OCS-A 0501 MASS USA

# VINEYARD WIND

# Draft Construction and Operations Plan

## Volume III Text

## Vineyard Wind Project

June 3, 2020

**Submitted by**
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**700 Pleasant Street, Suite 510**
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**Submitted to**
**Bureau of Ocean Energy Management**
**45600 Woodland Road**
**Sterling, Virginia 20166**

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June 3, 2020

# Section 3.0

## Project Evolution

# 3.0 PROJECT EVOLUTION

## 3.1 Introduction

The Vineyard Wind Project is intended to deliver 800 megawatts ("MW") of power to the New England grid, providing a commercially sustainable offshore wind energy project within its leased area, as described in Lease OCS-A 0501. In order to ensure that the Project fulfills its purpose and need, Vineyard Wind evaluated numerous technologies and designs for their technical and commercial feasibility, as well as their potential environmental impacts. The main Project elements driving the concept for the proposed Project Envelope are (1) the wind turbine generators ("WTGs"); (2) the WTG foundations; (3) the electrical service platform; and (4) potential cable routes. In addition, the Project layout design was driven by conditions and existing uses within Vineyard Wind's Lease Area. As described in Section 2.1 of the Project Summary (Section 2.0 of Volume III), the evolution of offshore wind technology and installation techniques often outpaces the speed of permitting processes. The envelope concept allows for optimized projects once permitting is complete while ensuring a comprehensive review of the project by regulators and stakeholders, as BOEM recognized in its National Offshore Wind Strategy. The flexibility provided in the envelope is important because it precludes the need for numerous permit modifications as infrastructure or construction techniques evolve after permits are granted but before construction commences.

## 3.2 WTG Selection

Vineyard Wind considered WTGs ranging in size from 3.6 MW to more than 10 MW. The Project Envelope proposed eight to 10 MW WTGs because these WTGs: (1) will be commercially available at the time of construction; (2) are cost effective; and (3) produce fewer potential environmental impacts.

<u>Commercial Availability</u>: Currently, WTGs up to 9.5 MW WTGs are commercially available. A 10 MW is expected to be available at the time of Project construction. While WTGs larger than 10 MW are under development, at the time of COP submission in 2017, they were not expected to be commercially available in the time needed for planned construction.

<u>Cost Effectiveness</u>: Cost effectiveness considers the fabrication, installation, maintenance, and decommissioning costs of individual WTGs. While smaller WTGs may be less costly to fabricate, they are commercially unattractive because a significantly larger number of units and foundations are needed to deliver 800 MW of power; smaller WTGs are also generally less efficient than the larger WTGs. Thus, installation, maintenance, and decommissioning costs are significantly higher. Considering all of these factors, at the time of COP submission in 2017, WTGs between eight and 10 MW were the most cost effective.

Environmental Impacts: Vineyard Wind considers the principal potential environmental impacts associated with the WTGs to be the Project design footprint and construction-related impacts. Eight to 10 MW WTGs will have a Project footprint of up to 100[3] positions, while smaller capacity WTGs could almost double the number of positions needed to deliver 800 MW of power. Thus, the Project footprint and its attendant potential environmental impacts would be significantly larger as would construction-related impacts associated with installation of the increased number of WTGs.

Due to delays in the Project schedule resulting from BOEM's extended review of the Project, Vineyard Wind is now considering the potential use of eight to ~14 MW WTGs as reflected in this minor COP modification submitted on January 31, 2020.

## 3.3 WTG Foundations

Vineyard Wind evaluated three foundation types for technical and commercial feasibility and potential environmental impacts: (1) monopile foundation; (2) jacket foundation with piles; and (3) self-floating gravity base foundations. These foundations represent the majority of foundation concepts that have been used for commercial offshore wind projects to-date. Concept designs were prepared to support the evaluation, and quotes were obtained from potential installation and fabrication contractors. The Project Envelope includes two of the three foundations considered (monopile and jacket foundations). As discussed in more detail below, gravity-based foundations were determined to not be preferable based on the site-specific conditions of the Project. Similarly, suction bucket and floating foundations were not considered appropriate for the Project.

### *Monopile Foundation*

Technical feasibility: Monopiles are a proven technology, having been used in large numbers of offshore WTG installations in Europe. The principal considerations for using monopile foundations are sea depths and soil conditions. Seabed conditions within the Wind Development Area ("WDA") area are considered well-suited for monopiles due to soils of an appropriate stiffness (see Volume II for further detail). The soils allow for a feasible installation while at the same time providing enough support for an operating project. Water depths within the WDA range from 37-49.5 meters ("m") (121-162 feet ["ft"]). Vineyard Wind has conducted detailed calculations to validate the technical feasibility of using monopiles and concluded that monopiles are compatible with the ocean depths and conditions within the WDA. Although the monopile is the preferred technology, transportation techniques (i.e. available vessels for transport to the site), may be limited due to the size of monopiles needed for deeper waters.

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3 Up to 106 turbine locations are being permitted to allow for spare positions (in the event of environmental or engineering challenges); however, only up to 100 positions will be occupied by a WTG.

Commercial feasibility: Because monopiles are a proven technology for offshore wind, there is a robust supply chain in Europe. Suppliers are able to fabricate monopiles to needed specifications with a relatively short lead-time. In addition, installation of monopiles is not unduly complicated and can be accomplished relatively quickly, typically within one to three hours per pile. There are also lower commercial risks associated with monopile installation because of their simple design and installation methods used.

Environmental impacts: Installation of monopiles does not involve dredging the seabed and the need for scour protection is expected to be limited (i.e., a total of 1,500- 2,100 square meters ["$m^2$"] [0.37-0.52 acres]) per pile. Therefore, seabed disturbance will be limited. The most significant potential impact from monopile installation is noise associated with pile-driving. However, because individual monopile installation occurs over hours, rather than days or weeks, noise impacts are temporary and of short duration. In addition, noise mitigation measures can be considered.

### *Jacket Foundation*

Technical feasibility: Jacket foundations are also a proven technology, having been used in numerous offshore wind projects in Europe. Jacket foundations are also regularly used in oil and gas projects in the US and throughout the world. As with monopile foundations, seabed conditions within the WDA are well-suited for jacket foundations; these foundations are also compatible with the ocean depths and conditions within the WDA.

Commercial feasibility: Jacket foundations are not as widely used as monopile foundations for offshore wind projects. It is expected that jacket foundations would require a significantly longer lead-time for fabrication and would be more costly than monopiles. Each jacket foundation may require up to four piles, which could increase installation time and costs.

Environmental Impact: Like monopiles, jacket foundations will not require dredging of the seafloor at this site. Scour protection is similarly limited (a total of 1,300- 1,800 $m^2$ [0.32-0.44 acres]) per jacket. Therefore, seabed disturbance is limited. The piles required for the jacket foundation are typically smaller than monopiles, but each jacket requires up to four piles. Noise generated by the installation of individual piles may be less intense than monopile installation, but there would be more piles to install. Nevertheless, noise impacts would be temporary and of short duration. In addition, noise mitigation can be considered.

### *Gravity-Based Foundations*

Technical feasibility: Gravity-based foundations are best-placed on stable soils. The WDA is not conducive for gravity-based foundations because of the soft topsoils throughout the area. In addition, gravity-based foundations require a large concrete-based structure in order to provide the weight needed for the WTGs. Because of the foundations' significant weight, the foundations could not be installed using heavy lift vessels and equipment. Instead, they would have to be fabricated as self-floating foundations. To date, industry has had limited experience with self-floating gravity-based foundation structures.

Commercial feasibility: As gravity-based foundations have had limited application, supply chains are not readily available. Also, because of their size and weight, fabrication would have to be done locally and there is no local harbor readily available that could serve as a fabrication yard. Thus, there would be significant lead times and excessive costs required to establish a suitable fabrication yard (e.g., installing necessary extensions and reinforcements) and to fabricate the foundations. These combined costs far exceed costs associated with monopiles and jacket foundations and are thus not considered a commercially viable option for the Project.

Environmental impact: The size of gravity-based foundations and the scour protection necessary would displace large areas of the seafloor. In addition, excessive dredging could be required to remove the sand layer found throughout the WDA. Thus, seafloor impacts would be significant and there are no mitigation measures that would meaningfully reduce them.

### *Other Foundation Types*

Vineyard Wind did not do a detailed analysis on the use of suction bucket foundations and floating foundations. Both are considered uneconomical for the Project. In addition, suction bucket foundations would have added risk due to variable soil conditions and low permeability soil layers overlaying dense sands in large areas of the WDA. In particular, these soil conditions are known to pose a high risk of suction bucket refusal during installation. The floating foundation technologies are considered risky and unproven for large turbines. In addition, the water depth at VW is too shallow for the most floating foundation concepts.

### *Scour Protection*

Vineyard Wind considered whether scour protection was necessary because the currents within the WDA are considered to be relatively low. However, as an extra measure of conservatism, scour protection was included in the Project design to ensure proper engineering and operation of the foundations. The size of the rock to be used in the scour protection was designed to be compatible with available scour protection installation techniques and tools. At the request of some fishermen, using larger rock was considered to potentially promote habitat creation. This option was ultimately not included because it would be more difficult to control the exact placement of larger rocks. This would potentially reduce the effectiveness of the scour protection and increase bottom impacts during installation.

## 3.4 Wind Development Area and WTG Layout

The WDA is in the northern part of the Vineyard Wind Lease Area where water depths do not exceed 49.5 meters ("m") (162 feet ["ft"]) mean lower low water. The area, as well as the WTG layout proposed in the Project Envelope, was determined after consideration of water depths and non-technical restraints, and after consultation with relevant federal agencies and stakeholders. Costs associated with the area and various layouts were also considered.

In addition to optimizing the Project design (e.g., energy yield and ground conditions) the WTG layout proposed in the Project Envelope was designed to:

- Avoid major navigation routes;
- Avoid known or mapped shipwreck locations by locating a WTG a minimum distance from the location (see Appendix II-C);
- Minimize potential interference with known fishing activities within the area;
- Provide corridors through the WDA to facilitate navigation; and
- Provide a buffer zone against adjacent lease areas.

Vineyard Wind considered a more random layout of the Project design to fully optimize wind energy production. This included additional density around the edges of the WDA. As the principle concern from mariners and particularly fishermen was transit, Vineyard Wind agreed to provide transit lanes within the random layout. However, after further consideration, and discussions with the USCG and fishermen, Vineyard Wind modified the Project design to a grid pattern with the primary WTG layout being aligned with the primary transit direction (NE to SW). This is the final layout submitted in the COP. To address navigation concerns, there is a one nautical mile (nm) transit corridor in the center of the WDA and all turbines allow for direct passage in the NE to SW direction. In addition, the large spacing between the turbines[4] (0.8 nm on average) allow for direct passage in other directions, including north/south and east/west. Vineyard Wind also included a buffer for wind turbines located near adjacent leases (OCS-A 0500 and OCS-A 0502) to further reduce potential navigational conflicts and increase space for passage of vessels.

The Project layout was designed to address many competing interests, including competing fishing interests. Of particular concern was the potential impact of the Project on the scallop fishery out of New Bedford, which according to NOAA data, has an annual average value of over $281 million. The orientation of the transit corridor through the Project was specifically designed in consultation with the scallop industry to allow passage through the Project to fishing areas, and the wide distances between the turbines allows for mobile and fixed gear fishing within the Project area.

[4] The distance between the turbines is a balance between energy loss due to shadowing of other turbines and putting turbines in deeper water and therefore increasing the cost of the foundation due to increased need for steel.

The current layout provides a balance between mariner concerns and lease commercial viability. Additional spacing between turbines and/or larger transit lanes would further reduce the commercial viability of the Project, the purpose and need of which is to deliver 800 MW of wind power to the New England energy grid. As an example, doubling the spacing between WTGs would correspondingly halve the number of WTGs and would not meet the Project's purpose and need. Doubling or otherwise increasing the width of the transit lanes would similarly significantly decrease the available portion of the WDA for wind power generation and jeopardize the commercial viability of the Project. The adequacy of the transit lane dimensions based on an analysis of fishing vessel use and size is addressed in Appendix III-I. Changing from a random layout to a grid pattern already reduced energy production.

## 3.5 Electrical Service Platform

The number and locations of Electrical Service Platforms ("ESPs") consider reliability and cost. The Project Envelope proposes one 800 MW conventional ESP or two 400 MW conventional ESPs to maximize reliability and electrical design. Cost considerations are driven by the distance to shore and optimizing the inter-array cable layout. For this reason, the ESPs are proposed in the northwest portion of the WDA.

## 3.6 Export Cable

Potential Offshore Export Cable Corridors were identified by considering a number of factors, including mapping of special, sensitive, or unique (SSU) areas from the Massachusetts Ocean Management Plan (OMP), bathymetric data, the locations of navigation corridors, water currents, and mapped obstacles such as rock outcroppings and shipwrecks. In the initial desktop analysis for an offshore cable route, critical considerations included, but were not limited to:

- Avoiding SSU areas mapped in the Massachusetts OMP;
- Maintaining a water depth of at least 20 feet, and avoiding shoals;
- Avoiding slopes where the seafloor bathymetry changes dramatically; and
- Crossing navigation corridors in a perpendicular orientation.

In August/September 2017, an initial geophysical survey was performed along more than 125 miles (200 km) of potential offshore route segments. Vineyard Wind performed geophysical surveys and sampling in the offshore environment to examine potential Offshore Export Cable Corridors that would connect with potential Landfall Sites (New Hampshire Avenue, Covell's Beach, and the now-eliminated Great Island).

Results from the 2017 preliminary survey were used to distill the offshore route segments into a Western Offshore Export Cable Corridor and an Eastern Offshore Export Cable Corridor.

*Western Offshore Export Cable Corridor*

The Western Offshore Export Cable Corridor ("OECC") travels north between Martha's Vineyard and Nantucket via Muskeget Channel to the east of mapped North Atlantic Right Whale Core Habitat. Two possible variations of this route through the Muskeget Channel area have been identified: the western route, which travels through the channel itself, where water depths are greater but are accompanied by stronger currents, and the Eastern Route, which avoids the scoured channel itself. The Western OECC then continues northward on the west side of Horseshoe Shoals. As the cables approach the Cape Cod mainland, the western corridor has options for reaching the Landfall Sites at Covell's Beach, New Hampshire Avenue, or Great Island.

*Eastern Offshore Export Cable Corridor*

The Eastern OECC traveled north between Martha's Vineyard and Nantucket via Muskeget Channel to the east of mapped North Atlantic Right Whale Core Habitat. In the Muskeget Channel areas, the eastern corridor avoided the scoured channel itself, passing to its east. The eastern corridor then continued northward on the east side of Horseshoe Shoals. As the cables approach the Cape Cod mainland, the eastern corridor had options for reaching the Landfall Sites at New Hampshire Avenue or Great Island, but not Covell's Beach.

The Eastern Offshore Export Cable Corridor has been eliminated from further consideration after extensive review. The Western Offshore Export Cable Corridor has been selected as the optimum solution as it is technically suitable for cable installation and is the most direct. This route is shorter to the remaining two landfall locations (NH Avenue and Covell's beach). A shorter route allows for less impact area, less electrical line loses and less installation and operational costs. As more ferry traffic travels east from Lewis Bay, use of the Western Offshore Export Cable Corridor minimizes potential impacts, during construction, to ferry traffic as well.

## 3.7 Inter-array Cables

The Project has defined an area within the WDA where inter-array cables may be located (see Figure 3.1-19 of Volume I). The inter-array cables will connect radial "strings" of six to 10 WTGs to the ESPs. Vineyard Wind is permitting an Envelope approach for the inter-array cables that will include any potential layout within areas of the WDA that have been surveyed.

The development of the inter-array cable layout is highly dependent upon the WTG layout (selected turbine, number, and positions of WTGs). To support the Section 106 process, Vineyard Wind has surveyed an extensive amount of the WDA to designate areas where the inter-array cables may be located. Survey areas were based on an assessment of multiple potential WTG layouts (all of which are generated from the up to 106 turbine positions included in the Project Envelope). The design and optimization of the inter-array cable system will occur during final design of the Project, and will consider cable capacity and design, ground conditions, wind farm operating conditions, and installation conditions. If the number or position of WTGs changes, this has a ripple effect on the inter-array cable layout, as multiple strings of inter-array cables must be recreated to accommodate the change. This could lead to an inter-array cable layout in a different orientation than the pattern that has already been surveyed. Therefore, any change in the planned positions of WTGs, such as eliminating WTG positions in certain portions of the WDA or eliminating WTGs to add or widen transit corridors, would likely necessitate additional survey work to accommodate a new inter-array cable layout. Such survey work would impact the Project schedule and potentially cause Vineyard Wind to miss agreed deadlines for demonstrating the scheduled energy delivery date will be met.

## 3.8 Interconnection Points and Cable Routes

To ensure that all reasonable routing options were considered, Vineyard Wind delineated a study area that encompassed all of southeastern Massachusetts as well as eastern Rhode Island. In selecting cable routes, considerations focused on:

- Locations of possible interconnection points to the electrical grid;
- Existing transmission infrastructure and its capacity for accommodating the 800 MW Project; and
- Existing offshore cables.

Vineyard Wind considered a wide range of potential routing options including through Narragansett Bay, Buzzards Bay, Nantucket Sound, and Cape Cod Bay and landfall Sites ranging from municipal beach parking lots to unimproved ways and other developed and undeveloped areas. The potential export cable routes also encompassed possible interconnections at several substations located in southeastern Massachusetts as well as Rhode Island. The universe of routing options considered and their distance from the WDA and to interconnection points are presented in the table below.

### Table 3-1 Universe of Cable Route Options (all lengths approximate, miles)

| *Route #* | *Interconnection Point* | *Export Cable Length* | | |
|---|---|---|---|---|
| | | *Offshore[5]* | *Onshore* | *Total* |
| 1 | Kent County Substation (National Grid), Rhode Island | 78 | 3 | *81* |
| 2 | Brayton Point | 66 | <1 | *67* |
| 3 | Pine Street Substation, New Bedford | 62 | <1 | *63* |
| 4 | Canal Station, via Cape Cod Canal | 77 | <1 | *78* |
| 5 | Canal Station, via onshore | 71 | 7 | *78* |
| 6 | Falmouth Tap Switching Station, via Buzzards Bay | 58 | 4 | *62* |
| 7 | Bourne Substation, via Buzzards Bay | 65 | 10 | *75* |
| 8 | Falmouth Substation, via south coast of Cape Cod | 33 | 2 | *35* |
| 9 | Mashpee Substation, via south coast of Cape Cod | 31 | 14 | *45* |
| 10 | Barnstable (West Barnstable Substation or Barnstable Switching Station) | 41 | 6 | *47* |
| 11 | Barnstable (West Barnstable Substation or Barnstable Switching Station), via Yarmouth Landfall Site | 43 | 6 | *49* |
| 10/11A | Barnstable, via east end of Nantucket to Yarmouth | 63 | 6 | *69* |
| 12 | Canal Station, via ocean route | 135 | <1 | *136* |
| 13 | Pilgrim Station, via ocean route | 127 | <1 | *128* |

The first step in screening initial route options was to eliminate routes that equaled or exceeded 62 miles in total length because 62 miles is the maximum distance cables can be laid without requiring a mid-way reactor station and associated equipment, which would impose significant additional costs and could make the Project uncompetitive on a cost basis. This eliminated 10 routes, which are highlighted in gray in the table above.

The second step considered potential interconnection points, landfall Sites, distance from landfall to grid interconnection point, and locations for the proposed substation. The Falmouth substation was eliminated because it would require significant transmission system reinforcements, potentially including a new transmission line to one of the substations. Similarly, the Mashpee substation was eliminated because it would require significant transmission system reinforcements, including adding another transmission circuit to West Barnstable (more than 15 miles to northeast). The West Barnstable substation could accommodate an 800 MW project, but an interconnection into this substation at either 115 kV or 345 kV would require potential system upgrades and substation modifications. Eversource estimated that a 115 kV expansion at the West Barnstable Substation, which would accommodate the Project, would take approximately 42 months to complete, thus significantly delaying the Project's schedule. Eversource did not provide a timeline estimate for modifications necessary to complete a 345 kV interconnection, which would require a new four-breaker ring bus and transformer additions/modifications, although it is estimated that these modifications would take more time than the 115 kV expansion. A 115 kV interconnect at West Barnstable would require

[5] 1 mile = 0.87 nautical miles

additional bus work, and a 345 kV interconnect at West Barnstable would be a radial interconnection, which would still require the 115 kV work. Therefore, although the West Barnstable Substation could be considered a potential interconnection point for the Project, it is considered inferior to the Barnstable Switching Station for connection of the initial 800 MW.

The Barnstable Switching Station was determined to be the most feasible interconnection point for several reasons. It has the capacity to accommodate the full 800 MW with a 115 kV interconnect. This 115 kV switching station connects a number of 115 kV lines which supply power to the middle and eastern portions of the Cape. Three 115 kV lines from Barnstable Switch run to the west and connect with other major elements of the Eversource transmission system at the recently-constructed West Barnstable 345/115 kV Substation. In addition, Barnstable Switching Station has two spare bays that could accommodate the Project without any significant infrastructure work.

Vineyard Wind did consider the option of regional transmission and, as required, included an option for regional transmission in a bid to the Massachusetts electric utilities for the sale of power. This option was not selected by the Massachusetts utilities. In addition, regional transmission was not included in this COP for the following reasons:

- Vineyard Wind studied a regional transmission approach and was not able to identify any advantages over a generator lead line approach to grid connection, whether from economic, environmental, technical, or other considerations.
- A regional transmission approach would of necessity be a larger undertaking, and involve more project participants, than the Vineyard Wind generation project alone; participation by these other entities is beyond Vineyard Wind's control.
- At this time, there is no policy or commercial framework for regional transmission that is sufficiently developed to be at the point of undertaking permitting, whether or not in coordination with Vineyard Wind's COP.

The Project, however, is utilizing the largest commercially available AC cables in order to minimize the number of cables to support the 800 MW Project, minimize impacts associated with transmission, and maximize efficiencies and economies of scale.

## 3.9 Landfall Sites

Having selected the Barnstable Switching Station as the most favorable interconnection point for the Project, Vineyard Wind examined potential Landfall Sites where the transition from offshore cabling to onshore cabling could occur. The criteria used to identify potential Landfall Sites included:

- Ideally, a beach-front public parking area or similar available land able to accommodate the offshore-to-onshore transition and the necessary transition vault(s);

- Potential for direct access to offshore allowing for an open trench cofferdam transition, possibly eliminating a need for HDD or minimizing length and time to execute landfall;

- Clear egress onto a road of sufficient width to accommodate the duct bank;

- Enough space to accommodate the entry pit and drilling equipment associated with HDD, should that methodology be selected over open trench;

- In the case of residential surrounding land uses, a preference for seasonal use, rather than year-round, to avoid and minimize construction-period impacts to the public;

- Environmental considerations such as wetland resource areas and mapped eelgrass habitat; and

- Onshore route length.

Initially, approximately 50 possible landfall sites were identified along the south coast of Cape Cod and on the east coast of Buzzards Bay. These initial sites were reviewed in the context of cable length limitations and potential interconnection points, as well as fatal flaws. As a result of this analysis, most of the initial Landfall Sites were eliminated from further consideration.

For example, Kalmus Beach in Barnstable, where one of the existing Nantucket cables comes ashore, was initially considered as a potential landfall site but was eliminated from consideration for multiple reasons. First, an onshore route from this site would have passed directly through downtown Hyannis, which would impact many businesses in a high-traffic area. Barnstable town officials strongly advised that the Project avoid this area because of congested buried utilities in the downtown Hyannis area. Second, with the existing Nantucket Cable coming ashore at this location and additional in-road utilities, this location would not contain sufficient space for the proposed infrastructure for the Vineyard Wind Project.

To avoid congested areas, eight locations along the stretch of the south coast of Cape Cod from Mashpee to Yarmouth were considered. Vineyard Wind held discussions with local officials in the Towns of Mashpee, Barnstable, Yarmouth, and Falmouth to discuss potential sites and likely onshore routes. As a result of these discussions and reviews, two potential landfall sites and associated routes were eliminated from further consideration (Keys Beach, Barnstable and Bay View Beach, Yarmouth).

The closest landfall site to the WDA, South Cape Beach, was eliminated because it would require a lengthy onshore cable route of approximately 18 miles to the Barnstable Switching Station by way of Great Neck Road and a utility right-of-way. Much of the ROW has not been maintained to its full width, thus installation of the underground cables would likely necessitate a large amount of land clearing. The ROW also passes through some relatively dense residential neighborhoods. The landfall site is also within the Waquoit Bay Area of Critical Environmental Concern ("ACEC") and is a component of the Waquoit Bay National Estuarine Research Reserve, which is based in Falmouth and managed by the Massachusetts Department of Conservation and Recreation ("DCR") and the National Oceanic and Atmospheric Administration ("NOAA").

The Baxter Avenue, Yarmouth site was eliminated because there is insufficient workspace available for HDD operations without the use of one of two adjacent private properties. In addition, the route inland from this potential site would be along busy sections of Route 28 and Willow Street in Yarmouth. Finally, Seagull Beach, Yarmouth was eliminated because construction would be in close proximity to areas of salt marsh and bordering vegetated wetlands. The area is also mapped with a wide swath of eelgrass. Thus, potential environmental impacts associated with this site informed elimination for further consideration.

Through this process of elimination, three of the eight potential landfall sites were retained (New Hampshire Avenue and Great Island in Yarmouth, and Covell's Beach in Barnstable). However, Great Island was subsequently eliminated because, although Vineyard Wind initially engaged in productive discussions with the landowner about potential use of this site, upon further investigation it was determined that certain property rights were not as understood based on early-stage research. In addition, the Mass Wildlife's Natural Heritage & Endangered Species Program expressed concern over potential use of the site due to the presence of possible nesting habitat for Piping Plover.

Thus the New Hampshire Avenue and Covell's Beach were selected as the viable landfall sites.

## 3.10 Transmission Cables

The Project will employ high-voltage alternating current ("HVAC") technology for the proposed transmission. HVAC is preferred to high-voltage direct current ("HVDC"), as it is more flexible (transmission cables and substation capacity can be expanded as needed) and is more reliable for an 800 MW project with multiple circuits. In Europe, HVAC is widely used for projects less than 120 kilometers ("km") (75 miles ["mi"]) from shore; Vineyard Wind's WDA is located approximately 56 km (35 mi) south of the Cape Cod mainland.

While HVDC is used for long-distance power transmission in overseas markets, and has been proposed for long-distance domestic projects such as the Champlain Hudson Power Express and the Emera Atlantic Link project, both of which are significantly greater in length than the approximately 68 to 80 km (42 to 50 mile) distance from the WDA to Landfall Sites, it requires large and expensive converter stations at both ends of the cable system. With its relatively short distance to shore, the higher cost and complexity of an HVDC system is not justified. Furthermore, lead times for HVDC platforms are currently approximately 48 to 54 months, which is incompatible with the Project schedule.

## 3.11 Transmission Voltage

The voltage of the proposed export transmission system will be 220 kV, which is the standard and accepted operating voltage for comparable connections of offshore projects in Europe. These 220 kV AC three-core offshore cables are the highest voltage commercially available and type-tested in the market from multiple manufacturers. Other higher voltages such as 345 kV could theoretically be used for an offshore wind project, but they are not currently manufactured in a three-core submarine cable configuration. Voltages lower than 220 kV are not desired for this Project, as they could increase the number of cables required for the connection and increase overall losses. For example, using 115 kV cables could require significantly larger offshore and onshore cables, and, in some cases, additional cables, since each 115 kV cable would have approximately half the capacity of a 220 kV cable. Not only would this increase Project costs, but it would also enlarge the impact areas in the offshore and onshore environments.

## 3.12 Cable Installation Techniques

Section 4.2.3.3.2 of Volume I describes the cable installation techniques that are included in the Project Envelope. The primary installation techniques may include jet plowing (jet trenching), mechanical plowing, or mechanical trenching, though the other techniques described in Section 4.2.3.3.2 may be used where needed. Vineyard Wind intends to analyze conditions along the entire Offshore Export Cable Corridor and to select the most appropriate cable installation tool or tools for each segment of the route. The Project intends to use engineering best practices to select the optimum burial solution for the Project with the goal of minimizing the potential for there to be areas where sufficient cable burial is not achieved, and to thereby minimize the extent of cable protection that may be required.

## 3.13 Project Schedule

On May 23, 2018, Vineyard Wind was selected to provide the Commonwealth of Massachusetts with 800 MW of wind energy power through a competitive solicitation process. The long-term power purchase contracts between Vineyard Wind and Massachusetts' electric distribution companies were approved on April 12, 2019. Vineyard Wind is accordingly proposing continuous construction of the 800 MW Project. Constructing the Project in stages or with gaps between phases will not meet the power generation timeframe stipulated with the Commonwealth of Massachusetts.