Ocean Wind 1 Offshore Wind Farm Biological Assessment Addendum

For National Marine Fisheries Service

November 2022

U.S. Department of the Interior
Bureau of Ocean Energy Management
Office of Renewable Energy Programs

BOEM
Bureau of Ocean Energy Management

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STATEMENT OF NEED FOR ADDENDUM

On September 6, 2022, the Bureau of Ocean Energy Management (BOEM) transmitted a Biological Assessment (BA) to the National Marine Fisheries Service (NMFS) regarding the Ocean Wind 1 Offshore Wind Farm (Project). On October 4, 2022, BOEM and NMFS were notified by Ocean Wind LLC of new project information, of which a detailed description was provided to BOEM on October 27, 2022. Ocean Wind LLC also submitted an updated Construction and Operations Plan (COP) to BOEM on October 14, 2022. Updates to incorporate the new project information in the Biological Assessment are organized using the same section and table numbering as the Biological Assessment for ease of reference. The following information has been provided in this addendum:

- Revisions to incorporate updated marine mammal density models for the U.S. east coast, released by the Duke Marine Geospatial Ecology lab on June 20, 2022, and exposure estimates.
- Revisions to incorporate updates to the October 2022 COP, which include a shift to the location of the BL England substation to an adjacent portion of the same property which formerly housed elements of the BL England Generating Station, adjustment of the row A wind turbine generators (WTGs) (as depicted in Figure 2-9 of the Ocean Wind 1 Draft Environmental Impact Statement and outlined in a joint letter signed by Ocean Wind LLC and Atlantic Shores Offshore Wind, LLC) to create a minimum 1,500 meter distance between Ocean Wind 1's and Atlantic Shores South's WTGs, removal of references to the use of helicopters, and other minor updates.
- Revisions to incorporate additional details for the proposed Barnegat Inlet and Oyster Creek Channel dredging, use of sheet pile for temporary shoring at open cut trenches, shoreline stabilization, and submerged aquatic vegetation (SAV) mitigation.

The additional information and analyses in this addendum would not modify any effect determination presented in the September 6, 2022 Biological Assessment

1. INTRODUCTION

1.2 PROJECT AREA

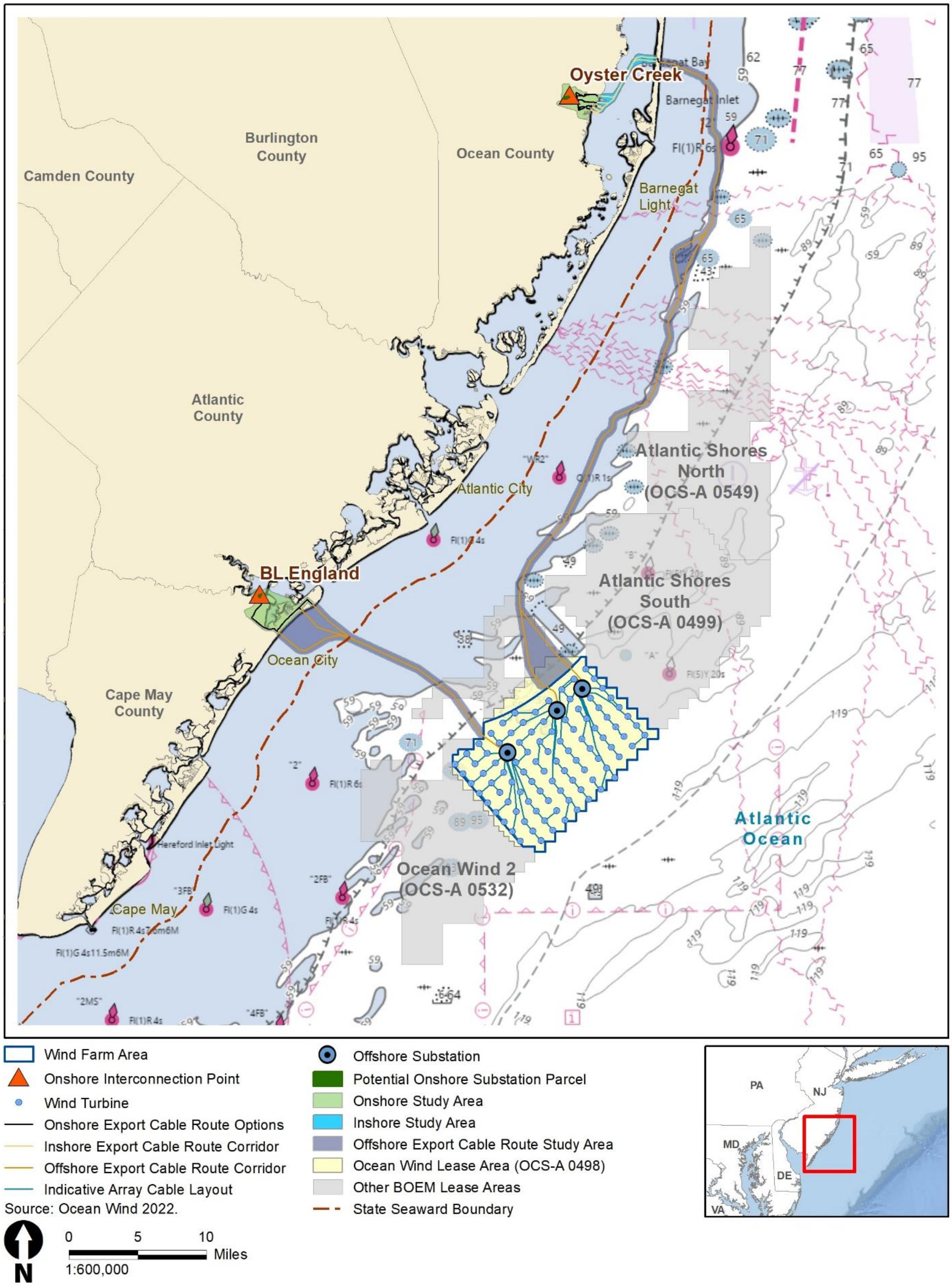


Figure 1-1 Ocean Wind 1 Project Area

1.3 DESCRIPTION OF THE PROPOSED ACTION

As detailed in Section 2.1 of the Draft Environmental Impact Statement (EIS), the Proposed Action would allow Ocean Wind to construct, operate, maintain, and eventually decommission a wind energy facility approximately 1,100 MW in scale on the OCS offshore of New Jersey within the range of design parameters outlined in Section 4 of the COP, Volume 1 (Ocean Wind 2022a, Alternative A). In-water Project components include the offshore wind farm, the offshore export cable, the inshore export cable, and OSS. The Project proposed by Ocean Wind would include up to 98 WTGs and their foundations, up to three OSSs and their foundations, scour protection for foundations, inter-array cables, and offshore export cables (these elements collectively make up the Offshore Project area). The proposed offshore Project elements are on the OCS as defined in OCSLA, except a portion of the export cables within state waters (Figure 1-1). The WTGs would extend up to 906 feet (276 meters) above mean lower low water (MLLW). Turbines are oriented in a southeast-northwest direction within the 68,450-acre (277-square-kilometer [km2]) Wind Farm Area with 10 open corridors in between of varying width. Corridor width between turbines (southwest-northeast orientation) varies depending on location within the array from 1.15 to 1.31 miles (1 to 1.13 nm, 1.9 to 2.1 km between WTGs. Southeast-northwest spacing between the turbines is 0.9 miles (0.8 nm) throughout the Wind Farm Area. Ocean Wind would mount the WTGs on monopile foundations, and OSSs would be placed on either monopile or piled jacket foundations. Maximum seabed penetration of the WTG foundation would be 164 feet (50 meters). Where required, scour protection would be placed around foundations to stabilize the seabed near the foundations, as well as the foundations themselves. The scour protection would be a maximum of 8.2 feet (2.5 meters) in height, would extend away from the foundation as far as 43 feet (13.1 meters), and would have a volume of 8,657 cubic yards (yd^3) (6,619 cubic meters [m^3]) per monopile. Each WTG would contain approximately 1,585 gallons (6,000 liters) of transformer oil and 146 gallons (553 liters) of general oil (for hydraulics and gearboxes). Other chemicals used would include diesel fuel, coolants/refrigerants, grease, paints, and sulfur hexafluoride. COP Volume I, Section 8.1 provides additional details related to proposed chemicals and their anticipated volumes (Ocean Wind 2022a).

The Project would involve temporary construction laydown areas and construction ports; however, the primary ports that are expected to be used during construction have independent utility and are not solely dedicated to the Project. These ports include a construction management base in Atlantic City, New Jersey; a foundation scope base in Paulsboro, New Jersey, or Europe; a WTG scope base in Norfolk, Virginia, or Hope Creek, New Jersey; and a cable staging base in Port Elizabeth, New Jersey, Charleston, South Carolina, or Europe. The operations and maintenance (O&M) facility would be in Atlantic City, New Jersey and serve multiple Ørsted Wind Power North America, LLC (Ørsted) projects in the mid-Atlantic.

The Project's export cables include both offshore and onshore segments. The offshore export cables would be alternating current (AC) electric cables that would connect the Project area to the mainland electric grid in Lacey Township, New Jersey, and Upper Township, New Jersey. Offshore, the export cables would be located in federal waters and New Jersey state territorial waters and would be buried to a target depth of 4 to 6 feet (1.2 to 1.8 meters) below the seabed. The onshore underground segment of the export cable would be located in Lacey, Ocean, and Upper Townships, New Jersey, and Ocean City, New Jersey.

A description of construction and installation, O&M, and decommissioning activities to be undertaken for the proposed Project is included in Sections 1.3.1, 1.3.2, and 1.3.3, below. Proposed mitigation, monitoring, and reporting conditions that are intended to minimize or avoid potential impacts to ESA-listed species are described in Section 1.3.5. Monitoring surveys to be completed before, during, and after construction are included in Section 1.3.4. For a more specific description of the Project Design Envelope, see Ocean Wind's COP (Ocean Wind 2022a). Adjustments to locations of WTGs and OSS, export cables, and array cables may occur based on results of the ongoing COP review; figures indicate current configurations.

1.3.1 Construction and Installation

The proposed Project would include the construction and installation of both onshore and offshore facilities. Offshore construction and installation activities, as well as any onshore activities that may result in temporary impacts to coastal waters, are discussed below. The distinct areas of the proposed Project include the offshore wind farm, offshore export cable, and inshore export cable. Components included in these areas are the WTGs (including foundations and scour protection), OSSs (including foundations and scour protection), inter-array cables (including scour protection), OSS cables, offshore export cables (including scour protection), and temporary cofferdams. Construction and installation would begin in 2023 and be completed in 2025. Ocean Wind anticipates beginning land-based construction before the offshore components. Based on the Project schedule included in COP Volume I, Chapter 4, Figure 4.5-1 (based on a record of decision anticipated for Quarter (Q)2 2023), construction and installation of offshore components would proceed on the following timeline (Figure 1-4; Ocean Wind 2022a):

1. Landfall cable installation works would begin in early Q4 2023 and conclude in late Q4 2024;
2. Offshore export cable installation activities would begin in mid-Q2 2024 and conclude in mid-Q1 2025;
3. WTGs and OSS foundation installation would begin in Q2 2024 and conclude in late Q4 2024;
4. Inter-array cable installation would begin in Q3 2024 and conclude in mid-Q2 2025; and
5. WTGs and OSS installation commissioning would begin mid-Q3 2024, with the array fully energized by Q4 2025.
6. Federal Channel Dredging would occur in Q4 2023

Ocean Wind would install up to 101 foundations which includes three OSS and 98 WTGs. Installation would require up to two jack-up vessels, support vessels and barges. For the WTGs, a single vertical hollow steel monopile with a 4-inch (10.3 centimeter [cm]) wall thickness will be installed for each location using an impact ham mer (IHC-4000 or IHC-S-2500 kilojoule impact hammer or similar) to an expected penetration depth of 164 feet (50 meters). Installation of a single monopile is expected to take 9 hours (1 hour pre-clearance period, 4 hours piling, and 4 hours moving to the next location). Up to two piles are expected to be installed per 24-hour period. The tapered monopiles for WTG foundations would be 37 feet (11 meters) in diameter at the seabed and 27 feet (8 meters) in diameter at the sea surface (Figure 1-3; Ocean Wind 2022a).

OSSs are generally installed in two phases: first, the foundation substructure is installed in a method similar to that described above; then, the topside structure is installed on the foundation structure. More information on installation can be found in COP Volume I, Section 6.1.2 (Ocean Wind 2022a). Ocean Wind would construct up to three OSSs to collect the electricity generated by the offshore turbines. OSSs help stabilize and maximize the voltage of power generated offshore, reduce potential electrical losses, and transmit energy to shore. OSSs would consist of a topside structure with one or more decks on either a monopile or piled jacket foundation. For the OSS, a piled jacket foundation is being considered. This would involve installing 52- by 8-foot (16- by 2.44-meter) diameter piles as a foundation for each OSS foundation using an impact hammer (IHC-S-2500 kilojoule impact hammer or similar) to an expected penetration depth of 230 feet (70 meters). Alternatively, a single monopile like the ones used for WTGs may be used for each OSS (each option was modeled). A maximum of three pin piles would be installed per 24-hour period. Each pin pile takes approximately 4 hours to install and a single OSS foundation is expected to take 6 days. A total of 98 monopiles would be installed for WTGs and 48 pin piles (or three monopiles) would be installed for OSS. For installation of both the WTG and OSS monopile foundations, installation of more than one pile at one time is not expected to occur; however, 24-hour-per-day pile driving may be conducted if approved by BOEM (see Section 1.3.5, Table 1-11 and Table 1-12 for more details).

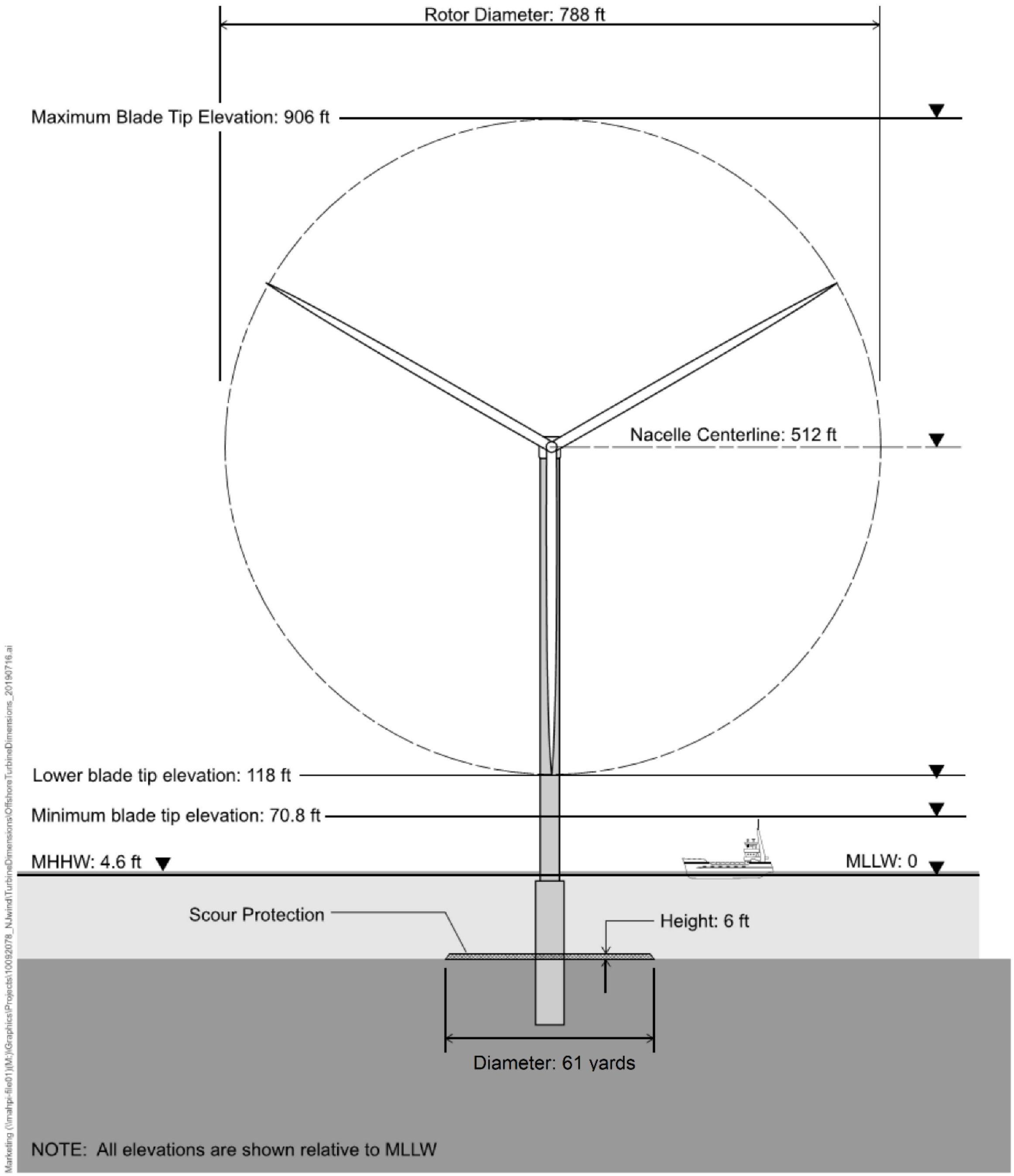


Figure 1-3 Ocean Wind 1 Maximum Design Scenario for Wind Turbines

Array cables would transfer electrical energy generated by the WTGs to the OSS(s). OSS would include step-up transformers and other electrical equipment needed to connect the 66-kilovolt (kV) inter-array cables to the 275 kV or 220 kV offshore export cables. Substations would be connected to one another via substation interconnector cables. Up to two interconnector cables with a maximum voltage of 275 kV would be buried beneath the seabed floor.

Installation of monopile and piled jacket foundations is similar, although piled jacket foundations would require more seabed preparation for each of the jacket feet. A maximum of two jack-up rigs are anticipated to be required in the Offshore Wind Area at any one time (e.g., simultaneously). However, as the acoustic modeling provided for this Project does not analyze concurrent pile driving, this BA assumes that only one monopile will be installed at a time. Pile installation would occur intermittently from May 1 through December 31 to avoid the times of year when North Atlantic right whales (NARWs; *Eubalaena glacialis*) are present in higher densities.

The WTGs and OSSs would be lit and marked in accordance with Federal Aviation Administration and USCG lighting standards and consistent with BOEM's Guidelines for Lighting and Marking of Structures Supporting Renewable Energy Development (BOEM 2021d). Ocean Wind proposes to implement an aircraft detection lighting system to automatically activate lights when aircraft approach. Ocean Wind would paint WTGs no lighter than radar-activated light (RAL) 9010 Pure White and no darker than RAL 7035 Light Grey to help reduce potential visibility against the horizon. Additionally, the lower sections of each structure would be marked with high-visibility yellow paint from the water line to an approximate height of at least 50 feet (15 meters), consistent with International Association of Marine Aids to Navigation and Lighthouse Authorities guidance.

Two offshore export cable route corridors are identified in the COP: Oyster Creek and BL England. The approximately 384 miles (618 km) of in-water transmission cables would be installed in two phases: a simultaneous lay and bury phase at a speed of 1.9 miles (3 km) per day (410 feet/hour; 125 meters/hour; 0.125 km/hour) and a post-lay burial phase at a speed of 6.0 miles (9.6 km) per day (1,312 feet/hour; 400 meters/hour), weather depending. The simultaneous lay and bury phase speed is less than the post-lay burial speed due to the requirement for the vessel to stop and perform anchor resets. Total installation of in-water cables is anticipated to occur over 386 days (Figure 1-4). Up to two offshore export cables would be buried under the seabed within the Oyster Creek export cable route corridor to make landfall and deliver electrical power to the Oyster Creek substation. The offshore export cable route corridor to Oyster Creek would begin within the Wind Farm Area and proceed northwest to the Atlantic Ocean side of Island Beach State Park with a maximum total length of 143 miles (230 km). It is anticipated that approximately 0.8 miles (1.3 km) of cable would be installed per day over a total of 179 days for the Oyster Creek offshore export cable. The inshore export cable route corridor to Oyster Creek would extend north within parking lots, then northwest under Shore Road, and then west into the Bay side of Island Beach State Park before entering Barnegat Bay. Upon entering Barnegat Bay, the export cable route would run west within a previously dredged channel. A second route corridor option would extend directly across Island Beach State Park. Both options would cross Barnegat Bay southwest to make landfall near Oyster Creek in either Lacey or Ocean Township.

Offshore export cables would be installed up to the transition joint bay using open cut (i.e., trenching) or trenchless methods (i.e., bore or HDD). The final method would be based on an assessment of topography, bathymetry, accessibility, tidal conditions, geotechnical situation, environmental constraints, and other parameters. Sheet piling would be temporarily installed to support open cut trenches and as intertidal cofferdams for HDD exit pits. Open cut installation entails excavation of a trench using a land-based or barge-mounted excavator, positioning and securing the cable, burial and backfill to restore pre-existing contours, and revegetation. HDD installation involves excavation of an exit pit, drilling and pumping drilling fluid to create a bore and then pulling conduit into the bore. The export cable is then pulled through the installed conduit. The installation process is supported by a marine work platform and support vessels. The landfall at Island Beach State Park would cross Swimming Beach 2. HDD is the preferred option at this location to achieve burial depths of 30 feet or more. The landfall for BL England would cross Ocean City beaches that are included in the USACE beach nourishment program. Based on USACE guidance, the cable must be buried at depths not attainable by open cut or trenching (30 feet or more) and therefore HDD is the preferred option (Ocean Wind 2022a). One offshore export cable would be buried under the seabed within the BL England export cable route corridor to make landfall and deliver electrical power to the BL England substation. The BL England offshore export cable route corridor would begin within the Wind Farm Area and proceed west to make landfall in Ocean City, New Jersey, with a maximum total length of 32 miles (51 km). Each offshore export cable would consist of three-core 275-kV AC cables. It is anticipated that approximately 1.2 miles (2.0 km) of cable would be installed per day over a total of 26 days for the BL England offshore export cable.

Dredging may be required in shallow areas in Barnegat Bay to facilitate vessel access for export cable installation west of Island Beach State Park and near the landfall at Lacey or Ocean Township. Ocean Wind also proposes to dredge Barnegat Inlet and the Oyster Creek Channel within the authorized width and depth, if necessary to allow for safe and reliable passage of construction vessels into Barnegat Bay. The Oyster Creek Federal Channel in Barnegat Bay is part of the Barnegat Inlet Federal Navigation Project, operated and maintained by USACE. Ocean Wind has coordinated with the USACE Philadelphia District regarding current channel conditions and planned maintenance dredging, as USACE maintains the authorized depths within Barnegat Inlet and the Oyster Creek Channel through regular maintenance dredging. Dredging of an approximately 18,000 cubic yards within an 3.7-acrea area would be conducted using a hydraulic cutterhead or closed-clamshell dredging and dredged material would be transferred to an upland disposal facility via a pipeline system, barge, or scow and disposed of in accordance with EPA Guidelines, USACE Guidelines, N.J.A.C. 7:7 Appendix G for the Management and Regulation of Dredging Activities and Dredged Material in New Jersey’s Tidal Waters, and applicable State Surface Water Quality Standards at N.J.A.C. 7:9B and permit conditions.

Ocean Wind 1 has conducted surveys to locate any third-party infrastructure, such as existing cables, that would be crossed by the Ocean Wind 1 export cable. Ocean Wind 1 is working with the third-party infrastructure owners to develop crossing agreements. Prior to cable installation over an existing live cable, Ocean Wind 1 would install a separation layer (typically three concrete mattresses) over each live crossing location. During simultaneous lay and burial of the export cable, the burial tool would gradually transition out of the seabed on the approach to the live crossing and stop at a safe stand-off distance (to be determined in each crossing agreement). The burial tool is then brought back up to the vessel and the cable is free laid onto the seabed, over the crossing (which is covered by three concrete mattresses). The burial tool is then redeployed to the seabed at safe distance (to be determined in each crossing agreement) on the other side of the crossing and burial operations re-commence along the route. A protection layer consisting of rock placement, mattress placement, or rock bags is then installed over the unburied length of cable on either side of the crossing (see COP Volume I, Section 6.1.2.6.3 for a description of proposed cable protection measures). Where an out of service cable is crossed by the Ocean Wind 1 export cable, Ocean Wind, in agreement with the cable owner, would remove the out of service cable in accordance with International Cable Protection Committee guidelines. Cables are typically removed by pulling a grapnel through the seabed, snagging the out of service cable and cutting it. Each end of the cut cable is peeled to one side and secured on the seabed, leaving a cable free corridor along the export route.

Ocean Wind has proposed several cable route installation methods for the array and substation interconnector cables. Array cables may reach a maximum total length of 190 miles (306 km), while cables associated with linking OSSs may reach a maximum cable length of 19 miles (31 km). It is anticipated that approximately 1.7 miles (2.7 km) of array cable would be installed per day over a total of 112 days (Figure 1-4). It is further anticipated that approximately 1.5 miles (2.4 km) of OSS inter-link cable would be installed per day over a total of 13 days. Cables may be laid and buried post-lay using a jetting tool if seabed conditions allow. Under this option, cables may remain unburied on the seabed within the Wind Farm Area for up to 2 weeks. All cables procured by Ocean Wind 1 would be required to have as a minimum specific gravity of 2.2. This criterion has been demonstrated to prevent unburied cable movement on the seafloor for up to 1 month prior to burial across previous projects in the United States and North Sea. Although all cables for Ocean Wind 1 would have a specific gravity of 2.2 or above, because site-specific conditions may vary across projects, an on-bottom stability assessment would be conducted by the installation contractor for all Ocean Wind 1 cables to ensure cables would remain in place while unburied. The on-bottom stability assessment is a 3D finite element assessment per DNV Recommended Practice F109 and DNV Standard N001. In the unlikely case stability cannot be confirmed for any number of cables, Ocean Wind would assess other pragmatic operational approaches which may include, early burial or temporary stabilization for the specific cables.

Alternatively, the array cables may be laid and buried simultaneously. Under this option, array cables could be installed by using a tool towed behind the installation vessel to simultaneously open the seabed and lay the cable, or by laying the cable and following with a tool to embed the cable. Possible installation methods for these options include jetting, vertical injection, control flow excavation, trenching, and plowing. The inter-array, substation interconnector, and export cables have a target burial depth of 4 to 6 feet (1.2 to 1.8 meters), although final burial depth is dependent on a cable burial risk assessment and coordination with pertinent agencies. The installation vessel would transit to and take position at the landfall location, and the cable end would be pulled into the preinstalled duct ending in the transition junction bay. The installation vessel would transit the route toward the OSS, installing the cable by simultaneous lay and burial (plow/jetting/cutting) or surface lay and burial by a cable burial vessel (jetting/cutting/control flow excavation).

In the event that cables cannot achieve proper burial depths or where the proposed offshore export, array, or substation cables would cross existing infrastructure, Ocean Wind proposes the following cable protection methods: (1) rock placement, (2) concrete mattress placement, (3) front mattress placement, (4) rock bags, or (5) seabed spacers. When the cable has been installed, post-cable-lay surveys and depth-of-burial surveys would be conducted to determine if the cable has reached the desired depth. The remedial protection measures described above may be required in places where the target burial depth cannot be met. A maximum of 10% of offshore export, array, and substation cables is expected to require remedial protection measures. The total area of permanent and temporary disturbance to the seabed by each Project component is listed in Table 1-2 and Table 1-3, respectively.

Table 1-2 Area of Permanent Disturbance to the Seabed by Project Component

Component	Area of Permanent Disturbance	
	Acres	km^2
WTG Foundations	2.3	0.01
WTG Scour Protection	58	0.23
OSS Foundations	0.1	<0.001
OSS Scour Protection	3	0.01
Array Cables	77 (cable protection)	0.31
Substation Interconnector Cables	8 (cable protection)	0.03
Offshore Export Cables within Wind Farm Area	4 (cable protection)	0.02
Offshore Export Cables outside Wind Farm Area	82 (cable protection)	0.33

Source: Modified from COP, Volume II, Table 2.2.5.5 (Ocean Wind 2022a).
Note: These are indicative estimates based on the Project Design Envelope. Potential permanent impacts will be updated based on final design
COP = Construction and Operations Plan; km^2 = square kilometers; WTG = wind turbine generator

Table 1-3 Area of Temporary Disturbance to the Seabed by Project Component

Component	Area of Temporary Disturbance	
	Acres	km^2
Array Cables	2,220	8.98
Substation Interconnector Cables	222	0.89

Component	Area of Temporary Disturbance	
	Acres	km²
Offshore Export Cables within Wind Farm Area	120	0.49
Offshore Export Cables outside of Wind Farm Area	1,980	8.01

Source: Modified from COP, Volume II, Table 2.2.5.5 (Ocean Wind 2022a).
Note: These are indicative estimates based on the Project Design Envelope. Potential temporary impacts will be updated based on final design
COP = Construction and Operations Plan; km^2 = square kilometers

Ocean Wind is continuing to evaluate the risk of encountering unexploded ordnance (UXO)/munitions and explosives of concern (MEC). These include explosive munitions such as bombs, shells, mines, torpedoes, etc. that did not explode when they were originally deployed or were intentionally discarded to avoid land-based detonations. The risk of incidental detonation associated with conducting seabed-altering activities such as cable laying and foundation installation in proximity to UXOs jeopardizes the health and safety of Project participants.

Ocean Wind follows the industry standard As Low as Reasonably Practical (ALARP) process, which minimizes the number of potential detonations (Crussell et al. 2021). While avoidance is the preferred approach for UXO/MEC mitigation, there may be instances when confirmed UXO/MEC avoidance is not possible due to layout restrictions, presence of archaeological resources, or other factors that preclude micro-siting. In such situations, confirmed UXO/MEC may be removed through physical relocation or in-situ disposal. Physical relocation will be the preferred method but is not an option in every case. UXO/MEC may be relocated through a "Lift and Shift" operation, in which case it would be relocated to another suitable location on the seabed within the area of potential effect or previous designated disposal areas for either wet storage or disposal through low or high noise order methods as described below for in-situ disposal. Selection of a removal method will depend on the location, size, and condition of the confirmed UXO/MEC, and will be made in consultation with a UXO/MEC specialist and in coordination with the agencies with regulatory oversite of UXO/MECs. If "lift and shift" operations are required to mitigate potential hazards from confirmed UXOs, areas for relocation would be selected in consultation with BOEM and other appropriate agencies. The distance moved from the as-found location would depend on the distance to the agreed upon relocation area. Factors such as UXO size, type, and condition will be considered prior to any relocation.

HRG surveys and data analyses are still underway, and the exact number and type of UXOs in the Project area are not yet known. As a conservative approach, however, it is currently assumed that up to 10 UXOs may have to be detonated in place. If necessary, these detonations would occur on up to 10 different days (i.e., no more than one detonation would occur within a 24-hour period). The Project does not expect that 10 E12-size UXOs (largest explosive modeled) will be present, but a combination of up to 10 UXOs may be encountered, and to be conservative the larger E12 bin will be used to analyze potential effects. A UXO/MEC Risk Assessment with Risk Mitigation Strategy was conducted for the Project (Ordtek 2020). The likelihood of encountering various MEC types was analyzed for the Project area and assigned one of five possibility rankings: very unlikely, unlikely, possible, likely, and very likely. The presence of MEC was determined to be very unlikely for most MEC types but recorded as possible for small projectiles (<6 inches [15.2 cm]) both nearshore and offshore, meaning that evidence suggests that this type of explosive ordinance could be encountered within the Project area. The primary munitions with potential for occurrence in the dump area close to the Project pose a limited risk and are of low net explosive quantity. Depth charges and torpedoes were given a possibility ranking of unlikely in the Offshore Project area, meaning that some evidence of this type of explosive ordinance in the wider region exists but it would be unusual to encounter it.

If detonation is determined to be the preferred and safest method of disposal, they would only occur during daylight hours. It is expected that impacts from detonations would occur within the current limits defined for the Project Design Envelope, but would depend on the soil conditions, burial depth, and type of UXO found. UXO would be disposed of in situ with low-order (deflagration) or high-order (detonation) methods or by cutting the UXO to extract the explosive components. As outlined in the construction schedule presented in Figure 1-4, UXO detonations would begin as early as June 2023 and would only occur from May 1 through December 31 to avoid times of year when NARWs are present in higher densities. Potential locations of UXO within the Project area have not been released at the time of this assessment.

Construction and installation would require several different types of vessels to support the Project (Table 1-4). Construction vessels would travel between the Wind Farm Area and the following ports that are expected to be used during construction: Atlantic City, New Jersey, as a construction management base; Paulsboro, New Jersey, or from Europe directly for foundation fabrication and load out; Norfolk, Virginia, or Hope Creek, New Jersey, for WTG pre-assembly and load out; and Port Elizabeth, New Jersey, or Charleston, South Carolina, or directly from Europe for cable staging. During installation of array and substation interconnection cables, Ocean Wind anticipates a maximum of 18 vessels operating during a typical workday in the Wind Farm Area. Many vessels would remain in the Offshore Project area (which includes the Wind Farm Area and offshore export cable corridors) for days to weeks at a time, potentially only making infrequent trips to port for bunkering and provisioning as needed. For offshore export cable installation, Ocean Wind anticipates a maximum of 26 vessels operating in the Project area during a typical workday (Table 1-5). A number of vessels involved in cable installation would utilize dynamic positioning thrusters. A list of Applicant Proposed Measures (APMs) to avoid, minimize, or mitigate impacts can be found in Table 1-11. When considering the number of construction vessels and trips per activity (Table 1-5) in terms of when and the duration the construction activity would be expected to occur (Figure 1-4) and if equal distribution of trips occurs across each quarter, vessel activity would be spread out as shown in Table 1-6.

Table 1-4 Construction Vessel Size Summary

Construction Activity	Vessel Type
WTG Installation	
--	Installation Vessel – 476 by 197 feet (145 by 60 meters) (not including helideck, crane); Displacement: 43000Te
--	Unpowered Feeder Barges – 410 by 115 feet (125 by 35 meters); Displacement: 21000Te
--	Tug – 148 by 49 feet (45 by 15 meters)
Foundations	
--	MP Installation: Floating Heavy Lift Vessel – 787 by 164 feet (240 by 50 meters); Displacement: 61.000T
--	SS Installation: Jack-Up Vessel – 459 by 131 feet (140 by 40 meters); Displacement: 8.000T
--	Noise Mitigation Vessel – 295 by 66 feet (90 by 20 meters); Displacement: 4900T
Export Cable Installation	
Export Cable Lay (offshore)	Approx. Length: 427 feet (130 meters); Beam: 98 feet (30 meters); Deadweight: 10,800Te
Trenching Support	Approx. Length: 328 feet (100 meters); Beam: 66 feet (20 meters); Deadweight: 3,000Te
Export Cable Lay (Inshore)	Approx. Length: 410 feet (125 meters); Beam: 115 feet (35 meters); Depth: 26 feet (8 meters) Plus Anchor handler support vessels

Construction Activity	Vessel Type
Export Cable Installation – Secondary Support Vessels	
Pre-lay Grapnel Runs, Boulder Removal, mattressing, surveys	Approx. Length: 262 feet (80 meters); Beam: 66 feet (20 meters); Gross: 2,400 GT
Survey	Approx. Length: 164 feet (50 meters); Beam: 33 feet (10 meters); Gross 615 GT
Anchor Handling Tug	Approx. Length: 98 feet (30 meters); Beam: 49 feet (15 meters); Gross: 345 GT
Rock Installation	Approx. Length: 525 feet (160 meters); Beam: 131 feet (40 meters); Cargo: 24,000Te
Crew Transfer Vessel (CTV)	Approx. Length: 89 feet (27 meters); Beam: 36 feet (11 meters); Gross: 235 GT
Array Cable Installation – Primary Array Cable Installation Vessels	
Array Cable Lay	Approx. Length: 459 feet (140 meters); Beam: 98 feet (30 meters); Deadweight: 10,000Te
Trenching Support	Approx. Length: 328 feet (100 meters); Beam: 98 feet (30 meters); Displacement: 12,200Te
Array Cable Installation– Secondary Support Vessels	
Pre-lay Grapnel Runs	Approx. Length: 230 feet (70 meters); Beam: 66 feet (20 meters); Gross: 1,660 ITC
Boulder removal	Approx. Length: 312 feet (95 meters); Beam: 66 feet (20 meters); Deadweight: 3,285 LT
Survey	Approx. Length: 164 feet (50 meters); Beam: 39 feet (12 meters); Gross: 615 GT
Crew Transfer Vessel (CTV)	Approx. Length: 98 feet (30 meters); Beam: 36 feet (11 meters); Gross: 235 GT
Crew transfer and accommodation	Approx. Length: 295 feet (90 meters); Beam: 66 feet (20 meters); Deadweight: 4,870 LT
Rock Installation	Approx. Length: 525 feet (160 meters); Beam: 118 feet (36 meters); Cargo: 24,000Te
Federal Channel Dredging	
Dredging	Cutterhead Dredge (Barnegat Bay Dredging Co., Inc. Fullerton or similar) or Closed-Clamshell Bucket Dredge
Sediment Barging	Shallow-water Sealed Barges or Scows and Shallow-draft Tug

GT = gross tonnage; ITC = International Convention on Tonnage Measurement; LT = long ton; T = imperial tons; Te = metric tonne

Table 1-5 Construction Vessel Summary

Vessel Type	Maximum Number of Simultaneous (at any one time) Vessels Required in the Project Area[a]	Maximum Number of Round Trips per Vessel Type	Approximate Vessel Draft (meters)[b]	Average/ Normal Operating Speed (knots)
WTG Foundation Installation				
Scour Protection Vessel	1	50	8	6.5

Vessel Type	Maximum Number of Simultaneous (at any one time) Vessels Required in the Project Area[a]	Maximum Number of Round Trips per Vessel Type	Approximate Vessel Draft (meters)[b]	Average/ Normal Operating Speed (knots)
Installation Vessel	4	99	13.5	10
Support Vessels	16	396	CTV: 3 SOV: 7.5 Noise Mitigation & monitoring vessel: 7	23
Transport/Feeder Vessels (including tugs)	40	396	7	4
- of which are anchored	2	198		
WTG Structure Installation				
Installation Vessels	2	99	6.5	10
Transport/Feeder Vessels	12	99	6.5	4
Other Support Vessels	24	594	7	23
Substation Installation[c]				
Primary Installation Vessels	2	12	13.5	10
Support Vessels	12	72	7	23
Transport Vessels	4	24	6	4
Array Cable Installation[d]				
Main Laying Vessels	3	99	5	2.4
Main Burial Vessels	3	99	5	2.4
Support Vessels	12	594	7	23
Substation Inter-link Cable Installation[e]				
Main Laying Vessels	Included in numbers for export and array cables	8	5	2.4
Main Burial Vessels		8	5	2.4
Support Vessels		12	7	23
Offshore Export Cable Installation[f]				
Main Laying Vessels	3	48	5	2.4
Main Cable Joining Vessels	3	36	6.5	2.4
Main Burial Vessels	3	48	5	2.4
Support Vessels	15	72	7	23
Federal Channel Dredging				
Dredging	1	1	<2.4	4
Scow/Barge/Tug	2	4	<2.4	4

Notes:
a “Simultaneous” refers to the number of vessels needed for an activity and indicates that the vessels would be required at the same time for the duration of the activity.
b “Vessel draft” is approximate and represents a conservative value that is subject to change.

c Substation installation is anticipated to occur over a maximum duration of 67 days.
d Array cable installation is anticipated to occur over a maximum duration of 12 months. The installation of each cable section is anticipated to occur over 3.5 days.
e Substation inter-link cable installation is anticipated to occur over a maximum duration of 1 month. The installation of each cable section is anticipated to occur over 20 days.
d Offshore export cable installation is anticipated to occur over a maximum duration of 6 months. The installation of each cable section is anticipated to occur over 59 days.
CTV = crew transfer vessel; N/A = not applicable; SOV = surface operation vessel; WTG = wind turbine generator

Table 1-6 Construction Vessel Number and Trip Distribution per Quarter and Activity

Activity	2023				2024				2025			
	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4
WTG Foundation Installation						61/ 314	61/ 314	61/ 314				
WTG Structure Installation							38/ 132	38/ 132	38/ 132	38/ 132	38/ 132	38/ 132
Substation Installation							18/ 18	18/ 18	18/ 18	18/ 18	18/ 18	18/ 18
Array Cable Installation							18/ 264	18/ 264	18/ 264			
Substation Cable Installation					NA/ 6	NA/ 6	NA/ 6					
Offshore Export Cable				12/3 4	12/3 4	12/3 4	12/3 4	12/3 4	12/3 4			
Dredging				1/1								
Scow/Barge/Tug				2/4								
Total	00/ 00	00/ 00	00/ 00	15/ 39	12/ 40	73/ 354	147/ 768	147/ 762	86/ 448	56/ 150	56/ 150	56/ 150

Note: Vessel and trip numbers are represented in each cell with the top number denoting the maximum number of vessels used for that particular construction activity separated with a "/" from the bottom number denoting the maximum number of vessel trips required for that particular construction activity.
N/A = not applicable; Q = quarter; WTG = wind turbine generator

1.3.2 Operations and Maintenance

The Project is anticipated to have an operating period of 35 years.[1] Ocean Wind would use an onshore O&M facility in Atlantic City, New Jersey, sited at the location of a retired marine terminal. Ørsted plans to rehabilitate this former marina facility near Absecon Inlet to create a port facility located off the Mid-Atlantic coast that can service potential wind turbine farms. The O&M facility would include offices, control rooms, warehouses, and workshop space. Approximately 500 feet (152 meters) of dockside harbor facilities and associated parking facilities would be added. The City of Atlantic City intends to secure authorization for marina upgrades, namely, dredging in the marina and at Absecon Inlet, for the benefit of multiple marina users which will be authorized under a different project. Ørsted's rehabilitation of the former marina facility (including office and warehouse construction) and the City of Atlantic City's

[1] For analysis purposes, BOEM assumes that the proposed Project would have an operating period of 35 years. Ocean Wind's lease with BOEM (Lease OCS-A 0498) has an operations term of 25 years that commences on the date of COP approval. (See https://www.boem.gov/sites/default/files/renewable-energy-program/State-Activities/NJ/NJ-SIGNED-LEASE-OCS-A-0498.pdf; see also 30 CFR § 585.235(a)(3).) Ocean Wind would need to request and be granted an extension of its operations term from BOEM under the regulations at 30 CFR 585.425 et seq. in order to operate the proposed Project for 35 years. While Ocean Wind has not made such a request, this BA uses the longer period to avoid possibly underestimating any potential effect.

marina upgrades are being reviewed and authorized by the USACE, state and local agencies. These improvements are therefore not considered part of the Proposed Action.

The proposed Project would include a comprehensive maintenance program, including preventative maintenance based on statutory requirements, original equipment manufacturers' guidelines, and industry best practices. Ocean Wind would inspect WTGs, OSSs, foundations, offshore export cables, inter-array cables, onshore export cables, and other parts of the proposed Project using methods appropriate for the location and element.

Ocean Wind would conduct inspections of foundations, bathymetry, scour (and associated scour protection, if deployed), and cable burial. Multi-beam echosounder (MBES) surveys would be conducted during years 1, 4, and 5 post-commissioning, after which an optimal survey frequency would be determined based on initial findings. Sonar, remotely operated vehicles, drones, and divers may be required. Routine maintenance is expected for WTGs, foundations, and OSSs. Ocean Wind would conduct annual maintenance of WTGs, including safety surveys, blade maintenance, and painting as needed. Ocean Wind is developing a cable monitoring and maintenance plan which will be included in the Facility Design Report and reviewed by the Certified Verification Agent. The offshore export cables, inter-array cables, and OSS interconnector cables typically have no maintenance requirements unless a failure occurs. Cables would be surveyed during years 1, 2-3, and 5-8 after commissioning an as needed after major storm events. Episodic repairs of cable faults, failures, and exposed cables would be conducted as necessary (see COP Volume I, Section 6.1.4.4 for a description of proposed cable maintenance activities). Routine maintenance to remove marine debris is not planned at this time; however, BOEM proposed measure #23 in Table 1-11 requires the Applicant to periodically monitor and report on lost monofilament and other fishing gear around WTG foundations. OSS would be routinely maintained for preventative maintenance up to 12 times per year. Spare parts for key Project components may be housed at the O&M facility so Ocean Wind could initiate repairs expeditiously.

Ocean Wind would need to use vessels and vehicles during O&M activities described above. The Project would use a variety of vessels to support O&M including crew transfer vessels (CTVs), service operation vessels, jack-up vessels, and supply vessels. Approximate parameters of CTVs are presented in Table 1-7. In a year, the proposed Project would generate a maximum of 908 crew vessel trips, 102 jack-up vessel trips, and 104 supply vessel trips; and a maximum of 2,278 CTV trips or service operations vessel trips (Table 1-8; Ocean Wind 2022a).

Table 1-7 Maintenance Vessel Size Summary

Vessel Type	Vessel Size Parameters
Crew Transfer Vessel	Approx. Length: 89 feet (27 meters); Beam: 36 feet (11 meters); Gross: 235 GT

GT = gross tonnage

Table 1-8 Operations and Maintenance Annual Vessel Trip Summary

Homeport	Approx. Distance to Project (nautical miles)	Vessel Type	Number of Expected Trips per year	Approximate Vessel Draft (meters)[a]	Average/ Normal Operating Speed (knots)
Atlantic City	24.4	Crew Vessel	908	3	23
Atlantic City	24.4	Jack-Up	102	5	10
Atlantic City	24.4	Supply Vessel	104	7	11

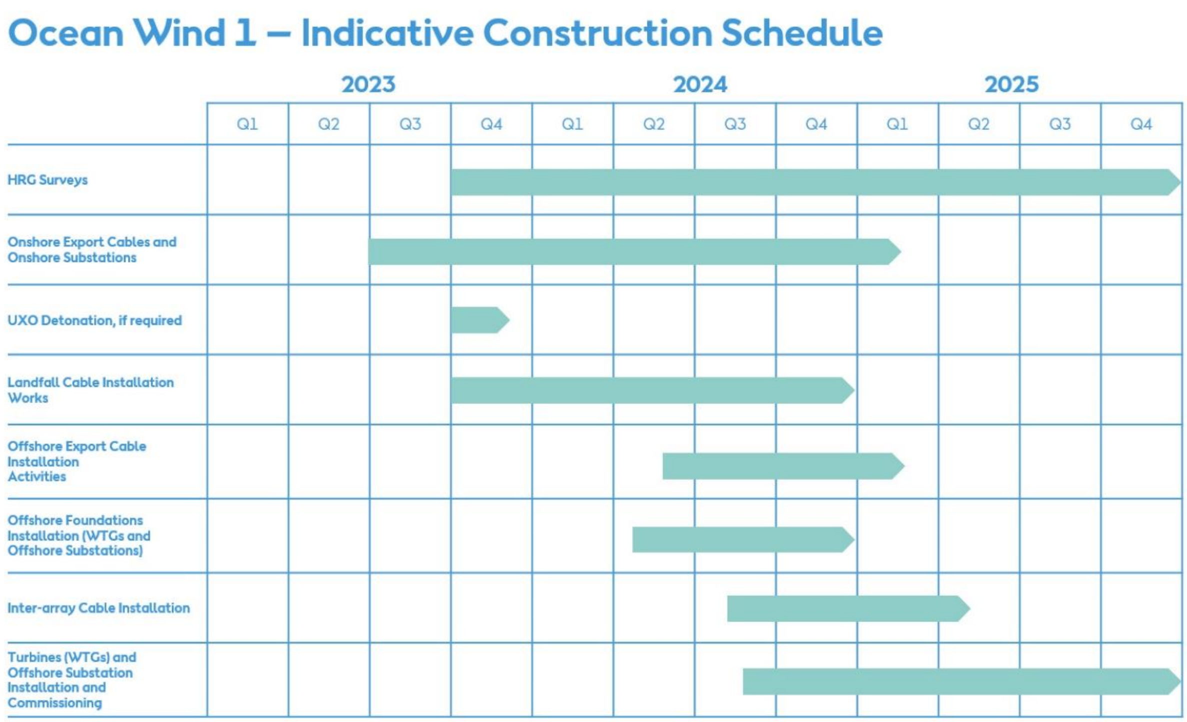
Homeport	Approx. Distance to Project (nautical miles)	Vessel Type	Number of Expected Trips per year	Approximate Vessel Draft (meters)[a]	Average/ Normal Operating Speed (knots)
Atlantic City	24.4	CTV/ Service Operations	2,278	CTV: 3 SOV: 7	23

[a] Vessel draft is approximate and represents a conservative value that is subject to change.
CTV = crew transfer vessel; NA = not applicable; SOV = surface operation vessel

1.3.4 Monitoring Surveys

This section outlines the surveys proposed for the Project. These include HRG surveys, geotechnical surveys, passive acoustic monitoring and biological monitoring surveys, and surveys that support the Fisheries Monitoring, Benthic Monitoring, and SAV Monitoring Plans and, at this time, span both construction and operation and maintenance phases (Table 1-9).

1.3.4.1 High-Resolution Geophysical and Geotechnical Surveys



Source: Ocean Wind 2022a

Figure 1-4 Offshore Construction Activities for the First 5 Years of the Project, as Outlined in the Ocean Wind 1 COP, Vol I

Table 1-9 Ocean Wind Monitoring Survey Activities for Two Years Pre-Construction, during Construction, and the First Five Years Post-Construction

Type	2021	2022				2023				2024				2025				2026				2027				2028				2029				2030				2031			
	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4
HRG								■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■																
Novel Hard Bottom																				■				■				■				■								■	
Soft Bottom: WTG										■										■				■				■				■								■	
Soft Bottom: Cable[1]																				■				■				■				■				■				■	
Soft Bottom: Sand Ridge[1]										■										■				■								■				■				■	
SAV[2]								■				■				■				■				■				■				■				■				■	
Trawl						■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■																
Structure-Associated Fish			■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■															
Clam				■				■				■				■				■				■																	
Oceanography[3]	■						■				■				■				■				■																		
Pelagic Fish[3]							■				■				■				■				■																		
Acoustic Telemetry (hydrophone tow)	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■																

[1] Surveys for this type may be required during Years 3+ if benthic function is still distinguishable from baseline.
[2] Surveys for SAV are required in Q3 2026, Q3 2027, and Q3 2029 consistent with the Benthic Monitoring Plan and are required annually in Q3 between 2023 and 2033 consistent with the SAV Mitigation Plan (Ocean Wind 2022b).
[3] Surveys for this type are only required once per phase (e.g., pre-construction, construction, and post-construction) and could occur during the spring of either year during construction and post-construction.
HRG = high-resolution geophysical; Q = quarter; SAV = submerged aquatic vegetation; WTG = wind turbine generator

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1.3.4.5 Submerged Aquatic Vegetation Monitoring

The proposed Submerged Aquatic Vegetation (SAV) Monitoring Plan (Inspire 2022b) is designed to document baseline delineations and conditions of SAV beds, assess potential impacts to these SAV beds as a result of the construction and operations of the inshore export cable(s) associated with the Project, and track recovery of these SAV beds over time to inform potential mitigation strategies, if necessary. Survey protocols and methodologies will be refined and updated based on feedback received from stakeholder groups, including NJDEP, NOAA, and BOEM. The proposed SAV Mitigation Plan (Ocean Wind 2022b) further outlines Ocean Wind's proposed process to ensure that any impacts, which cannot be avoided or minimized, on SAV incurred during construction and installation activities of the Ocean Wind 1 export cable are adequately mitigated.

1.3.5 Proposed Mitigation, Monitoring, and Reporting Measures

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Table 1-11 Mitigation Monitoring, and Reporting Measures – Committed to by the Applicant

No	Measure	Description	Project Phase	Expected Effects
Impact Pile Driving				
24	Pre-start clearance for impact pile driving	• Ocean Wind has proposed that piling may be initiated at any time within a 24-hour period • Prior to the beginning of each pile driving event, PSOs and PAM operators will monitor for marine mammals and sea turtles for a minimum of 30 minutes and continue at all times during pile driving. • All shutdown zones will be confirmed to be free of marine mammals and sea turtles prior to initiating ramp-up and the low frequency cetacean shutdown zone will be fully visible, and the NARW acoustic zone monitored for at least 30 minutes prior to commencing ramp-up. • If a marine mammal or sea turtle is observed entering or within the relevant shutdown zones prior to the initiation of pile driving activity, pile driving activity will be delayed and will not begin until either the marine mammal(s) or sea turtle(s) has voluntarily left the respective shutdown zones and been visually or acoustically confirmed beyond that shutdown zone, or when the additional time period has elapsed with no further sighting or acoustic detection (i.e., 15 minutes for dolphins, porpoises and seals and 30 minutes for whales, 30 minutes for sea turtles). • A PSO will observe a behavioral monitoring zone of 1,200 meters for all species of sea turtle; however the shutdown zone remains 500 meters.	Construction	The establishment of a shutdown zone may decrease the potential for impacts to ESA-listed species during impact pile driving.
SAV/Seabed Disturbance				
69	Mitigation	Implement the SAV Mitigation Plan dated November 2022 (Ocean Wind 2022b), which includes mapping efforts, monitoring activities, restoration of documented activities at an in-situ 1:1 ratio, annual reporting, as well as additional research to improve SAV mitigation in the future.	Pre-construction, construction, O&M	This mitigation measures would ensure any unavoidable impacts to SAV during construction are restored or mitigated.
BOEM PDCs/BMPs				
70	COP PDCs/APMs	Site offshore facilities to avoid known locations of sensitive habitat or species during sensitive periods; important marine habitat; and sensitive benthic habitat to the extent practicable. Avoid hard-bottom habitats and seagrass communities, where practicable, and restore any damage to these communities.	Pre-construction	The mitigation measure would avoid adverse impacts to marine mammals, sea turtles, and ESA-listed fish by avoiding sensitive habitat and species presence to the extent practicable.
71	COP PDCs/APMs	Use standard underwater cables which have electrical shielding to control the intensity of EMF.	Construction, O&M	The mitigation measure would decrease area of EMF effects to marine mammals, sea turtles, and ESA-listed fish.
72	COP PDCs/APMs	Conduct an SAV survey of the proposed inshore export cable route.	Pre-construction	The mitigation measure would not minimize adverse effects to marine mammals, sea turtles, and ESA-listed fish prey but identifying the potential for effects.
73	COP PDCs/APMs	Evaluate geotechnical and geophysical survey results to identify sensitive habitats and avoid these during construction, to the extent practicable.	Construction	The mitigation measure would avoid adverse impacts to marine mammals, sea turtles, ESA-listed fish, and their prey by avoiding sensitive habitat and species presence to the extent practicable.
74	COP PDCs/APMs	Obtain necessary permits to address potential impacts on marine mammals from underwater noise and established appropriate and practicable mitigation and monitoring measures in coordination with regulatory agencies.	Construction, O&M	The mitigation measure would minimize the potential for adverse effects on marine mammals, sea turtles, and ESA-listed fish resulting from potential Project effects by consulting with and adhering to agency required measures.
75	COP PDCs/APMs	Lessees and grantees should evaluate marine mammal use of the proposed Project area and should design the Project to minimize and mitigate the potential for mortality or disturbance. The amount and extent of ecological baseline data required should be determined on a project basis.	Pre-Construction	The mitigation measure would minimize the potential for adverse effects on marine mammals, sea

No	Measure	Description	Project Phase	Expected Effects
				turtles, and ESA-listed fish resulting from potential Project effects.
76	COP PDCs/APMs	Vessels related to Project planning, construction, and operation should travel at reduced speeds when assemblages of cetaceans are observed. Vessels also should maintain a reasonable distance from whales, small cetaceans, and sea turtles, and these should be determined during site-specific consultations.	Construction, O&M, decommissioning	The mitigation measure would minimize the potential for adverse effects on marine mammals, sea turtles, and ESA-listed fish resulting from vessel interactions.
77	COP PDCs/APMs	Lessees and grantees should minimize potential vessel impacts to marine mammals and sea turtles by having Project-related vessels follow the National Marine Fisheries Service (NMFS) Regional Viewing Guidelines while in transit. Operators should undergo training on applicable vessel guidelines.	Construction, O&M, decommissioning	The mitigation measure would minimize the potential for adverse effects on marine mammals, sea turtles, and ESA-listed fish resulting from vessel interactions. Training of crew and personnel would minimize the potential for adverse effects to ESA-listed species by increasing the effectiveness of mitigation and monitoring measures through educational and training materials and avoiding vessel interactions with ESA-listed species.
78	COP PDCs/APMs	Lessees and grantees should take efforts to minimize disruption and disturbance to marine life from sound emissions, such as pile driving, during construction activities.	Construction, O&M, decommissioning	The mitigation measure would minimize the potential for disruption and disturbance effects on marine mammals, sea turtles, and ESA-listed fish resulting from vessel interactions.
79	COP PDCs/APMs	Lessees and grantees should avoid and minimize impacts to marine species and habitats in the Project area by posting a qualified observer on site during construction activities. These observers are approved by NMFS.	Construction	The mitigation and monitoring measure would not minimize adverse effects but would ensure the effectiveness of the required mitigation and monitoring measures for construction activities.
80	Dredge BMP – USACE 2022	• Utilizing closed environmental clamshell bucket equipped with sensors • Controlled lift speed • Holding times for water decanting • No barge overflow • Limited rinsing/hosing of barge to prevent runoff • Discharge of decant water into same water body from which it came • Water quality (TSS & turbidity) monitoring • Silt curtain (along shallow areas vs construction area) as feasible. For example, during the HDD exit pit excavation dredging within Barnegat Bay along the Oyster Creek export cable routes. Additionally, during ultrashallow dredging in proximity to SAV beds, the installation of silt curtains is being considered parallel to the SAV beds to reduce sediment deposition in these sensitive areas.	Construction, O&M, decommissioning	The mitigation measure would reduce effects associated with turbidity.
81	Jetting Installation BMPs – USACE 2022	• Modifying installation speed/jetting pressure to minimize sediment resuspension • Water quality (TSS & turbidity) monitoring • Silt curtain (along shallow areas vs construction area) as feasible	Construction, O&M, decommissioning	The mitigation measure would reduce effects associated with turbidity.
82	BMPs for SAV	• Use of horizontal directional drilling (HDD) will allow the Project to avoid areas of SAV during construction on the eastern and western shorelines of Barnegat Bay and in Peck Bay • The current Ocean Wind construction schedule enables the in-water work within known SAV habitat to be conducted late fall through early spring which is outside the growing season for SAV • BMPs to be implemented when construction activities are within 500 feet (152 meters) from SAV beds: – Use of silt curtains along shallow areas to the maximum extent practicable (based on hydrodynamics and water depth)	Construction, O&M, decommissioning	The mitigation measure would reduce effects to SAV.

No	Measure	Description	Project Phase	Expected Effects
		– Utilization of a closed environmental clamshell bucket equipped with sensors during dredging activities – Modifying installation speed/jetting pressure during cable lay to minimize sediment resuspension and water quality (TSS and turbidity) monitoring.		
83	SAV site-specific monitoring program	The Project will develop and implement a site-specific monitoring program to ensure that environmental conditions are monitored before and after construction to determine the amount of restoration required. The monitoring plan is in the process of being developed in consultation with resource agencies. If required based on the results of monitoring, restoration may include the following: onsite in-kind restoration which may include transplanting or seed dispersion to restore the disturbed area to its preconstruction contours and conditions, offsite in-kind restoration, onsite ecological enhancement of similar ecological function and value, other options including stakeholder mitigation to be coordinated with the NJDEP, NOAA and consulting parties or a combination of the above.	Construction, O&M, decommissioning	The mitigation measure would reduce effects to SAV.

Source: Ocean Wind 2022; HDR, Inc. 2022a, 2022b

AAR = autonomous acoustic recorder; APM = Applicant Proposed Measure; ASV = autonomous surface vehicle; BMP = best management practice; BOEM = Bureau of Ocean Energy Management; CHIRP = compressed high-intensity radar pulse, dB = decibels; DE = Delaware; DMA = Dynamic Management Area; EMF = electromagnetic field; ESA = Endangered Species Act; ft = feet; h = hour; HD = high definition; HRG = high-resolution geophysical; IR = infrared; HSE = health, safety, and environment; IR = infrared; ISO = International Organization for Standardization; ITA = Incidental Take Authorization; kg = kilograms; kHz = kilohertz; km = kilometers; lbs = pounds; LOA = Letter of Authorization; L_{rms} = root mean squared sound pressure level; m = meters; MD = Maryland; mm = millimeters; NARW = North American right whale; NJ = New Jersey; NMFS = National Marine Fisheries Service; NMS = noise mitigation system; NOAA = National Oceanic and Atmospheric Administration; NVD = night-vision device; NY = New York; O&M = operations and maintenance; OSS = offshore substation; PAM = passive acoustic monitoring; PDC = Project Design Criteria; PECP = permits and environmental compliance; PSMMP = Protected Species Mitigation and Monitoring Plan; PSO = protected species observer; PTS = permanent threshold shift; QA/QC = quality assurance/quality control; ROSA = Responsible Offshore Science Alliance; RWSAS = Right Whale Sighting Advisory System; SAS = sighting advisory system; SAV = submerged aquatic vegetation; SBP = sub-bottom profiler; SFV = sound field verification; SMA = Seasonal Management Area; SPL = sound pressure level; USBL = Ultra-Short BaseLine; USACE 2022 = Ocean Wind USACE Permit Application Package, Attachment 02 Environmental Assessment, April 27, 2022; UXO = unexploded ordnance; VHF = very high frequency

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3. EFFECTS OF THE PROPOSED ACTION

3.2. MARINE MAMMALS

3.2.6 Effects Analysis for Marine Mammals

3.2.6.2. Underwater Noise

BOEM recognizes that underwater noise can result in the exposure of ESA-listed marine mammal species leading to ESA-level takes of harm and/or harass. The Proposed Action would produce temporary construction-related underwater noise and long-term operational underwater noise above levels that may impact listed species. Underwater noise generated by Project construction and operations include impact pile driving for the installation WTGs and OSS, detonations of UXOs, HRG surveys, vibratory installation, and removal of sheet piles for the cofferdam, vessel activity, cable laying and trenching, dredging, and WTG operations. These activities would increase sound levels in the marine receiving environment and may affect ESA-listed marine mammals in the Project area and Action Area.

3.2.6.2.1 Overview of Underwater Noise

The extent and severity of auditory and non-auditory effects from Project-generated underwater noise is dependent on the timing of activities relative to species occurrence, the type of noise impact, and species-specific sensitivity. To support the underwater noise assessment for the Project, the Applicant conducted Project-specific underwater noise modeling for the following Project activities: impact pile driving, vibratory sheet pile driving, UXO detonations, and HRG surveys. The assessment of underwater noise in this BA uses modeling and take numbers (Level A and Level B harassment as per the MMPA) presented in Ocean Wind's application for an LOA February 2022, and supplemented with an update memo submitted to NMFS in August 2022. A summary of the reports used in the BA are provided below:

1. UXO underwater modeling report for marine mammals, sea turtles and fish. Hannay, D.E. and M. Zykov. 2022. Underwater Acoustic Modeling of Detonations of Unexploded Ordnance (UXO) for Ørsted Wind Farm Construction, US East Coast. Document 02604, Version 3.0. Report by JASCO Applied Sciences for Ørsted.
2. Impact pile driving underwater modeling report for marine mammals sea turtles and fish. Küsel, E. T., M. J. Weirathmueller, K. E. Zammit, S. J. Welch, K. E. Limpert, and D. G. Zeddies. 2022. Underwater Acoustic and Exposure Modeling. Document 02109, Version 1.0 DRAFT. Technical report by JASCO Applied Sciences for Ocean Wind LLC.
3. Vibratory pile driving underwater modeling for marine mammals. JASCO Applied Sciences Inc. (JASCO). 2022. Distance to behavioral threshold for vibratory pile driving of sheet piles. Technical Memorandum by JASCO Applied Sciences for Ocean Wind LLC, Dated 21 March 2022.
4. HRG Survey underwater modeling for marine mammals. HDR. 2022a. Ocean Wind Offshore Wind Farm. Application for Marine Mammal Protection Act (MMPA) Rulemaking and Letter of Authorization Application. Prepared for: Ocean Wind LLC, Prepared by: HDR. Dated February, 2022.
5. Updated density estimates for take request. HDR. 2022c. Ocean Wind 1 Offshore Wind Farm. Updates to the Application for Marine Mammal Protection Act (MMPA) Rulemaking and Letter of Authorization. Prepared for: Ocean Wind LLC, Prepared by: HDR. Dated August, 2022.

3.2.6.2.4 Assessment of Effects

3.2.6.2.4.1 Impulsive Underwater Noise

Impact Pile Driving (C)

Effects of Exposure to Noise Above the PTS Thresholds

No PTS exposures are expected for blue whales, NARWs, or sperm whales for any Project activity; thus, the potential for PTS exposure to these ESA-listed species is considered extremely unlikely to occur and **discountable**. Therefore, the effects of noise exposure from Project impact pile driving leading to PTS **may affect**, **not likely to adversely affect** blue whales, NARWs, or sperm whales**.**

Modeling indicates that up to four individual fin whales and one sei whale may be exposed to underwater noise levels above PTS thresholds from impact pile driving noise. The potential for serious injury is minimized by the implementation of pre-clearance, shutdown zones, and ramp-ups for impact pile driving operations that would facilitate a delay of pile driving if marine mammals were observed approaching or within areas that could be ensonified above sound levels that could result in auditory injury. These measures also make it unlikely that any ESA-listed cetacean will be exposed to pile driving that would result in severe hearing impairment or serious injury and would more likely have the potential to result in slight PTS (i.e., minor degradation of hearing capabilities at some hearing thresholds). In addition, ramp-ups could be effective in deterring marine mammals from impact pile driving activities prior to exposure resulting in a serious injury. The potential for serious injury is also minimized through using a noise mitigation system during all impact pile driving operations. The proposed requirement that impact pile driving can only commence when the pre-clearance zones (Table 3-8) are fully visible to PSOs allows a high marine mammal detection capability, and enables a high rate of success in implementing these zones to avoid serious injury. However, exposures leading to PTS are still possible, therefore, the effects of noise exposure from Project impact pile driving leading to PTS **may affect, likely to adversely affect** fin whales and sei whales.

Effects of Exposure to Noise Above the Behavioral Thresholds and Masking

Considering impact pile driving activities, up to eight fin whales, four NARWs, and two sei whales, four blue whales (based on take numbers only), and six sperm whales (based on take numbers only) may be exposed to noise levels that exceed behavioral thresholds (Table 3-10 and Table 3-11). Although behavioral thresholds may be reached, how species react and the subsequence consequence of these reactions are relatively unknown. This is due to the lack of species-specific studies that outline the behavioral responses of ESA-listed marine mammal species likely to be present in the Action Area to Project activities (i.e., impact pile driving activities, vibratory pile driving activities, HRG surveys, or UXO detonations). Some avoidance and displacement of LFCs has been documented during other impulsive noise activities (seismic exploration), which may be used as a proxy to determine the potential behavioral reactions of LFC to other impulsive activities such as impact pile driving or UXO detonations. However, recent reports assessing the severity of behavioral reactions to underwater noise sources indicates that applying behavioral responses across broad sound categories (e.g., impact pile driving and seismic exploration are both impulsive) can lead to significant errors in predicting effects (Southall et al. 2021). Hearing-specific analyses are presented below.

Table 3-10 Number of ESA-Listed Marine Mammal Exposed to Sound Levels Above PTS and Behavioral Thresholds for Impact Pile Driving – WTG Installation – 10 dB Attenuation

Marine Mammal Species		PTS	Behavioral
LFC	NARW	0.9[a]	3.11
	Blue whale	0	0[b]

Marine Mammal Species		PTS	Behavioral
	Fin whale	3.69	7.05
	Sei whale	0.89	2
MFC	Sperm whale	0	0[c]

Source: HDR 2022c
Notes: Worst-case scenario presented, included modeling of two monopiles per 24-hour period and the results for the $L_{E,24h}$ threshold. Monopile foundation assumed tapered 8- to 11-meter-diameter piles, 50-meter penetration depth, and 4,000-kilojoule hammer energy. In the text, exposure values ≥0.5 were rounded up to the nearest integer, values <0.5 rounded down to 0.
dB = decibels; ESA = Endangered Species Act; LFC = low-frequency cetaceans; $L_{E,24h}$ = cumulative sound exposure level; MFC = mid-frequency cetaceans; NARW = North Atlantic Right Whale; PTS = permanent threshold shift; WTG = wind turbine generator
[a] PTS exposures were estimated for this species, but due to mitigation measures proposed by the Applicant, no PTS (Level A takes) exposures are expected and no Level A takes have been requested for these species.
[b] No Level B exposures were estimated for blue whale, but up to 4 Level B takes not calculated through density estimates are requested in the unlikely event that 4 individuals, or two cow and calf pairs, approach monopile installation.
[c] No Level B exposures were estimated for sei whale, but up to 3 Level B takes not calculated through density estimates requested for these species based on mean group size.

Table 3-11 Number of ESA-Listed Marine Mammal Exposed to Sound Levels Above PTS and Behavioral Thresholds for Impact Pile Driving – OSS Installation – 10 dB attenuation

Marine Mammal Species		Option 1: Three Monopiles		Option 2: 48 Pin Piles	
		PTS	Behavioral	PTS	Behavioral
LFC	NARW	0.04[a]	0.14	0.10[a]	0.75
	Blue whale	0	0	0	0
	Fin whale	0.15	0.27	0.48	1.20
	Sei whale	0.04	0.08	0.14	0.45
MFC	Sperm whale	0	0[b]	0	0[b]

Source: HDR 2022c.
Note: Worst-case scenario presented, included modeling of two monopiles per 24-hour period and the results for the $L_{E,24h}$ threshold. Monopile foundation assumed tapered 8- to 11-meter-diameter piles, 50-meter penetration depth, and 4,000-kilojoule hammer energy.
In the text, exposure values ≥0.5 were rounded up to the nearest integer, values <0.5 rounded down to 0.
dB = decibels; ESA = Endangered Species Act; LFC = low-frequency cetaceans; MFC = mid-frequency cetaceans; NARW = North Atlantic Right Whale; OSS = offshore substation; PTS = permanent threshold shift.
PTS and behavioral exposures are based on the number of MMPA Level A and Level B takes requested in the Letter of Authorization.
[a] PTS exposures were estimated for this species, but due to mitigation measures proposed by the Applicant, no PTS (Level A takes) exposures are expected and no Level A takes have been requested for these species.
[b] No Level B exposures were estimated for sei whale, but up to 3 Level B takes not calculated through density estimates requested for these species based on mean group size.

Impact Pile Driving - Behavioral Impact Summary

Based on the mitigation and monitoring measures presented and discussed (Table 1-11) and the animal's ability to move away from the noise, the potential for exposure of these ESA-listed species to noise levels leading to behavioral disruption would be reduced at the level of the individual animal and would not be expected to have population-level effects. However, as discussed above up to eight fin whales, four NARWs, two sei whales, four blue whales (based on take numbers only), and six sperm (based on take numbers only) whales may be exposed to noise above the behavioral thresholds (Table 3-10 and Table 3-11). Therefore, the effects of noise exposure to Project impact pile driving leading to behavioral disruption **may affect, likely to adversely affect** fin whales, NARWs, sei, blue and sperm whales.

Detonation of UXOs (C)

Table 3-15 Number of ESA-Listed Marine Mammal Exposures to Sound Levels above PTS and Behavioral Thresholds for the Detonation of 10 UXOs – Mitigated (10 dB)

Marine Mammal Species		PTS	Behavioral
LFC	NARW[a]	0.03[a]	0.35
	Blue whale	<0.01[b]	0 .04
	Fin whale	0.28	2.87
	Sei whale	0.08	0.87
MFC	Sperm whale	<0.01	0.01[b]

Source: HDR 2022c.
Notes:
In the text, calculated exposures that were ≥0.5 were rounded up to the nearest whole number. Those <0.5 were rounded down.
[a] Due to mitigation measures proposed by the Applicant, no PTS (Level A takes) exposures are expected, and no Level A takes have been requested for these species.
[b] No Level B exposures were estimated for sei whale, but up to 3 Level B takes not calculated through density estimates requested for these species based on mean group size.
dB = decibels; ESA = Endangered Species Act; LFC = low-frequency cetaceans; MFC = mid-frequency cetaceans; NARW = North Atlantic right whale; PTS = permanent threshold shift; UXO = unexploded ordnance

Effects of Exposure to Noise Above the TTS and Behavioral Thresholds and Masking

Considering UXO detonations, no blue, or sperm whale exposures leading to TTS and/or behavioral disturbance are expected; however, up to three fin whales and one sei whale may be exposed to noise levels that exceed TTS and behavioral thresholds (Table 3-15). Blue, sei and sperm whales are unlikely to be exposed to noises above TTS and behavioral thresholds due to their rarity in the Offshore Wind Area. Blue and sei whales prefer deep water and typically occur further offshore in areas with depths of 328 feet (100 meters) or more (Waring et al. 2011; Hain et al. 1985; Hayes et al. 2020;). Sperm whales are rarely seen in shallower waters of the continental shelf (less than 1,000 feet [305 meters]) deep and frequent the continental slope in water depths greater than 2,000 feet (NMFS 2010b). The low number of potential UXOs expected (up to 10) further reduces the potential for this effect to these species. Therefore, exposure to underwater noise above TTS and behavioral thresholds from UXO detonations is considered extremely unlikely to occur and **discountable** for blue, sei and sperm whales. Therefore, the effects of noise exposure to Project UXO detonations leading to TTS/behavioral disturbance **may affect, not likely to adversely affect** blue, sei, and sperm whales**.**

The following sections discuss the potential behavioral reactions of fin whales and NARWs to underwater detonations. Although behavioral thresholds may be reached, how species react to UXO detonations, and the subsequence consequence of these reactions is relatively unknown. For UXO detonation, masking is not anticipated to be an issue due to the short time frame over which the effect would occur.

3.2.6.2.4.2 Non-impulsive Underwater Noise

Vibratory Pile Driving (C)

Temporary cofferdams are being considered at four locations to connect the cables to shore:

1. Oyster Creek horizontal directional drilling (HDD), two cofferdams (Atlantic Ocean to Island Beach State Park; sea-to-shore);
2. Island Beach State Park Barnegat Bay HDD, two cofferdams or sheet piling for temporary shoring (Barnegat Bay onshore; bay-to-shore);

3. Farm Property HDD, two cofferdams or sheet piling for temporary shoring (bayside of Oyster Creek; shore-to-bay); and
4. BL England HDD, one cofferdam (sea-to-shore).

If required, they may be installed either as sheet pile structures into the seafloor or a gravity cell structure placed on the floor using ballast weight. Selection of a preferred design for cofferdams and landfall works is pending additional design and coordination. Ocean Wind anticipates that impacts relating to cofferdam installation and removal would eclipse any potential impacts of alternative methods and, therefore, the underwater noise modeling conducted for the cofferdam installation represents the most conservative values and are carried forward in this BA.

Installation and removal of sheet piles would require the use of a vibratory hammer. A practical spreading loss model was used by JASCO (HDR, Inc. 2022; JASCO 2022) to estimate the extent of potential underwater noise effects as a result of vibratory driving of sheet piles. The 10 meter received level of the vibratory pile driver was assumed to be 165 decibels relative to 1 micropascal measured at 1 meter (dB re 1 µPa-m) based on source levels for vibratory driving of sheet piles published in a pile driving compendia (Illingworth & Rodkin, Inc. 2007, 2017). Using simple geometric spreading loss model [$\alpha \cdot \text{Log10}$ (distance), where α is the spreading loss coefficient] the distance to the behavioral threshold was predicted (e.g., SPL 120 dB re 1 µPa). Practical spreading loss, $\alpha = 15$, is a common choice of coefficient for shallow water as it lies between spherical, $\alpha = 20$, and cylindrical, $\alpha = 10$, spreading. Modeling for the SEL PTS values assumed that the installation of cofferdams would require 18 hours over 2 days to complete, with vibratory pile driving taking place for no longer than 12 hours each 24-hour period over the installation period. It was also assumed that the removal of cofferdams would require 18 hours over 2 days to complete, with vibratory pile driving taking place for no longer than 12 hours each 24-hour period over the installation period. Table 3-16 summarizes the maximum distances to auditory injury (PTS) and behavioral thresholds per hearing group. The number of ESA-listed marine mammal species potentially exposed to noises above thresholds for vibratory sheet installation was estimated by multiplying the maximum distances to thresholds by the highest monthly species density (see Appendix A for additional details regarding species densities used in the modeling) by 4 days of vibratory pile driving and is summarized in Table 3-17. Due to lower densities of marine mammals in the nearshore areas of the cofferdam installation and removal, the transitory nature of marine mammals, and the very short duration of vibratory pile driving, these estimates are likely conservative. Estimated PTS exposures to marine mammal species resulting from vibratory installation and removal of cofferdams was less than one in all cases. No PTS (Level A harassment) takes were requested for ESA-listed marine mammal species in the LOA application from Ocean Wind.

Table 3-16 Maximum Range to PTS and Behavioral Effects, and Applicable Pre-clearance and Shutdown Zones to Be Applied during Vibratory Pile Driving

Hearing Group	Max Range to PTS (m) from L_{E24hr} Thresholds	Pre-clearance Zone (m)	Shutdown Zone (m)	Max Range to Behavioral Effects (m)
LFC	86.7	150	100	10,000
NARW	86.7	150	100	10,000
MFC	7.7	150	50	10,000

LFC = low-frequency cetacean; m = meter; Max = maximum; MFC = mid-frequency cetacean; NARW = North Atlantic right whale; PTS = permanent threshold shift; L_{E24hr} = cumulative sound exposure level, 24 hours.

Table 3-17 Number of ESA-Listed Marine Mammals Exposed to Sound Levels Above PTS and Behavioral Thresholds for Vibratory Pile Driving – Cofferdam Installation

Marine Mammal Species		PTS	Behavioral
LFC	NARW	<0.01	0.89
	Blue whale	<0.01	0.02
	Fin whale	<0.01	1.25
	Sei whale	<0.01	0.44
MFC	Sperm whale	<0.01	0.06

Sources: HDR 2022c
Note: In the text, calculated exposures that were ≥0.5 were rounded up to the nearest whole number. Those <0.5 were rounded down.
ESA = Endangered Species Act; LFC = low-frequency cetaceans; MFC = mid-frequency cetaceans; NARW = North Atlantic right whale; PTS = permanent threshold shift

The Applicant-proposed mitigation measures outlined for vibratory pile driving include pre-clearance zones, shutdown zones, and ramp-up procedures and are summarized in Table 1-11. As outlined in Table 3-16, the pre-clearance zones and shutdown zones cover the largest PTS zone modeled for each species group.

Effects of Exposure to Noise Above the Behavioral Thresholds and Masking

Considering vibratory pile driving, up to one NARW and one fin whale may be exposed to noise levels that exceed behavioral thresholds (Table 3-17). Vibratory pile driving is only expected to occur over a 4-day period at four potential shoreline locations: Oyster Creek, Island Beach State Park Barnegat Bay, Farm Property bayside of Oyster Creek, and BL England. Behavioral effects are considered possible and may extend out to 6.2 miles (10 km) from the Project.

Blue, sei, and sperm whales are generally rare in nearshore areas. Therefore, exposure to underwater noise above behavioral thresholds from vibratory pile driving is considered extremely unlikely to occur and **discountable** for these species. Therefore, the effects of noise exposure from Project vibratory pile driving leading to behavioral disruption **may affect, not likely to adversely affect** blue, sei, or sperm whales.

Low-frequency Cetaceans (LFC)

Up to one NARW and one fin whale could be exposed to underwater noise above behavioral thresholds from vibratory pile driving. Due to lower densities of marine mammals in the nearshore areas of the cofferdam installation and removal, the transitory nature of marine mammals, and the very short duration of vibratory pile driving, these estimates are likely conservative. The nearshore areas where vibratory pile driving will occur overlaps with a biologically important area for migrating NARWs. Timing of migrations includes a northward migration during March to April and a southward migration during November to December between summer feeding and winter calving grounds. During this migration period adults may be accompanied by calves and periodically feed and rest along their migration route (Hayes et al. 2020). Fin whales are present in the area year-round; however, they generally prefer deeper water greater than 295 feet (90 meters) (Hayes et al. 2020). There is limited information regarding the potential behavioral reactions of LFCs to vibratory pile driving. Potential effects may include avoidance and ceasing feeding activities as with impact pile driving activities. If animals are exposed to underwater noise above behavioral thresholds, the noise could result in displacement of mother and calf pairs from a localized area (e.g., up to 6.2 miles [10 km] from shore; Table 3-16). However, this displacement would be temporary for the duration of activity, which would be a maximum of 12 hours for installation for two days and 18 hours of removal for two days with break in between each period. LFCs would be expected to resume pre-construction activities following the installation/removal period. In addition, the behavioral disturbance area (6.2 miles [10 km] from shore) would not impede the migration of NARWs to critical habitats located to the north and south of the Offshore Wind Area as animals would still be able to pass along offshore areas. The energetic consequences of any avoidance behavior or masking effects and potential delay in resting or foraging are not expected affect any individual's ability to successfully obtain enough food to maintain their health or impact the ability of any individual to make seasonal migrations or participate in breeding or calving. Any TTS effects would be expected to resolve within a few days to a week of exposure and are not expected to affect the health of any individual whale or its ability to migrate, forage, breed, or calve.

Vibratory Pile Driving - Behavioral Impact Summary

Based on the mitigation and monitoring measures presented and discussed (Table 1-11), the potential for exposure of these ESA-listed species to noise levels leading to behavioral disruption would be reduced at the level of the individual animal and would not be expected to have population-level effects. However, as discussed above, up to one NARW and one fin whale may be exposed to noise above behavioral thresholds (Table 3-17). Therefore, the effects of noise exposure from Project vibratory pile driving leading to behavioral disruption **may affect, likely to adversely affect** NARWs and fin whales**.**

HRG Surveys (pre-C, C, O&M, D)

Table 3-20 Annual and Total Number of ESA-Listed Marine Mammal Exposed to Sound Levels Above PTS and Behavioral Thresholds for HRG Surveys

Marine Mammal Species		Years 1, 4, and 5 (88 days of HRG surveys per year)		Years 2 and 3 (180 days of HRG surveys per year)		Total (years 1, 2, 3, 4, and 5)	
		PTS	Behavioral	PTS	Behavioral	PTS	Behavioral
LFC	NARW	<0.01	0.46	0.01	0.94	<0.05	3.26
	Blue whale	<0.01	0.02	<0.01	0.03	<0.05	0.12
	Fin whale	0.01	1.24	0.02	2.56	0.07	8.84
	Sei whale	0	0	0	1	0	2
MFC	Sperm whale	0	0.04[a]	0	0.09[a] [a]	0	0.3[a]

Source: HDR 2022c

Notes: ESA = Endangered Species Act; HRG = high-resolution geophysical; LFC = low-frequency cetacean; MFC = mid-frequency cetacean; NARW = North Atlantic right whale; PTS = permanent threshold shift

[a] No Level B exposures were estimated for sei whale, but up to 3 Level B takes not calculated through density estimates requested for these species based on mean group size.

Effects of Exposure to Noise Above Behavioral Thresholds and Masking

Considering HRG surveys, modeling indicates that three NARWs, nine fin whales, two sei whales, and three sperm whales (based on take numbers only) may be exposed to noise levels that exceed behavioral thresholds (Table 3-20) in any survey year. Behavioral effects are considered possible and may extend out to 463 feet (141 meters) from the Project. Blue whales prefer deep water and typically occur farther offshore in areas with depths of 328 feet (100 meters) or more (Waring et al. 2011).

Low-frequency Cetaceans (LFC)

Three NARWs, nine fin whales, and two sei whales could be exposed to underwater noise above behavioral thresholds from HRG surveys on an annual basis depending on survey effort (Table 3-20). The areas where HRG surveys will occur overlaps with a biologically important area for migrating NARWs. Timing of migrations includes a norward migration during March and April and a southward migration during November and December between summer feeding and winter calving grounds. During this migration period adults may be accompanied by calves and periodically feed and rest along their migration route. Fin whales are present in the area year-round; however, fin as well as sei whales generally prefer the deeper waters of the continental slope and more often can be found in water greater than 295 feet (90 meters) deep (Hain et al. 1985; Waring et al. 2011; Hayes et al. 2020). There is limited information regarding the potential behavioral reactions of LFCs to HRG surveys. If animals are exposed to underwater noise above behavioral thresholds, it could result in mother and calf pairs being displaced from an immediate location around the vessel (e.g., up to 463 feet [141 meters]; Table 3-19). However, this displacement would be temporary and transient and would occur for the duration of the HRG equipment/vessel transit relative to the receiver (e.g., the marine mammal). The behavioral disturbance area (463 feet [141 meters] from the vessel) would not impede the migration of NARWs to critical habitats located to the north and south of the Offshore Wind Area as animals would still be able to move outside of the behavioral disturbance zone easily or wait until the vessel passes. In addition, the pre-clearance zones and shutdown zones proposed for the selected HRG surveys cover the entire behavioral zone for NARWs and part of the behavioral zones for fin and sei whales (Table 3-20), which would limit the potential for behavioral effects. Due to the relatively small monitoring zones outlined in Table 3-19, the ability to monitor for marine mammals within those zones is considered high. Due to the range of frequencies emitted during HRG surveys, masking of all hearing groups is considered possible. Masking of LFC communications is considered more likely due to the overlap of these surveys with lower-frequency signals produced by these species. However, as the effects of masking would be transient in nature (moving with the vessel) the potential for communications to be masked is reduced.

Mid-Frequency Cetaceans (MFC)

Up to three sperm whales (based on take numbers only) could be exposed to underwater noise above behavioral thresholds from HRG surveys on an annual basis (Table 3-20). The area over which surveys would occur would not extend to the continental shelf where sperm whales are more commonly observed. If sperm whales are exposed to underwater noise above behavioral thresholds, it could result in localized temporary displaced from an immediate area around the survey vessel (e.g., up to 462 feet [141 meters]; Table 3-19). In addition, the pre-clearance zones and shutdown zones proposed for the selected HRG surveys cover part of the behavioral zones for sperm whales (Table 3-20) which would limit the potential for behavioral effects. Due to the relatively small monitoring zones outlined in Table 3-19 the ability to monitor for marine mammals within those zones is considered high. Masking of high-frequency echolocation clicks used by sperm whales is not anticipated; however, some masking of other communications used by this species is possible. These effects would be transient in nature (moving with the vessel) the potential for communications to be masked for all is considered reduced.

HRG Surveys –Behavioral Impact Summary

Based on the mitigation and monitoring measures presented and discussed (Table 1-11) the potential for exposure of these ESA-listed species to noise levels leading to behavioral disruption would be reduced at the level of the individual animal and would not be expected to have population-level effects. However, as discussed above, up to three NARWs, nine fin whales, two sei whales, and three sperm whales (based on take numbers only) may be exposed to noise above behavioral thresholds (Table 3-20) annually. Therefore, the effects of noise exposure from Project HRG surveys leading to behavioral disturbance and masking **may affect, likely to adversely affect** NARWs, fin whales, sei whales, and sperm whales.

Aircraft Noise (C, O&M, D)

Fixed-wing aircraft may be utilized for monitoring activities during construction, O&M, and decommissioning (Table 1-11). Patenaude et al. (2002) showed that aircraft operations could result in temporary behavioral responses from beluga (*Delphinapterus leucas*) and bowhead whales (*Balaena mysticetus*). Responses included short surface durations, abrupt dives, and percussive behaviors (i.e., breaching and tail slapping) (Patenaude et al. 2002). Most observed reactions by bowheads (63%) and belugas (86%) occurred when the helicopter was at altitudes of 492 feet (150 meters) or less and lateral distances of 820 feet (250 meters) or less.

BOEM would require all aircraft operations to comply with current approach regulations for any sighted NARWs or unidentified large whale. Current regulations (50 CFR 222.32) prohibit aircraft from approaching within 1,500 feet (457 meters) of NARWs. BOEM expects that most aircraft operations would occur above this altitude limit except under specific circumstances. With the implementation of these mitigation measures, exposure of noises above PTS, TTS, and behavioral thresholds for all ESA-listed marine mammal species is considered extremely unlikely to occur and **discountable**. Therefore, noise exposure from Project aircraft activities leading to PTS/ behavioral disturbance or masking **may affect, not likely to adversely affect** ESA-listed cetaceans.

Cable Laying or Trenching Noise (C)

During construction, vessels used for array cable installation would include main laying vessels and burial vessels in addition to support vessels. Main laying and burial vessels could include barges or dynamic positioning vessels, each with three associated anchor-handling tugs. Anchoring would occur every 1,640 feet (500 meters). Support vessels would be required including crew boats, service vessels for pre-rigging foundations with cable, and vessels for divers, pre-lay grapnel run, and post-lay inspection. The action of laying the cables on the seafloor itself is unlikely to generate high levels of underwater noise. Most of the noise energy would originate from the vessels themselves including propellor cavitation noise and noise generated by onboard thruster/stabilization systems and machinery (e.g., generators), including noise emitted by the tugs when moving the anchors.

Dredging (C)

Dredging may also be required in the shallow areas of Barnegat Bay to allow vessel access for export cable installation. Locations include the prior channel (west side of Island Beach State Park/east side of Barnegat Bay), the west side of Barnegat Bay at the export cable landfall, and the Oyster Creek section of the federal channel in Barnegat Bay if the USACE is unable to conduct dredging in this area as part of the federal channel dredging that is currently under contract. In 2020, USACE completed Section 7 ESA consultation for maintenance dredging of the Barnegat Inlet Federal Navigation Project and use of maintenance material for shoreline protection and habitat creation/restoration in Barnegat Bay. This analysis concluded that dredging Oyster Creek channel and beneficial use placement operations were not anticipated to result in significant direct, indirect, or cumulative adverse impacts to federally- or state-listed threatened or endangered species (USACE 2020a). NMFS concurred that the action was not likely to adversely affect listed species or critical habitat. The ESA consultation for maintenance dredging of the Barnegat Inlet Federal Navigation Project did not assess the transfer of dredged materials via pipeline for upland facility disposal.

3.2.6.3. Dredging Effects on Marine Mammals [C]

As mentioned in Section 3.2.6.2, dredging for the Project may occur in the Wind Farm Area and export cable corridors for sandwave clearance. Ocean Wind has indicated that sandwave clearance work could be undertaken by traditional dredging methods such as a mechanical clamshell dredge, as well as hydraulic trailing suction hopper or controlled-flow excavator. Dredging may be required at the HDD in-water exit pit at the Oyster Creek landfall site on the east side of Island Beach State Park and at the HDD in-water exit pit for the BL England site. Dredging may also be required in the shallow areas of Barnegat Bay to allow vessel access for export cable installation. Locations include the prior channel (west side of Island Beach State Park/east side of Barnegat Bay), the west side of Barnegat Bay at the export cable landfall, and the Oyster Creek section of the federal channel in Barnegat Bay if the USACE is unable to conduct dredging in this area as part of the federal channel dredging that is currently under contract. Dredging for the Project is anticipated to be less than 1 acre / 7,000 yd^3 (5,352 m^2). Approximately

18,000 yd^3 (13,762 m^3) of sediment would be removed from a 3.7-acre (0.01 km^2) area to maintain the Oyster Creek federal navigation channel to its authorized 200-foot width and 8-foot depth (61-meter width and 2.4-meter depth). While the effects of maintenance dredging to authorized depth and width were analyzed by the USACE as part of their ESA consultation for the Barnegat Inlet Federal Navigation Project, the transfer of material via a pipeline system, barge, or scow for disposal at an upland facility was not analyzed and so the effects of dredged material transfer and disposal are considered in the following analysis. Inshore dredging is proposed to occur over less than one month.

3.2.6.10. Air Emissions (Vessel Discharges and Offshore Equipment) (C, O&M, D)

During O&M, air quality impacts are anticipated to be smaller in magnitude compared to construction and decommissioning. Offshore O&M activities would consist of WTG operations, planned maintenance, and unplanned emergency maintenance and repairs. The WTGs operating under the Proposed Action would have no pollutant emissions. Pollutant emissions from O&M would be mostly the result of operations of ocean vessels used for maintenance activities. A summary of the emissions resulting from the Project during O&M is provided in Table 3-26. The Project would produce greenhouse gas emissions that contribute to climate change; however, its contribution would be less than the emissions reductions from fossil-fueled sources during operation of the Project. The Project must demonstrate compliance with the NAAQS.

3.3. SEA TURTLES

3.3.5 Effects Analysis for Sea Turtles

3.3.5.1. Underwater Noise

3.3.5.1.1 Effects on Sea Turtles

3.3.5.1.1.3 Assessment of Effects

Aircraft Noise (C, O&M, D)

Fixed-wing aircraft may be utilized for monitoring activities during construction, O&M, and decommissioning (refer to Table 1-11).Patenaude et al. (2002) showed that aircraft operations could result in temporary behavioral responses to marine mammals; however, similar studies on sea turtles is not available in the literature. Kuehne et al. (2020) demonstrated that underwater noise from large Boeing EA-18G Growler aircrafts and determined that sound signatures of aircraft at a depth of 98 feet (30 meters) below the sea surface had underwater noise levels of 134 (± 3) dB re 1 µPa L_{rms}.

Popper et al. (2014) suggest that in response to continuous sounds (e.g., aircraft operations), sea turtles have a high risk for behavioral disturbance in the near field (e.g., tens of meters), moderate risk in the intermediate field (hundreds of meters) and low risk in the far field (thousands of meters). The potential risk for injury and TTS are considered low at all distances (Popper et al. 2014). BOEM expects that most aircraft operations would occur above 1,500 feet (457 meters) (NARW aircraft approach regulation) except under specific circumstances. Exposure of noises above PTS, TTS, and behavioral thresholds from Project aircrafts for all ESA-listed sea turtles is extremely unlikely to occur and is **discountable**. Therefore, the effects of noise exposure from Project aircraft activities leading to PTS/ behavioral disturbance **may affect, not likely to adversely affect** ESA-listed sea turtles.

3.3.5.2. Dredging Effects on Sea Turtles [C]

Impacts from dredging during construction, in addition to the noise discussed in Section 3.3.5.1, could affect ESA-listed sea turtles through impingement, entrainment, and capture associated with mechanical and hydraulic dredging techniques. As mentioned in Section 3.2.6.2, clamshell and suction dredging for the Project may occur both inshore and offshore within the Wind Farm Area and export cable corridors for sandwave clearance. Additionally, dredging may also be required in the HDD pits at landfall and in shallow areas of Barnegat Bay to allow vessel access for export cable installation. Approximately 18,000 yd^3 (13,762 m^3) of sediment would be removed from a 3.7-acre (0.01 km^2) area in order to maintain the Oyster Creek federal navigation channel to its authorized 200-foot width and 8-foot depth (61.0-meter width and 2.4-meter depth). Mechanical dredging would consist of lowering an open clamshell bucket through the water column and once the bucket contacts the seafloor, closing the bucket jaws to trap and scoop the sediment that is then brought to the surface. Hydraulic dredging uses dragheads that trail along the seafloor removing sediment. While the effects of maintenance dredging to authorized depth and width were analyzed by the USACE as part of their ESA consultation for the Barnegat Inlet Federal Navigation Project (USACE 2020a), the transfer of material via pipeline system, barge, or scow for disposal at an upland facility was not analyzed and so the effects of dredged material transfer and disposal are considered in the following analysis.

The fact that a sea turtle would have to be directly below the clamshell bucket during dredging on the seafloor indicates that physical interactions between the mechanical dredge and sea turtles is extremely unlikely to occur. Further, dredging and material disposal is anticipated to occur during cold weather months when sea turtles are not anticipated to be present. Finally, the Project would employ controlled/continuous rate of descent and lift which would decrease the rate of speed and potential to surprise an unsuspecting sea turtle on the seafloor.

Sea turtles have been known to become entrained in trailing suction hopper dredge or trapped beneath the draghead as it moves across the seabed. Direct impacts, especially for entrainment, typically result in severe injury or mortality (Dickerson et al. 2004; USACE 2020b). Sea turtles may be crushed during placement of the draghead on the seafloor, impinged if unable to escape the draghead suction and become stuck, or entrained if sucked through the draghead. Of the three direct impacts, entrainment most often results in mortality. About 69 projects have recorded sea turtle takes within channels in New Jersey, Delaware, and Virginia and there have likely been numerous other instances not officially recorded (Ramirez et al. 2017). However, the risk of interactions between hopper dredges and individual sea turtles is expected to be lower in the open ocean areas where dredging may occur compared to nearshore navigational channels where sea turtles are more concentrated in a constrained operating environment (Michel et al. 2013; USACE 2020b). This may be due to the lower density of sea turtles in these areas (Sea Turtle Densities) as well as differences in behavior and other risk factors. Sea turtles are most often able to escape from the oncoming draghead of a hydraulic dredge due to the slow speed that the draghead advances (up to 3 miles per hour or 4.4 feet/second [1.4 m/s]; NMFS 2020). During swimming and surfacing, sea turtles are highly unlikely to interact with the draghead and are most vulnerable when foraging or resting on the seafloor. The potential capture of sea turtles in the dredging equipment could occur, but is more likely in channels and areas that otherwise have high densities of sea turtles. There are no known large aggregation areas or areas where turtles would be expected to spend large amounts of time stationary on the bottom where they could be entrained in a suction dredge.

Furthermore, the Project would employ PSOs on landfall dredges, inshore where sea turtles are known to be more vulnerable to dredging, further decreasing the risk of impingement or entrainment of sea turtles during suction dredging activities. Inshore dredging is proposed to span less than one month. Therefore, given the short duration of dredging where sea turtles are most vulnerable, PSOs, and available information, the risk of injury or mortality of individual sea turtles resulting from dredging necessary to support offshore wind Project construction would be low and population-level effects are unlikely to occur. Since there is a low risk of interactions with dredges and the mitigation and monitoring measures that will be implemented, the likelihood of a sea turtle becoming entrained in a dredge associated with the Proposed Action is considered extremely unlikely to occur and **discountable**. Therefore, the effects of entrainment from Project dredging leading to injury or mortality **may affect, not likely to adversely affect** ESA-listed turtles**.**

Dredging would increase turbidity and temporarily affect an overall very small area that may be used as foraging habitat by sea turtles. In areas such as the maintenance yard landfall (i.e., Island Beach State Park at Barnegat Bay), open cut trenching was chosen as the preferred installation method over HDD to avoid impacts to adjacent SAV beds. Open cut trenching and the installation of temporary shoring would result in short-term impacts similar to those analyzed for cable installation and seafloor preparation. This method would limit the impacts to SAV to less than 1 acre (0.004 km^2) and make the likelihood of impacts to green sea turtle foraging from Project dredging activities so small it cannot be meaningfully measured, detected, or evaluated. SAV beds would be monitored before and after construction (Inspire 2022b), and SAV impacted by Project activities would restored (Ocean Wind 2022b). Pelagic prey items are extremely unlikely to be affected due to the operation of both dredges on the seafloor, therefore leatherback sea turtle prey items are extremely unlikely to be affected (Table 3-40). The benthic organisms preyed upon by Kemp's ridley and loggerhead sea turtles may survive entrainment and motile organisms, such as crabs, may avoid the dredge (Table 3-40). However, entrainment of crabs does occur (Reine et al. 1998) and we expect that most small benthic invertebrates in the path of the dredge would be entrained. Given the size of the area where dredging will occur and the short duration of dredging, the loss of benthic invertebrates will be small, temporary, and localized. Based on this analysis, we expect any impact of the loss of prey items to foraging for ESA-listed sea turtles due to dredging to be so small that they cannot be meaningfully measured, evaluated, or detected and considered **no effect**.

3.4 MARINE FISH

3.4.2 Effects Analysis for Marine Fish

3.4.2.1. Underwater Noise Effects on Marine Fish

3.4.2.1.2 Assessment of Effects

3.4.2.1.2.3 Non-impulsive Underwater Noise

Aircraft Noise (C, O&M, D)

Fixed-wing aircraft may be utilized for monitoring activities during construction, O&M, and decommissioning (refer to Table 1-11). Patenaude et al. (2002) showed that aircraft operations could result in temporary behavioral responses to marine mammals; however, similar studies on fish are not available in the literature. Kuehne et al. (2020) demonstrated that underwater noise from large Boeing EA-18G Growler aircrafts and determined that sound signatures of aircraft at a depth of 98 feet (30 meters) below the sea surface had underwater noise levels of 134 (± 3) dB re 1 µPa SPL. Noise from helicopters required for the Project are expected to be less than those generate by these larger aircrafts.

3.4.2.2. Dredging Effects on Marine Fish [C]

Impacts from dredging during construction, in addition to the noise discussed in Section 3.4.2.1, could affect ESA-listed marine fish through impingement, entrainment, and capture associated with mechanical and hydraulic dredging techniques. As mentioned in Section 3.2.6.2, clamshell and suction dredging for the Project may occur both inshore and offshore within the Wind Farm Area and export cable corridors for sandwave clearance. Additionally, dredging may also be required in the HDD pits at landfall and in shallow areas of Barnegat Bay to allow vessel access for export cable installation.

In addition, approximately 18,000 yd^3 (13,762 m^3) of sediment would be removed from a 3.7-acre (0.01 km^2) area in order to maintain the Oyster Creek federal navigation channel to its authorized 200-foot width and 8-foot depth (61-meter width and 2.4-meter depth), employing either mechanical or hydraulic dredging. Mechanical dredging would consist of lowering an open clamshell bucket through the water column and once the bucket contacts the seafloor, closing the bucket jaws to trap and scoop the sediment that is then brought to the surface. Hydraulic dredging would use dragheads that trail along the seafloor removing sediment.

However, as the effects of maintenance dredging to authorized depth and width were analyzed by the USACE as part of their ESA consultation for the Barnegat Inlet Federal Navigation Project, the effects of these actions are not considered in this document. Dredged material would be transferred to an upland disposal facility via a pipeline system, barge, or scow for disposal. The previous ESA consultation for maintenance dredging of the Barnegat Inlet Federal Navigation Project (USACE 2020a) did not assess the transfer of dredged materials via pipeline for upland facility disposal.

Dredge material transport pipelines can either float on the water surface or be submerged and rest on the bottom of the water body. These pipelines used to transport materials from the dredges to a disposal site also have the potential to impact ESA-listed Atlantic sturgeon via temporary sedimentation, turbidity, habitat disturbance, and subsequent impacts to potential prey.

Floating pipelines are supported at regular intervals by buoyancy units/material and are flexible enough to accommodate waves and currents. Floating pipelines provide a means of avoiding impacts to benthic habitats such as SAV and would also avoid impacts to benthic prey for Atlantic sturgeon. Floating pipelines are anchored to the bottom to hold them in place and may result in very small, temporary impacts to sediments, turbidity, and benthic organisms, but likely no more than waves and currents. Atlantic sturgeon are not anticipated to be impacted by temporary floating pipelines.

Submerged pipelines are floated into place and then sunk in the desired location. Foraging sturgeon are at the sea bottom interacting with the sediment (Dadswell 2006), where submerged pipelines may displace sediment (and replace soft bottom with hard bottom habitat), result in scour around the pipeline, and/or crush immobile benthic organisms, and therefore interfere with prey item availability, similar to the effects of presence of structures (described in Section 3.4.2.3). Movement of submerged pipelines due to waves and currents may increase the extent of the potential physical damage to benthic habitats. However, Atlantic sturgeon are highly mobile and would be able to avoid the pipeline and areas of disturbance and temporarily elevated turbidity due to emplacement and movement of submerged pipelines. Any effects from an increase in turbidity would be insignificant and temporary. Sturgeon would continue to forage in available habitat nearby. Therefore, any impacts to the Atlantic sturgeon would be temporary and benthic habitats and potential prey are anticipated to recover following removal of the submerged pipeline.
Structural failure in either floating or submerged pipelines could result in an unexpected blowout of sand and subsequent temporary impacts on water quality, sedimentation, turbidity, and stability of unconsolidated sediments. Pipeline monitoring would avoid unanticipated movement of submerged pipelines and support structures for floating pipelines placed near or over hardbottom, and for discharge of slurry/leaks along the length of a submerged pipeline near hardbottom or floating pipeline placed over hardbottom.In addition, no juvenile or adult Atlantic sturgeon were recorded during a previous 3-year trawl survey of Barnegat Bay that spanned all four seasons (Valenti et al. 2017). Therefore, neither floating nor submerged pipelines are anticipated to adversely impact Atlantic sturgeon.

Additionally, open cut trenching is being considered for landfalls not under the USACE beach nourishment program, including the west side of Island Beach State Park (Prior Channel Route) and at the Holtec landfall due to elevated risks of inadvertent returns of drilling mud occurring during HDD. Open cut trenching and HDD are anticipated to result in localized and short-term impacts on seabed disturbance, temporary impacts associated with suspension and settlement of sediments, and underwater noise. However, Atlantic sturgeon are highly mobile and would be able to avoid the areas of disturbance and temporarily elevated turbidity. Any effects from open cut trenching or HDD would be insignificant and temporary. Sturgeon could continue to forage in available habitat nearby. In addition, no juvenile or adult Atlantic sturgeon was recorded during a previous 3-year trawl survey of Barnegat Bay that spanned all four seasons (Valenti et al. 2017). Therefore, any impacts to the Atlantic sturgeon would be temporary and benthic habitats and potential prey are anticipated to recover following open cut trenching or HDD.

Proposed mitigation, monitoring, and reporting conditions that are intended to minimize or avoid potential impacts to ESA-listed species are described in Section 1.3.5. Monitoring surveys to be completed before, during, and after construction are included in Section 1.3.4. SAV beds would be monitored before and after construction (Inspire 2022b), and SAV impacted by Project activities would be restored (Ocean Wind 2022b).

4. REFERENCES

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Appendix A. Marine Mammal Densities

Mean monthly density estimates (animals per square kilometers) of all the marine mammal species in the Project area were derived using the Duke University Marine Geospatial Ecology Laboratory models which were updated on June 20, 2022. The new models resulted in updated density estimates for all taxa for which Ocean Wind is requesting take and serve as a complete replacement for the Roberts et al. (2016a) models and subsequent updates (2016b, 2017, 2018, 2021a, 2021b) (Tables A-1 through A-5).

Table A-1 Mean Monthly Marine Mammal Density Estimates for Modeled Marine Mammal Exposures to WTG and OSS Installation within a 5 km Buffer Around the Lease Area

Marine Mammals	Monthly Densities (animals per km^2)												Annual Density
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
North Atlantic right whale					0.00010	0.00003	0.00001	0.00001	0.00002	0.00004	0.00012	**0.00045**	
Fin whale			--	--	0.00080	0.00067	0.00041	0.00023	0.00027	0.00030	0.00038	**0.00141**	--
Sei whale		--	--	--	0.00021	0.00005	0.00001	0.00001	0.00002	0.00007	0.00021	**0.00042**	--
Sperm whale	--	--	--	--	**0.00008**	0.00003	0.00001	0.00000	0.00000	0.00000	0.00003	0.00004	--

Source: Roberts et al. 2022
Notes:
- **Bold** values indicate highest monthly density May – December.
- Underlined values represent the second highest monthly density May – December.
- Exposure modeling for the blue whale was not conducted because impacts on this species approach zero due to their low predicted densities in the Project; therefore, this species was excluded from all quantitative analyses and tables based on modeling results.

Table A-2 Mean Monthly Marine Mammal Density Estimates for Modeled Marine Mammal within a 10 km Buffer Around the Affected Area for Cofferdam Installation

Marine Mammals	Monthly Densities (animals per km^2)												Annual Density	October – May Average
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec		
North Atlantic right whale	0.00066	0.00054	0.00030	0.00017	0.00004	--	--	--	--	0.00003	0.00013	0.00038	--	**0.00028**
Blue whale	--	--	--	--	--	--	--	--	--	--	--	--	**0.00075**	--
Fin whale	0.00070	0.00021	0.00041	0.00052	0.00018	--	--	--	--	0.00017	0.00017	0.00081	--	**0.00039**
Sei whale	0.00013	0.00008	0.00015	0.00019	0.00009	--	--	--	--	0.00003	0.00014	0.00029	--	**0.00014**
Sperm whale	0.00001	0.00001	0.00001	0.00002	0.00002	--	--	--	--	0.00000	0.00005	0.00003	--	**0.00002**

Source: Roberts et al. 2022
Note: **Bold** values indicate density used in Cofferdam exposure estimates.

Table A-3 Mean Monthly Marine Mammal Density Estimates for Modeled Marine Mammal within a 5 km Buffer Around the Affected Area of the High-Resolution Geophysical Surveys (Export Cable Route)

Marine Mammals	Monthly Densities (animals per km²)												Annual Density	October – May Average
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec		
North Atlantic right whale	0.00088	0.00076	0.00047	0.00029	0.00007	0.00002	0.00001	0.00001	0.00001	0.00004	0.00014	0.00047	--	**0.00026**
Blue whale	--	--	--	--	--	--	--	--	--	--	--	--	**0.00001**	--
Fin whale	0.00134	0.00053	0.00069	0.00082	0.00040	0.00042	0.00019	0.00011	0.00014	0.00027	0.00032	0.00122	--	**0.00054**
Sei whale	0.00022	0.00013	0.00026	0.00038	0.00014	0.00005	0.00001	0.00001	0.00001	0.00004	0.00020	0.00043	--	**0.00016**
Sperm whale	0.00002	0.00002	0.00001	0.00004	0.00007	0.00000	0.00000	0.00000	0.00000	0.00000	0.00006	0.00004	--	**0.00002**

Source: Roberts et al. 2022
Note: **Bold** values indicate density used in HRG ECR exposure estimates.

Table A-4 Mean Monthly Marine Mammal Density Estimates for Modeled Marine Mammal within a 5 km Buffer Around the Affected Area of the High-Resolution Geophysical Surveys (Wind Farm Area)

Marine Mammals	Monthly Densities (animals per km²)												Annual Density	October – May Average
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec		
North Atlantic right whale	0.00066	0.00073	0.00061	0.00049	0.00011	0.00003	0.00001	0.00001	0.00002	0.00004	0.00009	0.00037	--	**0.00026**
Blue whale	--	--	--	--	--	--	--	--	--	--	--	--	**0.00001**	--
Fin whale	0.00187	0.00142	0.00106	0.00102	0.00093	0.00076	0.00051	0.00029	0.00031	0.00031	0.00038	0.00144	--	**0.00086**
Sei whale	0.00026	0.00016	0.00034	0.00075	0.00025	0.00006	0.00001	0.00001	0.00002	0.00008	0.00025	0.00042	--	**0.00022**
Sperm whale	0.00004	0.00002	0.00001	0.00007	0.00010	0.00003	0.00001	0.00000	0.00000	0.00000	0.00003	0.00003	--	**0.00003**

Source: Roberts et al. 2022
Note: **Bold** values indicate densities used in HRG WFA exposure estimates.

Table A-5 Mean Monthly Marine Mammal Density Estimates for Modeled Marine Mammal within a 15 km Buffer Around the Affected Area of the pUXO Detonations for Months in which Detonations are Allowed (May through October)

Marine Mammals	Monthly Densities (animals per km^2)												Annual Density
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
North Atlantic right whale	--	--	--	--	**0.00008**	0.00002	0.00001	0.00001	0.00002	0.00004	--	--	--
Blue whale	--	--	--	--	--	--	--	--	--	--	--	--	**0.00001**
Fin whale	--	--	--	--	0.00068	0.00061	0.00034	0.00019	0.00023	0.00029	--	--	--
Sei whale	--	--	--	--	0.00021	0.00006	0.00001	0.00001	0.00002	0.00006	--	--	--
Sperm whale	--	--	--	--	0.00008	0.00003	0.00003	0.00001	0.00000	0.00000	--	--	--

Source: Roberts et al. 2022
Note: **Bold** values indicate densities used in pUXO exposure estimates.

References

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