channel, which provides navigable access to marine terminal facilities within the bay (see Figure 1). The Port of Coos Bay plans to widen and deepen sections of the existing FNC in Coos Bay (pending permit approval), therefore both the existing and proposed channel geometries were assessed. The navigation assessment findings are summarized below:

- **Existing Navigation Channel:** The existing channel can potentially support FOW integration activities for the smaller size range of foundations (e.g., ~200ft {60m} width or less), though throughput (MW installed per year) may be limited based on tight weather windows. The existing depths are likely capable of supporting FOW buildout for the range of turbine size considered (10-20MW).
- **Proposed Navigation Channel:** The proposed channel will be able to accommodate a larger device than the existing channel, potentially approximately 250ft {76m} in width.
- **Further Improvements:** To accommodate the larger sizes of floating foundations (up to 400ft {122m} in width), further widening beyond the planned improvements in the Entrance Channel and the Inner Channel is likely needed. A wider Entrance and Inner Channel – beyond the existing planned improvements - would also benefit tow-out for the smaller floating foundations. Further channel improvements would likely be a lengthy process (5-7+ years) to implement and would require coordinating long-term planning with the USACE and other stakeholders.
- **Operations:** Assembly and installation activities will likely be limited to favorable weather months (e.g., May-October), which could result in a deployment and installation window of six months or fewer. Given the current Entrance Channel maintenance dredging schedule, tow-out operations may not be able to take advantage of a fully dredged channel earlier in the installation season. There could be conflicts between tow-out and dredging equipment or other marine traffic (fishing vessels, commercial deep-draft vessels, etc.) in the channel during WTG installation. These conflicts should be assessed as part of a future Navigation Safety Risk Assessment.

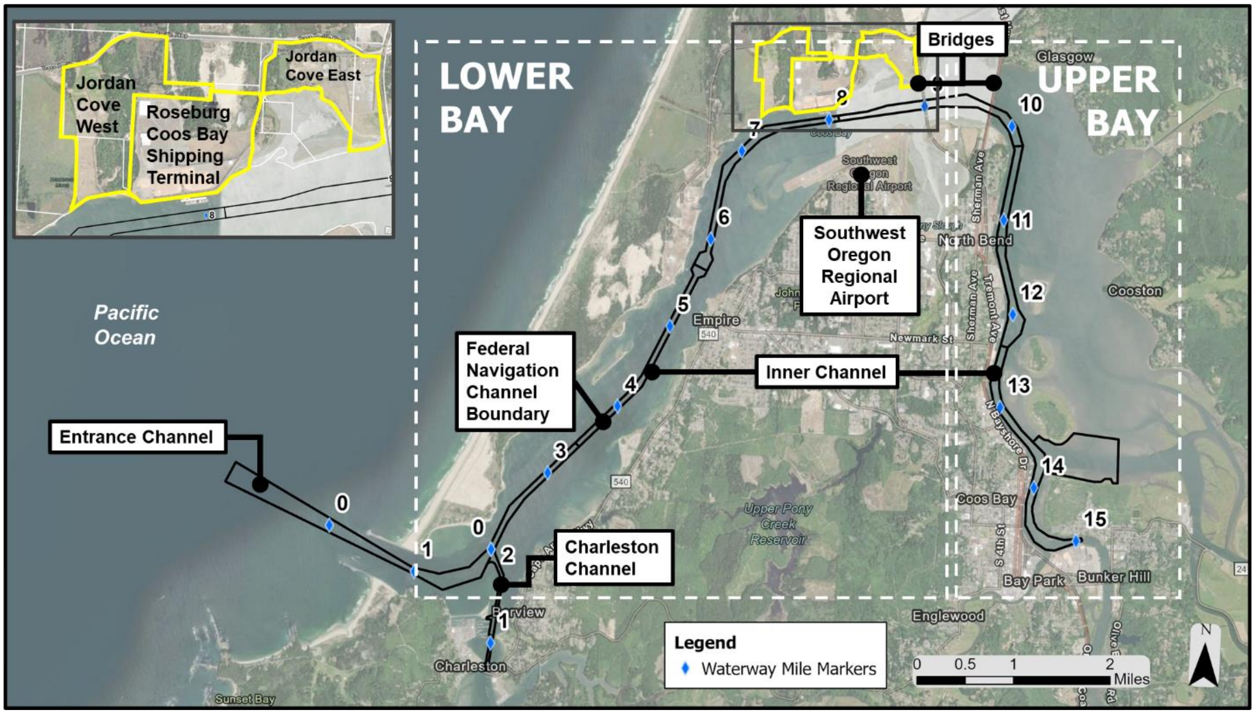


Figure 1. Coos Bay area overview. Favorable WTG integration areas shown in yellow outline.

Marine Terminal Infrastructure: The technical screening assessment concluded that there are locations within the bay that are potentially capable of supporting WTG integration, foundation fabrication/assembly, component manufacturing, and O&M, with investment. The findings of the marine terminal assessment are summarized for each type of facility below.

Integration Facility: Integration of the WTG to the floating foundation is the critical element for supporting installation of a floating wind farm and is therefore a focus of this study. Through coordination with stakeholders, the north areas of the bay (Jordan Cove West, Roseburg Coos Bay Shipping Terminal {CBST}, and Jordan Cove East, see Figure 1) were identified as potentially favorable areas for integration facility development, but further coordination with the FAA is needed to confirm that this area is feasible. The Jordan Cove West site was selected as an example development location as it is not in use, is large in size, and has sufficient waterfront adjacent to the navigation channel to support integration activities. The results are summarized below:

- **Throughput:** The number and size of turbines deployed annually affects the size of the facility which is needed. Fewer larger units may require less capital investment in the marine terminal (because fewer units need to be deployed each year to meet a given deployment goal in MW), but may require more investment in navigation improvements to accommodate a larger foundation geometry.
- **Airspace:** Further coordination with the FAA and Coos County Airport District is needed to coordinate and confirm potential development locations for an integration facility relative to airspace restrictions surrounding the nearby Southwest Oregon Regional Airport.
- **Potential Upgrades Needed:**
  - Wharf**:** A new bulkhead & high-capacity wharf will be needed to accommodate integration. A lower capacity structure may be needed to support commissioning activities. Based on limited review of geotechnical conditions, new overwater structures are likely to be pile-supported.
  - Yard**:** Grading, ground improvements, and surfacing will be needed to provide a flat storage area capable of meeting bearing capacity requirements.

  - Berths: Berth dredging to accommodate unloading of vessels, turbine integration, & commissioning is needed outside of the footprints of previous dredging activities. Depths in the bay outside the navigation channel are unlikely to be sufficient for wet-storage or commissioning activities.
  - Wet Storage: Unless foundations are stored upland following delivery or assembly, dredging outside of the FNC to accommodate wet storage of foundations and/or integrated turbines is needed.
- **Capital Costs:** An example integration facility development scenario (Example Development Scenario A, which is described in Table 11 and visualized in Figure 2) was used as the basis for developing a construction cost estimate. The example development consists of 2 heavy-lift berths, 1 commissioning berth, and an ~80 acre (32 hectare) storage yard and is likely to support buildout of 250-750MW per year, depending on turbine size and integration duration. This study was not intended to optimize the integration facility location or layout, and costs for port infrastructure upgrades will vary, depending on the size of the FOW project, annual throughput requirements, turbine rating, site conditions, environmental considerations, material prices, and other project-specific requirements. Planning-level costs for the example construction were estimated to be $475 million, but may be in the range of $235-$950 million, according to the Association for the Advancement of Cost Estimating's Class V cost estimate scheme (-50% to +100%) for concept-level screening. A larger or smaller facility may ultimately be developed, depending on the annual installed capacity goals and size of the turbines selected for installation.
- **Operations:** When no longer in use for FOW, a new integration wharf could meet operational requirements of other industries and could be an asset for servicing other industries.

Foundation Fabrication/Delivery

- To conduct integration in Coos Bay, foundations need to be delivered via marine transport or assembled on site. Costs for port infrastructure upgrades to support fabrication or delivery will vary, depending on the size of the FOW project, annual throughput requirements, turbine rating, site conditions, environmental considerations, material prices, and other project-specific requirements.
- Although there may be enough upland area within the example Jordan Cove West site to accommodate both integration & fabrication activities, the shoreline length is limited. For adjacent integration & fabrication facilities in the north area of the bay, parts of the adjacent parcels (Roseburg CBST and/or Henderson Marsh) would need to be secured for development.
- **Potential Upgrades Needed**: Upgrades needed are linked to the type of structure, and method of foundation delivery or launching employed. Examples of potential launching infrastructure improvements include a new high capacity launching wharf with a submersible vessel and dredged pit, marine rail, gantry crane & slipway, or other. Grading, ground improvements & surfacing, and other technology-specific improvements are likely needed for a fabrication facility.

Component Manufacturing

- Siting of a component manufacturing facility is less limited by airspace & navigation constraints than by integration or fabrication, and there are several potential development options in the Upper and Lower Bays which meet the acreage needs for a manufacturing facility.
- **Potential Upgrades Needed**: Requirements would be determined based on a site-specific investigation; for an example, development at Terminal 1 would likely require a new wharf to provide sufficient bearing capacities. Depending on the results of a geotechnical investigation, ground improvements & surfacing may also be needed.

O&M Base

- There are several options for siting an O&M vessel base within the bay, which may require modification & investment. Additional analysis is needed to determine whether existing facilities can be re-configured to support crew transfer vessel (CTV) and Service Offshore Vessel (SOV) moorage and whether a new breakwater is needed to provide safe harbor.

- **Potential Upgrades Needed**: Potential investments required may include wharf upgrades and moorage floats. New administrative buildings, storage warehouses, parking, and security upgrades may also be needed.

Next Steps

Further site investigation, analysis, and design development will need to be conducted to refine the design concepts and cost estimates. Key next steps include:

- Bridge simulations of specific floating foundations to refine navigational improvements which may be required, and coordination with the local US Coast Guard (USCG) unit.
- Yard, wharf, and berth dredging location and orientation will need to be refined upon site selection.
- The location and orientation of potential wet-storage and/or commissioning areas need to be refined based on a detailed coastal engineering analysis and stakeholder input.
- Coordination with original equipment manufacturers (OEMs) on specific marine terminal needs, and integration/commissioning durations.
- Refinement of wharf elevations and structure type based on final location
- Further investigation into launching (float-off) systems and solutions for accommodating foundation delivery or fabrication within the bay.
- Engage with regulatory authorities, users, developers, USACE, USCG, and others to refine project criteria and inform feasibility assessment work.
- Outreach with tribes & other local stakeholder groups to solicit input and incorporate into project planning & development.
- Conduct a Navigation Safety Risk Assessment to assess potential impacts to existing marine traffic.
- Coordination & engagement with the FAA and Coos County Airport District to refine constraints related to airspace penetration for integration, fabrication, maintenance, and tow-out activities. A Notice of Proposed Construction or Alteration (Form 7460-1) will need to be submitted to the FAA for approval.

Figure 2. 3D rendering of example integration facility concept at the Jordan Cove West site in Coos Bay – looking northeast.

1 Introduction

The Coos Bay Offshore Wind Port Infrastructure Study was commissioned by TotalEnergies Simply Blue Energy US (TotalEnergies SBE US) to identify the constraints, opportunities, needs, and planning-level costs required to provide suitable port infrastructure for supporting a future floating offshore wind (FOW) industry in Southern Oregon. The state of Oregon has enacted legislation to plan for the development of up to 3GW of FOW energy by the year 2030, but a port facility capable of supporting wind farm installation is needed. Of the existing ports near the Bureau of Ocean and Energy Management's (BOEM's) Oregon FOW Planning Area, Coos Bay is the most suited for supporting FOW due to its deep draft navigation channel & lack of critical airdraft restrictions[2] (Porter & Philips, 2016). However, the capabilities and challenges associated with supporting FOW buildout from Coos Bay needed to be investigated.

A FOW port must provide navigable access for support vessels, foundations, and integrated devices. Additionally, the port must have adequate marine terminal facilities to handle & store large FOW components, integrate turbines and/or foundations, and support O&M activities. The components and integrated devices are very large, and existing Oregon ports were not designed to accommodate the emerging FOW industry. Historically, the Port of Coos Bay (the Port) has facilitated the export of logs, lumber, and woodchips produced within the region and the existing navigation channels & marine terminal infrastructure were primarily designed for serving the forest products industry.

This report evaluates the capacity of the Port's infrastructure to support FOW by:

- Documenting existing marine terminal & navigation infrastructure;
- Developing requirements for supporting FOW activities; and
- Assessing existing infrastructure capabilities & constraints, while identifying the necessary upgrades.

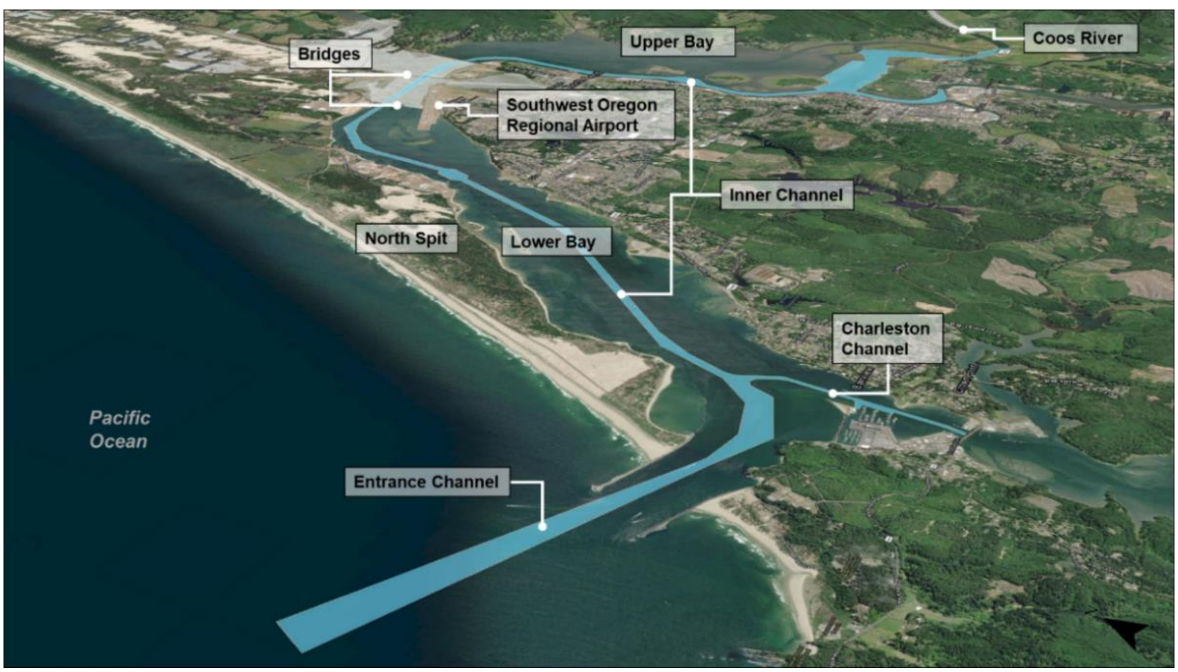


Figure 3. Coos Bay - oblique aerial with key areas and infrastructure identified.

[2]Airdraft restrictions are present in Coos Bay (due to airport, bridges), which may constrain where certain FOW activities may occur, but they do not preclude the integration or transport of turbines from occurring within the bay.

2 Basis of Assessment

This section summarizes the key assumptions that formed the basis of the port infrastructure study.

2.1 Floating Offshore Wind Criteria

2.1.1 Development Scenarios

Table 1 summarizes the key study assumptions related to the development scenario and anticipated throughput rates.

Table 1. Development scenario & throughput study parameters.

Parameter	Proposed/Example Criteria
Wind Turbine Generator (WTG) Rating	10MW, 15MW, 20MW
Size of Full Buildout in Southern Oregon	Assumed that O&M-related facilities will support a full buildout of ~3GW of offshore wind.
Throughput Objectives	Throughput refers to the number of WTGs that can be assembled and installed in the wind farm each year. Assumed minimum throughput: ~350MW/year (1 project). 350MW per year results in a ~9-year buildout schedule for 3GW of offshore wind in Southern Oregon. To meet a shorter schedule, a higher throughput is required. This study assesses sensitivity of increased throughput.

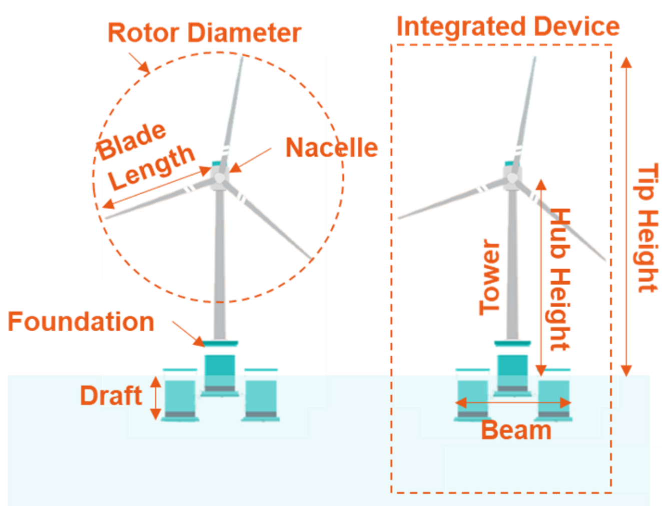
2.1.2 Foundation Type

Technology agnostic; this may include semi-submersible, tension leg platform, barge, or other. Material may include concrete, steel, or a combination thereof (no specific design); a range of potential device geometries will be assessed to help understand port infrastructure sensitivities relative to the size of the foundation.

2.1.3 WTG and Foundation Geometry

For the purposes of this study, the assumed device geometry is provided in Table 2. A range of potential foundation geometries was assessed to help understand port infrastructure sensitivities relative to foundation size/design. To assess the range of potential floating foundation sizes & geometries, the hulls have been parameterized as Type A (a larger foundation) and Type B (a smaller foundation). The parameterized geometries are not specific to any design and were developed to reasonably bracket the range of substructure size likely to be deployed in this region. The range of sizes considered was developed in coordination with TotalEnergies SBE US and is intended to represent possible foundation geometries for supporting a WTG up to 20MW.

Table 2. Device Geometry Assumptions

Parameter	Proposed/Example Criteria	Definitions
WTG Geometry[3]	**Rotor Diameter:** 790-860ft (240-260m) **Blade Length:** 395-430ft (120-130m) **Hub Height**: 490-540ft (150m-165m) **Tip Height**[4]: 885-970ft (270m-296m)	
Foundation Geometry	**Type A:** **Draft (light**): 33ft (10m) **Beam:** 400ft (122m) **Type B:** **Draft (light**): 20ft (6m) **Beam:** 200ft (61m)	
Integrated WTG Geometry	**Type A:** **Draft (w/ WTG):** 43ft (13m) **Beam:** 400ft (122m) **Type B:** **Draft (w/ WTG):** 25ft (7.6m) **Beam:** 200ft (61m)	

2.1.4 Floating Offshore Wind Activities Assessed

- Turbine Integration and Marshalling
  - The integration facility must have the ability to import, store, stage, maneuver, lift, and affix turbine components (up to 600-800 ton {544-726 metric tons}) to the foundation.
    - Integration requires utilization of a high-capacity crane (600+ tons {544+ metric tons}) for lifts up to the hub height (see Table 2). Depending on the foundation type, the horizontal distance from the tower to the wharf could be greater than 100ft (30m). Crane type may be large crawler crane (e.g., Liebherr LE 13,000) or a ring crane.
  - Servicing major repairs of installed devices.
  - Staging and storage of sea-keeping systems (mooring lines, anchors).
- Foundation Fabrication
  - May include full fabrication of the floating structure, receipt and final assembly of sub-assembly, or receipt of the fully assembled floating foundation.
  - Foundation fabrication facilities must have the capability to receive and store raw materials or pre-fabricated elements, assemble and store foundations, and float off (launch) the heavy foundations (1,800-14,000+ tons {1,600-12,700+ metric tons}) into the water from the upland fabrication yard.
- WTG Component Manufacturing
  - Manufacturing of blade, tower, or nacelles to serve a wider industry on the US West Coast.
  - A manufacturing terminal must be large enough to accommodate manufacturing facilities & the associated storage areas. It also must have a berth & navigable access to accommodate loading components onto transport vessels.
- Operations and Maintenance
  - Vessel base for crew transfer vessels (CTVs) and service offshore vessels (SOVs).

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[3] Lower end of range based on Gaertner, et. Al. (2020)'s definition of the IEA Wind 15MW turbine; higher end of range based on estimated scaled up geometrically for a 20MW WTG.

[4] Maximum distance between the water surface elevation and the tip of the blade (maximum distance occurs when one blade is facing straight up).

2.1.5 Port Infrastructure Elements Assessed

2.1.5.1 Navigation Infrastructure Elements Assessed

The navigation infrastructure assessment evaluated the capabilities and constraints associated with the Coos Bay Federal Navigation Channel (FNC). A FNC is a navigation channel that is managed and maintained by the US Army Corps of Engineers (USACE).

2.1.5.2 Marine Terminal Infrastructure Elements Assessed

Marine terminal infrastructure that is needed to support FOW buildout includes the following critical elements, as defined below and shown in Figure 4:

- **Yard:** Upland part of a marine terminal supporting integration, which is utilized for storage of components, office space, etc.
- **Wharf:** Overwater structure that is usually parallel with the shoreline and can be "open" (pile-or column supported) or "closed" (solid fill with bulkhead or caissons).
- **Berth:** Designated location where a vessel may be moored. For overwater structures, the berth is the part of a wharf or pier where people, equipment, and components are moved to and from vessels or devices. The berth area needs to provide sufficient depths for moored vessels/devices for all water levels.
- **Berth navigation area:** The area encompassing the berth and the area adjacent to the berth required for marine terminal navigation and maneuvering of the devices or vessels.
- **Navigation channel offset:** The distance between the berth and FNC edge. Potential impacts to navigation are less likely when the width of the berth navigation area is equal to or less than the navigation channel offset.
- **Wet storage area:** area for temporary storage of floating foundations (prior to integration) or assembled devices (prior to tow-out).

Marine terminal infrastructure (yard, wharf, berth, see Figure 4) requirements for supporting FOW assembly and fabrication have been assessed at a conceptual level to identify any required upgrades.

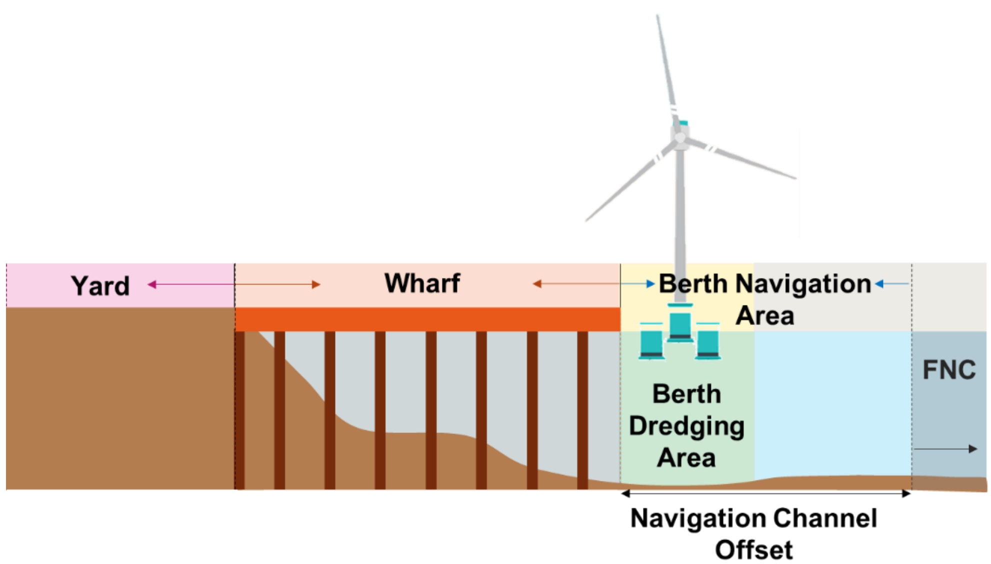


Figure 4. Definitions: Marine Terminal Facility

2.1.6 Initial Study Area

Mott MacDonald assessed port facilities within the Initial Study Area, which was coordinated with TotalEnergies SBE US and the Port. Within the Initial Study Area (see Figure 5), the assessment focused on waterfront areas and Port property, excluding the following:

- Areas that are not adjacent to existing navigation channels
- Parcels belonging to the airport
- Parcels labeled as residential
- North Spit Bureau of Land Management (BLM) Land - western snowy plover conservation habitat[5], recreational trails, etc.

Parcel and property ownership information were based on the Coos County July 2021 GIS dataset. For this study, it was assumed that the planned Jordan Cove Energy Project (JCEP) development area may be available for FOW development; as of December 2021, it was announced that the JCEP liquid natural gas project will not proceed.

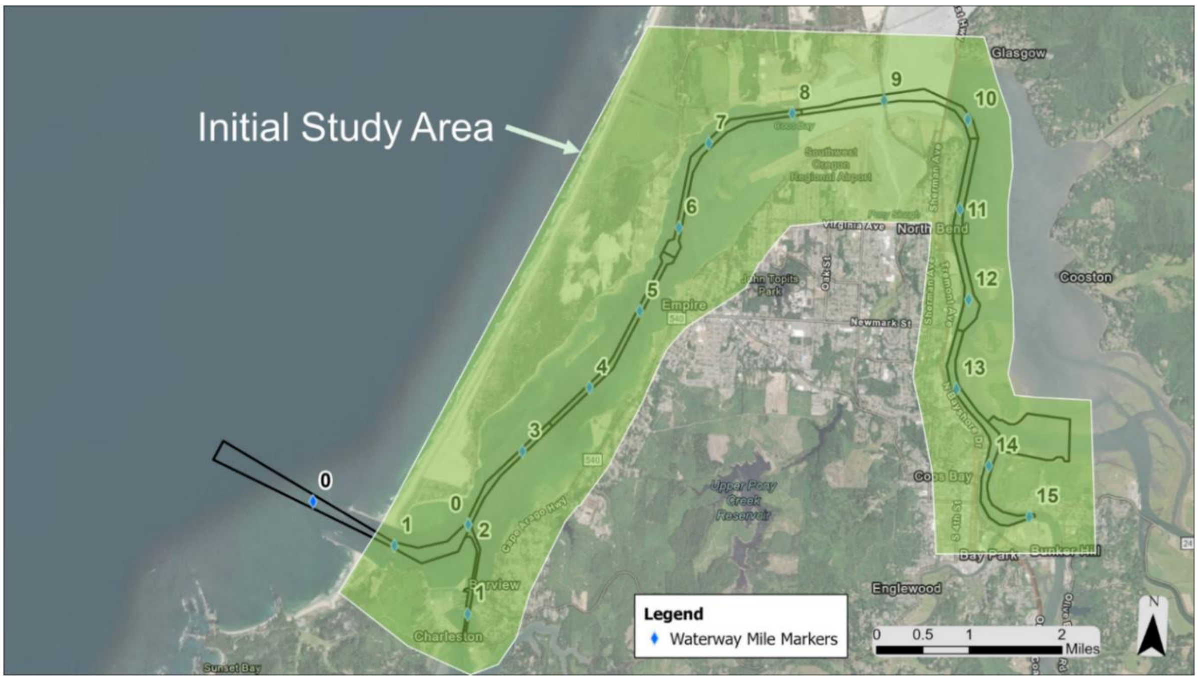


Figure 5. Initial Study Area

2.2 Site Conditions

Coos Bay is located 95 miles (153 km) north of the Oregon-California border and is the largest coastal deep-water port between San Francisco and Puget Sound.

The subsections below summarize Mott MacDonald's review of site conditions, which was conducted to inform the navigation & marine terminal assessments.

[5] Western snowy plovers are listed as a threatened species; one of the eight protected nesting sites in Oregon is located on the North Spit of Coos Bay and is managed by the Bureau of Land Management in cooperation with Oregon Department of Fish and Wildlife, and the US Army Corps of Engineers.

2.2.1 Wave Conditions & Seasonality

The various offshore activities needed for wind farm construction will each have specific operational criteria that must be met for safe operations. A conceptual sensitivity assessment was conducted to constrain the assumed installation season period for this study, considering the following:

- Limiting wave height, offshore installation activities: Hs < 8.2ft (2.5m).
- Data Source: Wave information from CDIP buoy 139[6] (Umpqua Offshore).

Wave conditions within Coos Bay were not simulated as part of this study, but it should be noted that integration activities typically require very calm wave conditions, as small motions near the water surface elevation translate to larger motions at hub height. Although ocean swell is not expected to penetrate the bay, numerical modeling of wind-waves and currents at the proposed integration location should be conducted in a future project phase to evaluate wave conditions at the berth relative to structure motion criteria.

Resulting Study Assumption: As shown in Figure 6, some activities (e.g. tow-out, major repairs) will be restricted to an installation season during the warmer weather months when wave heights are lower. Given the conceptual level of assessment and variability from year to year, a 6-month installation season (~180 days) is assumed for this study to be conservative. This installation season length will serve as in input to the throughput assessment (Section 5.1.1).

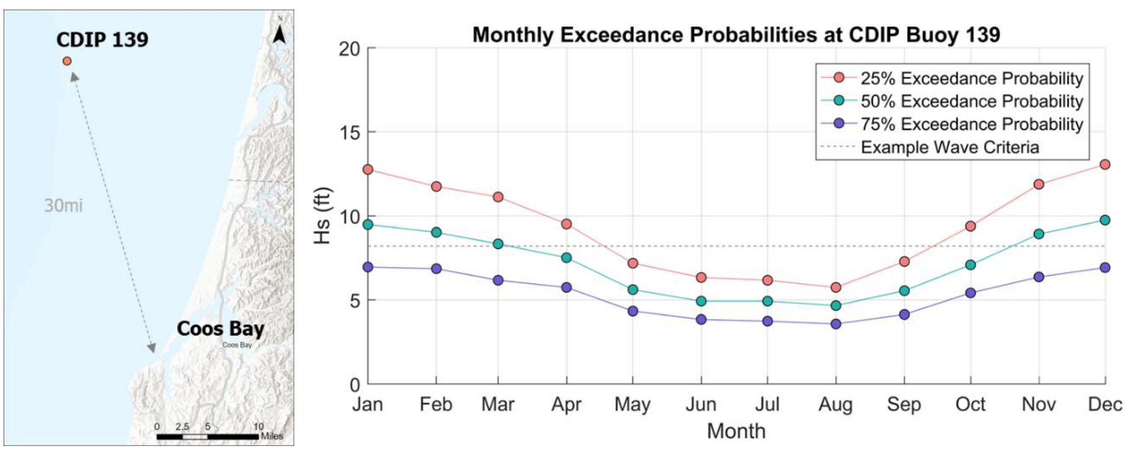


Figure 6. Monthly wave height exceedance probabilities at CDIP Buoy 139 (Umpqua Offshore).

2.2.2 Airspace

Southwest Oregon Regional Airport is located in North Bend, near the interface of the Lower and Upper Bays. The areas surrounding the Southwest Oregon Regional Airport are regulated by the Federal Aviation Administration (FAA), who is responsible for making determinations about the appropriate height of buildings, wind turbines, and other potential obstructions in the vicinity of the airport. Figure 7 shows the Federal Aviation Regulation (FAR) Part 77 airspace surfaces associated with regional airports in relation to the FNC. Based on discussions with the FAA Northwest Mountain Region Airport District Office (and in coordination with TotalEnergies SBE US), the following airspace constraints were assumed for this study.

[6] There are two active wave buoys offshore of Coos Bay: CDIP 139 (~30 miles north of Coos Bay entrance) and NDBC 46015 (~50 miles south of Coos Bay entrance). According to Lin and Demirbelik (2018), buoy data from these two sources exhibit very similar wave heights, periods, and directions, so the buoy closer to Coos Bay (CDIP 139) was selected as the basis of wave information for this study.

Resulting Study Assumption: Integration activities (height ~700-1,000ft[7] {210-305m}) should be located outside of the runway approaches (runways 13, 22, and 31), which are shown in red in Figure 7, below. These constraints were applied to this conceptual assessment but will need to be refined in coordination with the FAA and the airport sponsor (Coos County Airport District) as the project develops.

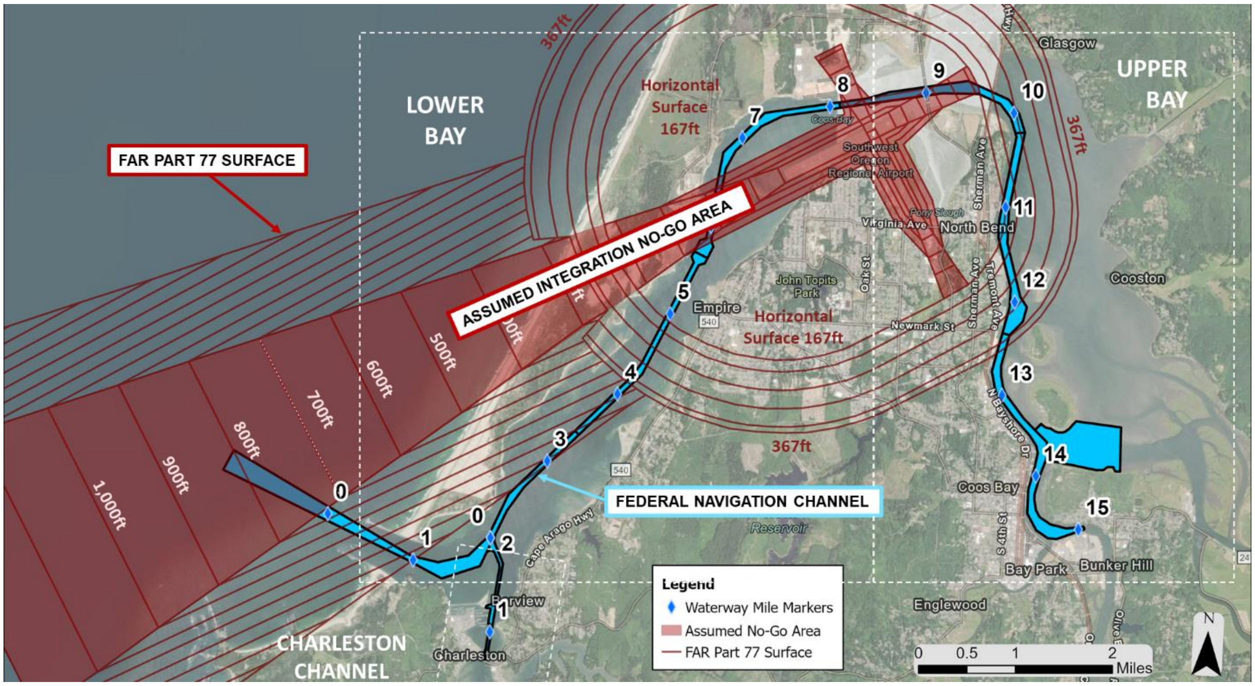


Figure 7. Assumed WTG Integration No-Go Area (red shaded area) based on FAR Part 77 airspace surface. FAR Part 77 surface elevations shown in feet relative to mean sea level.

2.2.3 Bay Bathymetry

The water depths[8] in the bay (outside of the assumed integration no-go area) were reviewed relative to potential integration activities. Review of available water depths relative to conceptual requirements for wet-storage, integration, and commissioning resulted in the following:

- Integration and Commissioning: If airspace restrictions are more limiting than those assumed in this study, vessel/barge-based integration within the protected waters of Coos Bay may be a possible alternative to quayside integration. Review of existing elevations indicated that the depths needed for vessel or barge-based integration are not available outside of the FNC. Significant dredging would be required to facilitate vessel or barge-based integration.
- Wet-storage: Wet-storage areas may be needed for floating foundations (prior to integration) or integrated WTGs (prior to tow-out). Based on review of existing elevations, the depths outside of the FNC are likely not able to support wet storage for foundations or integrated devices without dredging.

Resulting Study Assumption: This study assumes integration will be conducted quayside. Wet storage assumed to utilize existing underutilized berths in the harbor, or new mooring locations along the shoreline, rather than dredging a new wet-storage field elsewhere in the bay.

[7] The range of heights during integration represent the range of WTG geometries provided in Table 2 and the range of heights due to rotation of the blades (e.g. max height when one blade is pointed up; min height when one blade is facing down).

[8] Project basemap was developed by compiling elevation data from the following public sources: Coos Bay Entrance to Coos River Topobathy Survey (USACE, 2014); Port Orchard 1/3 arc second DEM (NOAA, 2008); and USACE Hydrograhic Condition Survey Data (USACE, 2021).

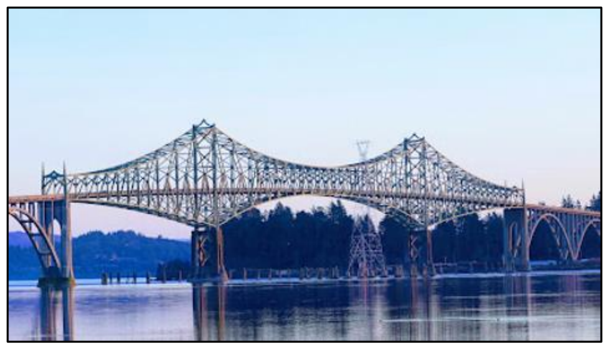
2.2.4 Coos Bay Navigation Infrastructure

This section summarizes existing (and proposed) navigation infrastructure & conditions within Coos Bay. For the purpose of this assessment, the section of the channel upstream of the two bridges near river mile (RM) 9 will be referred to as the **Upper Bay**, and the portion of the channel downstream of the bridges will be referred to as **Lower Bay** (see Figure 8). Together, the Upper and Lower Bays make up the Inner Channel. The Inner Channel provides navigable access to marine terminal facilities within Coos Bay. The Entrance Channel (see Figure 8) provides a navigable pathway from the Pacific Ocean into the sheltered waters of the bay.

2.2.4.1 Bridges

The horizontal constraints and air draft limitations imposed by the two bridges located near RM9 are summarized in Table 3.

Table 3. Coos Bay Bridges

Railroad Swing Bridge	**McCullough Memorial Fixed Bridge**
Horizontal Clearance: 197ft (60m) Vertical Clearance: NA	Horizontal Clearance: 515ft (155m) Vertical Clearance: 123ft (38m) at edge of FNC; 150ft (45m) at center of FNC
 Image Source: The World Newspaper	 Image Source: Frank Murphy

Resulting Study Approach: The horizontal and vertical clearances of the bridges near RM9 will be incorporated into navigation screening criteria to determine which types of FOW activities may occur in the Upper Bay.

2.2.4.2 Federal Navigation Channels

Current & Historic Use: The current & historic use of the Coos Bay FNCs is primarily for serving the wood chips, logs, lumber, plywood, and paper products industries. The existing navigation channel in the Lower Bay (west of bridges) was designed to accommodate a wood chip vessel with the following geometry: overall length of 680ft (207m), Beam of 106ft (32m), and draft of 38ft (12m). The Upper Bay design vessel is smaller, with an overall length of 520-600ft (158-183m) and a beam of 70-85ft (21-26m) (USACE, 1994).

Over the past few decades, the Port of Coos Bay has seen an increase in the size of deep draft vessels calling on Coos Bay terminals, but a steady decrease in the number of vessels calling annually. The number of deep draft vessel calls in Coos Bay has decreased from ~300 vessels/year in 1990 to ~50 vessels/year in 2016, which is about one vessel per week (Coos Bay Harbor Safety Committee, 2018).

Existing & Proposed Geometry: Our understanding of existing and proposed navigation infrastructure (as part of the Coos Bay Channel Modification project) is summarized in Table 4. Figure 8 shows the location of the channel segments within Coos Bay.

The proposed channel dimensions in Table 4 are associated with the Coos Bay Channel Modification project, which has been ongoing since 2006 when opportunities for channel modification were first explored and preliminary engineering studies were initiated. A number of approvals and permits still need to be secured before the project can move forward (Port of Coos Bay, 2020). At the time of this report, the Port estimates that permit approval is a minimum of 2 years away. The USACE is currently preparing an environmental impact statement to evaluate potential effects of the proposed actions.

Table 4. Coos Bay Navigation Infrastructure – Existing and Proposed

Area	Dredging Window [9]	Segment	Existing Authorized Width (ft)	Existing Authorized Depth (ft)	Proposed Authorized Width (ft)	Proposed Authorized Depth (ft)
Entrance Channel	June 15 – Oct. 31	Coos Bay Entrance	300ft (91m)	47ft (14m)	450ft (137m)	NA
Inner Channel: Lower Bay	June 15 – Oct. 31	Coos Bay Ranges	300ft (91m)	37ft (11m)	450ft (137m)	45ft (14m)
		Coos Bay and Empire Ranges	300ft (91m)	37ft (11m)	450ft (137m)	45ft (14m)
		Jarvis Ranges	300ft (91m)	37ft (11m)	450ft[10] (137m)	45ft (14m)
Inner Channel: Upper Bay	July 1– Oct. 31	North Bend Turn	400ft (122m)	37ft (11m)	NA	NA
		North Bend Ranges	400ft (122m)	37ft (11m)	NA	NA
		Ferndale & Marshfield Ranges	400ft (122m)	37ft (11m)	NA	NA

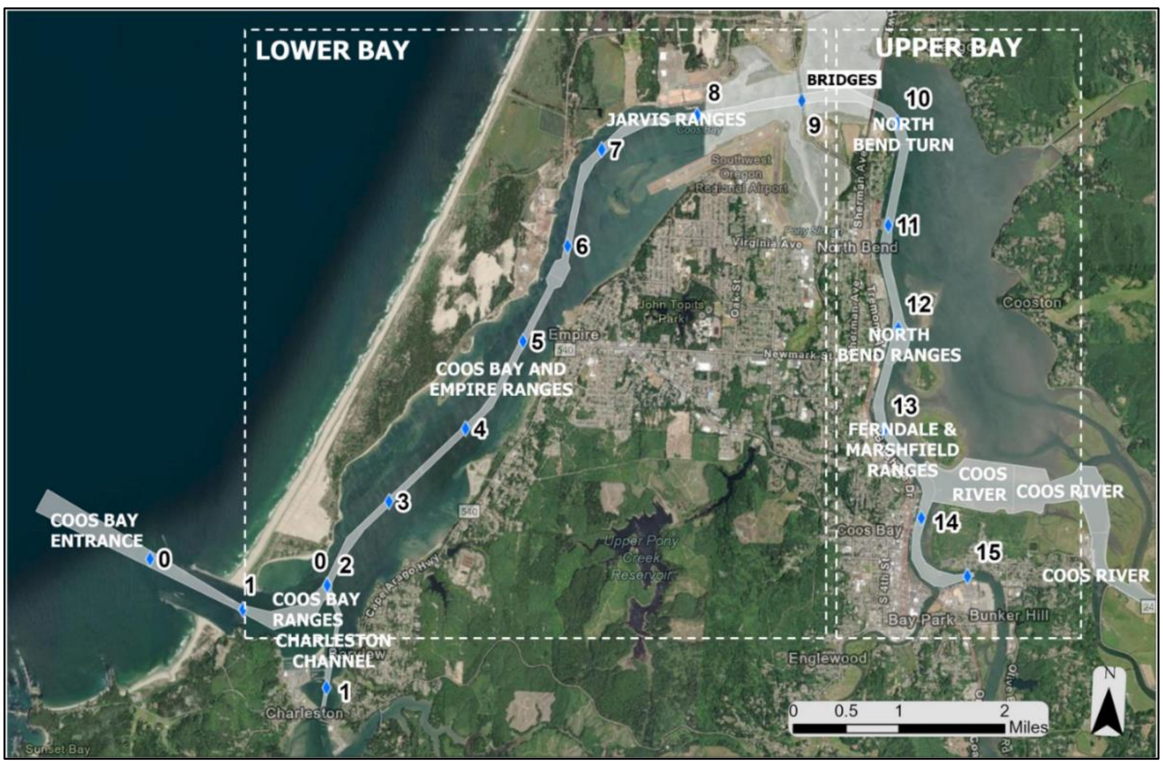


Figure 8. Existing navigation infrastructure; the blue diamonds & corresponding numbers represent river mile (RM) markers.

[9] Dredging windows according to Moffatt and Nichol (2015).

[10] Note that proposed channel modifications (deepening to 45ft and widening to 450ft) will extend to RM 8.2 (~1,000ft east of the Jarvis Ranges boundary). At the time of this report, the authors understand that the final alignment and geometry of proposed navigation channel modifications are not yet finalized.

Resulting Study Approach: Potential for FOW development will be assessed relative to both existing navigation infrastructure & proposed modifications to navigation infrastructure.

2.2.4.3 Weather Restrictions

A brief summary of existing navigation conditions within Coos Bay is provided below based on review of the Coos Bay Harbor Safety Plan (Coos Bay Harbor Safety Committee, 2018) and the Feasibility Study informing the existing channel design (USACE, 1994):

- Weather
  - Strong southerly prevailing winds in summer (25-30kts).
  - Larger ship movements can be affected when winds are greater than 25kts.
  - Region is subject to fog, which can reduce visibility.
- Entrance Channel
  - The Entrance Channel is exposed to high energy Pacific coast swell; calmer wave conditions (smaller Hs) occur during warmer weather months.
  - Max current velocities ~3-3.5kts.
  - It can be dangerous to cross the bar during strong ebb currents or during periods of high river discharge due to wave-current interaction.
  - Most favorable to pass through Entrance Channel towards the end of the flood tide (right before high water slack).
  - The bar is closed to deep draft vessels ~3-10 days each year due to weather.
- Bridges (~RM9)
  - Delays in deep draft vessel navigation past the bridges near RM9 have occurred, typically when visibility is limited (at night or during adverse weather/fog)

Resulting Study Approach: Towing large floating foundations presents a new channel use relative to current and historic operations. The Entrance Channel is more exposed than the Inner Channel; navigation capabilities should be assessed separately with specific criteria for each.

2.2.4.4 Dredging Operations

The USACE conducts annual maintenance dredging within Coos Bay to restore authorized depths within the FNCs.

Schedule: Dredging within each area of the bay occurs within the authorized regulatory window, typically during the warmer weather months (see Table 4) and should be a consideration for assessing marshalling activities in the Entrance Channel.

2.2.5 Coos Bay Marine Terminal Infrastructure

The Port of Coos Bay owns more than 1,000 acres (405 hectare) of land on the North Spit area. Port jurisdiction currently includes seventeen terminals, five of which are located seaward of the two bridges (Railroad Swing Bridge and McCullough Memorial Fixed Bridge). Port facilities have access to U.S. Hwy 101 and Class 3 rail network. A rail spur runs down the west bank of the bay. Helipad infrastructure can be found nearby at the Southwest Oregon Regional Airport (Porter & Philips, 2016).

Mott MacDonald has compiled a Marine Terminal Facility Database, summarizing the key parameters associated with existing facilities within Coos Bay. The database, provided in Appendix A, is based on public information, the Port of Coos Bay's *Terminals and Docks* dataset, information provided by the South Coast Development Council, and information contained within the *Project Blue Coos Bay site tour information.pdf,* provided by TotalEnergies SBE US.

2.3 Port Infrastructure Study Assumptions & Exclusions

This port infrastructure study was based on the following project assumptions:

- Port infrastructure upgrades were developed at a pre-feasibility assessment level.
- The study was based on prior project experience, publicly available information, and information made available by the Port and TotalEnergies SBE US. Existing conditions database is limited to relevant/specific characteristics only and based on readily available public information; not intended to be comprehensive.
- Technology developments may allow for differences in WTG and substructure designs and additional efficiencies in integration, deployment, and maintenance beyond the level considered in this study.
- The navigation assessment was conducted at a conceptual level only; device-specific maneuverability and other operational details were not included and will need to be investigated at a later project phase.
- Environmental and regulatory considerations were not investigated as part of this work; however the presence of eelgrass and snowy plover sensitive areas were considered based on publicly available GIS datasets.
- Study Exclusions:
  - Potential upgrades to port/harbors outside of Coos Bay were not developed.
  - Numerical metocean modeling or vessel simulation were not completed as part of this study.
  - Detailed condition assessments, inspections, surveys, and detailed geotechnical and structural analysis were not part of this work.
  - Bathymetry data was compiled from publicly available information only.
  - Decommissioning was not assessed within this study.
  - Disposal options for dredged material were not assessed as part of this study; open-water disposal was assumed for cost estimating purposes.
  - Vessel space use conflicts were not assessed (e.g., existing vessel traffic relative to potential FOW fleet).
  - Assessment of specific equipment needs (such as crane lifts) not included as part of this scope of work. Specific equipment selections may affect infrastructure requirements.
  - Detailed construction schedules were not developed.
  - Phased construction options and considerations not included at this stage.

3 Navigation Infrastructure

While fixed FOW turbines are often integrated offshore, FOW turbines in the Pacific need to be integrated in port at a marshalling facility due to sea state conditions and equipment limitations in deep water. A FOW port must provide navigable access for support vessels, foundations, and integrated devices. Channel geometry may impose limitations on the times and durations when the channel can be used safely for various device geometries and vessels. A navigation assessment was conducted to assess the capability of existing and proposed FNCs within Coos Bay to support safe and efficient installation of an FOW farm and to assess the need for potential geometric or operational modifications to the FNC to meet a range of potential floating foundation geometries.

3.1 Approach

The conceptual-level navigation assessment was conducted to evaluate the capabilities and challenges of supporting the following activities:

- **Component transport**: breakbulk carriers, cargo vessels, barges, or other vessels used for delivery or transport of manufactured components
- **Tow-out and installation**: floating devices, anchor handling vessels (AHVs), harbor tugs
- **Substructure delivery:** specialty vessels such as heavy lift vessels, semisubmersible vessels/barges, etc.
- **O&M**: CTVs and SOVs

The existing navigation conditions were characterized by collecting information related to the authorized FNC dimensions, shoaling patterns, maintenance dredging practice, current vessel operations, and local regulations and safety guidance. Requirements for the Entrance Channel and Inner Channel were evaluated separately with consideration for environmental conditions, authorized channel dimensions, shoaling, maintenance dredging schedule, and vessel/device maneuverability. The estimated requirements were then compared to existing navigation conditions within the bay to evaluate the capabilities of the existing channels and the need for upgrades. For this study, it is assumed that the required US-Flagged vessels are available, which include ocean tugs, harbor tugs, anchor handling vessels (AHVs), breakbulk carriers, and deck barges. Findings are relative to the vessels provided in the BOEM 2016-011's potential vessel fleet database (Porter & Philips, 2016).

3.2 Navigation Requirements for Floating Foundations

3.2.1 Navigation Criteria

To develop conceptual navigation criteria, various methods (PIANC 2014, USACE 2006, Thoresen 2003) were reviewed, in addition to marine transport contractor outreach[11]. Conceptual channel dimension requirements for accommodating the floating foundations were developed and are summarized in Table 5 and defined in Figure 9. Channel requirements are larger for the Entrance Channel to account for increased exposure to environmental conditions. Actual requirements for channel depth and width need to be considered for each specific foundation technology.

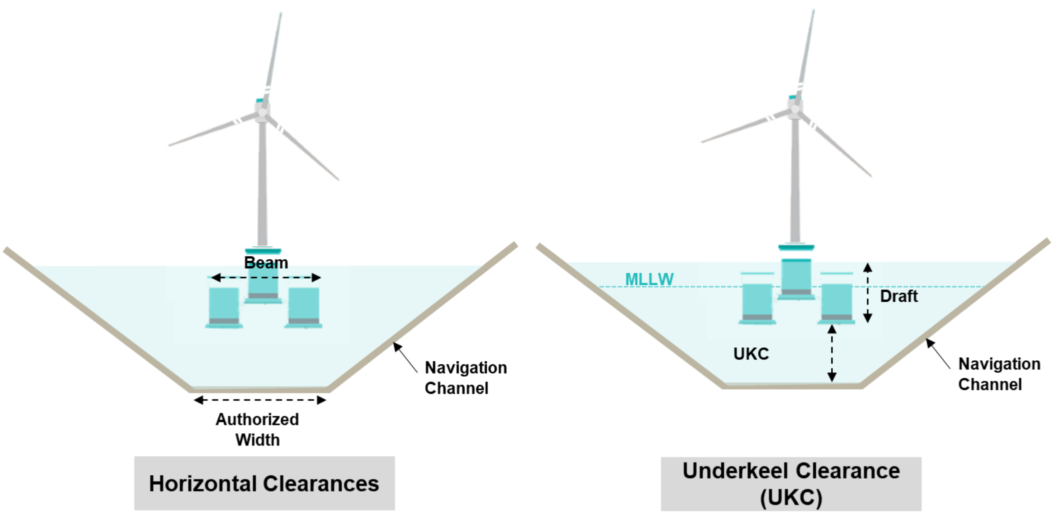


Figure 9. Definitions: Navigation Clearances

Table 5. Navigation Assessment Criteria

Parameter	Inner Channel	Entrance Channel
Width to Beam Multiplier	1.5x-3.0x	2.0x-3.5x
Underkeel Clearance	5-9+ft. (1.5-2.7+ m)	10-15+ft. (3-4.5+ m)
Design Tide (Towing)	MHW[12]	MHW

3.2.2 Navigation Assessment Findings

The navigation criteria for foundations were compared to the available and planned infrastructure to assess potential constraints. Due to beam limitations relative to horizontal clearances, the floating devices (Type A and Type B) are not able to navigate through the Upper Bay. The estimated maximum foundation dimensions which may be able to safely navigate through the existing and proposed Lower Bay channels are provided in Table 6. Estimated channel modifications (in addition to the proposed modifications) that may be needed to accommodate the parameterized foundation types are summarized in Table 7.

[11] Navigation channel requirements are less certain for emerging industries such as FOW than for typical commercial navigation and will vary for specific technologies. Therefore, a range of potential channel requirements was developed.

[12] MHW is approximately 7ft MLLW, according to NOAA Station 943279 at Charleston.

Table 6. Estimated potential maximum foundation dimensions.

Channel Conditions	Estimated Maximum Draft	Estimated Maximum Width
Existing FNC Dimensions	39ft (12m)	200ft (61m)
Proposed FNC Dimensions	44ft (13m)	250ft (76m)
Proposed FNC Dimensions with localized entrance dredging (widening)	44ft (13m)	300ft (91m)

Table 7. Estimated channel modifications (additional depth or width) potentially needed to accommodate wet-tow of device Type A and Type B.

Parameterized Foundation Geometry	Required Additional Depth (with respect to Proposed dimensions)	Required Additional Width (with respect to Proposed dimensions)
Type A (400ft {122m} beam, 43ft {13m} draft)	Entrance Chanel: 0ft Inner Channel: 0ft	Entrance Channel: 300+ft (91+m) Inner Channel: 150+ft (46+m)
Type B (200ft {61m} beam, 25ft {7.5m} draft)	Entrance Channel: 0ft Inner Channel: 0ft	Entrance Channel: 0-250ft (0-76m) Inner Channel: 0-150ft (0-46m)

The navigation assessment findings for towing floating devices through the Inner and Entrance Channels are summarized below:

- **Existing Navigation Channel**: The existing channel can potentially support FOW integration activities for the smaller size range of foundations (potentially ~200ft {61m} beam or less), but throughput may be limited due to tighter horizontal clearances. Smaller foundations may limit the WTG rating and require deployment of more units to meet the targeted annual throughput. Deepening is not likely to be required for towing, but localized deepening may be needed for delivery of foundations and tow-out will be limited to higher water levels.
- **Proposed Navigation Channel**: With the proposed improvements, the modified channel will be able to accommodate a larger device (potentially ~250ft {76m} beam).
- **Further Channel Improvements**: To accommodate the larger sizes of floating foundations (up to 400ft {122m} beam), further widening beyond the planned improvements in the Entrance Channel and the Inner Channel is very likely needed. A wider Entrance Channel and Inner Channel – beyond the existing planned improvements - would benefit tow-out for the smaller floating foundations as well. Numerical modeling and simulations will be needed to verify go/no-go criteria and the effect on throughput.
  - Additional channel widening will be subject to a number of permit requirements and will require coordination with the USACE and US Coast Guard (USCG). Channel modifications may either be pursued through congressional actions or through a local sponsor and may be on the order of 5-10 years.
- **Operations**: Winter shoaling may lead to downtime earlier in the installation season, before dredging occurs to restore navigable depths. There could be conflicts between tow-out and dredging activities in the channel during WTG installation without a change to the maintenance dredging schedule.

3.2.2.1 Alternative Tow-Out Methods

Tow-out through the channel may be possible for devices that exceed the dimensions listed in Table 6 through an alternative transit solution, such as a dry-tow on a semi-submersible vessel (see Figure 10). The channel geometry requirements for a wet-tow depend on the dimensions of the floating foundation, whereas the channel geometry requirements for a dry-tow depend on the dimensions of the vessel (typically narrower beam). The fully assembled floating foundation could theoretically be rolled onto a semi-submersible vessel in the harbor and transported offshore to be "floated" off. This operation would be sensitive to wave climate offshore and would need further investigation. Determining whether this alternative solution is feasible is highly dependent on the device specifics, offshore wave conditions, and port infrastructure and would need to be investigated further at a later stage of the Project.

Figure 10. Example of wet-tow of an integrated unit (left) and dry-tow of a floating foundation (right). Source: Boskalis.

3.3 Navigation Requirements for Support Vessels

The focus of the navigation assessment was on constraints for floating foundations, due to their unique geometry and the change in channel use relative to current operations in the Bay. A brief summary of the limitations for FOW support vessel navigation in Coos Bay is provided below.

- **Component Transport Vessels**: Component transport vessels are similar to historical vessel use and can safely navigate the Coos Bay FNCs. Navigation for deep draft vessels may be limited to higher water levels and/or favorable weather conditions. The size of vessel than can transit into the Upper Bay may be limited by horizontal and vertical bridge clearances and the size of available turning basins[13].
- **AHVs and Harbor Tugs:** The FNCs of the Upper and Lower Bay can likely accommodate AHVs and harbor tugs.
- **Substructure Delivery & Launching:** The size and geometry of specialty vessels for foundation delivery or launching spans a wide range. The existing/proposed Lower Bay can accommodate these types of vessels up to a certain size, but limitations for safe navigation will need to be assessed for each specific vessel. Substructure delivery and launching activities will be limited to high tide.
- **O&M:** The Coos Bay FNCs can accommodate CTVs and SOVs in the Upper and Lower Bay, although the size of SOVs able to transit into the Upper Bay or Charleston Channel may be limited.
- **Vessel Availability:** Since FOW specific vessel fleets do not yet exist in the U.S., the availability of various vessel types may vary, depending on future technology development. In general, towing vessels & expertise are available in the Pacific Northwest & U.S. West Coast. Some specialty vessels may need to be mobilized from outside of the west coast (e.g. AHVs). Depending on how foundations are delivered or launched on site, a purpose-built submersible barge may be needed. For the dry-tow of an integrated device (the alternate method described in Section 3.2.2.1), a Jones Act vessel may be needed & could require a new build. For further information on vessel availability on the U.S. West Coast, please refer to Section 7.2 of BOEM Report 2016-011 (Porter & Phillips, 2016).

[13] USACE (2006) recommends a turning basin radius that is at a minimum 1.2X the length of the vessel, in areas of low currents.

4 Marine Terminal Screening

Preliminary site screening was conducted to focus the assessment on certain geographic areas within Coos Bay for serving specific FOW functions. In addition to the existing marine terminals within the bay, greenfield sites and vacant lots were also included within the site screening. The site screening assessment for large facilities (integration, fabrication/assembly, and component manufacturing) is summarized in Section 4.1 and the regional screening for an O&M base is presented in Section 4.2.

4.1 Large Facilities Screening

4.1.1 Existing Marine Terminal Infrastructure

A summary of existing marine terminal facilities in Coos Bay is provided in Appendix A Marine Terminal Database.

4.1.2 Preliminary Screening Criteria

The high-level screening criteria below (Table 8) was applied to identify sites that may meet the basic requirements for FOW facility development. The criteria were not developed to indicate feasibility and is focused on inherent site characteristics that are less likely to be modified.

Table 8. Preliminary Screening Criteria – Large Facilities

<table>
<tr><th></th><th>Wharf or shoreline length</th><th>Navigation</th><th>Upland/ Quayside Area</th><th>Distance from FNC</th><th>Airspace Restrictions</th><th>Development & Current Use</th></tr>
<tr><td>Integration Facility</td><td>1,000-1,600ft (305-488m)</td><td>Downstream of bridges (Air Draft and Horizontal Clearance)</td><td>>25-50 acres (10-20 hectare)</td><td>250-500ft (76-152m)</td><td>Integration outside runway approaches (see Figure 7).</td><td rowspan="3">Considerations:
Port-owned vs. privately owned
Greenfield/ vacant lots vs. active terminals</td></tr>
<tr><td>Fabrication Facility</td><td>1,000ft (305m)</td><td>Downstream of bridges (Air Draft and Horizontal Clearance)</td><td>>60-100 acres (24-40 hectare)</td><td>250-500ft (76-152m)</td><td>>200-400ft (61-122m)</td></tr>
<tr><td>WTG Component Manufacturing</td><td>1,000ft (305m)</td><td>~120ft (37m) Width
~20ft (6m) Depth
Sufficient turning basin (~700ft / 213m)</td><td>>100 acres (40 hectare)</td><td>-</td><td>-</td></tr>
</table>

4.1.3 Screening Results

The preliminary screening criteria was compared to the site characteristics at existing marine terminals within the Initial Study Area. The facilities screened for each type of activity are summarized in Figure 11 below. These areas are assessed as likely meeting the most basic/minimal requirements for consideration for FOW site development. Following the technical screening, the project team solicited input on the screened locations from the Port and the South Coast Development Council, which is summarized in Table 9. Through consideration of the technical screening results, stakeholder input and apparent (non-exhaustive) environmental considerations, Mott MacDonald coordinated with TotalEnergies SBE US to select Jordan Cove West, Roseburg Coos Bay Shipping Terminal (CBST), and Jordan Cove East as the focus areas for further investigation as part of the gap analysis (Section 5.1). Though the other screened locations (e.g., Henderson Marsh or other future port site acquisitions) were not selected for further analysis in this study, they may still be potential development options.

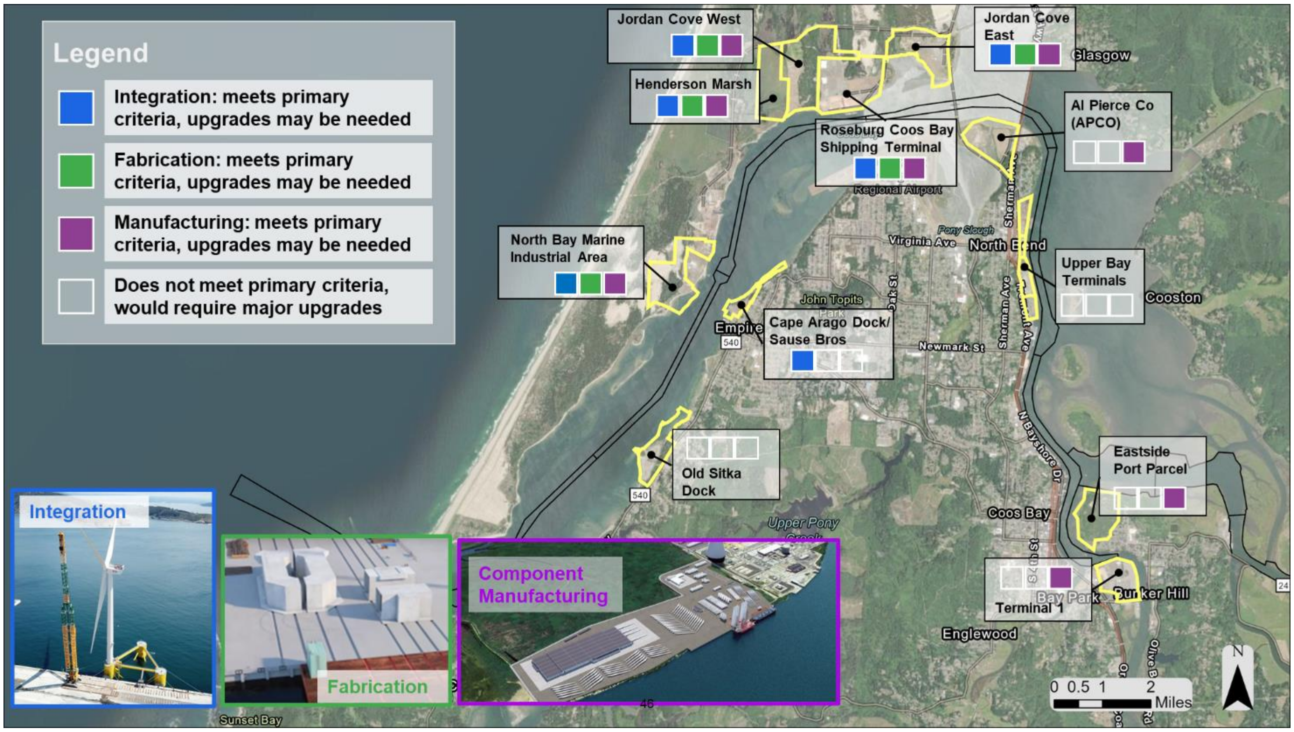


Figure 11. Large facility technical screening assessment results.

Table 9. Large facility site screening summary for integration (I), foundation fabrication (F), and WTG component manufacturing (M).

Terminal	Screening Result	Justification for screening out certain activities	Key Environmental Considerations & Stakeholder Input
North Bay Marine Industrial Area	I, F, M	-	Port signed MOU to develop a container terminal at this location – potentially unavailable.
Old Sitka Dock	-	Upland area is limited.	-
Cape Arago Dock/ Sause Bros	I	Upland area is limited.	May be suitable for wet-storage or commissioning activities with dredging.
Henderson Marsh	I, F, M	-	Majority is a designated wetland; securing a permit for site development may be more challenging than for greenfield or developed sites. May be considered if needed.
Jordan Cove West	I, F, M	-	Availability linked to Jordan Cove LNG Development.
Roseburg CBST	I, F, M	-	Operational, private facility.
Jordan Cove East	I, F, M	-	Availability linked to Jordan Cove LNG Development.
Al Pierce Co (APCO)	M	Navigation - floating foundations cannot navigate upstream of the bridges.	Availability linked to Jordan Cove LNG Development.
Upper Bay Terminals	-	Available parcels too narrow for Large Facility site development.	Includes Ocean Terminals & Ko-Kwel Wharf (see Appendix A); some areas may be suitable for O&M Base, pending further analysis.
Eastside Port Parcel	M	Navigation - floating foundations cannot navigate upstream of the bridges.	Some wetlands within property, but ~70-80% developable; zoning changes may be needed for development; most of property is zoned as light density residential; could be difficult to rezone through the City of Coos Bay planning commission, as the community is in need of developable residential ground.
Terminal 1	M	Navigation - floating foundations cannot navigate upstream of the bridges.	Port of Coos Bay intends to purchase this property.

4.2 O&M Base Screening

A regional navigation screening assessment was conducted to identify potential harbors/channels that provide navigable access for both CTVs and SOVs. Within Coos Bay, the Upper Bay, Lower Bay, and Charleston Channel navigation channel geometries were reviewed. Outside of Coos Bay, navigation conditions within Reedsport, Winchester Bay, Bandon, and Florence were reviewed. The assumed geometry of the O&M support vessels & the associated navigation criteria used for preliminary screening is summarized in Table 1.

Table 10. O&M Base Navigation Screening Criteria

Vessel	Assumed Geometry	Required Channel Geometry
CTV	Draft ~8ft (2.4m) Beam ~30ft (9.1m)	Depth ~10-12ft (3.1-3.7m) Width ~35-90ft (10.7-27.4m)
SOV	Draft ~20ft (6.1m) Beam ~75ft (22.3m)	Depth ~20-23ft (6.1-7.0m) Width ~150-225ft (45.7-68.6m)

The findings of the O&M navigation screening assessment are summarized below:

- Of the harbors considered, Coos Bay offers the most favorable conditions for navigation of both CTVs and SOVs.
  - Within Coos Bay, both the Upper and Lower Bays may be able to support an O&M base, but depending on the frequency of vessel transit, navigation past the bridges into the Upper Bay may constrain the size of SOVs employed.
  - Charleston Channel may be able to accommodate smaller SOVs.
- Reedsport and Florence may also be able to support an SOV/CTV base, depending on the SOV vessel specifics.

5 Marine Terminal Infrastructure

5.1 Integration Facility

This section summarizes the assessment of existing facilities at Jordan Cove West, Roseburg CBST, and Jordan Cove East relative to requirements for a FOW integration facility.

5.1.1 Throughput Assessment

To develop a range of integration facility requirements, a throughput assessment was conducted to estimate the potential throughput that can be achieved for a given number of berths & upland storage area. The sensitivities of various WTG ratings, and construction timings were also assessed. It was assumed that the storage yard is full of components at the start of the installation season, and that vessel deliveries are only needed to replenish components once integration has begun.

Table 11 includes the three following example development scenarios:

a. One FOW project at a time, limited shoreline – less shoreline length (# of berths) needed, but more upland area needed to meet throughput similar to example B; relative to example B, more components are delivered and stored prior to the installation season, which frees up berth space for assembly & commissioning activities during the favorable weather months. A concept schematic for this example scenario is provided in Figure 13, and a 3D rendering is shown in Figure 14.
b. One FOW project at a time, limited upland area – more shoreline length needed (# of berths), and less upland area needed to meet similar throughput to example A; more frequent vessel deliveries are needed throughout the installation season to replenish the storage yard with WTG components.
c. Two FOW projects at a time – conceptual scenario to demonstrate the scale of site development needed to accommodate two simultaneous wind farm installations; larger facilities may be needed to meet more aggressive goals for FOW development[14]. A concept schematic for this example scenario is provided in Figure 13.

Specific integration facility requirements will depend on the project throughput targets (size and number of wind farm installations), the WTG rating, results of the metocean downtime assessment, and WTG integration timelines & OEM preferences. The three development scenarios shown in Table 11 do not capture all possible port layout configurations (e.g., for smaller WTG ratings, 3 commissioning berths may be needed to meet throughput targets) and are only intended to provide a few examples of marine terminal requirements and the associated range of throughput that may be possible for a given configuration. Actual marine terminal requirements will need to be refined as project details develop.

A wide range of throughput potential is provided for each example marine terminal configuration. The ranges of throughput potential in Table 11 are representative of various WTG ratings (10, 15, 20MW) and construction timing (3-5 days for integration, 6-10 days for commissioning) assumptions. In general:

- The lower range of throughput potential for a given port layout represents a lower WTG rating (10MW) and longer construction timings (5 days for integration, 10 days for commissioning).
- The higher range of throughput potential for a given port layout represents a higher WTG rating (20MW) and shorter construction timings (3 days for integration, 6 days for commissioning).

[14] As of the date of this report, Oregon's state goals for FOW development include 3GW of installations by 2030.

Table 11. Example marine terminal configurations & associated throughput scenarios.

Example Development Scenario	High-Capacity Heavy Lift Berths	Lighter-Capacity Commissioning Berths	Conceptual Component Storage Yard Size	Example Throughput Potential Range (MW/year)	Example Parameters				
A. One project, limited shoreline	2	1	Large ~80ac (30ha)	250-700MW	WTG Rating	Integration Duration (Days)	Commissioning Duration (days)	No. Units Deployed per Year	Throughput Potential (MW/year)
					10MW	5	10	25	250 (Low)
					15MW	3-5	6-10	22-35	330-525 (Mid)
					20MW	3	6	35	700 (High)
B. One project, limited upland area	2	2	Small ~50 ac (20ha)	300-900MW	WTG Rating	Integration Duration (Days)	Commissioning Duration (days)	No. Units Deployed/ year	Throughput Potential (MW/year)
					10MW	5	10	32	320 (Low)
					15MW	3-5	6-10	29-49	435-735 (Mid)
					20MW	3	6	46	920 (High)
C. Two projects	4	2	Very Large ~150 ac (60ha)	500-1,500MW	WTG Rating	Integration Duration (Days)	Commissioning Duration (days)	No. Units Deployed/ year	Throughput Potential (MW/year)
					10MW	5	10	50	500 (Low)
					15MW	3-5	6-10	48-73	720-1,095 (Mid)
					20MW	3	6	72	1,440 (High)

Throughput Assessment Outcome: The throughput assessment indicates that a given throughput can be met for various combinations of marine terminal shoreline lengths (number of berths) & upland areas (storage yard capacities). Therefore, the gap analysis will be conducted based on a range of potential marine terminal requirements, as the exact shoreline length and upland area needed will depend on project specifics.

5.1.2 Marine Terminal Capability Gap Analysis

Based on the results of the screening assessment and coordination with TotalEnergies SBE US, the Port, and the South Coast Development Council, the north areas of the bay (Jordan Cove West, Roseburg CBST, and Jordan Cove East sites) were selected for further investigation as part of the gap analysis. Figure 12 and Table 12 summarize the existing conditions at the three sites.

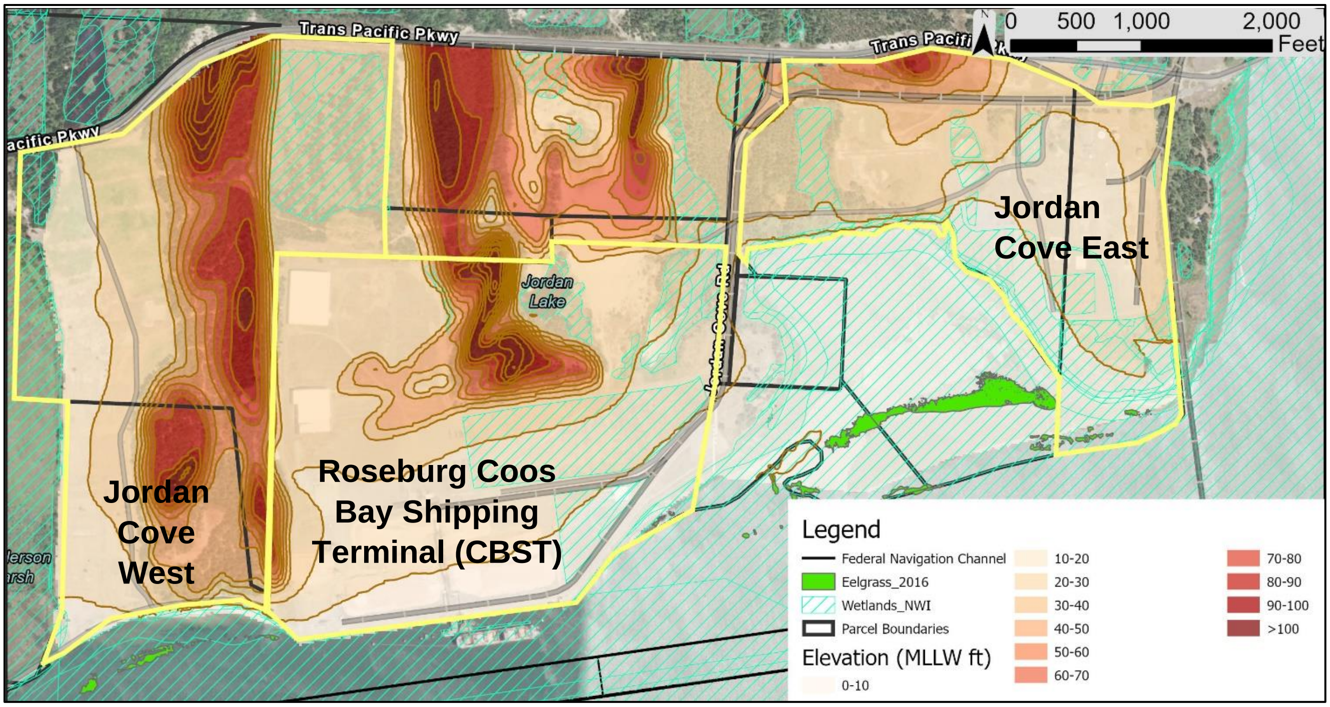


Figure 12. Wetland distribution (Howards, et. al, 2019), eelgrass distribution (Clinton, et. al., 2007) and upland elevations for integration facility focus area.

Concept requirements for an integration facility were developed and are summarized in Table 13. Relative to the preliminary screening criteria (Table 8) that were applied earlier in the study to focus the assessment on certain areas within Coos Bay, the more detailed requirements summarized in Table 13 were developed to identify specific upgrades needed at existing facilities. The conceptual integration facility requirements were compared to the existing conditions within the integration focus area. Gaps in existing Coos Bay facilities relative to the conceptual requirements for integration are summarized in Table 14, with further detail provided in Section 5.1.3.

Table 12. Existing Conditions – Integration Focus Area

Element	Jordan Cove West	Roseburg CBST	Jordan Cove East
Nearshore/Berth Depths	No existing berth Nearshore elevations ~10ft (3m) MLLW	Berth Depth: 40ft (12m) MLLW Berth Length: 1,000ft (305m) berth + dolphins	No existing berth Intertidal flats (~0ft MLLW)
Total Shoreline Length	1,700ft (518m)	3,500ft (1,067m)	3,500+ft (1,067+m)
Wharf Geometry	N/A	1 berth; 260ft (79m) wharf & ~450ft (137m) access pier	N/A
Wharf Live Load Capacity	N/A	Timber Pile Dock, assumed 500psf (2T/m^2)	N/A
Yard Area	200ac (81ha)	125ac (51ha) developed, 200ac (81ha) total	50ac (20ha) developed, 160ac (65ha) total in parcel
Yard Elevations (MLLW)	Low: 4ft (1.2m) Highest: 155ft (47m); Avg: 36ft (10.9m)	Low: 2ft (0.6m) Highest: 14ft (4.2m); Avg: 37ft (11.3m)	Low: 2ft (0.6m) Highest: 87ft (26m); Avg: 15ft (4.6m)
Ground Conditions	No developed land. forest/woodland	Developed land, dunelands	Intertidal flats, dunelands, developed land
Geotechnical	Focus area appears to be underlain by loose hydraulic fill sand (0-20ft {0-6m} thick); very dense dune and natural sand deposit (50-140ft {15-43m} thick); transitioning to gravel at lower depths & weathered sandstone rock (at depths between 70-150ft {21-46m} below ground surface). A layer of peat may be encountered in some areas between the loose and dense sand deposits.		
Seismic Considerations	Focus area is in highly active seismic region with high liquefaction potential. Area is prone to landslides and global slope instability.		
Environmental Considerations	Eelgrass seawards of shoreline Wetlands present on landwards end of site (~20% of site)	Eelgrass not documented Wetlands present on eastern side of site (~20% of site)	Eelgrass seawards of shoreline Wetlands present on seawards end of site (~30% of site)
Existing Upland Infrastructure	-	85,000ft^2 (7,900m^2) warehouse, 120,000ft^2 (11,000m^2) warehouse, 2,000ft^2 (200m^2) office, 10,000ft^2 (1,000m^2) rail transload facility Chip loader ~200ft (61m) feet tall	
Utilities	Tie ins: raw water, potable water, IWWP, communication lines, electric	Electric, septic, water	Tie ins: potable water, IWWP, communication lines, electric
Current Use	Owned by JCEP, not developed	Owned by Roseburg Forest Products; used for exporting woodchips	Owned by JCEP, operated by Lost Creek Rock Products for timber
Roadway/Rail Access	Adjacent to transpacific parkway. 4 minutes from Highway 101. Coos Bay Rail Line adjacent northern boundary.	Located on Jordan Cove Road and accessed via transpacific parkway. 4 minutes from Highway 101. Coos Bay Rail Line north spit rail spur on site.	Located on Jordan Cove Road and adjacent to transpacific parkway. 4 minutes from Highway 101. Coos Bay Rail Line on site
Zoning	*CB#6-WD* – Coos Bay Estuary Management Plan #6 Water-Dependent Development Shorelands	*CB#6-WD* – Coos Bay Estuary Management Plan #6 Water-Dependent Development Shorelands	Mix of Industrial and *CB#7-D* – Coos Bay Estuary Management Plan #7 Development Shorelands
Airspace (see Figure 7)	FAR Part 77 Height: 167ft (51m) Outside of assumed Integration No-Go Area.	FAR Part 77 Height: 167ft (51m) East part of site within assumed Integration No-Go Area.	FAR Part 77 Height: 167ft (51m) Outside of assumed Integration No-Go Area.

Table 13. Conceptual Minimum Integration Facility Criteria (to support one project at a time).

Element	Criteria
Berth Dredging Area	• Shoreline Length: 1,000-3,000ft (300-900m) - 2 integration/vessel berths & 0-3 commissioning berths • Berth Depths: 31-49ft (9-15m) (depending on foundation geometry) • Width (offset between berth and FNC boundary): 250-500ft[15] (76-152m)
Wet Storage	Wet storage areas are likely needed to store foundations (required depths 26-39ft {8-12m} MLLW) prior to integration or integrated devices (required depths 31-49ft {9-15m} MLLW) prior to tow-out.
Wharf Geometry	• Length: 1,000-1,300ft (300-400m) high capacity wharf; additional commissioning berths not included. • Width: Minimum 150-300ft (50-100m) dockside width • Elevation: Minimum ~12-16ft (3.7-4.9m) MLLW[16]
Wharf Live Load Capacity	• Component Delivery, Storage & Staging: 3,000-4,000psf (15-20 T/m^2) • WTG Integration (heavy lift operations, crawler or ring crane operation): 4,000-6,000+psf (20-30+T/m^2); Note: bearing capacity requirements are increasing with device size.
Other Considerations	• Environmental: Overwater coverage of sensitive habitats (eelgrass) should be minimized. • Orientation & layout: Wharf layout and location is linked to the Berth Dredging Area and should be designed with consideration for both upland logistics and marine terminal navigation.
Yard Area	70-100+ acres (28-40+ hectare)
Yard Elevation	Needs to be designed to mitigate future flood risk with consideration for sea level rise. Current FEMA Flood Hazard Zone (1% annual chance of inundation) within study zone is 10.5ft-11.5ft (3.2m-3.5m) MLLW.
Yard Bearing Capacity	2000-4000psf (10-20 T/m^2) - concrete or crushed rock surfacing
Yard - Other Considerations	Services, Facilities & Utilities; Land use and noise/lighting impacts.
Airspace	Outside of assumed Integration No-Go Area (see Figure 7).

Table 14. Integration Facility Gap Analysis Summary.

Element	Assessment
Berth Dredging Area	New dredging is required to accommodate integration, vessel, and commissioning berths. The length of shoreline with sufficient offset from the navigation channel in the northern part of the bay is limited.
Wet Storage	There are no areas outside of the FNC with suitable depths for wet storage of foundations or integrated WTGs. Dredging for new wet storage berths is needed.
Integration Wharf	Existing wharf infrastructure does not meet load or geometry requirements. A new high-capacity (4,000-6,000psf {20-30T/m^2}) wharf will be needed.
Integration Yard Size	Areas within Coos Bay provide sufficient upland area for development of an integration facility.
Grading	Upland earthworks are needed to provide a flatter yard surface, depending on final location and port circulation requirements.
Ground Conditions	Ground improvements and grading are required to meet bearing capacity requirements, similar to the proposed Jordan Cove Energy Project.
Yard surface treatment	High-capacity surfacing is required.
Utilities	Site utilities & connections required; level of investment (new versus upgrades to existing utilities) dependent on the location of site development. Stomwater drainage, collection, and treatment may need to be considered. Any site on the north spit (Jordan Cove West, Jordan Cove East, or Roseburg CBST) would need their own wastewater treatment system or septic systems developed since this area is outside of existing sanitary districts. Natural gas lines (if needed) would also need to be extended to the north spit.
Roadway Connections	Access road within the site is needed to link facility to regional roadway network (TransPacific Parkway).
Substructure Delivery	Investment (dredging, lifting solution, bespoke launching system, heavy lift vessel, or other) is needed to facilitate delivery & launching of foundations in Coos Bay (see Section 5.1.3).

[15] The Port Designer's Handbook (Thoresen, 2010) recommends a navigation channel offset (distance between wharfline and FNC boundary) of 1.25 times the beam of a moored vessel, which was applied in this study. The actual offset required between the wharfline and the existing navigation channel may be smaller or larger, pending further analysis of vessel traffic & changes to the FNC alignment/geometry.

[16] Based on application of methods for determining the minimum wharf elevation from USACE (2017) and Thoresen (2010).

5.1.3 Example Site Concept Development

Within the integration focus area in the north of the bay, Jordan Cove West was selected for development of an example site concept and to provide a basis for construction cost estimates. Of the three sites assessed, Jordan Cove West was selected for example concept development to avoid displacing existing operations at Roseburg CBST and to avoid the need for significant dredging/earthworks to provide navigable access to Jordan Cove East. Upon further analysis & consideration of additional factors, a different site may be determined to be more favorable for FOW facility development.

A schematic-level layout was developed to represent Example Development Scenario A (left panel of Figure 13, which also serves as the basis for the construction cost estimate in Section 5.1.5. This example concept includes two multipurpose (integration & vessel) berths, one commissioning berth, and a storage yard of ~80 acres (32 hectare). As described in the throughput assessment (Section 5.1.1), Example Development Scenario A is representative of a case where the available shoreline length is more limited than available upland area. Since this constraint applies within the integration focus area, which has abundant upland space but limited shoreline length, Example Development Scenario A was selected for site concept layout, visualization, & cost estimating. Note that the scenario on the left of Figure 13 can be adjusted to include additional storage yard space and additional commissioning berths to increase throughput.

The schematic of Example Development Scenario C (with facilities for supporting two project buildouts at the same time) is provided to show the scale of facility development needed to support more aggressive throughput rates. For both Example Development Scenarios shown, there are additional refinements and optimizations that should be considered in future phases – these options are only intended to show representative potential development scales.

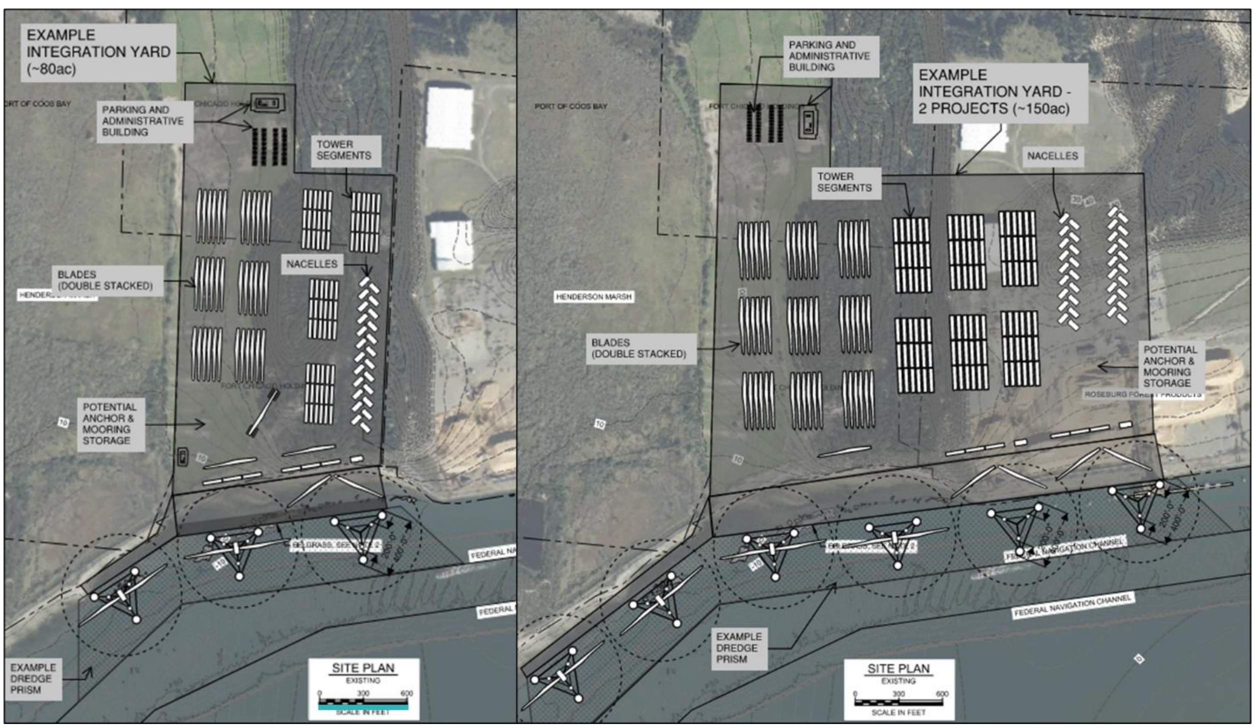


Figure 13. Schematic-level integration site concepts to support one FOW project at a time (Example Development Scenario A, left panel) and two FOW projects at a time (Example Development Scenario C, right panel).

A 3D rendering of Example Development Scenario A was developed and is shown in Figure 14.

Figure 14. 3D rendering of example integration facility concept at the Jordan Cove West site – looking north.

5.1.4 Conceptual Engineering Design Considerations

The following provides considerations for further development & optimization of the schematic level layouts.

- **Location**
  - Habitat: designated wetlands and eelgrass are documented within the focus area based on publicly available datasets (see Figure 12). The location & extent of these habitats will need to be surveyed and confirmed so that site development can be designed to reduce disturbance.
  - Federal Infrastructure: two USACE pile dikes are located near RM7, in front of Henderson Marsh.
  - Other Infrastructure: the existing berth & chip loader at the Roseburg CBST are operational.
  - Airspace: the facility is located outside of the integration no-go area (see Section 2.2.2); height restrictions will need to be coordinated with the FAA and local airport sponsor as the project develops.
- **Berth Dredging**
  - The total number of berths needed (2 assembly/vessel berths & 0-3 commissioning berths) depends on throughput targets, available storage area, downtime risks, and OEM preferences.
  - Location of commissioning berths will be coordinated with stakeholders
    - Location shown (in front of Henderson Marsh) may require removal of existing pile dike.
    - Berth dredging in front of the existing Roseburg CBST property may require stabilization of the upland site (e.g. retaining structure, pile-supported structure, ground improvements, site grading, etc.).
    - Commissioning berths may not need to be located at the integration facility.

  - Depending on the size of foundations & throughput requirements, the integration and/or commissioning berths may need to extend beyond the length of the Jordan Cove West parcel (either west towards Henderson Marsh or east towards the Roseburg CBST berth).
- **Wet Storage:** Dredging may be needed to accommodate wet storage areas; potential areas to consider for wet storage (or commissioning) include Henderson Marsh shoreline, Roseburg CBST shoreline, areas adjacent to the FNC between RM1 and RM5, Cape Arago Dock/Sause Bros, and Old Sitka Dock.
- **Wharf structure considerations:**
  - Given the area's susceptibility to liquefaction & the required bearing capacities of the wharf structure, pile foundations with penetration into the dense sandy gravel bearing layer is a likely option for supporting the wharf. The embedded pile length is estimated to range between 50-100ft (15-30m).
  - As described in Section 2.2.1, integration requires very calm wave conditions. Depending on the results of numerical wave simulations (to be conducted in a future project phase), a sloped revetment beneath the wharf may be considered to dampen wave energy at the berth.
- **Wharf geometry considerations:**
  - Wharf elevation (min ~12-16ft {3.6-4.9m} MLLW) will need to be engineered to mitigate future flooding risk and with consideration for sea level rise & potential tsunami impacts.
  - Wharf length may be ~1,000-1,300ft (305-396m) to accommodate two integration/vessel berths; this wharf length can likely fit within the Jordan Cove West shoreline.
  - Exact positioning of the wharf and berth dredging area will be dependent on the site conditions such as bathymetry, intertidal habitat, side slope stability requirements to dredged berth depth, maintenance dredging requirements, wave conditions, and construction costs.
  - Navigation Channel Offset - the offset between the navigation channel boundary and the wharf should be a minimum of approximately 250-500ft (76-152m), depending on the foundation size (Thoresen, 2013). The example wharfline shown in Figure 13 is likely sufficient for foundations up to a beam of ~350ft (107m). For larger foundations, the wharfline may need to be landwards relative to the wharfline shown in Figure 12, which may require higher excavation and dredging volumes. The required navigation channel offset should be engineered with consideration for existing vessel traffic patterns within the FNC.
- **Yard Development**
  - Yard elevations: the elevations of the yard will need to be engineered to mitigate flooding risk and accommodate future sea level rise; grading is needed to provide a flatter surface for the Jordan Cove West site (see Figure 12 for existing elevations).
  - Surface treatment & ground improvements:
    - Lateral spreading and settlement as the result of liquefaction are the main geotechnical design considerations for the yard area. The loose sand present should be densified through ground improvements to mitigate liquefaction and settlement potential. This aligns with ground improvement plans as part of the Jordan Cove Energy Project.
    - Vibro-compaction with sand is anticipated to be an effective method to improve and stabilize the liquefiable and lateral spreading sand layers. Settlement resulting from ground improvement techniques should be considered in site design.
  - Orientation: The exact orientation may be optimized to limit the requirements for site grading. WTG storage may be further from the shoreline to limit the need for grading and may be refined at a later date.
- **Substructure delivery:** see Section 5.1.6.

- **Demolition & Site Prep**
  - The level of demolition & site preparation needed will depend on the site developed. As Jordan Cove West is a greenfield site, no demolition of existing structures will be required for upland development; however, depending on the number and location of commissioning berths and wet storage areas, removal of existing pile dikes (near Henderson Marsh) or earthworks and stabilization of the Roseburg CBST shoreline may be needed.
  - If pile removal is required, the cost and duration will depend on whether the removal is subject to environmental requirements (e.g., full extraction) or is only a functional requirement. Removal of pile dike structures may require evaluation of impacts to the FNC.
  - If site development extends into the Roseburg CBST site, one option for maintaining existing site use is to install the existing chip loader on rails & use the berth for vessel deliveries and/or integration. The loader could be rolled away from the berth during the FOW installation seasons and rolled back into position afterwards..

5.1.5 Construction Cost Estimates

The costs for constructing an integration facility will vary depending on annual throughput targets, the location of the development, turbine rating, site conditions, environmental considerations, material prices, and other project-specific requirements. Since these details are not yet known, an opinion of planning-level construction costs for port infrastructure upgrades was developed based on an example integration facility development (as shown in Figure 14). Assumptions for the planning level construction cost estimation are provided in Table 15 and were based on Example Development Scenario A in Table 11. Costs were developed according to a Class V level estimate scheme of the Association for the Advancement of Cost Estimating, typically used for concept screening and are provided in Table 16. The Class V estimates have a range of -50% to +100%, and include considerations of changes in scope, site conditions, and market conditions. Estimates were developed based on prior project experience, literature review, and conceptual engineering analysis. Actual costs will vary, depending on the size of the FOW project, annual throughput requirements, results of future site investigations, and other project-specific requirements.

Table 15. Planning-level construction cost estimate assumptions.

Element	Example Parameters - 1 Project
Throughput	250-700MW
Wharf	New ~1,500ft 4,000-6,000 psf integration wharf. New ~750ft 1,000psf commissioning wharf. (New ~460m 20-30T/m^2 integration wharf. New ~230m 5T/m^2 commissioning wharf). Example wharfline location minimizes dredging while providing sufficient navigation channel offset for foundation up to ~350ft (107m) beam. The wharfline may be able to be shifted landwards, which would increase dredging volumes but reduce overwater coverage & new wharf area; this could potentially reduce total construction costs.
Yard	Ground improvements and surface treatment needed for upland site; yard area ~75 acres (30 hectare). A mix of high capacity and medium/low capacity surface treatments required. Includes allowance for drainage, fire suppression, lighting, utilities, curbs, bollards, signage, etc.
Berth Dredging	Berth dredging for 3 berths able to accommodate moorage of integrated WTGs.
Navigation	FNC modifications excluded from cost estimate.
Wet Storage Areas	Dredging needed outside of FNC for wet storage is not included in this cost estimate.

Table 16 - Conceptual Cost Estimate Summary

Element	Conceptual Cost
Mobilization and Demobilization	$25 million
Wharf	$325 million
Yard	$105 million
Berth Dredging	$20 million
Conceptual Estimate Total (limited contingency)	**$475 million**
Range (-50%/+100%)	***$235 million to $950 million***

5.1.6 Construction Schedule Considerations

Construction schedule considerations were developed for the integration facility port infrastructure upgrades. Some typical activities that will impact the construction schedule are listed below. Note that some activities can be conducted in parallel to minimize schedule & fit into in-water construction windows[17]. The total estimated buildout will depend on the location of site development, environmental considerations, and availability to work outside of the typical in-water construction window for Coos Bay.

- Site specific data collection (e.g. topographic and bathymetric surveys, eelgrass survey, geotechnical investigations, etc).
- Preliminary design and permitting – design drawings and permit approval
- Final design and bidding – construction level design and procurement
- Demolition works (if needed) – any existing in-water structures (e.g. pile removal) or upland infrastructure
- Wharf construction – all piles installed first, considering Coos Bay estuary in-water work windows
- Berth dredging – for integration & commissioning
- Wet storage dredging – if needed (unless dry storage is available)
- Integration crane procurement & assembly – may require overseas procurement
- Integration yard grading and ground improvements

Assuming wharf construction is the critical path, the estimated marine terminal construction duration is ~3-5+ years, depending on the final size, orientation, location, and considering typical in-water work window constraints. Construction may potentially be phased to allow for simultaneous construction and wind farm component staging and integration, which would allow part of the facility to be in use prior to the end of construction. The feasibility of this option depends on the throughput needs, construction methodology, and other factors.

Note that navigation channel modifications would be conducted on a different schedule and may require longer lead times.

5.2 Foundation Fabrication Facility & Delivery

To conduct integration within Coos Bay, foundations need to be delivered to site or assembled on-site. The options contemplated for foundation delivery or assembly within Coos Bay are summarized in Figure 16. Though fabrication facility requirements depend on the foundation technology and geometry, it is estimated that at least ~60-100 acres (24-40 hectare) of upland area would be needed, as shown in Figure 16. The 60-100 acre (24-40 hectare) range is intended to capture potential variability of the following factors that will determine the required fabrication yard size:

[17] At the time of this report, the Oregon Department of Fish and Wildlife In-Water Work Window for Coos Bay is October 1st through February 15th.

- Throughput targets (number and size of assembly line(s))
- Foundation technology material (concrete, steel, or hybrid)
- Supply chain considerations (e.g. on-site assembly of imported, pre-assembled elements or on-site fabrication of elements from raw materials).
- Temporary storage requirements (whether assembled foundations are stored upland or in wet storage areas).

Other criteria used to screen potential fabrication sites (see Table 8) include shoreline length, navigable access for floating foundations, and airspace limitations. The Jordan Cove West site has sufficient upland area for both foundation fabrication & integration, but the available shoreline length & width of the parcel near the shoreline is limited. Unless foundations are floated off of a semi-submersible, oceangoing vessel (option A in Figure 16), a high-capacity integration wharf or launching system would need to be constructed outside the bounds of the Jordan Cove West shoreline – waterwards of Henderson Marsh or Roseburg CBST parcels. If fabrication is conducted on-site, part of the adjacent parcels (Henderson Marsh or Roseburg CBST) may need to be secured & upgraded to support fabrication & launching activities.

Site upgrades may include upland grading, ground improvements, paving, construction of a launching system and meeting other technology-specific needs. Examples of launching system infrastructure include:

- High capacity launching wharf together with
  - Lifting system (ring cranes, specialty heavy lift vessel, etc).
  - Submersible vessel or barge
- Slipway & gantry or bridge crane
- Marine railway

Launching within the bay via semi-submersible vessel would likely require dredging to accommodate float-off. Launching activities would need to be timed with higher water levels.

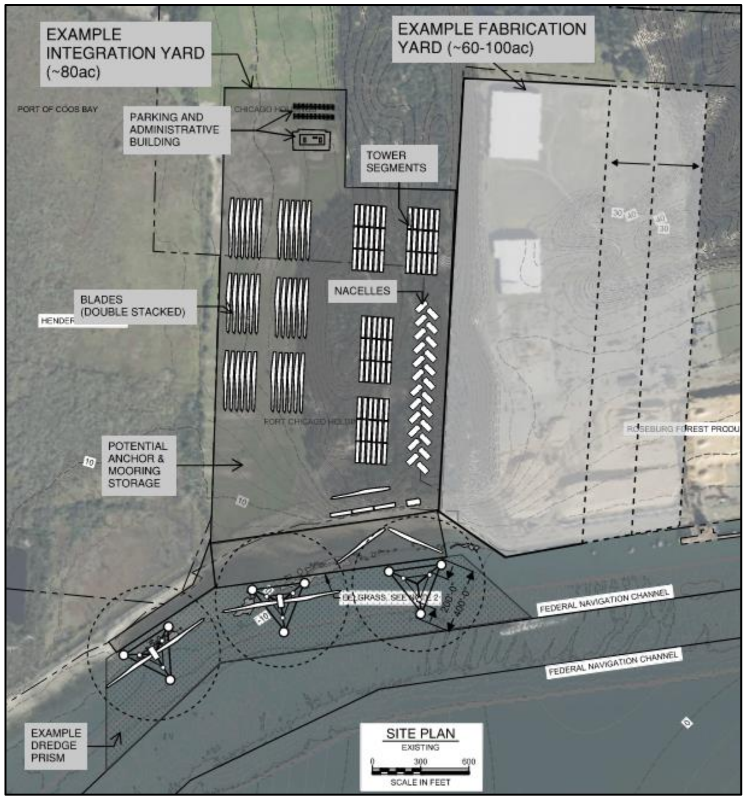


Figure 15. Schematic showing example footprint of integration & fabrication facilities.

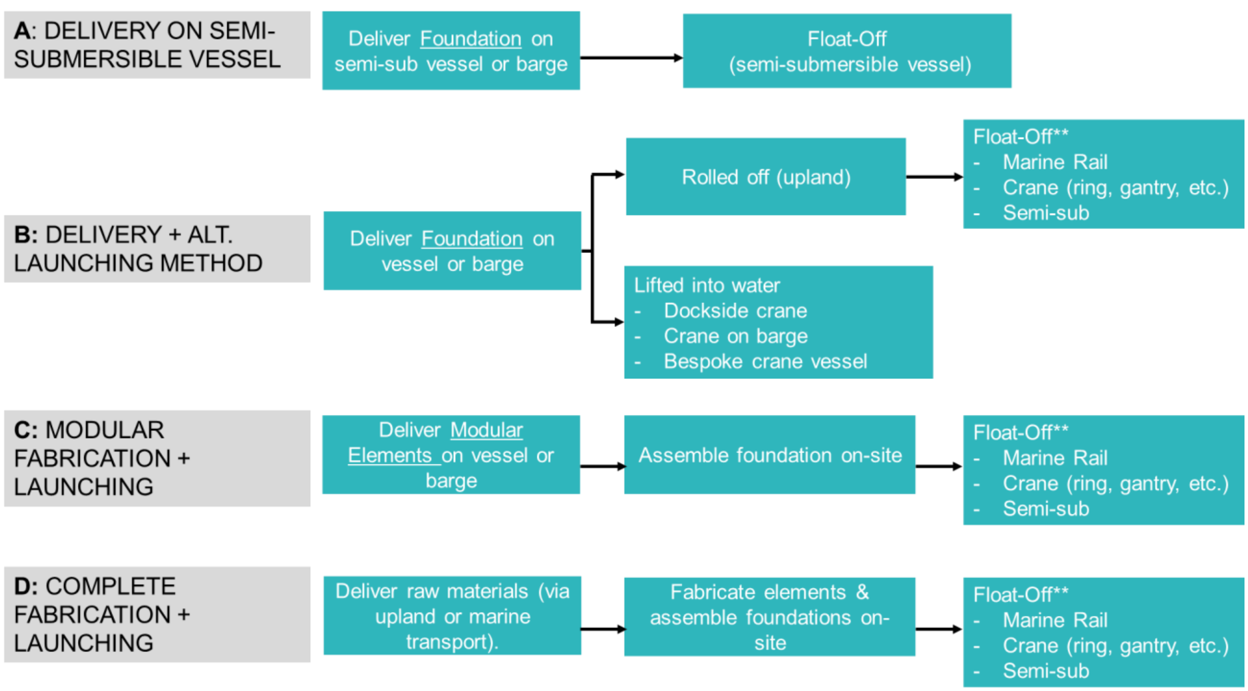


Figure 16. Foundation delivery/assembly options in Coos Bay.

**Note: depending on the fabrication, integration, & launching systems employed, float-off may be conducted for the assembled foundation or for an integrated WTG.

5.3 Component Manufacturing Facility

The screening assessment indicates that there are several facilities that may be capable of supporting component manufacturing facilities in Coos Bay[18], but development potential has not yet been investigated with consideration for supply chain, workforce availability, and site-specific details. The sites screened for potential component manufacturing development locations are located both in the Lower Bay and in the Upper Bay, as manufacturing sites are less restricted by navigation & airspace relative to integration & fabrication. Key screening criteria (Table 8) included sufficient upland area, shoreline length, and navigation access for bulk carriers or other types of vessels that may be used to transport components to other West Coast facilities. A wharf with bearing capacities able to support the loading/unloading of heavy WTG components (approximately 2,000-4,000psf {10-20T/m^2}, depending on the components and transport equipment) is also needed. In the Lower Bay, if the integration focus area sites are not developed as integration facilities, there is sufficient area and shoreline to support a manufacturing facility.

Navigation

The design vessel for the existing Upper Bay FNC had an overall length of 520-600ft (158-183m) and a beam of 70-85ft (21-26m) (USACE. 1994), which is similar to the smaller end of component transport breakbulk carriers. The size of the existing turning basin near RM15 is approximately 700ft (213m), which may limit the length of vessel that can safely turn around. USACE (1994) documented navigational challenges for transiting past the two bridges, which has been known to cause delays, especially in periods of reduced visibility (at night or during fog. Further investigation of navigation conditions is required to assess the feasibility & reliable transport of components from a facility located in the Upper Bay.

At the Terminal 1 site, the following upgrades may be needed, pending further analysis:

- Navigation improvements (e.g. bridge modifications and/or expansion of RM15 turning basin) depending on vessel size limitations & requirements.

Marine Terminal

At the Terminal 1 site, the following upgrades may be needed:

- New wharf & bulkhead to accommodate handing of heavy components; the existing timber wharf structure at this site would not be sufficient for meeting live load requirements of the heavy components.
- Ground improvements & new surfacing may be needed - geotechnical conditions were not assessed for this site; need for ground improvements to be determined, pending geotechnical investigation.
- Land area: 100 acres (40 hectare) were estimated to be the minimum yard area needed for technical screening of potential manufacturing sites. If more space is needed, additional land may need to be secured in addition to the Terminal 1 parcel (e.g. the adjacent GMA site).

The Eastside Port Parcel has more upland area available, but would require increased investment and modifications (change in zoning, additional greenfield development and dredging to provide vessel access).

[18] Criteria used for screening (see Table 8) included sufficient upland area, shoreline length, and navigation access for bulk carriers or other types of vessels that may be used to transport components to other West Coast facilities.

5.4 O&M Base

Facility requirements for a O&M vessel base to support crew transfer and minor repairs depend on the project size, distance to the wind farm, and the strategy of the contractor executing the Service and Maintenance Agreement (SMA). O&M vessels may consist of a combination of CTVs, SOVs, and helicopters, and the specific fleet composition will depend on the O&M strategy adopted. To support 3GW of FOW, an example vessel fleet may consist of ~3 CTVs and at least 1 SOV.

Concept-level criteria for an O&M vessel base includes:

- Yard Area of 2-10 acres for warehouses, parking, offices, security, etc;
- Wharf live load capacity of 500-1,000psf (2-5 T/m^2) for crew & equipment transfer. Moorage floats do not require the same loading capacities;
- Vessel berths to accommodate fleet of CTVs and/or SOVs; if helicopters are included within the SMA, a helipad would be required;
- Wave exposure – small craft, such as CTVs, are more sensitive to wave action than larger vessels; further investigation and wave modeling is needed to confirm whether a new breakwater (fixed or floating) within the bay is needed to provide safe harbor for smaller craft vessels; and
- Navigable access for vessel fleet (CTVs and SOVs) (see Table 10).

The O&M base navigation screening (Section 4.2) concluded that there are several options for siting an O&M vessel base within Coos Bay, but that these options may require modification & investment in site upgrades. A summary of potential upgrades that may be needed is provided below.

- Potential investments required may include a new wharf, moorage floats, dredging, and a helipad.
- Additional analysis is needed to determine whether existing facilities can be re-configured to support CTV and SOV moorage and whether a new breakwater is needed to provide safe harbor.
- Depending on the location selected for site development, new administrative buildings, storage warehouses, parking, and security upgrades may also be needed.

The level of investment needed will depend in part on the following factors:

- Strategy adopted by the contractor executing the SMA (e.g. offshore vs onshore-based strategy, size and composition of vessel fleet, etc).
- Construction of new facility versus re-purposing an existing facility.
- Site conditions - if re-purposing an existing facility, the level of investment will be influenced by the capabilities and conditions of existing wharf, bulkhead, and moorage floats as well as existing berth depths.
- Wave conditions - if it is determined that a breakwater is needed to provide safe harbor for smaller craft vessels (CTVs), more investment will be needed.

6 Conclusions & Next Steps

This section provides a summary of the study conclusions and recommended next steps for further project development.

6.1 Conclusions

Existing & proposed infrastructure in Coos Bay was assessed relative to the potential for supporting WTG integration & tow-out, foundation fabrication, WTG component manufacturing, and O&M activities. A technical screening assessment was conducted in coordination with relevant stakeholders, which identified the northern areas of the bay (Jordan Cove West, Roseburg CBST, and Jordan Cove East) as potentially favorable sites for integration facility development. Other areas that may be suitable for foundation assembly, component manufacturing, or serving as an O&M base were also identified (see Section 4).

Outcome: With investments and appropriate stakeholder coordination, Coos Bay has the physical characteristics to support the FOW industry in Southern Oregon in a variety of functions including integration, foundation fabrication and assembly, WTG manufacturing, and O&M. The factors that make Coos Bay favorable to support the industry include the planned navigation channel improvements and the availability of waterfront acreage. The investments needed include a new wharf, storage yard, and dredging, and may total in the range of $235-$950 million or higher, depending on the total scope of services provided. To confirm investment feasibility, coordination with stakeholders, including with the FAA and local airport district on airspace restrictions, is needed. Details are provided below.

6.1.1 Navigation Infrastructure

The navigation assessment focused on the ability of existing and proposed channels to support towing of floating devices. These findings and potential improvements required are summarized below:

- **Existing Navigation Channel:** The existing channel can potentially support FOW integration activities for the smaller size range of foundations (~200ft {61m} width or less), though throughput may be limited based on tight weather windows.
- **Proposed Navigation Channel:** With the proposed improvements, the modified channel will be able to accommodate a larger device, potentially in the range of 250ft (76m) in width.
- **Further Improvements:** To accommodate the larger sizes of floating foundations (up to 400ft {122m} in width), further widening beyond the planned improvements in the Entrance Channel and the Inner Channel is very likely needed. A wider Entrance Channel and Inner Channel – beyond the existing planned improvements - would also benefit tow-out for the smaller floating foundations as well. Numerical modeling and simulations will be needed to verify go/no-go criteria and effect on throughput.
- **Operations:** Assembly and installation activities will be limited to favorable weather months (e.g., May-Oct), which could result in a deployment and installation window of six months or fewer.

The existing & proposed channel may be able to support larger foundations than those listed above (200ft {61m} and 250ft {76m} beam, respectively) if integrated WTGs are towed out on semi-submersible vessels and floated off offshore. Whether this dry-tow solution is feasible is highly dependent on the device specifics & further investigation of operational limitations relative to offshore wave conditions.

6.1.2 Marine Terminal Infrastructure

The findings of the marine terminal assessment are summarized below for each FOW activity considered.

- **Integration Facility**
  - **Throughput:**
    - The number and size of turbines deployed annually affects the size of the facility which is needed. Fewer larger units may require less capital investment in the marine terminal due (less units deployed per year), but may require navigation improvements or will be more subject to downtime due to tighter navigation tolerances.
    - A minimum throughput of 350 MW/year was assumed for this study, but depending on how Oregon renewable energy targets develop, a higher throughput rate (larger integration facility) may be needed to support several project installations at once. There is sufficient upland area in the north areas of the bay to support several projects. The length of shoreline needed to meet higher annual deployment rates would require development outside the bounds of the Jordan Cove West boundaries.
  - **Potential Upgrades Needed**
    - Wharf**:** A new bulkhead & high-capacity wharf will be needed to accommodate integration (and potentially foundation delivery or launching). Depending on the method of foundation delivery or fabrication, a high-capacity launching wharf may also be needed. A lower capacity structure may be needed to support commissioning activities. Based on limited review of geotechnical conditions at Jordan Cove West, a pile-supported structure is likely if this site is selected for development. Other sites may have different preferred structure types (e.g. bulkhead, caisson, or other). Refinement of the wharfline location may also affect the preferred structure type.
    - Yard**:** Grading, ground improvements, and surfacing will be needed to provide a flat storage area capable of meeting bearing capacity requirements.
    - Berths**:** Berth dredging to accommodate unloading of vessels, turbine integration, & commissioning is needed outside of the footprints of previous dredging activities.
    - Wet Storage: Unless foundations are stored upland following delivery or assembly, dredging outside of the FNC to accommodate wet storage of foundations and/or integrated turbines is needed.
  - **Capital Costs:** Costs for port infrastructure upgrades will vary, depending on the size of the FOW project, annual throughput requirements, site conditions, environmental considerations, and other project-specific requirements. Planning-level costs for an example integration facility concept (Example Development Scenario A in Table 11 and Figure 14) may be in the range of $235-950 million.
  - **Operations:** When no longer in use for FOW, a new integration wharf would meet operational requirements of other industries and could be an asset for servicing other industries.
- **Foundation Fabrication/Delivery**
  - To conduct integration in Coos Bay, foundations need to be delivered via marine transport or assembled on site. There are several options for methods of launching the foundations (or integrated WTGs) into the water, which would all require investment.
  - Although there may be enough upland area within the Jordan Cove West site to accommodate both integration & fabrication activities, the shoreline length is limited. For adjacent integration & fabrication facilities in the north area of the bay, parts of the adjacent parcels (Roseburg CBST and/or Henderson Marsh) would need to be secured for development.
  - **Potential Upgrades Needed**: Upgrades needed are linked to the method of foundation delivery or launching employed. Examples of potential launching infrastructure improvements include a new

high capacity launching wharf, dredged pit, marine rail, gantry crane & slipway, or other. For the fabrication yard, grading, ground improvements & surfacing, and other technology-specific needs may be needed.

- **Component Manufacturing**
  - Siting of a component manufacturing facility is less limited by airspace & navigation constraints than integration or fabrication, so there are several potential development options in the Upper and Lower Bays.
  - In the Upper Bay, the size of vessels able to access the site may be limited by bridge clearances & the size of the existing turning basin.
  - In the Lower Bay, the available facilities are similar to those considered for integration.
  - **Potential Upgrades Needed**: Requirements to be determined based on site-specific investigation; for an example, a new wharf is likely needed at Terminal 1 to provide sufficient bearing capacities. Depending on the results of a geotechnical investigation, ground improvements & surfacing may also be needed. Navigation improvements (bridge modifications or turning basin expansion) may be needed to accommodate larger vessels.
- **O&M Base**
  - There are several options for siting an O&M vessel base within the bay, modification & investment may be required.
  - Additional analysis is needed to determine whether existing facilities can be re-configured to support CTV and SOV moorage and whether a new breakwater is needed to provide safe harbor.
  - **Potential Upgrades Needed**: Potential investments required may include a new wharf, moorage floats, and a helipad; Depending on the location selected for site development, new administrative buildings, storage warehouses, parking, and security upgrades may also be needed. A new breakwater may be required, depending on the results of additional wave analysis within the bay.

6.1.3 Summary of Findings

Table 17 provides a summary of the port infrastructure study findings.

Table 17. Study Finding Summary Table.

Element	Key Considerations/Activities	Key Constraints	Findings
Entrance Channel	Integration/tow-out Component delivery Foundation delivery	Channel width Maintenance dredging schedule Metocean conditions & wave exposure	Existing/proposed channel can likely accommodate smaller sized foundations. Larger foundations may require localized Entrance Channel widening. The channel may be able to accommodate larger devices if foundations or integrated WTGs are transported via dry-tow. Change in maintenance dredging schedule/frequency may be needed to reduce downtime during installation.
Inner Channel	Integration/tow-out Component delivery/transport Foundation delivery O&M	Channel width RM9 Bridges Upper Bay turning basins	Existing/proposed channel may be able to accommodate smaller sized foundations; larger foundations may require widening of Inner Channel. Towing activities likely limited to higher tides. The size of component delivery vessels (breakbulk, cargo vessels, etc) or SOVs able to transit into the Upper Bay may be limited.

Element	Key Considerations/Activities	Key Constraints	Findings
Wharf	Integration Commissioning Foundation Launching/Delivery Component loading/unloading	Seismic/liquefaction risk Bearing capacities Geotechnical conditions Environmental (eelgrass) Distance to navigation channel	New high-capacity wharf needed to support integration and/or component manufacturing. Location should consider sufficient distance to the navigation channel while minimizing dredging/excavation volumes. Depending on development location, a pile-supported structure may be favorable to mitigate geotechnical risks. Depending on method of foundation delivery/float-off, high-capacity launching wharf may also be needed. Lower capacity structure may be needed for commissioning. Upgrades may be needed to existing facilities within Coos Bay to support mooring line and anchor staging.
Berth	Integration Commissioning Component Unloading	Available shoreline length Distance between wharf and navigation channel Nearshore depths Maintenance dredging considerations Existing pile dikes Environmental (eelgrass)	New berth dredging is needed to support integration, commissioning, component vessels, and wet storage. Wet-storage and commissioning berths may not need to be located at or adjacent to the integration facility.
Yard	Component storage & staging Foundation assembly Component manufacturing O&M Base Anchor & mooring line storage	Seismic/liquefaction risk Hilly elevations Existing bearing capacities Wetlands Existing operations	With required investments, there is sufficient area in Coos Bay to support integration, fabrication, component manufacturing, and O&M.
Wet-Storage and Staging	Temporary storage for foundations (prior to integration) Temporary storage for integrated WTGs (prior to tow-out)	Depths outside of FNC Maintenance dredging considerations	Existing depths outside of the FNC are not adequate for wet storage of foundations or integrated WTGs. Dredging is needed, and may be more suitable to occur at existing berths (E.g. Cape Arago Dock). If upland yard space is available, foundations and/or integrated WTGs may be able to be stored upland, obviating the need for wet storage.
O&M Base	Vessel base for CTVs & SOVs; crew & equipment transfer. Offices & storage.	Wave exposure (CTVs facility) Moorage for SOVs	There are several potential options for supporting O&M within Coos Bay. Additional siting analysis is needed to determine if exiting facilities can be re-purposed to support CTV and SOV berths. A breakwater may be required, pending additional wave analysis within the bay.

6.2 Next Steps

Further investigation should be conducted to refine these concept-level findings as project planning progresses and as FOW devices, vessels, technology, equipment, and industry experience continues to develop. Select examples of further analysis and design that will need to be conducted include:

- Application of full bridge simulations to refine navigation constraints for device towing in the Entrance Channel and Inner Channel.
- Completion of a Navigation Safety Risk Assessment, as required by the USCG, to assess and mitigate potential impacts to navigation from a new port facility. This would include investigation of existing marine traffic and identification of potential conflicts with FOW operations (e.g. tow-out) to inform project planning & development of mitigation strategies.
- Determination of any required changes to Aids to Navigation (AOTNs) to facilitate FOW. This should be conducted in coordination with the USCG's Waterways Analysis and Management System tool.
- Refinement of wharf and berth orientation and location based on a detailed coastal engineering analysis considering dredging impacts & maintenance dredging needs.
- Wave modeling within the bay to determine suitable locations for a O&M vessel base and the need for a breakwater.
- Numerical wave and current modeling should also be conducted to assess wave conditions at potential integration locations relative to structure motion criteria.
- Environmental, geotechnical, and land/hydrographic surveying within the vicinity of the project area for incorporation into planning and engineering design work.
- A metocean downtime assessment to compare weather conditions (wind, waves, water levels) to operational criteria for certain activities. This should also include wave modeling at the proposed development location to assess wave conditions relative to strict criteria for integration. The integration wharf design & orientation may be able to be adjusted to dampen wave energy.
- A detailed port planning/throughput study with specific goals for development of buildout alternatives. Throughput assessment should incorporate findings from metocean downtime study.
- Further investigation into launching (float-off) systems and solutions for accommodating foundation delivery or fabrication within the bay.
- Outreach with regulatory authorities, users, developers, USACE, USCG, to refine project criteria and inform feasibility assessment work. Regulatory actions required prior to project development may include (but are not limited to):
  - NEPA Environmental Assessment
  - Endangered Species Act consultation with National Marine Fisheries Service, US Fish and Wildlife Service
  - National Historic Preservation Act tribal consultation
  - USACE Clean Water Act Section 404, Harbors Act Section 10 permit
  - USACE Section 408 permit
  - Oregon Department of Lands Removal/Rill Permit (Joint Permit Application), Oregon DEQ Section 401 (Joint Permit Application)
  - Department of State Lands Waterway lease authorization, Oregon Department of Fish & Wildlife Habitat Migration Policy compliance
- Outreach with tribes & other local stakeholder groups to solicit input and incorporate into project planning & development.
- Historical eelgrass survey (Clinton, et. al., 2007) is documented within the project area vicinity. A new survey should be conducted to locate the current extents of eelgrass.

- Coordination & engagement with the FAA and Coos County Airport District to refine constraints related to airspace penetration for integration, fabrication, maintenance, and tow-out activities. A Notice of Proposed Construction or Alteration (Form 7460-1) will need to be submitted to the FAA for approval.
- Wet-storage and staging area orientation and location need to be refined based on a detailed coastal engineering analysis to consider maintenance dredging needs, wave exposure, and other environmental conditions.

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Appendix A – Marine Terminal Database

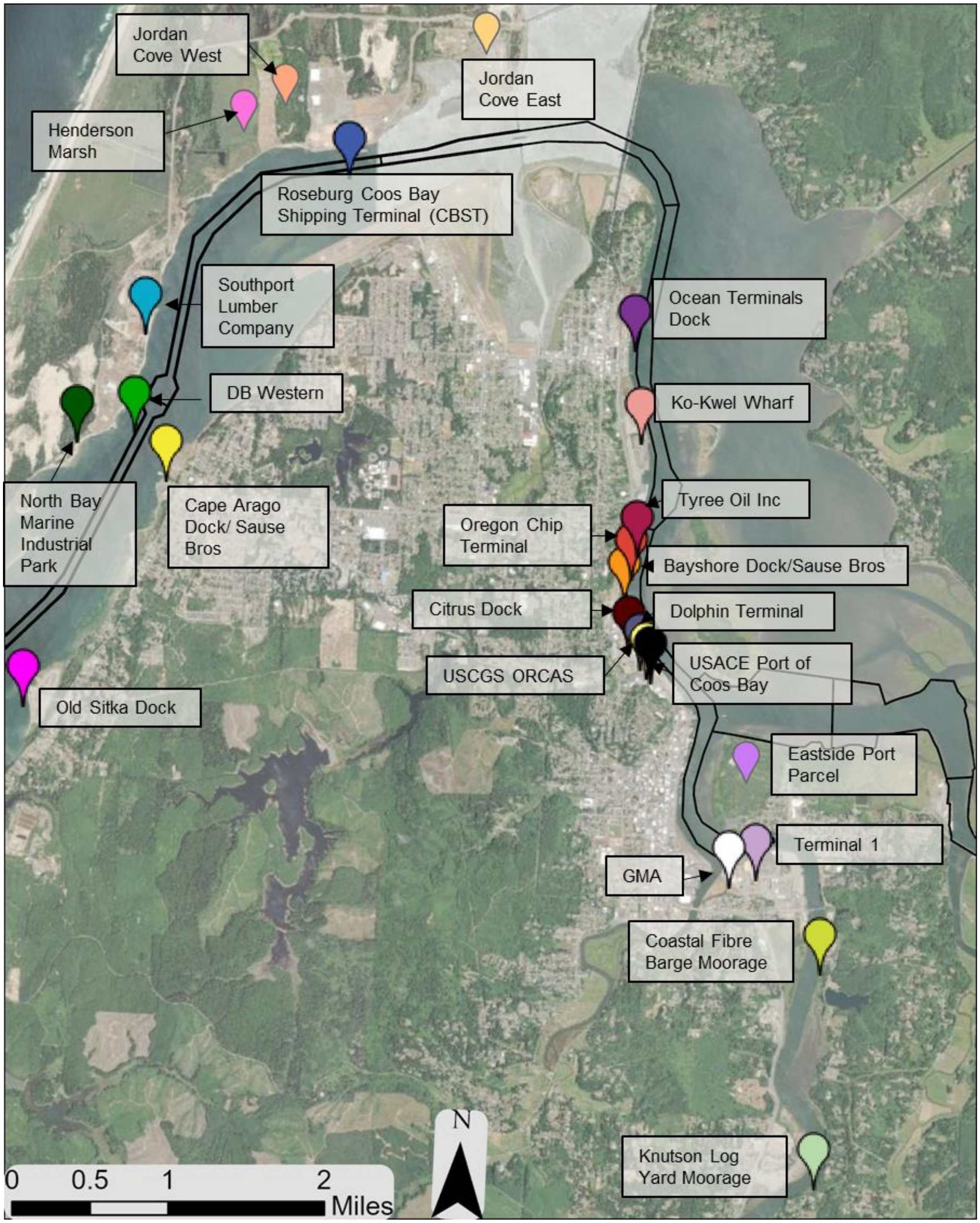

Figure A1. Existing Coos Bay marine terminal facilities & potential development areas.

The information provided in Table A1 is based on public information, the Port of Coos Bay's *Terminals and Docks* dataset, information provided by the South Coast Development Council, and information contained within the *Project Blue Coos Bay site tour information.pdf,* provided by TotalEnergies SBE US.

Properties marked with an asterisk (*) in Table A1 are owned by the Port of Coos Bay.

Table A1. Preliminary Marine Terminal Facility Database

Facility	Existing Facility Characteristics
Old Sitka Dock ● **LAT:** 43°22'28.95"N **LON:** 124°17'45.38"W	The Old Sitka Dock is in the Lower Bay and is currently a high-end RV resort. There was previously a timber dock located here. • Marine Structure/Dock type: none • Distance from navigation channel: 1,200ft (366m) • Berth: Not active • Berth Dredging Area Depth: 16ft (4.9m) MLLW • Shoreline Length: 4,000ft (1,220m) • Yard: 40ac (16 ha); additional 40ac (16ha) are tidelands • Airspace Ceiling Height: no restrictions
Cape Arago Dock/ Sause Bros (private terminal) ● **LAT:** 43°23'46.22"N **LON:** 124°16'44.54"W	Cape Arago is a utility/work dock located in the Lower Bay that has 25ac yard and 25ac of additional tideland. There is an existing berth. • Marine Structure/Dock type: timber dock • Distance from navigation channel: 890ft (271m) • Berths: 1 – 505ft (154m) • Berth Dredging Depth: 20ft (6.1m) MLLW • Shoreline Length: 4,000ft (1,220m) • Yard: 25ac (10ha) • Airspace Ceiling Height: 1,67ft (51m) MSL
North Bay Marine Industrial Park* ● **LAT:** 43°23'57.92"N **LON:** 124°17'26.17"W	North Bay Marine Industrial Park is proposed to be part of the large multi modal containership project. • Marine Structure/Dock type: timber dock • Distance from navigation channel: 190ft (58m) • Berth: 1 – 380ft (116m) • Berth Dredging Area Depth: 15ft (4.6m) MLLW • Shoreline Length: 1200ft (366m) • Yard: 50ac (20ha) Airspace Ceiling Height: 167ft (51m)
D.B. Western, Inc. ● **LAT:** 43°24'1.93"N **LON:** 124°16'59.93"W	DB Western is a utility/work dock and used for vessel repair and construction in the Lower Bay with 35ac total space and 10ac of developed yard space. A portion of the DB Western is proposed to be a part of the large multi modal containership project. • Marine Structure/Dock type: timber dock • Distance from navigation channel: 610ft (186m) • Berth: 1 – dolphins 200 (61m) feet; wharf 140ft (43m) • Berth Dredging Area Depth: 20ft (6.1m) MLLW • Shoreline Length: 1,700ft (518m) • Yard: 10ac (4ha) • Airspace Ceiling Height: 167ft (51m) MSL • Navigation Channel Offset: 610ft (186m)
Southport Lumber Company / Southport Forest Products Sawmill and Barge Facility ● **LAT:** 43°24'35.06"N **LON:** 124°16'56.98"W	Southport Lumber has a deadload barge slip. • Marine Structure/Dock type: Deadload barge slip • Distance from navigation channel: 1,100ft (335m) • Berth: 1 – 420ft x 120ft (128 x 36m) • Berth Dredging Area Depth: 20ft (6.1m) MLLW • Shoreline Length: 1,500ft (457m) • Yard: 30ac (12ha) wetlands included • Airspace Ceiling Height: 1,07ft (33m) MSL

Henderson Marsh* ● **LAT:** 43°25'25.08"N **LON:** 124°16'17.57"W	Henderson Marsh is a greenfield port property in the Lower Bay. • Yard: 277ac wetland (112ha); 100+ more acres (40+ more ha) located north of Transpacific Parkway • Shoreline Length: 3,200ft (975m) • Airspace Ceiling Height: 167ft (51m) MSL Stakeholder input: Port sees a potential way forward to development, but site is designated wetland; significant regulatory challenges may be associated with site.
Jordan Cove West ● **LAT:** 43°25'31.52"N **LON:** 124°16'0.04"W	Jordan Cove West is undeveloped land with variable elevations. This site had been proposed to be the berth area for LNG ships for JCEP. • Yard: 60ac (24ha) flat ground; 225ac (91ha) total with wetlands and duneland • Shoreline Length: 1,750ft (533m) • Airspace Ceiling Height: 167ft (51m) MSL Stakeholder input: dredging and fill biproducts have been deposited onsite; Jordan Cove LNG project had planned on dredging out along the waterfront to construct vessel slips; appears unlikely that LNG project will be developed – area may be available.
Roseburg Coos Bay Shipping Terminal (CBST) ● **LAT:** 43°25'30.00"N **LON:** 124°15'26.79"W	Roseburg CBST is an outbound woodchip facility in the Lower Bay with 150ac developed land and 50ac of duneland. • Marine Structure/Dock type: timber dock • Distance from navigation channel: 300ft (91m) • Berth: 1 – dolphins 1,000ft (305m); wharf 260ft (80m) • Berth Dredging Area Depth: 40ft (12m) MLLW • Shoreline Length: 6,000ft (1,830m) • Yard: 150+ac (60+ha); 50ac {20ha} duneland • Airspace Ceiling Height: 167ft (51m) MSL Stakeholder input: Vessel berths about every 10 days and takes about 2 days to load; facility employs approximately 25 people that facilitate 24-hour operations; products from this terminal typically go to Japan or China.
Jordan Cove East* ● **LAT:** 43°26'1.02"N **LON:** 124°14'32.27"W	The Jordan Cove East site consists of two taxlots totaling approximately 166ac (67ha). The site consists of a 48-acre taxlot owned by the Port of Coos Bay and a 16 acre, in-water taxlot owned by the Jordan Cove Energy Project. • Yard: ~50ac (20ha) • Shoreline Length:4,000ft (1,220m) • Airspace Ceiling Height: 1,67ft (51m) MSL Stakeholder input: Partially developed site; some paved, but mostly just fill to undeveloped waterfront; would need to dredge out to the navigation channel; appears unlikely that LNG project will be developed – area may be available.
Ocean Terminals Dock ● **LAT:** 43°24'36.58"N **LON:** 124°13'12.39"W	Ocean Terminals Dock is used for inbound and outbound logs in the Upper Bay. • Marine Structure/Dock type: Unknown • Distance from navigation channel: 125ft (38m) • Berth: 1 – 900ft (274m); wharf 502.5ft (153m) • Berth Dredging Area Depth: 37ft (11m) MLLW • Shoreline Length 2,000ft (610m) • Yard: 34ac (14ha) • Airspace Ceiling Height: 167ft (51m) MSL
Ko-Kwel Wharf ● **LAT:** 43°24'5.72"N **LON:** 124°13'7.68"W	KoKwel Wharf is s a former inbound and outbound logs facility in the Upper Bay. It has about 5ac of undeveloped land and 14ac developed yard space in the Upper Bay. • Marine Structure/Dock type: timber dock • Distance from navigation channel: 150ft (46m) • Berth: 1-1,000ft (305m) • Berth Dredging Area Depth: 37ft (11m) MLLW • Shoreline Length:4,000ft (1,220m) • Yard: 14ac (6ha) • Airspace Ceiling Height: 250ft (76m) MSL

Tyree Oil Inc ● **LAT:** 43°23'27.74"N **LON:** 124°13'7.28"W	Tyree Oil Inc is a terminal in the Upper Bay with four large barrel storage tanks and is the receipt of petroleum products. It has lighter barge moorage. • Marine Structure/Dock type: lighter barge moorage • Distance from navigation channel: 100ft (30m) • Berth: 1 – dolphins 300ft (91m); wharf 200ft (61m) • Berth Dredging Area Depth: 28ft (8.5m) MLLW • Shoreline Length: 300ft (91m) • Storage: 70,000 barrel (via tank farm) • Airspace Ceiling Height: 330ft (100m) MSL
Oregon Chip Terminal ● **LAT:** 43°23'20.21"N **LON:** 124°13'9.53"W	Oregon Chip Terminal is a outbound woodchip facility in the Upper Bay and has large woodchip machinery onsite. • Marine Structure/Dock type: Unknown • Distance from navigation channel: 380ft (116m) • Berth: 1 – dolphins 1,000ft (305m) • Berth Dredging Area Depth: 37ft (11m) MLLW • Shoreline Length: 1,000ft (305m) • Yard: 5ac (2ha) • Airspace Ceiling Height: None
Bayshore Dock ● **LAT:** 43°23'12.48"N **LON:** 124°13'12.18"W	Bayshore Dock is a utility/ work dock in the Upper Bay. • Marine Structure/Dock type: timber dock • Distance from navigation channel: 100ft (30m) • Berth: 1 – 700ft (213m) • Berth Dredging Area Depth: 30ft (9m) MLLW • Shoreline Length:500ft (153m) • Yard: 2.5ac (1ha) • Airspace Ceiling Height: None
Citrus Dock – Port of Coos Bay Utility / Work Dock* ● **LAT:** 43°22'55.73"N **LON:** 124°13'9.25"W	Citrus Dock is a utility/work dock in the Upper Bay with minimal yard space • Marine Structure/Dock type: timber dock • Distance from navigation channel: 85ft (26m) • Berth: 1 – dolphins 200ft (61m); wharf 140ft (43m) • Berth Dredging Area Depth: 20ft (6.1m) MLLW • Shoreline Length: 200ft (61m) • Yard: 0.25ac (0.1ha) • Airspace Ceiling Height: None
Dolphin Terminal – Port of Coos Bay Utility / Work Dock* ● **LAT:** 43°22'50.21"N **LON:** 124°13'3.71"W	Dolphin Terminal is used for in-water loading of outbound logs in the Upper Bay. There is minimal yard space. • Marine Structure/Dock type: timber dock • Distance from navigation channel: 110ft (33m) • Berth: 1 – dolphins 750ft (229m); dock 60ft (18m); floating pier 140ft (43m) • Berth Dredging Area Depth: 36ft (11m) MLLW • Shoreline length: 150ft (46m) • Yard: < 0.25ac (<0.1ha) • Airspace Ceiling Height: None
USCGC ORCAS ● **LAT:** 43°22'47.44"N **LON:** 124°13'0.75"W	USCGS ORCAS is the homeport for the USCG Cutter Orcas. Its yard is a gravel parking lot with concrete pad and storage trailer. • Marine Structure/Dock type: timber dock • Distance from navigation channel: 140ft (143m) • Berth: 1- wooden pier 12ft x 160ft (3.7m x 49m); floating dock 130ft (40m) • Berth Dredging Area Depth: 25ft (7.6m) MLLW • Shoreline Length: 250ft (76m) • Yard: 0.3ac (0.12ha) • Airspace Ceiling Height: None

US Army Corp of Engineers Port of Coos Bay Moorage ● **LAT:** 43°22'45.87"N **LON:** 124°12'58.74"W	USACE Port of Coos Bay Moorage is a utility/work dock in the Upper Bay that is used for government vessel moorage. It is located adjacent to the USCGC ORCAS dock. Its yard is primarily a gravel lot. • Marine Structure/Dock type: timber dock • Distance from navigation channel: 120ft (37m) • Berth: 1 – 350ft (107m) with dolphins; fixed dock 125ft (38m); floating dock 100ft (30m) • Berth Dredging Area Depth: 25ft (7.5m) MLLW • Shoreline Length: 300ft (91m) • Yard: 0.5ac (0.2ha) • Airspace Ceiling Height: None
GMA ○ **LAT:** 43°21'38.79"N **LON:** 124°12'18.62"W	GMA is a terminal in the Upper Bay that is used for garnet. It has dry storage space. • Marine Structure/Dock type: timber dock • Distance from navigation channel: 85ft (26m) • Berth: 1 – 600ft (183m) • Berth Dredging Area Depth: 36ft (11m) MLLW • Shoreline Length: 1,000ft (305m) • Yard: 28ac (11ha) (12 south of railroad, 16 north of railroad) • Airspace Ceiling Height: None Stakeholder input: GMA is active, but there are ~16ac that they're not using.
Terminal 1* ● **LAT:** 43°21'41.65"N **LON:** 124°12'6.49"W	Terminal 1 is used as a breakbulk general cargo and is primarily forest products. It has a chip facility and large log storage area. • Marine Structure/Dock type: wood pile supported dock • Distance from navigation channel: 100ft (30m) • Berth: 2– 1,200ft (365m) • Berth Dredging Area Depth: 37ft (11m) MLLW • Shoreline Length: 4,000ft (1,220m) • Yard: 95ac (38ha); 20ac (8ha) covered dry storage; an additional ~12ac (5ha) of laydown/storage area is located south of Isthmus Slough bridge. • Airspace Ceiling Height: None Stakeholder input: Flat and already has a developed waterfront. Port has recently acquired Terminal 1 (formerly Georgia Pacific property).
Eastside Port Property* ● **LAT:** 43°22'18.08"N **LON:** 124°12'14.65"W	Greenfield property with no berth or wharf infrastructure. • Marine Structure/Dock type: none • Distance from navigation channel: 100ft (30m) • Berth: none • Berth Dredging Area Depth: N/A • Shoreline Length: 5,000ft (1,525m) • Yard: 125ac (51ha) • Airspace Ceiling Height: None Stakeholder Input: wetlands present in area; estimated 70-80% is developable; development may require zoning change from residential zoning, which may be challenging.
Coastal Fibre Barge Moorage ● **LAT:** 43°21'11.11"N **LON:** 124°11'35.23"W	Coastal Fiber Barge Moorage is below the bunker hill bridge and not along the federal navigation channel. It is used for barge loading of woodchips • Marine Structure/Dock type: timber dock • Distance from navigation channel: N/A • Berth: 1 – 445ft (136m) • Berth Dredging Area Depth: 22ft (6.7m) MLLW • Shoreline Length: 900ft (274m) • Yard: 8ac (3.2ha) • Airspace Ceiling Height: None

Knutson Log Yard Moorage ● **LAT:** 43°19'59.30"N **LON:** 124°11'33.76"W	Knutson Log Yard Moorage below the bunker hill bridge and not along the federal navigation channel. It is used for landside unloading of inbound logs. • Marine Structure/Dock type: N/A • Distance from navigation channel: N/A • Berth: 1 – dolphins 500ft (152m) • Berth Dredging Area Depth: 22ft (6.7m). MLLW • Shoreline Length: 1,400ft (426m) • Yard: 14ac (5.6ha) • Airspace Ceiling Height: None