3.0 ALTERNATIVES TO THE PROPOSED ACTION

The alternatives to the proposed action must be derived from the stated purpose and need. In accordance with the CEQ regulations for implementing the NEPA, reasonable alternatives must be rigorously explored, objectively evaluated and, for those alternatives eliminated from detailed study, a brief discussion on the reasons for elimination must be provided. Additionally, reasonable alternatives not within the jurisdiction of the lead agency must be included in the analysis. Geographical and non-geographical alternatives (including No Action taken) must be analyzed and screening criteria must be clear and conclusive to insure that alternatives considered meet the basic purpose and need and are technologically feasible and economically viable. Discussion on the environmental impacts of the alternatives is first offered in a concise descriptive summary in a comparative form with associated tables. The environmental impacts of the proposed action, no action and considered alternatives are then subject to detailed analysis presented in sections on the affected environment (CEQ § 1502.15) and the environmental consequences (CEQ § 1502.16). The decision maker and the public are then provided with a description of issues and a clear basis for a choice to be made of the options available.

3.1 SCOPE OF ALTERNATIVES

To address the requirements under NEPA as described above, MMS conducted a comparison of other potentially reasonable alternative locations for offshore wind facilities in the New England region of the United States. CEQ §1502.14 requires the EIS to examine reasonable alternatives to the proposed action. In accordance with CEQ's guidelines for applying NEPA, reasonable alternatives are defined as those that are practical or feasible from the technical and economic standpoint and using common sense, rather than simply desirable from the standpoint of the applicant. Furthermore, an alternative that is outside the legal jurisdiction of the lead agency must still be analyzed in the EIS if it is reasonable. A potential conflict with local or federal law does not necessarily render an alternative unreasonable, although such conflicts must be considered (CEQ § 1506.2(d)).

The purpose and need of the proposed action is to provide a renewable energy facility that utilizes the unique wind resources offshore of New England using a technology that is currently available, technically feasible, and economically viable, that can interconnect with and deliver electricity to the NEPOOL grid, make a substantial contribution to enhancing the regions electrical reliability and achieving the renewable energy requirements under the Massachusetts and regional RPS. With consideration of this, sites potentially capable of achieving this purpose and need were included in the scope of analysis. Analyzing such sites in this EIS provides the decision-maker as well as cooperating agencies and the public, useful information for understanding the environmental impacts of potential alternatives and comparing such impacts to the impacts of the proposed action.

3.2 PRELIMINARY SCREENING ANALYSIS

To select its alternatives for detailed evaluation, MMS first developed a screening process aimed at eliminating those project alternatives which did not meet the purpose and need statement (see Section 1.1) of the proposed action and which were not technically feasible and economically viable with the proposed action. The geographic scope of the alternatives analysis included areas offshore of the New England States.

3.2.1 Define Screening Analysis Criteria and Methodology

The criteria used in the screening analysis considered the applicability to the purpose and need for the proposed action, economic viability, and technological feasibility. The alternatives were then subjected to the screening criteria. The failure to meet the described criteria was considered cause for the elimination of the alternative. The geographical and non-geographical alternatives that met the described criteria were then carried with the proposed action and no action alternative to further detailed environmental analysis. The screening criteria described below include applicability to the project's purpose and need, economic viability, and technological feasibility.

3.2.1.1 Applicability to the Project's Purpose and Need

Alternatives to be considered for detailed environmental analysis must meet the basic purpose and need as described in Section 1.1. Specifically, alternatives to the proposed action involve exploitation of offshore wind energy resources and the ability to operate with current technology on a scale capable of making a substantial contribution to the state's mandated percentage of energy required from renewable sources.

3.2.1.2 Economic Viability

In order to understand whether different alternatives were economically comparable, MMS developed an economic model to assess the economics of offshore wind facilities. The model was used to rank the alternative sites according to their relative economic performance, taking into account the projected schedule for development. The cost of energy was chosen as the measure of economic performance. A detailed description of the economic model as well as independent peer review comments on the model is available in Appendix F.

The results of the economic model show that the site of the proposed action (Horseshoe Shoal site) has the greatest economic potential and that South of Tuckernuck Island, Monomoy Shoals, and the Smaller Project alternatives are generally economically comparable in terms of their cost per kilowatt hour (kWhr), albeit somewhat higher.[7]

3.2.1.2.1 ISO Operation and Cost of Electricity

Electricity producers bid on the price of electricity on an hourly basis and therefore the price paid varies during the day throughout the year. The bidding is based on each producers particular set of costs for generating the electricity and the amount of profit they are trying to make. The New England ISO bidding system has made the production and sale of electricity a highly competitive process where slight changes in generation costs or production levels can have a major affect on profitability. Wind projects are particularly vulnerable to varying production because the source of the fuel (wind) cannot be controlled and hence the instantaneous amount of generation cannot be controlled. This factor alone affects how a wind energy producer would bid into the ISO system and what price they would be paid for their electricity. Since energy production output from a wind energy facility has less certainty than conventional power plants, it is important in assessing alternatives in the siting and design of a wind energy facility to understand factors that affect the generation and the sale of electricity within the ISO operating system, as this affects the profitability and ultimately the viability of the project (Refer to Appendix F).

3.2.1.3 Technological Feasibility Requirement

The technological feasibility requirement describes physical criteria that set the parameters within which a project can be constructed and operated, as well as, the technology available for construction and operation. Physical site screening criteria include water depth, extreme storm wave (ESW) height, avoidance of bedrock and large boulders, distance from the generation site to the onshore transmission system, and wind speed.

[7] Cost of energy is defined for this analysis as the starting electricity sales price, in 2007 dollars per KWhr, needed to meet or exceed a specified debt coverage ratio after the project is placed in service. Debt coverage ratios were calculated as the future annual operating cash flow divided by the principal and interest payment for a given year.

3.2.1.3.1 Water Depth

Water depth criteria include both a minimum and a maximum, given current construction method technologies and equipment, and foundation design. The current foundation technology limitations require that offshore wind projects be located in areas of water depths generally less than 100 ft (30 m) in depth to be considered economically feasible. Most existing commercial scale offshore wind projects are sited in areas of water depth ranging from 8 to 65 ft (2.5 to 20 m). Since offshore construction requires large vessels that typically draft at least 7 ft (2.1 m), waters shallower than this are inaccessible. The monopile is the current state of the art for offshore foundations, and this technology is limited by deeper water depths because of the horizontal loading forces of waves and wind. At water depths greater than about 70 ft (21.3 m) the monopile diameter becomes so large and the wall thickness so great in order to withstand the loading over greater height above the bottom, that it is not technologically feasible to manufacture, transport and install a monopile of this design, and a different type of foundation design is required (e.g., multi-legged foundation).

Water depths in the 65 to 147 ft (20 to 45 m) range are currently being pursued on several demonstration projects (such as the Beatrice Demonstrator Project). Depending upon the site specific characteristics of waves, water depths, and bottom conditions, a large commercial scale project could include a variety of foundation types in order to balance technology needs with costs (see Table 3.2.1-1).

3.2.1.3.2 Storm Wave

Storm wave criteria actually reflect a combination of wave heights and water depths, since the energetics associated with a long period swell passing by a wind turbine foundation are different than a breaking wave. As waves come to shore or approach shallow water associated with a shoal, drag on the bottom increases, causing the wave to stack up and assume a more vertical face, which at some point becomes unstable and the top of the wave curls forward and collapses. Waves affect an offshore wind turbine in two primary ways. Either a large wave exerts tremendous horizontal loading on the foundation as it passes by, with the worst case scenario being failure of the structural integrity and collapse of the tower (Report No. 3.2.1-1) or, large waves cause repetitive horizontal movement of the tower, nacelle and rotors that creates excessive wear and tear of moving parts and necessitating increased maintenance and replacement, or a worst case scenario being fatigue and failure of moving parts so that the turbine breaks down more frequently and does not operate enough to cover costs. Also, with greater wave heights the foundation has to extend further above the sea surface before the connection with the tower can be made, since the foundation is the component designed for wave impact and contact with sea water. The larger the foundation, the more costly it becomes. Foundations generally make up roughly 1/4th to 1/3rd of the cost of an offshore wind project.

A 2003 report prepared by the firm Garrad Hassan for the US Army Corps of Engineers, New England District, assessed various environmental design parameters for existing wind projects and those proposed for construction up to 2006 (Morgan et al., 2003). Of the 13 projects for which water depths and the 50 year return storm wave height information was available, 8 had ratios of average water depth to ESW height greater than one and 5 had a ratio less than one. The average ratio of average water depth to ESW for the 13 projects is 1.29. However, if only those in the majority category are included (ratios greater than 1), then the average ratio is 2.0. Based on this, and ignoring other parameters such as geologic conditions and foundation type, it appears that the current industry practice is that the ESW height should be no more than about half of the average water depth within the turbine array for projects located in relatively shallow water. There is anecdotal information that the Blythe project in the UK, with a ratio of about 0.75, is experiencing a significantly accelerated fatigue life from the breaking waves.

A secondary aspect of wave heights that can affect offshore wind project operations and maintenance is the number of days out of the year when wave heights exceed the ability to get maintenance personnel transferred from vessels to the tower in order to do required maintenance. While multiple maintenance crews can be deployed simultaneously to make up for missed days, at some point there is a diminishing return on performing maintenance. If extended periods of time occur when a proportion of wind turbines cannot operate because of breakdown or lack of maintenance, then the generation revenue drops and the project economics suffer. Current technology for maintenance access limits the suitable wave height to approximately 4.9 ft (1.5 m) or less.

3.2.1.3.3 Substrate

Since foundation design is typically 1/4 to 1/3 the total cost of a WTG installation, the type of foundation can have a substantial affect on the overall project costs and the economic viability and profitability of the project. Monopile installation would typically be accomplished by means of a pile driving ram or vibratory hammer to a substantial depth (about 85 ft [26 m] below the seafloor in the case of the proposed action). In areas of bedrock and excessive boulders, driven monopiles cannot be deployed and either a gravity based foundation or a multi-legged foundation is required in order to have a stable foundation on which to erect the tower and generating equipment. Given the greater amount of steel, increased installation costs, and potentially higher maintenance costs, gravity based and multi-legged foundations are generally more expensive than a driven hollow monopile. Also, these other types of foundations create a greater footprint which may exhibit greater environmental impacts. Finally, rocky substrate conditions can make it difficult and or cost prohibitive to bury interconnecting cables below the seafloor. Therefore site selection between alternative locations needs to consider substrate characteristics relative to the type of foundation that can be deployed to support the remaining wind generating equipment. Seabed geology for the regional alternatives was determined by the use of NOAA Charts. Detailed geotechnical data was collected for the proposed action site (see Table 3.2.1-1).

3.2.1.3.4 Transmission Line Distance

Transmission line distances are dependent upon which cable design is being considered. Basically, there are three types of electric transmission cables: pressurized fluid filled AC cables, solid dielectric AC cables, and high voltage direct current (HVDC) cables. Wind projects are typically designed with solid dielectric AC cables because of the ability to relatively easily install miles of cable having low maintenance characteristics, avoiding the pumping systems needed for fluid filled cables, and avoiding the need for converter stations associated with DC current transmission. As the cable length increases, so does the cost for the cable itself as well as installation.

Since the cost of the transmission cable is only one of numerous components of a wind project that are part of the *pro forma* calculations, the determination of a distance that can be used as a criterion is site specific. Of course, there are certain technological limits to some of the cable types that come into play as the cable lengths become very long (TRC, 2006). For example, the fluid filled AC cables typically cannot exceed about 20 miles (32 km) in length because of the limitations on pumping the cooling liquid, and the additional pump stations that would be needed for greater cable lengths. The HVDC cables can be very long, if designed to handle line losses, but they require that converter stations be built to switch the DC to AC flow of electricity. The solid dielectric AC cables that are the industry standard for offshore wind energy projects typically have limits of about 31 miles (49.9 km), and geologic conditions such as thermal resistivity must be taken into consideration when assessing line losses relative to cable length for buried cables (see Table 3.2.1-1 and Report No. 3.2.1-2).

3.2.1.3.5 Minimum Wind Speeds

There is no single minimum wind speed criterion that can be relied on as a siting criterion, because so many factors go into the costs for construction and operation, which must be subtracted from the revenue from the electricity generated. Modern turbines are designed with a minimum cut-in speed that balances the cost of wear and tear against the smaller amount of electricity and therefore smaller revenue generated at lower wind speeds. The typical range for cut-in wind speeds is 7 to 10 mph for commercial scale wind turbines. A project developer needs to consider the site specific wind data versus the revenue generated at low wind speeds and subtract the maintenance costs of running the turbines at lower wind speeds (see Table 3.2.1-1).

3.2.1.3.6 Technology Availability

The current foundation technology limitations require that offshore wind projects be located in areas of water depths generally less than approximately 100 ft (30 m) in depth to be considered economically feasible. One demonstration project, the Beatrice Demonstrator project in the UK is targeting turbine locations in waters up to 150 ft (45 m) to allow collection of information on the design and the economics relative to long term maintenance and operation. Several companies have recently begun exploring the feasibility of floating foundations, yet none are currently available for commercial production.

Foundations for 65 to 147 ft (20 to 45 m) water depths are currently being explored in order to determine their technological feasibility within the requirements for a commercial scale project to be economically viable. Typically, it is expected that to go to these greater water depths would require tri-pod or quadra-pod foundations in order to get the anchoring and stability necessary in deeper water. The Beatrice Demonstrator project has recently completed constructing two WTG in the Miray Forth area of the North Scottish Sea. The project involves a jacketed structure as the foundation (four legs crossed braced) to support the large 5 MW turbine in a water depth of 144 ft (44 m). The economic viability for large scale commercial application of this technology has yet to be determined and most estimates place this design at least 5 to 10 years into the future (see Table 3.2.1-1).

3.3 ALTERNATIVES CONSIDERED

3.3.1 Geographic Alternatives

In order to conduct a comprehensive evaluation of reasonable alternative locations for an offshore wind energy project that would be capable of serving the New England region, MMS identified and initially screened nine wind farm sites (in addition to the proposed action) along the coast from Maine to Rhode Island. The sites were chosen based on geographic diversity, having at least some potential in terms of wind resources, and the necessary area required for the proposed facility size. The Phelps Bank site was chosen as a result of a comment/request from the Massachusetts Office of CZM that an alternative be evaluated for a site located more than 25 miles (40 km) offshore with water depths less than 150 feet. The Offshore Nauset site was chosen as a result of agency interests in comparing a deep water alternative. The ten sites including the proposed action are as follows:

1. Offshore Portland, Maine
2. Offshore Cape Ann, Massachusetts
3. Offshore Boston, Massachusetts
4. Offshore Nauset, Massachusetts (east of Nauset Beach)
5. Nantucket Shoals (southeast of Nantucket Island, Massachusetts)
6. Phelps Bank (southeast of Nantucket Island, Massachusetts)
7. East of Block Island, Rhode Island
8. Monomoy Shoals (east of Monomoy, Massachusetts)
9. South of Tuckernuck Island
10. Horseshoe Shoals (proposed action)

Figure 3.3.3-1 shows the location of these sites with respect to the New England Coast Line.

3.3.2 Non-Geographic Alternatives

Alternatives that include modifications to the proposed action that reduce the scope (smaller or condensed configuration) or temporal impacts (phased development schedule) should be analyzed in an EIS. Non-geographic alternatives must include design alternatives that would decrease pollution emissions, construction impacts, aesthetic intrusion, as well as relocation assistance, possible land use controls that could be enacted, and other possible efforts. Non-geographic alternatives are subjected to the same screening criteria as geographical alternatives. As with geographical alternatives, those that meet the screening criteria are carried forward for further detailed analysis.

The non-geographic based alternatives that were analyzed in reference to the proposed action include:

- Smaller Alternative (half the MW capacity of the proposed action at the same location)
- Condensed Array Alternative
- Phased Development Alternative
- No Action Alternative

3.3.3 Alternatives Considered But Screened Out Due to Physical Constraints

Alternative sites were selected based upon their potential to meet the basic purpose and need to utilize offshore wind resources to provide electricity to the New England Power Pool. The application of the physical criteria (Section 3.2.1) resulted in the elimination of seven of the sites from further consideration. Therefore, in accordance with CEQ §1502.14, further detailed analysis was not conducted and the reasons that each site was eliminated is provided in the following discussion (see Table 3.2.1-1).

3.3.3.1 Portland, Maine

The center of the Offshore Portland Alternative is located 19.3 miles (31 km) east of Portland, Maine. The alternative site would be located somewhere within a 197 square mile (511 km^2) area as shown on Figure 3.3.3-1. Coordinates that bound the alternative location are shown in Table 3.3.3-1. The mean wind resources in this area are between 17.9 and 21.3 mph (8.0 and 9.5 m/s) (Figure 3.3.3-2).

The area around the outer harbor of Portland, Maine (Figure 3.3.3-3) was evaluated using the Site Screening Criteria described above and not selected for further environmental analysis due to water depth, wave height, and seabed substrate. Specifically:

- Water depths are estimated to average 200 ft (61 m), which would require monopiles of such large size that their construction, transport, and installation would not be technologically feasible. Floating foundations have not been developed for deep water applications and foundation technology adapting oil and gas type floating platform substructures to wind energy applications is not likely to be proven by the date anticipated for project development;
- Open ocean exposure to the east results in ESWs of approximately 90 ft (27 m), which can cause structural failure or excessive turbine fatigue; and
- Seabed geology in this area is likely to include an abundance of shallow bedrock and rock outcroppings that would interfere with WTG foundation installation and embedment of submarine cables (NOAA Chart No. 13286).

In addition to these physical criteria, another potential concern with this site includes its potential to affect migratory movements of whales, particularly the endangered northern right whale, traveling between the Northern Right Whale critical habitats located at the northern and southern extents of the Gulf of Maine.

3.3.3.2 Cape Ann, Massachusetts

The center of the Offshore Cape Ann Alternative is located 8.3 miles (13.4 km) east of Cape Ann, Massachusetts. The alternative site would be located somewhere within a 196.4 square mile (508.7 km^2) area shown on Figure 3.3.3-1. Coordinates that bound the alternative location are shown in Table 3.3.3-1. The mean wind resources in this area are between 17.9 and 20.1 mph (8.0 and 9.5 m/s) (Figure 3.3.3-2). The area around Cape Ann, Massachusetts (Figure 3.3.3-4), was evaluated using the Site Screening Criteria described above and not selected for further environmental analysis due to water depth, wave height, and seabed substrate. Specifically:

- Water depths are estimated to average 150 ft (45.7 m), which would require monopiles of such large size that their construction, transport, and installation would not be technologically feasible. Floating foundations have not been developed for deep water applications and foundation technology adapting oil and gas type floating platform substructures to wind energy applications is not likely to be proven by the date anticipated for project development;
- Open ocean exposure to the east results in ESWs of approximately 62 ft (19 m), which can cause structural failure or excessive turbine fatigue; and
- Seabed geology in this location appears to be primarily gravel, boulder piles and ridges; that would interfere with WTG foundation installation and embedment of submarine cables (NOAA Chart No. 13286).

In addition to these physical criteria, an issue specific to this area which makes it less favorable is that the area is close to the Stellwagen Bank National Marine Sanctuary, and areas of dense whale congregations such as humpback and northern right whales (National Marine Sanctuary Program, 2007). The Sanctuary occupies approximately 42 square miles (108.8 km^2) of the OCS east of the coastline of mainland Massachusetts and north of Cape Cod.

3.3.3.3 Boston, Massachusetts

The center of the Offshore Boston Alternative is located 14.2 miles (22.9 km) east of Boston, Massachusetts. The alternative site would be located somewhere within a 214.2 square mile (554.8 km^2) area shown on Figure 3.3.3-1. Coordinates that bound the alternative location are shown in Table 3.3.3-1. The mean wind resources in this area are between 17.9 and 20.1 mph (8.0 and 9.5 m/s) (Figure 3.3.3-2). The area around the outer harbor of Boston, Massachusetts (Figure 3.3.3-5) was evaluated using the Site Screening Criteria described above and not selected for further environmental analysis due to water depth, wave height, and seabed substrate. Specifically:

- Water depths are estimated to average 200 ft (61 m) which would require monopiles of such large size that their construction, transport, and installation would not be technologically feasible. Floating foundations have not been developed for deep water applications and foundation technology adapting oil and gas type floating platform substructures to wind energy applications is not likely to be proven by the date anticipated for project development;

- Open ocean exposure to the east results in ESWs of approximately 75 ft (23 m) which can cause structural failure or excessive turbine fatigue; and
- Seabed geology in this location appears to include a number of relatively large boulder ridges that would interfere with WTG foundation installation and embedment of submarine cables (NOAA Chart No. 13287).

In addition to these physical criteria, the majority of this potential alternative site is within the Stellwagen Bank National Marine Sanctuary, which makes this alternative less favorable due to potential for impacts to marine mammals in the area and conflicts with designated uses of the Sanctuary.

3.3.3.4 Nauset, Massachusetts (East of Nauset Beach)

The center of the Offshore Nauset Alternative is located 19.3 miles (31.1 km) east of Nauset, Massachusetts. The alternative site would be located somewhere within a 202.3 square mile (524 km^2) area shown on Figure 3.3.3-1. Coordinates that bound the alternative location are shown in Table 3.3.3-1. The mean wind resource in this area ranges from 20.1 to 21.3 mph (9.0 to 9.5 m/s) (Figure 3.3.3-2).

The area offshore of Nauset, Massachusetts (East of Nauset Beach) (Figure 3.3.3-6) was evaluated using the Site Screening Criteria described above and not selected for further environmental analysis due to water depth and wave height. Specifically:

- Water depths are estimated to average 650 ft (198 m) which would prevent the use of foundations resting on or inserted in the seafloor. Floating foundations have not been developed for deep water applications and foundation technology adapting oil and gas type floating platform substructures to wind energy applications is not likely to be proven by the date anticipated for project development; and
- Open ocean exposure to the east results in ESWs of approximately 55 ft (17 m) which can cause structural failure or excessive turbine fatigue.

In addition to these physical criteria evaluated, another issue is that the site is in close proximity to Northern Right Whale Critical Habitat precautionary area (National Marine Sanctuary Program, 2007).

3.3.3.5 Nantucket Shoals, Southeast of Nantucket Island, Massachusetts

The center of the Nantucket Shoals Alternative is located 4.8 miles (7.7 km) southeast of Nantucket Island, Massachusetts. The alternative site would be located somewhere within a 210.7 square mile (545.7 km^2) area as shown on Figure 3.3.3-1. Coordinates that bound the alternative location are shown in Table 3.3.3-1. The Nantucket Shoals area southeast of Nantucket Island, Massachusetts (Figure 3.3.3-7) was evaluated using the Site Screening Criteria described above and not selected for further environmental analysis due to wave height and transmission line distance. Specifically:

- Open ocean exposure to the east results in ESWs of approximately 65 ft (20 m) which can cause structural failure or excessive turbine fatigue; and
- The interconnection distance to shore (assuming landfall in Hyannis) is approximately 41 miles (66 km). This distance exceeds the normal use of AC transmission cables (should be less than approximately 31 miles [50 km]) and would require the use of HVDC transmission cable. HVDC transmission lines have not yet been proven to be a commercially available technology for offshore wind farms. DC transmission may be possible though likely more costly due to requirements to install AC to DC converters. It would not be possible to connect to the existing two

Nantucket Cables that cross from Nantucket to the Cape Cod because of their limited transmission capacity.

3.3.3.6 Phelps Bank (Southeast of Nantucket Island, Massachusetts)

The center of the Phelps Bank Alternative is located 44.4 miles (71.5 km) southeast of Nantucket Island, Massachusetts. The alternative site would be located somewhere within a 210.5 square mile (545.2 km^2) area as shown on Figure 3.3.3-1. Coordinates that bound the alternative location are shown in Table 3.3.3-1. The area around the Phelps Bank (southeast of Nantucket Island, Massachusetts, Figure 3.3.3-8) was evaluated using the Site Screening Criteria described above and not selected for further environmental analysis due to wave height and transmission line distance. Specifically:

- Open ocean exposure to the east results in ESWs of approximately 65 ft (20 m) which can cause structural failure or excessive turbine fatigue; and
- The interconnection distance to shore (assuming landfall in Hyannis) is approximately 67 miles (108 km). This distance exceeds the normal use of AC transmission cables and would require the use of HVDC transmission cable. HVDC transmission lines have not yet been proven to be a commercially available technology for offshore wind farms. DC transmission may be possible though likely more costly due to requirements to install AC to DC converters.

3.3.3.7 East of Block Island, Rhode Island

The center of the East of Block Island Alternative is located 6.4 miles (10.3 km) east of Block Island, Rhode Island. The alternative site would be located somewhere within a 209.5 square mile (54.6 km^2) area as shown on Figure 3.3.3-1. Coordinates that bound the alternative location are shown in Table 3.3.3-1. The area east of Block Island, Rhode Island (Figure 3.3.3-9) was evaluated using Site Screening Criteria described above and not selected for further environmental analysis due to wave height and seabed substrate. Specifically:

- Extreme storm waves in the area are estimated to be approximately 50 ft (15.2 m) which can cause structural failure or excessive turbine fatigue; and
- Seabed geology in this location is likely to consist of an abundance of boulders and rock outcroppings that would interfere with WTG foundation installation and embedment of submarine cables (NOAA Chart No. 13288).

3.3.4 Other Alternatives Considered But Not Subject to Detailed Analysis

The following additional alternatives were considered in the preparation of this EIS, but were not subject to detailed analysis, for the reasons identified and briefly described below.

3.3.4.1 Onshore Sites

Onshore wind energy projects, as well as other onshore renewable energy technologies, were not subject to detailed analysis in this EIS due to the fact that they do not satisfy the stated purpose and need, as described in Section 1.1. In addition, with respect to wind energy, there are limited contiguous sites in Massachusetts that are capable of accommodating commercial wind energy facilities. As compared to the approximately 14,000 MWs of wind energy capacity currently installed onshore in the United States, Massachusetts has approximately 5 MWs of existing installed wind energy capacity, with an additional 3 MWs capacity under construction (AWEA, 2007). According to DOE wind resource potential maps, Massachusetts onshore wind resources are rated in general by region, where eastern Massachusetts is rated “marginal”, central Massachusetts is rated “fair” and some areas of western Massachusetts are rated as “good” (DOE EIA, 2003).

3.3.4.2 Near Shore Waters

The geographic areas defined on Figure 3.3.3.1 included near shore waters on some of the alternatives considered (e.g., Portland, Cape Ann, Block Island). These alternative sites were selected based upon their potential to meet the basic purpose and need as described in Section 1.1. Siting a facility near shore within the geographic confines of each alternative described in Figure 3.3.3.1 was not selected for detailed analysis due to the potential increase in impacts and decrease in wind resources. The application of the physical criteria (Section 3.2.1.3.) to the offshore portion of each area resulted in the elimination of seven of the sites from further consideration. Therefore, in accordance with CEQ §1502.14, further detail analysis was not conducted.

3.3.4.3 Dispersed Sites

The applicant has proposed a commercial scale alternative energy facility located within a specific contiguous area of the OCS. Distributing the power potential of this proposed project to multiple sites on the OCS (e.g., four locations on the OCS, each with approximately 100 MW of installed capacity) was considered but eliminated from detailed analysis due to the fact that such dispersal of construction and operational impacts throughout the offshore region increases the geographic scope of direct, indirect and cumulative impacts. Additionally, it is believed that such dispersal of generating sites would decrease the efficiency and reliability of the energy production, and the associated costs (i.e., additional cabling and electric service platform installations) would render any such project uneconomic. Therefore, in accordance with CEQ §1502.14, further detail analysis was not conducted.

3.3.4.4 Tidal In-Stream Energy Conversion (TISEC) Device

TISEC devices are an exciting new renewable energy technology for the marine environment. However, commercial demonstration of such technologies is still relatively unproven, and available tidal resources in New England are considered marginal as compared to other sites nationally. TISEC development would not be consistent with the purpose and need of the proposed action, as described in Section 1.1.

TISEC devices are a similar technology to wind turbines except that they are installed in the water column and are moved by underwater tidal currents. Though the speed of tidal currents is very slow compared to that of wind, the density of water is more than 1,000 times that of air. Therefore, even slow tidal current speeds can generate considerable energy. Since tidal current speeds are predictable, the TISEC technology can be a more consistently reliable source of electric power generation. Because TISEC devices are underwater generation facilities, they avoid aesthetic impacts on the ocean surface or landscape. In addition to the turbines, which must be able to move toward the direction of changing currents or allow for multidirectional flow, the TISEC devices require an anchoring system and an electrical interconnection line to a land-based transmission system.

TISEC device projects must be sited at or near known areas with a strong tidal current regime and tidal current speeds that range from 2 to 4.7 knots (1.02 to 2.4 m/s). In addition, they generally need to be close to onshore transmission lines, either immediately adjacent to or within 0.25 to 0.5 mile (0.4 to 0.8 km) (TRC, 2006).

In general, research shows that New England has marginal resources in terms of tidal power generation relative to other locations across the country (TRC, 2006). For instance, there are many other potential TISEC locations in the United States and/or Canada that have tidal energy levels that exceed the tidal resources in New England. Construction and a full build out of a tidal energy facility would not be expected to take place for several years, and the size of the first pilot projects likely would be small and not able to provide a substantial contribution to the New England and regional RPS. Therefore, in accordance with CEQ §1502.14, further detail analysis was not conducted.

3.3.4.5 Wave Energy

Wave energy project development is not consistent with the purpose and need of the proposed action described in Section 1.1. Wave energy conversion takes energy from ocean waves and converts it to mechanical energy that is then converted to usable electric energy. The initial conversion is done using various devices that capture the energy. Research in this area shows that the average power density of waves on the New England coast is approximately half that of California, and therefore the offshore areas of Massachusetts are less likely for development of this technology, especially given the infancy of this new field (TRC, 2006). Construction and a full build out of a wave energy project in New England would still be many years from now, and construction of the first pilot projects likely would be small and not able to provide a substantial contribution to the Massachusetts and regional RPS. Therefore, in accordance with CEQ §1502.14, further detail analysis was not conducted.

3.3.4.6 Solar (Photovoltaic and Thermal Electric)

Development of a solar power system (photovoltaic or thermal electric) is not consistent with the purpose and need of the proposed action described in Section 1.1. Photovoltaic (PV) systems used to generate electricity include: (1) flat plate technology, which uses an arrangement of PV cells mounted on a rigid flat surface and exposed freely to incoming sunlight; and (2) concentrator technology, which uses an arrangement of PV cells and lenses to concentrate sunlight on a small area of cells.

Based on the PV systems currently in operation, flat plate technology ranges in size from 50 - 200 kilowatts (kW), while concentrator technology ranges between 2 kW and 200 kW. At these lower power generation levels, PV applications are most feasible and economical for off-grid and consumer applications.

Despite their prevalence in consumer applications, PV systems have the highest energy costs among alternative energy sources (greater than $0.20/kWhr in 2002 as compared to $0.12/kWhr for the Cape Wind project), which may be attributed to the costs of producing the materials used in PV cells and modules (i.e., crystalline technologies). Because of the high capital costs associated with PV systems, coupled with low efficiencies, the technology does not represent a commercially competitive alternative to the proposed action within the timeframe of the proposed action.[8] Therefore, in accordance with CEQ §1502.14, further detail analysis was not conducted.

3.3.4.7 Ocean Thermal

Development of an Ocean Thermal Energy Conversion (OTEC) project is not consistent with the purpose and need of the proposed action described in Section 1.1. OTEC is a technology that converts solar radiation to electric power. Since the ocean is composed of layers of water that have different temperatures, it creates a natural thermal gradient. The OTEC systems use this gradient to drive a power-producing cycle, which can produce a significant amount of energy as long as the temperature differential

[8] Some installations have been constructed as a result of public funding, but costs remain high. For instance, a 425- kW PV solar energy system was recently constructed in Brockton, Massachusetts at a cost of $7 per watt. Costs were addressed via a $1.6 million city of Brockton bond, $789,000 grant from the U.S. DOE, and more than $1 million from the Massachusetts Technology Collaborative (MTC) Renewable Energy Trust. The Project would generate 535 MW hours per year and is expected to provide power to 71 homes and result in no emissions (MTC, 2007).

is about 36 °F (20 °C) between the warmer surface water and colder deep water. The oceans cover more than 70 percent of the earth's surface making them the largest solar energy collector and energy storage system. The potential for OTEC as an alternative resource is great; however, the economics of energy production have delayed the financing of a permanent, continuously operating OTEC plant (TRC, 2006).

The natural thermal gradient necessary for OTEC operation is generally found in the tropical zone between the latitudes of 20 degrees North (N) and 20 degrees South (S). As a result, the siting criteria for such facilities are not compatible with the existing conditions found along the coast of New England and the technology as it exists today does not appear suitable for the New England area. Therefore, in accordance with CEQ §1502.14, further detail analysis was not conducted.

3.3.4.8 Floating Wind Turbines

This technology utilizes a floating structure that provides enough buoyancy to support the weight of a wind turbine. It must also be able to restrain pitch, roll, and heave motions within acceptable limits in order to operate efficiently and safely. A variety of platform, mooring, and anchoring technologies have been proposed for floating wind turbine systems. This technology remains in its infancy and is not expected to be commercially viable for at least 10 to 15 years. As such, development of a marine wind energy project employing this foundation technology is not consistent with the purpose and need of the proposed action as described in Section 1.1.

3.3.5 Geographic Alternatives Considered and Subject to Detailed Analysis Including the Proposed Action

In accordance with CEQ regulations for implementing NEPA, alternatives considered that meet the screening criteria are subject to further detailed environmental analysis in the "environmental consequences" section of the EIS which discusses the specific environmental impacts or effects of each of the alternatives including the proposed action and no action. In order to avoid duplication between the alternatives section and the sections of the EIS dedicated to detailed analysis, this section is dedicated to describing and comparing the alternatives to the proposed action with a brief summary of impacts.

The geographic alternatives considered and subject to detailed analysis include the proposed action, South of Tuckernuck Island, and Monomoy Shoals. Alternatives subject to detailed analysis, but not involving a change of location from the proposed action (Smaller Alternative, Phased Development Alternative, Condensed Array Alternative, and No Action Alternative) are examined in Section 3.3.6. Figure 3.3.5-1 shows all of the alternatives that met screening criteria.

3.3.5.1 Horseshoe Shoal - Proposed Action

3.3.5.1.1 Description

The proposed action entails the construction of an electric generating facility consisting of 130 wind turbine generators arranged in a grid pattern in the Horseshoe Shoal region of Nantucket Sound, Massachusetts. The northernmost WTGs would be approximately 3.8 miles (6.1 km) from the dry rock feature (offshore near Bishop and Clerks) and approximately 5.2 miles (8.4 km) from Point Gammon on the mainland; the southernmost part of the area of the proposed action would be approximately 11 miles (17.7 km) from Nantucket Island (Great Point), and the westernmost WTG would be approximately 5.5 miles (8.9 km) from the island of Martha's Vineyard (Cape Poge) (see Figure 2.1.1-2). The area occupied by the WTGs and ESP is 25 square mile (64.7 km^2).

Each of the 130 wind turbine generators would generate electricity independently of each other. For this area of Nantucket Sound, the wind power density analysis determined that orientation of the array in a northwest to southeast alignment provides optimal wind energy potential for the wind turbine generators. The optimal WTG spacing within the array is 0.39 mile (629 m) by 0.62 mile (1,000 m) between each WTG based on wind direction analysis, which corresponds to a 6 x 9 rotor diameter configuration.

Hydrographic surveys indicate water depths are as shallow as 0.5 ft (0.15 m) (MLLW), with depths of up to 60 ft (18.3 m) (MLLW) occurring between the northern and southern legs of the shoal. However, water depth within the portion of the site where WTGs would be sited ranges from 12 to 50 ft (3.7 to 15.2 m) (MLLW). WTG foundations installed in water depths of 10 to 40 ft (3 to 12.2 m) would utilize a 16.75 ft (5.1 m) diameter monopile and in water depths of 40 to 50 ft (12.2 to 15.2 m) would utilize an 18.0 ft (5.5 m) diameter monopile. The extreme wave height in the area is 17.4 ft (5.3 m).

An ESP would be required to be installed and maintained within the approximate center of the WTG array. It would serve as the common interconnection point for all of the WTGs within the area of the proposed action. The ESP would be a fixed template type platform consisting of a jacket frame with six 42-inch diameter (1.1 m) driven piles to anchor the platform to the ocean floor. The 200 ft by 100 ft (61 m by 30.5 m) platform would rest atop a steel superstructure. The platform would be placed approximately 40 ft (12.2 m) above the MLLW datum plane in 28 ft (8.5 m) of water. Each WTG would interconnect with the ESP via a 33 kV submarine cable system. The ESP would provide electrical protection and inner-array cable sectionalizing capability in the form of circuit breakers. It would also include voltage step-up transformers to step the 33 kV inner-array transmission voltage up to the 115 kV voltage level of the submarine cable connection to the land-based system.

Solid dielectric submarine cables from each wind turbine generator would interconnect within the grid and terminate at their spread junctions on an electrical service platform. The electric service platform would serve as the common interconnection point for all of the wind turbine generators. The proposed submarine cable system is approximately 12.5 mile (20.1 km) in total length (7.6 miles [12.2 km] within the Massachusetts 3.5 mile [5.6 km] territorial line and 4.9 miles [7.9 km] on the OCS) from the electric service platform to the landfall location in Yarmouth. The submarine transmission cable system consists of two parallel cables that would travel north to northeast in Nantucket Sound into Lewis Bay past the westerly side of Egg Island, and then make landfall at New Hampshire Avenue. The proposed onshore transmission cable route to its intersection with the NSTAR electric transmission ROW would be located entirely along existing paved ROWs where other underground utilities already exist. The remaining portion of the onshore transmission cable route would be located underground within an existing maintained NSTAR electric transmission ROW, terminating at an existing substation.

The cables would be installed between the WTGs and ESP, as well as the transmission line between the ESP and shore, using a jet plow technology that simultaneously loosens sediments to create a space for the cable to be laid in and allows for natural in-filling. The shoreline crossing of the transmission cable would be installed using horizontal directional drilling technology and onshore cable construction would employ standard cable trenching, conduit placement, and cable pulling methods and equipment.

3.3.5.1.2 Summary of Impacts on Physical, Biological, Socioeconomic Resources and Land Use, and Navigation and Transportation

Construction, decommissioning and operation of the proposed action would result in varying levels of impacts to the physical environment, biological resources, socioeconomics and land use, and navigation and transportation. A summary of the impacts within these four major categories is provided below (see Table E-1 in the Executive Summary for additional summary information describing the impacts of the proposed action).

Physical Resources

The proposed action would result in impacts to above water and underwater ambient sound levels as a result of construction and decommissioning activities and to above water sound levels as a result of operation. The maximum calculated pile driving sound level at any location would be 41 dBA whereas the lowest ambient level measured would be 35 dBA. During operation, the sound levels of the proposed action would range from 19.2 to 25.9 dBA, well below the ambient conditions of 54 to 71 dBA.

In addition to noise impacts, the proposed action would result in air quality impacts from vessels and equipment involved in the pre-construction G&G investigations, and construction, decommissioning, and maintenance phases of the proposed action. The quantities of these pollutants would be small in relation to other air pollution sources in the general region and would not have a noticeable effect on air quality. A summary of total emissions from the proposed action is provided in Table 5.3.1-7. With respect to water quality, impacts would be temporary and localized and result from installation of monopiles and undersea cables. With respect to EMFs, the proposed action would generate a small EMF in the immediate vicinity of the undersea cables and onshore cables. This small EMF is not expected to adversely affect marine or human life (see Section 5.3.1.7 for information on predicted EMF levels for the proposed action at different locations).

Operation of the proposed action is not anticipated to impact hydrodynamics or water quality. The proposed action would require the storage of 40,000 gallons (151,400 liters) of mineral oil on the ESP. Based on analyses conducted, probabilities of a large spill are extremely small.

Biological Resources

The proposed action would affect terrestrial vegetation and terrestrial fauna via its upland portion of the interconnection line. The upland portion of the interconnection line would be located within an existing previously disturbed and maintained utility ROW, and thus impacts would be limited. Impacts to coastal and intertidal vegetation, would also be limited since no seagrass has been identified close to the footprint of the proposed action, and HDD technology would be used at landfall to avoid impacts to vegetation along the intertidal zone.

With respect to avifauna, the proposed action is in Nantucket Sound which is in the general vicinity of Monomoy National Wildlife Refuge and other locations where there are important staging areas and habitat for roseate terns, and least terns (Perkins, et al., 2003) (Details on potential avian species affected are provided in Section 5.3.2.4). With respect to avian T&E species, information on the piping plover suggest that collision mortality associated with the proposed action would result in minor to moderate adverse impacts but would not jeopardize the Atlantic coast population. With respect to the roseate tern, information shows that a low level of WTG collisions can be expected but would only have a minor to moderate affect on the roseate tern population. Detailed analysis of the piping plover and roseate tern are provided in Appendix G.

Subtidal offshore resources would be affected by the monopiles and scour protection associated with WTGs in the area of the proposed action, which results in a hard bottom structure for colonization by benthos. The added structure is expected to attract a variety of finfish to the site, which could improve recreational fishing resources. Most of the impacts to soft-bottom benthic communities are expected to occur during the cabling activities of the construction and decommissioning periods. Permanent impacts include the direct mortality to benthic organisms due to jet plowing and the placement and removal of pilings for the WTGs and ESP. The total area of permanent benthic impact for the proposed action due to the WTG and ESP piles is 0.67 acres (2,711 m^2). The proposed scour protection scenario includes 106 turbines protected by scour mats covering 1.96 acres (7,936 m^2) and 24 turbines protected by rock armor covering 8.75 acres (35,417 m^2).Additionally, during construction, the total area of temporary impact for the cable that connects the WTGs to the ESP is 580 acres (2.3 km^2) and the temporary impact of the area disturbed from installation of the cable from the ESP to the shore is 220 acres (86 acres [0.3 km^2] outside the three mile limit, plus 134 acres [0.5 km^2] inside the three mile limit) (refer to Table 5.3.2-3).

Marine mammals that are not listed under the ESA, but are protected under the MMPA, that may be found in the area of the proposed action include the gray seal, harbor seal, harp seal, hooded seal, Atlantic white-sided dolphin, striped dolphin, common dolphin, harbor porpoise, long-finned pilot whale, and minke whale. Due to possible proximity to these marine mammals under the proposed action, there is potential for impact to these species during construction and decommissioning as a result of collisions with large construction vessels.

Socioeconomic Resources and Land Use

The proposed action would cause an increase in the number of workers to fill the construction requirements of the alternative. The increase would result in approximately 391 full-time jobs during the 27-month period, with fewer workers required for decommissioning. Limited impacts to urban and suburban infrastructure would be anticipated as a result of the proposed action due to the relatively small number of workers relative to the population of the region, the relatively short duration of the work, and capacity of existing infrastructure including housing, emergency services and transportation to address the needs of the proposed action.

With respect to environmental justice, a socioeconomic analysis was conducted and showed that the counties within the area of impact had a lower percent minorities than the rest of the Commonwealth, and a lower percentage of people living under the poverty level than the rest of the Commonwealth, and thus the area of impact is not within an environmental justice population (refer to Section 4.3.3.3).

The proposed action would result in visual impacts to areas along the south coast of Cape Cod as well as areas along the shorelines of Nantucket and Martha's Vineyard that are oriented toward the proposed action (refer to visual simulations of the proposed action at Figure 5.3.3-5). With respect to cultural resources, no submerged historic properties or archaeological sites are recorded in the area of the proposed action. The proposed action would be visible from historic properties and from Tribal areas of cultural and religious importance, and thus would affect cultural resources as a result of such visual impacts.

Navigation and Transportation

The area of the proposed action is used for fishing and boating (power and/or sail), and the shoreline areas are used for bird watching, and beach-going and other general recreational activities. The proposed action is not expected to affect overland transportation arteries or airport facilities. The proposed action received FAA approval indicating WTGs in the area would not affect air navigation or associated communication systems (refer to Appendix B). With regard to navigation, the individual turbines would be located either directly on Horseshoe Shoal or in close proximity it, where vessels are less likely to navigate (refer to detailed discussion of navigation in Section 5.3.4). In addition, the turbines would be spaced in a grid of approximately 6 x 9 rotor diameters (629 x 1000 m) which would allow ample room for vessels, including trawlers, to navigate through the area. However, as discussed in Section 5.3.4.4.2, impacts to radar for vessels operating within the WTG array lead to a moderate impact to navigation safety, under certain conditions. The applicant and the USCG have developed mitigation measures (see Section 9.3.4) to reduce the impacts to an acceptable level.

3.3.5.2 South of Tuckernuck Island

3.3.5.2.1 Description

The South of Tuckernuck Island Alternative is approximately 3.79 miles (5.31 km) southwest of Tuckernuck Island in Federal waters (see Figure 3.3.5-1). Water depth within the site ranges between 15 ft and 100 ft (4.6 m and 30.5 m) below MLLW, with an estimated average depth of approximately 57 ft (17.5 m). The extreme wave height estimate in the area is 52.5 ft (16.0 m). The South of Tuckernuck Island Alternative would have the same generation capacity as the proposed action (130 WTG's, 3.6 MW machines plus an ESP), but would require an area of approximately 36 square miles (93.2 km^2). The proposed turbine spacing for the South of Tuckernuck Island Alternative is a grid arrangement approximately 9.0 rotor diameters (0.62 mile [1.0 km]) by 6 rotor diameters (0.34 mile [0.629 km]). Configuration of the South of Tuckernuck Island alternative was developed based on avoidance of turbine placement in the Cape and Islands Ocean Sanctuary (M.G.L c.132A, Section 13) while avoiding infeasible water depths.

This site would require foundations to be placed in various water depths ranging from approximately 15 to 100 ft (4.6 to 30.5 m), but still benefits from some sheltering effects from open ocean waves due to Nantucket Island to the east. The South of Tuckernuck Island Alternative would likely require three different sized monopiles and a quad-caisson foundation depending on water depth. Foundations in water depths between 0 and 30 ft (0 and 9.1 m) would utilize a 16.75 ft (5.1 m) monopile, while foundations in water depths between 30 and 45 ft (9.1 and 13.7 m) would utilize an 18.0 ft (5.5 m) monopile, and foundations in water depths between 45 and 65 ft (13.7 and 19.8 m) would utilize a 19.0 ft (5.8 m) diameter monopile. The quad-caisson foundation, a fabricated steel structure, would be utilized for all WTGs installed at a water depth greater than 65 ft (20 m). This structure would consist of four tower foundations that support the tower interface (see Figure 3.3.5-2). This structure would require more fabrication and installation due to its large size and the more challenging sea conditions off the southern coast of Nantucket Island.

The construction sequencing for this alternative would be similar to that described for the Nantucket Sound alternatives. However, rather than the mechanical driving of the structure into the seabed as described for the monopiles, the caissons of the quad-caisson foundation would be set on the seabed and then suctioned into place to the appropriate depth.

The 115 kV transmission cable system for the South of Tuckernuck Island Alternative would consist of the same equipment as described in Section 2.3 of this document. The total length of the interconnect cable route, from the alternative site of the ESP to the Barnstable Substation, would be 33.4 miles (53.8 km). The location, WTG configuration, and interconnection routing for this alternative are provided in Figure 3.3.5-3.

3.3.5.2.2 Comparison of Alternative with Proposed Action

Environmental impacts associated with the South of Tuckernuck Island Alternative would be greater than the proposed action with respect to avifauna, subtidal resources, non-ESA mammals, fish and fisheries, and essential fish habitat, and less than the proposed action with respect to impacts on visual resources. In the remaining resource impact categories, the South of Tuckernuck Island Alternative would have comparable impacts to the proposed action (see Table 3.3.5-1 for a full comparative listing of impacts relative to the proposed action).

With respect to avifauna, the South of Tuckernuck Island Alternative would have a greater potential for impacts to terrestrial, coastal, and marine birds than the proposed action, primarily because of the increased area in which the turbines would be located (the South of Tuckernuck Island Alternative would require an area of approximately 36 square miles (93.2 km^2) versus the area of the proposed action, which is 25 square miles (64.7 km^2).

With respect to subtidal resources, the additional pilings, cross-braces, and scour protection required at the South of Tuckernuck Island Alternative because of the greater depth at the site, substantially increase (by more than 10 times) the vertical habitat structure available for colonization by benthos for the life of the Project. However, anchoring impacts associated with construction at the South of Tuckernuck Island Alternative would be twice that of the proposed action and would result in greater overall impact to benthos including shellfish. The South of Tuckernuck Island Alternative also would have greater impacts on benthic resources as a result of the much longer interconnection line requirement compared to that of the site of the proposed action. The greater impacts on benthos also result in greater impacts on fish and fisheries and essential fish habitat, which utilize the benthic resources and would be affected due to greater duration of construction and turbidity impacts. The greater size of the foundations at the South of Tuckernuck Island Alternative would also attract greater numbers of fish at the site due to the larger increase in hard bottom structure than the proposed action.

With respect to non-ESA mammals, the South of Tuckernuck Island Alternative is in closer proximity to seal haul-out and breeding sites than the proposed action, and therefore, development at this site has a greater potential to impact seals both during construction and operation. In addition, there is greater potential to impact whales at the South of Tuckernuck Island Alternative than the site of the proposed action since the site is proximate to historical sightings of these mammals.

With respect to visual impacts, generally fewer viewers would see the project at the South of Tuckernuck Island Alternative site compared to the proposed action, because it would be beyond or close to beyond visible range from Cape Cod, which has the major population density in the area (see Figure 3.3.5-4). As a result, there would be less visual impact associated with the South of Tuckernuck Island Alternative than the proposed action.

3.3.5.2.3 Summary of Impacts on Physical, Biological, Socioeconomic Resources and Land Use, and Navigation and Transportation

Construction, decommissioning and operation of the South of Tuckernuck Island Alternative would result in varying levels of impacts to the physical environment, biological resources, socioeconomics and land use, navigation and transportation. A summary of the impacts within these four major categories is provided below. Table 3.3.5-1 summarizes the impacts of the proposed action with the alternatives analyzed.

Physical Resources

The South of Tuckernuck Island Alternative would result in impacts to above water and underwater ambient sound levels as a result of construction and decommissioning activities and to above water sound levels as a result of operation. The maximum predicted sound levels would occur during construction of the South of Tuckernuck Island Alternative and would be approximately 30 dBA (at the modeled receptor for the South of Tuckernuck Island Alternative at Madaket Beach on Nantucket Island). In addition to noise impacts, the South of Tuckernuck Island Alternative would result in air quality impacts from vessels and equipment involved in the pre-construction G&G investigations, and construction, decommissioning, and maintenance phases of the work. The quantities of these pollutants would be small in relation to other air pollution sources in the general region and would not have a noticeable effect on air quality. With respect to water quality, impacts would be temporary and localized and result from installation and removal of monopiles and undersea cables. These activities would be expected to meet the state water quality designation in the area, since there are no known major sources of pollutant input or other degrading factors. With respect to EMFs, the South of Tuckernuck Island Alternative would generate a small EMF in immediate proximity to the undersea cables and onshore cables, which is not expected to adversely affect marine or human life.

Operation of the South of Tuckernuck Island Alternative is not anticipated to impact hydrodynamics or water quality. The South of Tuckernuck Island Alternative would require the storage of 40,000 gallons (151,400 liters) of naphthenic mineral oil for insulation and cooling of the four 115 kV transformers on the ESP. Based on analyses conducted for the proposed action (Report No. 3.3.5-1), probabilities of occurrence of a large spill at the ESP are extremely small and given the similarity in likely design and activities, this would apply to the ESP for this alternative.

Biological Resources

The USFWS (2008), in their publication "Northeast Coastal Areas Study – Significant Coastal Habitats", identifies the area around Tuckernuck Island as being of high conservation significance. The southern half of Tuckernuck Island consists of outwash plains characterized by coastal heathland, a globally restricted and endangered plant community. This community occurs only from Long Island, NY, to Cape Cod, MA. The shallow waters and shoals of Muskeget Channel and the areas surrounding Tuckernuck and Muskeget Islands are highly productive for marine fish, shellfish, and eelgrass (*Zostera marina*), providing rich feeding grounds for terns and gulls in summer and sea ducks in winter. The largest concentration of oldsquaws (*Clangula hyemalis*) in the western Atlantic occurs here (counts of over 150,000 have been recorded), along with thousands of common eiders (*Somateria mollissima*) and three species of scoter (*Melanitta* spp.). In late summer a thousand or more roseate terns (*Sterna dougallii*), a U.S. Endangered species, feed here in preparation for their southward migration.

Extensive sand spits on Tuckernuck, Muskeget, and Skiff Islands (west side of Muskeget Channel off Martha's Vineyard) support rare plants and are favored haul out points for large numbers of harbor and gray seals (*Phoca vitulina* and *Halichoerus grypus*, respectively). One of only two U.S. breeding locations for gray seal is on Muskeget and the island also supports major herring gull (*Larus argentatus*) and great black-backed gull (*Larus atricilla*) colonies. These islands support many State and Federally-listed rare species including: Nantucket shadbush (*Amelanchier nantucketensis*), a candidate species for listing under the Act, several pairs of short-eared owl (*Asio flammeus*), piping plover (*Charadrius melodus*), a U.S. Threatened species, least tern (*Sterna antillarum*), northern harrier (*Circus cyaneus*) and common tern (*Sterna hirundo*).

The South of Tuckernuck Island Alternative would affect terrestrial vegetation and terrestrial fauna via its upland portion of the interconnection line. The upland portion of the interconnection line would be located within an existing previously disturbed and maintained utility ROW, and thus impacts would be limited. Impacts to coastal and intertidal vegetation, would also be limited since no seagrass has been identified close to the footprint of the South of Tuckernuck Island Alternative, and HDD technology would be used at landfall to avoid impacts to vegetation along the intertidal zone. With respect to avifauna, the South of Tuckernuck Island Alternative is located in close proximity to the South of Tuckernuck Island area, and construction and operation of the South of Tuckernuck Island Alternative would affect the avian resources in this area including impacts to eiders, scoters, long-tailed ducks, and pelagic species, such as shearwaters, storm-petrels, and jaegers.

Subtidal resources would be affected by the monopiles and additional pilings/cross-braces and scour protection associated with WTGs at the South of Tuckernuck Island Alternative, which would have to be designed using a quad-caisson foundation in some areas due to the greater water depths. This foundation design results in a substantial vertical habitat structure for colonization by benthos for the life of the South of Tuckernuck Island Alternative. The added structure is expected to attract a variety of finfish to the site. Anchoring impacts associated with construction and decommissioning would affect a large area of the seafloor causing temporary disturbance of the substrate, and to shellfish. The work would temporarily cause an increase in turbidity, which would result in finfish temporarily avoiding the area and a short term and limited impact to EFH.

With respect to Non-ESA marine mammals, the South of Tuckernuck Island Alternative is in close proximity to seal haul-out and breeding sites and therefore, development at this site has the potential to impact seals both during construction and operation. In addition, there is potential to impact whales at the South of Tuckernuck Island alternative during construction since the site is proximate to historical sightings of these mammals. With respect to T&E species, the South of Tuckernuck Island Alternative could result in temporary disturbance to listed species during construction and decommissioning, including: the federally-endangered roseate tern (*Sterna dougallii*), the federally-threatened piping plover (*Charadrius melodus*) and three federally protected sea turtle species: loggerhead, leatherback, and Kemp's Ridley sea turtles. During operations, impacts would most likely be limited, since these species occurrence in the area is also limited, and operational activities that could impact T&E species are limited.

Socioeconomic Resources and Land Use

The South of Tuckernuck Island Alternative would cause an increase in the number of workers to fill the construction requirements of the alternative. The increase would result in approximately 391 full-time jobs during the 27-month period, with fewer workers required for decommissioning. Limited impacts to urban and suburban infrastructure would be anticipated due to the relatively small number of workers relative to the population of the region, the relatively short duration of the work, and capacity of existing infrastructure including housing, emergency services and transportation to address the needs of the South of Tuckernuck Island Alternative.

With respect to environmental justice, a socioeconomic analysis was conducted and showed that the counties within the area of impact had a lower percent minorities than the rest of the Commonwealth, and a lower percentage of people living under the poverty level than the rest of the Commonwealth and thus the area of impact is not within an environmental justice population (refer to Section 4.3.3.3).

With respect to visual resources, the seascape from Tuckernuck Island southwest towards the South of Tuckernuck Island Alternative consists of panoramic open ocean views of the Atlantic Ocean. The South of Tuckernuck Island Alternative would be located close to Nantucket and the east end of Martha's Vineyard and would have visual impact from those locations. However, it would be far away from Cape Cod and would be rarely visible from that area (see Figure 3.3.5-4).

With respect to cultural resources, no submerged historic properties or archaeological sites are recorded in the South of Tuckernuck Island Alternative area, and there are no shipwrecks charted in the vicinity of the alternative site. The South of Tuckernuck Island Alternative would be visible from historic properties and from Tribal areas of cultural and religious importance, and thus would affect cultural resources as a result of such visual impacts.

Navigation and Transportation

The South of Tuckernuck Island Alternative is located close to land (Nantucket Island) and the popular boating and recreational area around Nantucket Island. The South of Tuckernuck Island Alternative is not expected to affect overland transportation arteries or airport facilities (the South of Tuckernuck Island Alternative received FAA approval [see Appendix B]). With respect to navigation, the array would be located away from navigational channels and the turbines would be spaced in a grid of approximately 6 x 9 rotor diameters, which would allow ample room for vessels including trawlers to navigate through the area. However, given the radar impacts discussed in Section 3.3.5.2 above, and similar spacing criteria of WTG's between the proposed action and this alternative, navigation safety would be moderately impacted under certain conditions.

3.3.5.3 Monomoy Shoals

3.3.5.3.1 Description

The Monomoy Shoals Alternative site is 3.5 miles (5.6 km) southeast of Monomoy Island, within the eastern approach to Nantucket Sound (Figure 3.3.5-1). Water depth within the Monomoy Shoals Alternative site ranges between 13 ft and 34 ft (3.9 and 10.4 m) below MLLW, with an estimated average depth of approximately 24 ft (7.3 m) (Navigational Chart No. 13237 – Nantucket Sound and Approaches. Ed. 38, March 3, 2001). This alternative would have the same generation capacity as the proposed action (130 WTG's, 3.6 MW machines plus and ESP), but would require a slightly larger area (25.9 square miles [67.1 km^2]). The proposed turbine spacing for the Monomoy Shoals Alternative is a grid arrangement approximately 9.0 rotor diameters (0.62 mile [1,000 m]) by 6 rotor diameters (0.39 mile [629 m]). Configuration of the Monomoy Shoals Alternative was developed based on avoidance of turbine placement in the Cape and Islands Ocean Sanctuary (M.G.L c.132A, Section 13) while avoiding infeasible water depths.

The construction and decommissioning methods for the Monomoy Shoals Alternative would be similar to those presented in Section 2.3 of this document for the proposed action. Although driven monopile foundations and jet plow cable embedment are anticipated to be the proposed method of construction, it is possible that bed rock outcroppings and shallow surface bedrock at the Monomoy Shoals Alternative site may necessitate surface laying of the cable or other alternative installation methods. In addition, it is anticipated that the construction and decommissioning time tables for this alternative would be significantly longer than the proposed action, due to more limited accessibility (primarily due to wave conditions).

The 115 kV transmission cable system for the Monomoy Shoals Alternative would consist of the same equipment as described in Section 2.1 of this document. As shown in Table 3.3.5-2, the total length of the interconnect cable route, from the alternative site ESP to the Barnstable Substation, would be 29.8 miles (48 km). Of this amount, approximately 2.9 miles (4.7 km) of cable would be in Federal waters, 21.0 miles (33.8 km) would be in State waters, and 5.9 miles (9.5 km) of cable would be located in an upland transmission ROW. The interconnect cable would be routed from the ESP in a north-northwesterly direction for about 20.6 miles (33.2 km) and then turn north-northeast for about 3.3 miles (5.3 km) before making landfall. The transmission cable would be located approximately 3.0 miles (4.8 km) south of Monomoy Island. The total inner array length of 33 kV cable would be approximately 74 miles (119.1 km). The location, WTG configuration, and interconnection routing for this alternative are provided in Figure 3.3.5-5.

3.3.5.3.2 Comparison of Alternative with Proposed Action

Environmental impacts associated with the Monomoy Shoals Alternative would be greater than the proposed action with respect to avifauna, subtidal resources, non-ESA mammals, fish and fisheries, essential fish habitat, and T&E species, and have less impact than the proposed action with respect to impacts on visual resources and impacts to cultural resources as they relate to visual impacts on historic structures.[9] In the remaining resource impact categories, the Monomoy Shoals Alternative would have

[9] Under the Monomoy Shoals Alternative, the impact categories: subtidal offshore resources, fish and fisheries, and essential fish habitat, have impacts that would be greater than the proposed action but only with respect to construction and decommissioning. Operational impacts would be expected to be the same for these impact categories as for the proposed action.

comparable impacts to the proposed action (see Table 3.3.5-1 for a full comparative listing of impacts relative to the proposed action).

With respect to non-T&E avifauna, Monomoy Island (including the Monomoy National Wildlife Refuge) provides important resting, nesting and feeding habitat for migratory birds, and due to the proximity to Monomoy Island, the Monomoy Shoals Alternative would have greater potential impacts than the proposed action to terrestrial, coastal, and marine birds.

With respect to subtidal resources, construction and decommissioning impacts on benthic habitat would be more for the Monomoy Shoals Alternative than for the proposed action because of the additional interconnection line length, and the greater wave heights, which would prolong the construction time frame. The greater impacts on benthos also would result in greater impacts to fish and fisheries (including shellfish) and essential fish habitat, which utilize the benthic resources and would be affected due to greater duration of construction and turbidity impacts.

With respect to non-ESA marine mammals, the Monomoy Shoals Alternative site is located adjacent to the northwestern extent of a designated Northern Right Whale Critical Habitat whereas the site of the proposed action is located away from this area (NOAA Chart No. 13200, 2005). Due to the location of this Critical Habitat, there is a greater likelihood of construction, decommissioning, and operational impacts to right whales in this area, than in the area of the proposed action. With respect to acoustical harassment, vessel harassment, water quality, and EMF the operational impacts to whales would be expected to negligible to minor. While improbable, an oil spill would have moderate to major impacts on cetaceans within Nantucket Sound. Of the whale species in the area, the right whale population should be considered at greatest risk to being negatively impacted by an oil spill because of the small population size and slow recovery of their numbers from earlier depletion events.

With respect to T&E species, six federally and/or state protected species have nested at the Monomoy National Wildlife Refuge (pied-billed grebe, northern harrier, piping plover, roseate tern, and arctic tern [USFWS, 2001]). As the Monomoy Shoals Alternative is located close to the avian T&E habitat associated with the Monomoy National Wildlife Refuge, avian T&E impacts would be greater than for the location of the proposed action.

With respect to impacts on visual resources, and visual impacts on historic structures, the Monomoy Shoals Alternative is located further from the populated and historic areas of Cape Cod and is thus expected to be beyond view of the most populated area and historic structures than the proposed action.

3.3.5.3.3 Summary of Impacts on Physical, Biological, Socioeconomic Resources and Land Use, and Navigation and Transportation

Construction, decommissioning and operation of the Monomoy Shoals Alternative would result in varying levels of impacts to the physical environment, biological resources, socio-economics and land use, and navigation and transportation. A summary of the impacts within these four major categories is provided below. Table 3.3.5-1 summarizes the impacts of the proposed action with the alternatives analyzed.

Physical Resources

The Monomoy Shoals alternative would result in impacts to above water and underwater ambient sound levels as a result of construction and decommissioning activities and to above water sound levels as a result of operation. In addition to noise impacts, the Monomoy Shoals Alternative would result in air quality impacts from vessels and equipment involved in the pre-construction G&G investigations, and construction, decommissioning, and maintenance phases of the Monomoy Shoals Alternative. The quantities of these pollutants would be small in relation to other air pollution sources in the general region and would not have a noticeable effect on air quality. With respect to water quality, impacts would be temporary and localized and result from installation of monopiles and undersea cables. With respect to EMFs, the Monomoy Shoals Alternative would generate a small EMF in immediate proximity to the undersea cables and onshore cables, which would not negatively affect marine or human life.

Operation of the Monomoy Shoals Alternative is not anticipated to impact hydrodynamics or water quality. The Monomoy Shoals Alternative would require the storage of 40,000 gallons (151,400 liters) of naphthenic mineral oil for insulation and cooling of the four 115 kV transformers on the ESP. Based on analyses conducted for the proposed action (Report No. 3.3.5-1), probabilities of the occurrence of a large spill at the ESP are extremely small and given the similarity in likely design and activities, this would apply to the ESP for this alternative. However, as mentioned below, however improbable, the consequences of an oil spill at this alternative location has the potential for greater biological impacts to sensitive marine and coastal birds and marine mammals compared to the proposed action.

Biological Resources

The Monomoy Shoals Alternative would affect terrestrial vegetation and terrestrial fauna via its upland portion of the interconnection line. The upland portion of the interconnection line would be located within an existing previously disturbed and maintained utility ROW, and thus impacts would be limited. Impacts to coastal and intertidal vegetation, would also be limited since no seagrass has been identified close to the footprint of the Monomoy Shoals Alternative, and HDD technology would be used at landfall to avoid impacts to vegetation along the intertidal zone.

With respect to avifauna, the Monomoy National Wildlife Refuge is located close to the Monomoy Shoals Alternative, which provides important resting, nesting and feeding habitat for migratory birds. Specifically, Monomoy Island is an important staging area for roseate terns, provides habitat for roseate, common and least tern nesting colonies, harbors roseate and common tern restoration sites, and is a known piping plover nesting area (Perkins, et al., 2003). Due to the proximity to Monomoy Island, the Monomoy Shoals Alternative has the potential to negatively affect both non-T&E and T&E avian species as a result of disturbance during construction and as a result of the potential for collision into existing structures during operation. The Monomoy Shoals Alternative is also located in the vicinity of historic sitings of three federally and/or state protected sea turtle species (loggerhead, leatherback, and Kemp's Ridley sea turtles) and as such, has the potential to impact these T&E species. Further, this alternative is closer than the proposed action, to areas of whale concentration, particularly the designated Critical Habitat for the endangered Right whale.

Subtidal offshore resources would be affected by the monopiles and scour protection associated with WTGs at the Monomoy Shoal, which results in a hard bottom structure for colonization by benthos for the life of the Monomoy Shoals Alternative. The added structure is expected to attract a variety of finfish to the site, which could improve recreational fishing resources. Anchoring impacts associated with construction and decommissioning would affect a large area of the seafloor causing temporary disturbance of the substrate, and to shellfish. The work would temporarily cause an increase in turbidity, which would result in finfish temporarily avoiding the area and a short term and limited impact to EFH.

With respect to non-ESA Marine Mammals, the Monomoy Shoals Alternative site is due east and southeast of gray seal pupping grounds on Monomoy Island. This pupping ground is known to be used year round with the greatest use occurring during the winter and spring (Natural Heritage and Endangered Species Program [NHESP], 2002). Due to proximity to these areas, there is potential for impact to these species during construction and decommissioning as a result of collisions with vessels or harassment due to vessel activities. The Monomoy Shoals Alternative is outside of Nantucket Sound and in a region of greater occurrence of whale species and therefore has the potential to affect both ESA listed whales and well as others protected under the MMPA.

Socioeconomic Resources and Land Use

The Monomoy Shoals Alternative would cause an increase in the number of workers to fill the construction requirements of the alternative. The increase would result in approximately 391 full-time jobs during the 27-month period, with fewer workers required for decommissioning. Limited impacts to urban and suburban infrastructure would be anticipated as a result of the Monomoy Shoals Alternative due to the relatively small number of workers relative to the population of the region, the relatively short duration of the work, and capacity of existing infrastructure including housing, emergency services and transportation to address the needs of the Monomoy Shoals Alternative.

With respect to environmental justice, a socioeconomic analysis was conducted and showed that the counties within the area of impact had a lower percent minorities than the rest of the Commonwealth, and a lower percentage of people living under the poverty level than the rest of the state, and thus the area of impact is not within an environmental justice population (refer to Section 4.3.3.3).

With respect to visual resources, the seascape from Monomoy Island east-southeast towards the Monomoy Shoals Alternative site consists of panoramic open views of the Atlantic Ocean. The site is located further from the more populated area of Cape Cod, and thus viewing of the alternative from Cape Cod would be limited. (See Figure 3.3.5-6 for photo simulations of the Monomoy Shoals Alternative). However, the project is located relatively nearby to the Cape Cod National Seashore, and as such, could result in visual impacts to the heavy seasonal and tourism population that visits this area.

With respect to cultural resources, no submerged historic properties or archaeological sites are recorded in the Monomoy Shoals Alternative area. The Monomoy Shoals Alternative would be visible from historic structures and from Tribal areas of cultural and religious importance, and thus would affect cultural resources as a result of such visual impacts.

Navigation and Transportation

Fishing and boating (power and/or sail), seal-tours, bird watching, and beach-going are common activities among visitors to and off the waters off of Monomoy Island. The Monomoy Shoals Alternative is not expected to affect overland transportation arteries or airport facilities. With regard to navigation, the turbine array would be located on a shoal away from navigational channels where vessels are less likely to navigate. In addition, the turbines would be spaced in a grid of approximately 6 x 9 rotor diameters which would allow ample room for vessels including trawlers to navigate through the area. However, given the radar impacts discussed in Section 3.3.5.2 above, and similar spacing criteria of WTG's between the proposed action and this alternative, navigation safety would be moderately impacted under certain conditions.

3.3.6 Non-Geographic Alternatives Considered and Subject to Detailed Analysis Including No Action

This section evaluates the non-geographic alternatives including: Smaller Project Alternative and the Condensed Array Alternative.

3.3.6.1 Smaller Project

3.3.6.1.1 Description

The Smaller Project Alternative is located in the same area as the proposed action but contains only half the number of WTGs, and thus has half the generation capacity of the proposed action. Each monopile included in the Smaller Project Alternative is located within a footprint of a monopile of the proposed action. For the Smaller Project Alternative, the monopile locations along the north and south sides of the turbine array have been removed, making it further from Cape Cod and from Nantucket than the proposed action (see Figure 3.3.5-1, which shows the Smaller Project Alternative superimposed over the proposed action). Further detail on the location of the Smaller Project Alternative is shown in Figure 3.3.6-1. The transmission cable would be 29.7 miles (47.8 km) long, 23.8 miles (38.3 km) of which would be located under the sea.

3.3.6.1.2 Comparison of Alternative with Proposed Action

The Smaller Project Alternative has less impact than the proposed action in 13 impact categories: noise, air quality, water quality, avifauna, subtidal offshore resources, non-ESA marine mammals, fish and fisheries, essential fish habitat, threatened and endangered species, visual resources, cultural resources (as they relate to visual impacts on historic structures) competing uses of waters and sea bed, and port facilities. In the remaining resource impact categories, the Smaller Project Alternative would have comparable impacts to the proposed action (see Table 3.3.5-1 for a full comparative listing of impacts relative to the proposed action).

With respect to noise, construction related noise impacts to humans would be reduced under the Smaller Project Alternative as the alternative would be located further from both Cape Cod and from Nantucket than the proposed action, and because there would be half as many wind turbines to construct and decommission, and hence a shorter construction time than the proposed action. Operational noise would also be reduced due to the smaller number of turbines and their further distance from land.

Air quality impacts would be reduced under the Smaller Project Alternative as overall emissions from the construction and decommissioning vessels would be smaller than those under the proposed action. However, given the limited timeframe of the construction period, the impacts of air emissions from the construction and decommissioning of either alternative would be considered minor on a local and regional scale.

With respect to water quality, the temporary impacts to sediments related to the WTGs are reduced roughly proportional to the number of WTGs, though impacts related to the installation of the 115 kV cable would increase by one mile (1.6 km) as the ESP of the Smaller Project Alternative is further from shore. Because the number of vessels required to transit to and from the Project area during construction would decrease with the Smaller Project Alternative, the probability of marine vessels spilling fuel, lubricating oils or other substances would also decrease over that of the proposed action. In addition, the decrease in size of the ESP under the Smaller Project Alternative would result in a decrease in the total number of gallons of electrical insulating oil utilized on the ESP, and thus the potential size of an oil spill from the ESP would be reduced.

With respect to electric and magnetic field impacts, the Smaller Project Alternative would result in half the generation capacity of the proposed action and thus involve a smaller amount of electrical current in its interconnection cable and smaller EMFs than the proposed action. However, EMF impacts are negligible under the proposed action, and thus reductions in the levels result in no advantage over the proposed action with respect to construction, operation, and decommissioning impacts.

With respect to avifauna, the number of WTGs and the aerial extent of the proposed action would decrease and thus the number of construction/decommissioning events that could potentially displace the birds would similarly decrease over that of the proposed action.

With respect to benthic impacts, the Smaller Project Alternative results in the number of WTGs being reduced to 65. As a result, the temporary impacts to benthic habitat and resources related to the WTGs are reduced roughly proportional to the number of WTGs. Impacts related to the installation of the 115 kV cable limit would increase in proportion to the additional one mile (1.6 km) of cable. During operation, the smaller number of WTGs would reduce the number of structures that would provide new localized hard-bottom habitats for benthic resources to inhabit. These benthic macro invertebrates and fouling organisms are anticipated to attract prey and finfish to the monopiles. Overall, the benthic impacts of the Smaller Project Alternative would be expected to be less than those of the proposed action with respect to construction, decommissioning and operation because of its smaller footprint and impact area. The reduced impacts on benthos from the Smaller Project Alternative would also result in less impact to fish and fisheries (including shellfish) and essential fish habitat, which utilize the benthic resources.

With respect to non-ESA marine mammals, there would be some potential for reduction of impacts to marine mammals with the Smaller Project Alternative as there would be half as many WTGs and thus half as many vessel trips and chances for vessel strikes during construction.

With respect to T&E species, the Smaller Project Alternative would have a smaller affected area and would therefore reduce impacts to T&E species by limiting disturbance during construction compared to the proposed action. Disturbance associated with construction/decommissioning activities such as increased vessel traffic, presence of equipment, human presence, and noise would be reduced as a result of the smaller project scope and shorter duration of pile driving activities. The Smaller Project Alternative would also result in less interconnection disturbance between the individual WTGs and hence reduce the sediment plumes which could cause fish to avoid the construction site and displace some avian T&E species. The Smaller Project Alternative would reduce the number of wind turbines by half and thus could be expected to reduce the amount of avian T&E collisions predicted for the proposed action by half.

With respect to socio-economic conditions, the Smaller Project Alternative would offer less in terms of socio-economic benefits including number of construction jobs, electricity generated and revenues from taxes, than from the larger proposed action.

With respect to impacts to visual resources and impacts to historic structures, the views of the Smaller Project Alternative result in a somewhat reduced breadth of visual impacts when looking out at the horizon from Cape Cod or Nantucket. In addition, the Smaller Project Alternative is also somewhat further away from Nantucket and Cape Cod (see Figure 3.3.6-2 which shows visual simulations of the Smaller Project Alternative). Construction related visual impacts would also be reduced due to the shorter period of construction, and less time when large construction vessels would be visible.

With respect to competing uses, the Smaller Project Alternative is smaller than the proposed action and hence would have even less of a potential to impact competing uses in the area.

3.3.6.1.3 Summary of Impacts on Physical, Biological, Socioeconomic Resources and Land Use, and Navigation and Transportation

The following discussion is presented under the four categories of physical resources, biological resources, socioeconomic resources and land use, and navigation and transportation.

Physical Resources

The Smaller Project Alternative would result in impacts to above water and underwater ambient sound levels as a result of construction and decommissioning activities and to above water sound levels as a result of operation. In addition to noise impacts, the Smaller Project Alternative would result in air quality impacts from vessels and equipment involved in the pre-construction G&G investigations, and construction, decommissioning, and maintenance phases of the Smaller Project Alternative. The quantities of these pollutants would be very small in relation to other air pollution sources in the general region and would not have a noticeable effect on air quality. With respect to water quality, impacts would be temporary and localized and result from installation of monopiles and undersea cables. With respect to EMFs, the Smaller Project Alternative would generate a small EMF in the immediate vicinity of the undersea cables and onshore cables, which would not negatively affect marine or human life. Noise impacts from the Smaller Project Alternative would be limited to noise resulting from pile driving and vessel use. Noise during operation would result from the WTGs themselves.

Operation of the 65 WTG layout is not anticipated to impact hydrodynamics or water quality. The Smaller Project Alternative would require the storage of 20,000 gallons (75,700 liters) of oil on the ESP. Based on analyses conducted, probabilities of a large spill are extremely small. Based on analyses conducted for the proposed action (Report No. 3.3.5-1), probabilities of the occurrence of a large spill at the ESP are extremely small and given the similarity in likely design and activities, this would apply to the ESP for this alternative.

Biological Resources

The Smaller Project Alternative would affect terrestrial vegetation and terrestrial fauna via its upland portion of the interconnection line. The upland portion of the interconnection line would be located within an existing previously disturbed and maintained utility ROW, and thus impacts to terrestrial vegetation and terrestrial fauna other than birds would be limited. Impacts to coastal and intertidal vegetation, would also be limited since no sea grass has been identified close to the footprint of the Smaller Project Alternative, and HDD technology would be used at landfall to avoid impacts to vegetation along the intertidal zone.

With respect to avifauna, the Smaller Project Alternative is in the Nantucket Sound which is in the general vicinity of Monomoy National Wildlife Refuge and other locations where there are important staging areas and habitat for roseate terns, and least tern (Perkins, et al., 2003). The types of avian resources affected for the Smaller Project Alternative are the same as those for the proposed action (refer to Section 5.3.2.4) though potential impacts would be less due to the smaller number of turbines.

Subtidal offshore resources would be affected by the monopiles and scour protection associated with WTGs at the Smaller Project Alternative, which results in a hard bottom structure for colonization by benthos for the life of the Smaller Project Alternative. The added structure is expected to attract a variety of finfish to the site which could improve recreational fishing resources. Most of the impacts to soft-bottom benthic communities are expected to occur during the cabling activities of the construction and decommissioning periods. Permanent impacts include the direct mortality to benthic organisms due to jet plowing and the placement and removal of pilings for the WTGs and ESP. The total area of permanent benthic impact due to the WTG and ESP piles is 0.33 acres (1,335 m^2) for the Smaller Project Alternative. In addition, the installation of the 33 kV cable needed to connect the WTGs to the ESP would require 29.7 miles (47.8 km) of cable and 258 acres of benthic impacts (1.04 km^2). The temporary impacts to benthos would also result in temporary avoidance of the area by finfish and temporary impacts to EFH and shellfish.

Marine mammals that are not listed under the ESA, but are protected under the MMPA, that may be found in the vicinity include the gray seal, harbor seal, harp seal, hooded seal, Atlantic white-sided dolphin, striped dolphin, common dolphin, harbor porpoise, long-finned pilot whale, and minke whale. Due to possible proximity to these marine mammals under the Smaller Project Alternative, there is potential for impact to these species during construction and decommissioning as a result of collisions with vessels.

Socioeconomic Resources and Land Use

The Smaller Project Alternative would cause a decrease, as compared to the proposed action, in the number of workers to fill the construction requirements of the alternative. The Smaller Project Alternative would result in numerous jobs during the 27-month construction period, with fewer workers required for decommissioning. Limited impacts to urban and suburban infrastructure would be anticipated as a result of the Smaller Project Alternative due to the relatively small number of workers relative to the population of the region, the relatively short duration of the work, and capacity of existing infrastructure including housing, emergency services and transportation to address the needs of the Smaller Project Alternative.

With respect to environmental justice, a socioeconomic analysis was conducted and showed that the counties within the area of impact had a lower percent minorities than the rest of the Commonwealth, and a lower percentage of people living under the poverty level than the rest of the Commonwealth, and thus the area of impact is not within an environmental justice population (refer to Section 4.3.3.3).

The alternative would result in visual impacts to areas along the south coast of Cape Cod as well as areas along the shorelines of Nantucket and Martha’s Vineyard that are oriented toward the WTG array (refer to visual simulations at Figure 3.3.6-2). With respect to cultural resources, no submerged historic properties or archaeological sites are recorded in the area of the Smaller Project Alternative. The Smaller Project Alternative would be visible from historic structures and thus would affect cultural resources as a result of such visual impacts.

Navigation and Transportation

The area of the Smaller Project Alternative is used for fishing and boating (power and/or sail), and the shoreline areas are used for bird watching, and beach-going and other general recreational activities. The Smaller Project Alternative is not expected to affect overland transportation arteries or airport facilities. The proposed action received FAA approval indicating WTGs in the area, which include WTGs under the Smaller Project Alternative, would not affect air navigation or associated communication systems (refer to Appendix B). With regard to navigation, the turbine array would be located on a shoal away from navigational channels where vessels are less likely to navigate. In addition, the turbines would be spaced in a grid of approximately 6 x 9 rotor diameters which would allow ample room for vessels including trawlers to navigate through the area. However, given the radar impacts discussed in Section 3.3.5.2 above, and similar spacing criteria of WTG’s between the proposed action and this alternative, navigation safety would be moderately impacted under certain conditions.

3.3.6.2 Phased Development

3.3.6.2.1 Description

The Phased Development Alternative would utilize the same site as the proposed action and would employ the same transmission cable system layout (see Figure 3.3.5-1), but it would be constructed in two phases with time in between to allow monitoring of operations. The Phased Development Alternative could provide the potential to reduce impacts in the second phase based on evaluation of construction and operational impacts associated with the first phase and making changes to construction and or operational procedures or design. However, at this time any such reductions in impacts based on analysis of the first phase are uncertain and can not be anticipated in this alternatives analysis. In order to facilitate the study of a phased approach to constructing 130 WTGs, it was determined that for illustrative purposes, a 50/50 split would be most effective. A split in the proposed action of 130 WTGs into two phases was accomplished by dividing the project into an eastern half and a western half; each containing 65 WTGs (see Figure 3.3.6-3). The initial 65 WTG phase would be designed to allow expansion to 130 WTGs with as little re-construction as possible. The cabling layouts (both the inner array 33 kV and interconnecting 115 kV transmission system cables) used in this Phased Development Alternative are the same as presented in the proposed action.

Phase I

The western half of this alternative would be constructed during the first phase primarily because the 65 westernmost turbine sites would be located in the shallower waters of Horseshoe Shoal and would be in closer proximity to each other allowing for the least amount of inner array 33 kV cable for interconnection to the ESP. This would be the least costly construction of the two phases, thereby reducing interest costs of financing during construction on the overall two phase project. Assuming that assurances were in place for the completion of both phases, the ESP and the complete 115 kV transmission system (both circuits for the offshore and upland components) would be completed during Phase I allowing for power from the first 65 WTGs to be transformed and transmitted into the regional power grid. Both the ESP structure and the complete 115 kV cable system (both circuits) would be the same as those for the proposed action; however some portion of the electrical equipment on the ESP would be delayed until the second phase. The construction of the ESP and the installation of the 115 kV transmission cable along the eastern edge of the first phase eliminates (to the greatest degree possible) the need to conduct Phase II installation activities (eastern half) within the area of the operating first phase of the project. Phase I would include 65 turbines connected in 7 full strings (each made up of 8 to 10 WTGs) and one partial string (3 WTGs), requiring approximately 32.7 miles of 33 kV inner array cable (see Figure 3.3.6-3).

Phase II

The eastern half of this alternative would be constructed during the second phase. In general, a project developer would seek to minimize the time between the construction of the first and second phases in order to minimize the lag time and costs associated with:

- Procurement of equipment
- Staging area acquisition and build out
- Mobilization of construction and installation equipment and labor
- At sea construction

For analysis purposes, Phase II would be scheduled within a reasonable time frame of five to ten years to coincide with the state's continued desire for renewable energy sources should renewable energy still be mandated. Construction of Phase II within five years would not be considered a phased approach due to the short length of time between construction cycles. Construction of Phase II beyond ten years is not considered reasonable due to anticipated change to the underlying purpose and need for this project.

The balance of the ESP electrical equipment required for the additional 65 WTGs would be installed during Phase II. For the purposes of this analysis it is assumed that both circuits of the complete 115 kV cable system would be installed during the first phase. Phase II would include 65 turbines connected in 6 full strings (each made up of 9 or 10 WTGs) and the addition of 7 WTGs to one partial string of 3 WTGs that would have been installed in Phase I. Phase II would require approximately 34.0 miles (54.7 km) of 33 kV inner array cable (see Figure 3.3.6-3).

Decommissioning

Because it is assumed that all of the WTGs would have the same effective useful life (approximately 20 years), the decommissioning of the Phased Development Alternative would also be conducted in phases to correspond to the phased construction and duration of lag time. Phase I of the decommissioning would remove the WTGs, scour protection and inner array cables that were installed 20 years prior during Phase I (western half of the Project). Following a period of time equal to the lag between construction phases, Phase II of the decommissioning would take place 20 years after the completion of the Phase II construction and would remove the eastern half WTGs, scour protection and inner array cables, along with the ESP and the interconnecting 115 kV transmission system. Similar to the construction phases, the decommissioning of the Phased Development Alternative would require multiple mobilizations/demobilizations and staging and is expected to have similar impacts as the phased construction.

3.3.6.2.2 Comparison of Alternative with Proposed Action

The Phased Development Alternative would have greater impact during construction and decommissioning than the proposed action for 10 of 28 impact categories (air quality, water quality, avifauna, subtidal offshore resources, non-ESA marine mammals, fish and fisheries, essential fish habitat, threatened and endangered species, visual resources, and recreation and tourism). The impacts on these categories during operation would be similar to the impacts of the proposed action during operation. There would be no change in impacts for the other 18 impact categories for the Phased Development Alternative compared with the proposed action during construction, operation, or decommissioning (see Table 3.3.5-1 for a full comparative listing of impacts relative to the proposed action).

With respect to air quality, construction and decommissioning under the Phased Development Alternative would have more impacts due to the multiple mobilizations, demobilizations and staging operations. In addition, the multiple phases would result in increased air emissions from the construction vessels and equipment due to the increased total number of vessel trips and/or the duration of deployment required to complete the project as compared to the proposed action. With respect to the operation of the Phased Development Alternative, the impacts to air quality would be similar to the proposed action.

With respect to water quality, construction and decommissioning under the Phased Development Alternative would have more impacts due to the multiple mobilizations, demobilizations and staging operations. The longer duration of deployment, increased number of vessel trips required to complete the project, and phased build-out of the ESP would result in a greater probability of a marine vessel spilling fuel, lubricating oils or other substances.

With respect to non-T&E avifauna, construction and decommissioning impacts would be greater for the Phased Development alternative than for the proposed action because of the longer timeframes of the additional mobilizations and demobilizations of major construction vessels for pile driving and WTG installation/decommissioning related to each distinct phase. The total number of vessels required to complete the construction and decommissioning would also be greater than required for the proposed action, increasing potential impacts. With respect to the operation of the Phased Development Alternative, the impacts to non-T&E avifauna would be similar to the proposed action.

With respect to subtidal offshore resources, construction and decommissioning impacts on benthic habitat would be more for the Phased Development Alternative than for the proposed action because of the multiple mobilization and demobilizations that would be required and the multiple anchoring activities associated with the cable-laying and decommissioning activities. The greater impacts on benthos also would result in greater impacts to fish and fisheries (including shellfish) and essential fish habitat, which utilize the benthic resources and would be also affected by the multiple phases of construction and decommissioning. With respect to the operation of the Phased Development Alternative, the impacts to benthic habitat and resources, fish and fisheries would be similar to the proposed action.

With respect to non-ESA marine mammals, construction and decommissioning under the Phased Development Alternative would have more potential impacts due to the multiple mobilizations and demobilizations. The number of vessels required for each phase would increase, creating a greater potential for vessel strikes and underwater noise associated with the operation of the construction vessels. With respect to the operation of the Phased Development Alternative, the impacts to non-ESA marine mammals would be similar to the proposed action.

With respect to T&E species, impacts would be increased under the Phased Development Alternative due to the longer construction and decommissioning timeframes resulting from multiple mobilizations, demobilizations and staging operations. With respect to the operation of the Phased Development Alternative, the impacts to T&E avifauna and marine species would be similar to the proposed action.

With respect to visual resources and recreation and tourism, construction and decommissioning under the Phased Development Alternative would have more impacts due to the extended construction/decommissioning timeframe, multiple mobilizations, demobilizations and staging operations and increased construction vessel traffic. With respect to the operation of the Phased Development Alternative, the impacts to visual resources and recreation and tourism would be similar to the proposed action (see Figure 5.3.3-1).

3.3.6.2.3 Summary of Impacts on Physical, Biological, Socioeconomic Resources and Land Use, and Navigation and Transportation

Construction, decommissioning and operation of the Phased Development Alternative would result in varying levels of impacts to the physical environment, biological resources, socio-economics and land use, and navigation and transportation. A summary of the impacts within these four major categories is provided below.

Physical Resources

The Phased Development Alternative would result in impacts to above water and underwater ambient sound levels as a result of construction and decommissioning activities and to above water sound levels as a result of operation. In addition to noise impacts, the Phased Development Alternative would result in air quality impacts from vessels and equipment involved in the pre-construction G&G investigations, and construction, decommissioning, and maintenance phases of the Phased Development Alternative. The multiple mobilizations and demobilizations would result in an increase in air emissions from the construction vessels and equipment required for the Phased Development Alternative but would still be small in relation to other air pollution sources in the general region and would not have a noticeable effect on air quality. With respect to water quality, impacts would be temporary and localized and result from installation of monopiles and undersea cables. The potential for oil spills during construction is slightly greater due to the overall construction duration being more extended due to two mobilizations/demobilizations, and a slightly greater number of vessel trips to and from the site. In addition, the Phased Development Alternative would delay the installation of some portion of the electrical equipment on the ESP until the second phase, presenting a second potential of oil spill during installation and transfer. With respect to EMFs, the Phased Development Alternative would generate a small EMF in immediate proximity to the undersea cables and onshore cables, which would not negatively affect marine or human life.

Biological Resources

The Phased Development Alternative would affect terrestrial vegetation and terrestrial fauna via its upland portion of the interconnection line. The upland portion of the interconnection line would be located within an existing previously disturbed and maintained utility ROW, and thus impacts would be limited. Impacts to coastal and intertidal vegetation, would also be limited since no seagrass has been identified close to the footprint of the proposed action, and HDD technology would be used at landfall to avoid impacts to vegetation along the intertidal zone.

With respect to avifauna, the Phased Development Alternative is in Nantucket Sound which is in the general vicinity of Monomoy National Wildlife Refuge and other locations where there are important staging areas and habitat for roseate terns, and least tern (Perkins, et al., 2003). With respect to avian T&E species, information on the piping plover suggest that collision mortality associated with the Phased Development Alternative would result in minor adverse impacts but would not jeopardize the Atlantic coast population. With respect to the roseate tern, information shows that a low level of WTG collisions can be expected but would only have a minor affect on the roseate tern population.

Subtidal resources would be affected by the impacts to soft-bottom benthic communities that would occur during the cabling activities of the construction and decommissioning periods. Temporary impacts to benthic resources would be caused by anchoring activities associated with the cable-laying activities (anchors, anchor line sweep, jet plow pontoons), the WTG/ESP construction and decommissioning, as well as the installation and decommissioning of the scour control structures that would occur over both phases of the Phased Development Alternative. Permanent impacts include the direct mortality to benthic organisms due to jet plowing and the placement and removal of pilings and scour protection for the WTGs and ESP, which would result in a hard bottom structure for colonization by benthos. The added structure is expected to attract a variety of finfish to the site, which could improve recreational fishing resources. The total area of permanent benthic impact for the Phased Development Alternative once fully constructed is the same as the proposed action. The WTG and ESP piles would result in 0.67 acres (2,711 m^2) of impact and the total area of temporary impact for the cable that connects the WTGs to the ESP would be 580 acres (2.3 km^2). The temporary impact of the area disturbed from installation of the transmission cable system from the ESP to the shore would be 220 acres(0.89 km^2) (86 acres [0.34 km^2] outside the three mile limit and 134 acres [0.54 km^2] inside the limit).

Marine mammals that are not listed under the ESA, but are protected under the MMPA, that may be found in the area of the Phased Development Alternative include the gray seal, harbor seal, harp seal, hooded seal, Atlantic white-sided dolphin, striped dolphin, common dolphin, harbor porpoise, long-finned pilot whale, and minke whale. Due to possible proximity to these marine mammals under the Phased Development Alternative, there is potential for impact to these species during construction and decommissioning as a result of collisions with vessels which is further augmented by the multiple mobilizations, demobilizations and staging operations required for the Phased Development Alternative.

Socioeconomic Resources and Land Use

The Phased Development Alternative would cause an increase in the number of workers to fill the construction requirements. Limited impacts to Urban and Suburban Infrastructure would be anticipated as a result of the Phased Development Alternative due to the relatively small number of workers relative to the population of the region and capacity of existing infrastructure including housing, emergency services and transportation to address the needs of the Phased Development Alternative.

With respect to environmental justice, a socioeconomic analysis was conducted and showed that the counties within the area of impact had a lower percent minorities than the rest of the Commonwealth, and a lower percentage of people living under the poverty level than the rest of the Commonwealth, and thus the area of impact is not within an environmental justice population.

The Phased Development Alternative would result in visual impacts to areas along the south coast of Cape Cod as well as areas along the shorelines of Nantucket and Martha's Vineyard that are oriented toward the Phased Development Alternative. Visual impacts would be the same once the Phased Development Alternative was operational. With respect to cultural resources, no submerged historic properties or archaeological sites are recorded in the area of the Phased Development Alternative. The Phased Development Alternative would be visible from historic properties and thus would affect cultural resources as a result of such visual impacts.

Navigation and Transportation

The area of the Phased Development Alternative is used for fishing and boating (power and/or sail), and the shoreline areas are used for bird watching, and beach-going and other general recreational activities. The Phased Development Alternative is not expected to affect overland transportation arteries or airport facilities. The Phased Development Alternative received FAA approval indicating WTGs in the area, which include WTGs under the Phased Development Alternative, would not affect air navigation or associated communication systems. With regard to navigation, the turbine array would be located on a shoal away from navigational channels, where vessels are less likely to navigate. The multiple mobilizations, demobilizations and staging operations required for the Phased Development Alternative would result in a greater number of vessels for an extended period of time impacting the local navigation; however these impacts would still be minor. In addition, the turbines would be spaced in a grid of approximately 6 x 9 rotor diameters which would allow ample room for vessels, including trawlers, to navigate through the area. However, given the radar impacts discussed in Section 3.3.5.2 above, and similar spacing criteria of WTG's between the proposed action and this alternative, navigation safety would be moderately impacted under certain conditions.

3.3.6.3 Condensed Array

3.3.6.3.1 Description

In designing an offshore wind energy project, turbine spacing is considered which effectively balances the capture of the wind resource (and ultimately the power production), with a number of site specific physical and economic constraints such as water depth and watersheet use. Wind turbines need to be spaced far enough apart to reduce adjacent row wind wake effects (in order to optimize wind park efficiency) and to reduce structural fatigue from turbulence created by the wake effect. As a general rule, manufacturers of the WTGs recommend a minimum spacing of greater than 5 rotor diameters in order to avoid catastrophic structural fatigue and guarantee efficiencies (Seifert and Kronig, 2003).

In order to facilitate the study of a Condensed Array Alternative with 130 WTGs, a 6 x 6 rotor diameter spacing was chosen as a reasonable example that falls within the range of some existing offshore wind energy projects (see Table 3.3.6-1). The Condensed Array Alternative would maintain the same ESP location as the proposed action, and therefore the interconnecting 115 kV transmission cable system would remain the same in all aspects of design, length, installation and routing as the proposed action (see Figure 3.3.5-1). Both the ESP structure and the complete 115 kV transmission cable system (both circuits) would be the same as those proposed for the proposed action. The WTG locations in the proposed action currently are spaced approximately 6 rotor diameters apart in the north-south "columns" of the array. The 130 WTGs of the Condensed Array Alternative have been arranged with the same central column of WTGs as the proposed action's "F" column (WTGs F1 through F14) (see WTG array in proposed action at Figure 2.1.2-1), all maintaining the same location with 6 rotor diameters separation. The WTGs of the proposed action are separated by 9 rotor diameters within the east-west "rows." To reduce the spacing within these rows to 6 rotor diameters for the Condensed Array Alternative, the WTGs to the west of the ESP and the "F" column have been shifted to the east, and WTGs to the east of the ESP and the "F" column have been shifted to the west, providing for a 130 WTG array with 6 x 6 rotor diameter spacing condensed around a similar ESP location as the proposed action.

The cabling layouts (both the inner array 33 kV and interconnecting 115 kV transmission system) used in this Condensed Array Alternative are the same as presented in the proposed action. The WTGs in the Condensed Array Alternative have been arranged in similar interconnecting strings (14 strings of 8 to 10 WTGs each) as the proposed action (see Figure 3.3.6-4). The overall inner array 33 kV cable lengths would be reduced slightly to 58 miles (93 km) (from 66 miles [106 km] for the proposed action). The reduction (approximately 12 percent) would not be proportionate to the 25-30 percent east – west reduction of the condensed array because the inner array cables of the proposed action have been arranged to minimize overall length by maximizing the use of the shorter north – south transects and minimizing the cabling east to west.

The footprint area of the Condensed Array Alternative is approximately 16 square miles (41.4 km^2) (as compared to 25 square miles [64.7 km^2] for the proposed action). The distances to shore are presented in Table 3.3.6-2. If the Project's spacing were reduced to a 6 x 6 grid, modeling shows that the power production for the proposed 130 WTGs would be measurably reduced. The reduction in power is especially important in the summer months because of the typically high spot prices of electricity that occur in the summer compared to the rest of the year.[10] As a result, even a small loss of power from a denser configuration in the summer months compared to other months of the year would produce a disproportionally greater reduction in revenue for the applicant even though on an annual production basis the reduction in MWs produced might be considered minor. The assessment can be quantified as follows:

$$X = (((P1 – P2) \times ((L1 \times R2) + ((1-L1) \times R1))) / (((P1 \times (1-L2) \times R1) + (P1 \times L2 \times R2)) \times Y)) \times 100\%$$

Where:

P1 = production from a 6 X 9 array [configuration of the proposed action]
P2 = production from a 6 X 6 array [denser configuration]
L1 = percent of (P1 – P2) during peak power pricing hours
L2 = percent of year yielding peak power pricing (assumed to be large enough to consume all losses created by L1)
R1 = average rate/megawatt hour (MWHr) – during non-peak power pricing periods
R2 = average rate/MWHr – during peak power pricing periods
Y = percentage of net revenue to gross revenue
X = percentage loss in net revenue due to denser (6 X 6) configuration

3.3.6.3.2 Comparison of Alternative with Proposed Action

The Condensed Array Alternative would have greater impact than the proposed action for the competing uses impact category during construction, operation, and decommissioning. Additionally, the Denser Configuration Alternative would have less impact during construction for eight impact categories: noise, water quality, avifauna, subtidal offshore resources, non-ESA marine mammals, fish and fisheries, essential fish habitat, and threatened and endangered species. Of these impact categories noise and water quality would be expected to have similar impact as the proposed action during decommissioning while the other 6 would have a lesser impact. There would be greater expected impact compared to the

[10] The spot market for electricity is calculated on an hourly basis and can vary widely just within the span of a single hot summer day. While it is known that power costs are highest in the summer, it is not possible to predict future summer electricity prices.

proposed action during operation for the avifauna and threatened and endangered species impact categories. The remaining 19 impact categories would have the same level of impact as the proposed action during construction, operation, and decommissioning (see Table 3.3.5-1 for a full comparative listing of impacts relative to the proposed action).

With respect to construction noise, impacts to humans would be slightly less under the Condensed Array Alternative because of the increased distance to shore from the perimeter WTG pile driving. Impacts from operational noise, both above and below water, from the Condensed Array Alternative are expected to be the same as those of the proposed action.

The distance the construction and maintenance vessels must travel from the proposed staging area in Quonset RI to reach the furthest WTGs on the eastern edge of the Condensed Array Alternative is slightly less than the proposed action. This minor reduction is offset by the increased travel distances to reach the nearest WTGs on the western edge of the Condensed Array Alternative from Quonset. As a result, there would be no significant change in air emissions between the two alternatives during construction.

With respect to water quality, water quality impacts related to construction of the Condensed Array Alternative would be less than the proposed action due to the 8 mile (12.9 km) reduction in the amount of 33 kV cabling required.

With respect to avifauna, the 8 mile (12.9 km) reduction in inner-array cable installation would slightly reduce impacts during construction and decommissioning. With respect to operations, the denser spacing is expected to have a greater “barrier” effect due to the higher concentration of structures, thereby increasing the potential for avoidance, collision or other impacts during operation.

With respect to subtidal offshore resources, the Condensed Array Alternative would decrease the length of the 33 kV cable needed to connect the WTGs to the ESP from 66.7 miles to 58.0 miles (107.3 km to 93.3 km). This would result in a reduction of temporary impacts during construction and decommissioning to benthic habitats from 580 acres to 504 acres (2.3 to 2.0 km^2). The decrease in length of the 33 kV cable would also decrease temporary impacts to fish and fisheries, and EFH as a result of decreased area of turbidity and disturbed sea bottom. Impacts to T&E species would also be slightly less than for the proposed action as the shorter construction timeframe for the 33 kV cable would result in less disturbance to T&E avian species that could be in the vicinity.

With respect to marine mammals, there is a slightly reduced chance for vessel strike due to the shorter inner-array cabling activities involved with the Condensed Array Alternative compared to the proposed action. With respect to visual resources, visual impacts during construction and decommissioning activities would not be expected to be significantly different than construction related visual impacts of the proposed action. With respect to visual impacts during operations, the overall breadth of impact of the Condensed Array Alternative would have less of a visual impact than the proposed action. However, the concentration of structures would be increased for the Condensed Array Alternative, and thus the visual intrusion of the portion of the Condensed Array Alternative that is visible, would create more of an impact than the proposed action.

With respect to competing uses, vessels involved in commercial fishing within the area of the proposed action would experience increased competing use impacts due to the tighter spacing between the WTGs, which would make navigation more difficult.

3.3.6.3.3 Summary of Impacts on Physical, Biological, Socioeconomic Resources and Land Use, and Navigation and Transportation

Construction, decommissioning and operation of the Condensed Array Alternative would result in varying levels of impacts to the physical environment, biological resources, socio-economics and land use, and navigation and transportation. A summary of the impacts within these four major categories is provided below.

Physical Resources

The Condensed Array Alternative would result in impacts to above water and underwater ambient sound levels as a result of construction and decommissioning activities and to above water sound levels as a result of operation. In addition to noise impacts, the Condensed Array Alternative would result in air quality impacts from vessels and equipment involved in the pre-construction G&G investigations, and construction, decommissioning, and maintenance phases of the Condensed Array Alternative. The mobilization and demobilization phases would result in a temporary increase in air emissions from the construction vessels and equipment required for the Condensed Array Alternative but would still be small in relation to other air pollution sources in the general region and would not have a noticeable effect on air quality. With respect to water quality, impacts would be temporary and localized and result from installation of monopiles and undersea cables. With respect to EMFs, the Condensed Array Alternative would generate a small EMF in the immediate proximity to the undersea cables and onshore cables, which would not negatively affect marine or human life.

Biological Resources

The Condensed Array Alternative would affect terrestrial vegetation and terrestrial fauna via its upland portion of the interconnection line. The upland portion of the interconnection line would be located within an existing previously disturbed and maintained utility ROW, and thus impacts would be limited. Impacts to coastal and intertidal vegetation, would also be limited since no seagrass has been identified close to the footprint of the proposed action, and HDD technology would be used at landfall to avoid impacts to vegetation along the intertidal zone.

With respect to avifauna, the Condensed Array Alternative is in Nantucket Sound which is in the general vicinity of Monomoy National Wildlife Refuge and other locations where there are important staging areas and habitat for roseate terns, and least tern (Perkins et al., 2003). The denser array associated with the alternative may result in impacts to avian populations as a result of disturbance or collisions with the WTGs.

Subtidal resources would be affected by the impacts to soft-bottom benthic communities that would occur during the cabling activities of the construction and decommissioning periods. Temporary impacts to benthic resources would be caused by anchoring activities associated with the cable-laying activities (anchors, anchor line sweep, jet plow pontoons), the WTG/ESP construction and decommissioning, as well as the installation and decommissioning of the scour control structures that would occur over both phases of the Condensed Array Alternative. Permanent impacts include the direct mortality to benthic organisms due to jet plowing and the placement and removal of pilings and scour protection for the WTGs and ESP, which would result in a hard bottom structure for colonization by benthos. The added structure is expected to attract a variety of finfish to the site which could improve recreational fishing resources. The total area of permanent benthic impact for the Condensed Array Alternative due to the WTG and ESP piles is 0.67 acres (2,711 m^2). The length of the 33 kV cable under the Condense Alternative that would connect the WTGs to the ESP would be 58.0 miles (93.3 km), which would result in temporary impacts to 504 acres (2.0 km^2) of benthic habitat. The temporary impact of the area disturbed from installation of the transmission cable system from the ESP to the shore is 86 acres (0.34 km^2).

Marine mammals that are not listed under the ESA, but are protected under the MMPA, that may be found in the area of the Condensed Array Alternative include the gray seal, harbor seal, harp seal, hooded seal, Atlantic white-sided dolphin, striped dolphin, common dolphin, harbor porpoise, long-finned pilot whale, and minke whale. Due to possible proximity to these marine mammals under the Condensed Array Alternative, there is potential for impact to these species during construction and decommissioning as a result of collisions with vessels which is further augmented by the multiple mobilizations, demobilizations and staging operations required for the Condensed Array Alternative.

Socioeconomic Resources and Land Use

The Condensed Array Alternative would cause an increase in the number of workers to fill the construction requirements. Limited impacts to urban and suburban infrastructure would be anticipated as a result of the Condensed Array Alternative due to the relatively small number of workers relative to the population of the region and capacity of existing infrastructure including housing, emergency services and transportation to address the needs of the Condensed Array Alternative.

With respect to environmental justice, a socioeconomic analysis was conducted and showed that the counties within the area of impact had a lower percent minorities than the rest of the Commonwealth, and a lower percentage of people living under the poverty level than the rest of the Commonwealth, and thus the area of impact is not within an environmental justice population.

The Condensed Array Alternative would result in visual impacts to areas along the south coast of Cape Cod as well as areas along the shorelines of Nantucket and Martha's Vineyard that are oriented toward the Condensed Array Alternative. With respect to cultural resources, no submerged historic properties or archaeological sites are recorded in the area of the Condensed Array Alternative. The Condensed Array Alternative would be visible from historic properties and thus would affect cultural resources as a result of such visual impacts.

Navigation and Transportation

The area of the Condensed Array Alternative is used for fishing and boating (power and/or sail), and the shoreline areas are used for bird watching, and beach-going and other general recreational activities. The Condensed Array Alternative is not expected to affect overland transportation arteries or airport facilities. The Condensed Array Alternative in the same general vicinity as the proposed action which received FAA approval indicating there would not be an effect on air navigation or associated communication systems. Thus the Condensed Array Alternative would also be expected to not affect air navigation or associated communication systems. With regard to navigation, the turbine array would be located on a shoal away from navigational channels, where vessels are less likely to navigate, though the 6 x 6 rotor diameter grid spacing would require mariners to navigate more carefully in the area to avoid collisions with the WTGs. Given the radar impacts discussed in Section 3.3.5.2 above, and the smaller spacing criteria of WTG's with this alternative, navigation safety would be at least moderately impacted under certain conditions.

3.3.6.4 No Action

3.3.6.4.1 Description and Comparison with Proposed Action

Under the No Action Alternative, the resulting environmental effects from taking no action are compared with the environmental effects of authorizing the proposed action or selected alternative. The opportunity for development of a wind power generating facility would not occur or be postponed. The potential environmental impacts resulting from the proposed action would not occur or would be postponed. All impacts, positive and negative, associated with the proposed action would be eliminated. The incremental contribution of any of the proposed action to cumulative effects would also not occur. Strategies that could provide replacement resources for the loss of potential energy production and their associated impacts are discussed in detail in Section 5.4.6.

3.3.6.4.2 Summary of Impacts Under the No Action Alternative

Under the No Action Alternative, the proposed action would not be constructed and the associated impacts detailed in Section 5 would not occur. The No Action Alternative evaluated other strategies for addressing the demand for electricity in New England if the proposed action were not constructed and the viability of those strategies and impacts associated with those other strategies. In general, other than wind energy, only fossil fueled generating technologies would be able to address the electric generation output level of the proposed action within the same timeframe of the proposed action. As a result, impacts associated with the No Action Alternative would come from the burning of fossil fuels for energy production. Specific impacts would depend on the type of fossil fuel used (natural gas, oil, coal) the technology and pollution control systems chosen, and site specific issues associated with individual electric generation facilities.

For a gas fired facility, the principal pollutant of concern is NO_x. Emissions of NO_x result from the combustion of nitrogen contained in fuel and the air supplied for combustion. NO_x contribute to the formation of ground level ozone and acid rain. Natural gas facilities also emit VOC and carbon monoxide (CO) as a result of incomplete fuel combustion, which occurs to some degree even in state-of-the-art combined cycle combustion turbines (CCCT) systems being installed today. Although efficient combustion techniques employed in today’s combustion turbines combined with the use of relatively clean burning natural gas reduce VOC and CO emissions below any other fossil fuel fired combustion technology, large quantities of these pollutants would still be emitted. In addition to the emissions of criteria pollutants, a gas-fired facility would also emit non-criteria pollutants and CO_2. Non-criteria pollutants include Hazardous Air Pollutants (HAPs), which the EPA considers of special concern and for which the EPA has developed national emission standards for specific source categories such as combustion turbines. Some of the HAPs emitted by a natural gas fired combustion turbine include formaldehyde, xylene, toluene, and benzene.

Oil and Coal facilities would also emit the previously referenced pollutants, and in addition would emit substantial quantities of SO_2, which contributes to acid rain, sulfate deposition and can react with other compounds in the atmosphere to form particulates. Particulate Matter also forms through incomplete combustion of fuels or using fuels with high noncombustible content (ash). Elevated particulate levels have been attributed to a variety of health effects such as respiratory ailments, especially in the young and the elderly. Finally, all fossil fuel facilities would emit CO_2, a greenhouse gas.

In addition to air pollution, fossil fuel fired electric generation can use large quantities of water for cooling and may result in water quality impacts or other localized impacts depending on siting such as impacts to wetlands, rare and endangered species, visual impacts, etcetera. A more detailed cost benefit analysis describing impacts under the No Action Alternative is provided in Section 5.4.6.

3.4 TRANSMISSION CABLE SYSTEM SITING ALTERNATIVES

On September 17, 2002, the applicant and NSTAR jointly filed a petition with the EFSB and a petition with the DPU to construct, operate and maintain two new 115 kV electric transmission cables to interconnect the proposed action with the regional electric grid in New England.

As part of its review process, the EFSB was required to evaluate whether there is a need for additional transmission resources and evaluate the proposed action in terms of its consistency with providing a reliable energy supply to the Commonwealth with a minimum impact on the environment at the lowest possible cost. A project proponent must present to the EFSB alternatives to its planned action which may include: (a) other methods of generating, manufacturing, or storing electricity or natural gas; (b) other sources of electrical power or natural gas; and (c) no additional electric power or natural gas.

The applicant identified and presented four alternatives to the EFSB that would potentially meet its project need, each of which could provide reliable service for the applicant's proposed action. These approaches included connecting the proposed action: (1) to NSTAR's 115 kV Barnstable Switching Station; (2) to NSTAR's 115 kV Harwich Substation; (3) to NSTAR's 115 kV Pine Street Substation in New Bedford; and (4) to a new 115 kV substation on Martha's Vineyard, then proceeding on to the mainland.

Upon its review, the EFSB concluded that the Martha's Vineyard Alternative did not warrant further consideration because of the magnitude of increased cost over the Barnstable Interconnect without any offsetting benefits. Although the Harwich and New Bedford Alternatives would be somewhat less costly than the Martha's Vineyard Alternative, each would cost approximately $50 million more than the Barnstable Interconnect. Because the Barnstable Switching Station is the major bulk substation on Cape Cod, with six 115 kV transmission lines available to carry energy to various parts of Cape Cod, interconnection at this location would provide high reliability in that energy from the proposed action could be reliably delivered to the grid even if one of the lines emanating from the Barnstable Switching Station is out of service. Therefore, the EFSB determined that, all other considerations being equal, a direct connection at the Barnstable Switching Station provides greater reliability than an indirect connection through another, smaller substation at a greater distance from the Barnstable Switching Station.

The EFSB found that the Barnstable Interconnect was preferable to both the Harwich and New Bedford Alternatives with respect to providing a reliable energy supply for the Commonwealth, with a minimum impact on the environment at the lowest possible cost. In addition, the EFSB found that, with the implementation of the proposed mitigation and conditions, the environmental impacts of the proposed facilities along the primary route would be minimized with respect to marine construction impacts, land construction impacts and permanent impacts. Therefore, the EFSB approved the applicant and NSTAR's proposal to construct two approximately 18 miles (29 km), 115 kV underground electric transmission cables along the primary route identified by the applicant.

The applicant has conducted a comprehensive analysis to identify the best route to provide the needed transmission interconnection from the facility to the mainland electrical grid system. A detailed assessment of alternative routes was conducted that concluded that the route proposed would be preferable to alternative routes with respect to providing a reliable energy supply for the Commonwealth, with a minimum impact on the environment at the lowest possible cost (EFSB, 2004).