6.0 CUMULATIVE IMPACT ANALYSIS

The "cumulative impact" of a proposed action under 40 CFR Section 1508.7 of the NEPA regulations is defined as "the impact on the environment which results from the incremental impact of the action when added to other past, present and reasonably foreseeable future actions regardless of what agency (Federal or non-federal) or persons undertake such other acts." In order to measure cumulative impacts, a point from which measurements begin must be established, called a "baseline." The baseline for impact-producing factors for this cumulative effects analysis is current conditions. That is, the analysis of cumulative effects focuses on the current aggregate effects of all past actions that have taken place within the geographic area without itemizing the historical details of individual past actions. The proposed action is within a non-pristine, but unindustrialized area where current competition for OCS space is not intense. Competition for OCS space in this area is not expected to become intense during the reasonably foreseeable future (20 years) encompassed by this cumulative scenario. No past or present wind energy or other renewable energy projects exist in the geographic area defined for this cumulative analysis.

Geographically, the cumulative impact study area is shown in Figure 6.1-1. It extends northeastward from Nantucket Island to Monomoy Island including Monomoy Shoals and northwestward from Nantucket Island through Narragansett Bay to Quonset, Rhode Island including Martha's Vineyard. The northernmost boundary would be defined as the northern shore of Nantucket Sound and the easternmost boundary would be a point described as Latitude 41.4571, Longitude -69.8676. This geographic study area includes a broad scope of onshore and offshore projects that have been constructed, or may have the potential to be constructed in the future that could affect the location of the Project.

Temporally, projects included in the cumulative impact analysis were limited to present activity that includes: (1) the proposed action; (2) any ongoing projects or known proposed projects (i.e., projects for which an application has at least been filed or for which planning documentation exists); and (3) projects not now taking place, but which may occur periodically over the next 20 years because they have occurred in the recent past. Maintenance dredging of channels and harbor areas would be an example of such an activity. In combination, these three classes of activities comprise a cumulative scenario that explains expectations for the kinds of activities that could take place within the study area.

The following agencies were contacted in order to determine what projects were under review or proposed for the near future within the cumulative impact study area: the USACE, New England Division; Massachusetts Division of Conservation and Recreation (MassDCR); the Coastal Zone Management Program (CZMP); and the Massachusetts Department of Environmental Protection (MassDEP). The impact levels characterizing cumulative impacts are those used in Section 5.0. Direct impacts occur at the same time and place that the activity occurs. Indirect impacts are displaced in time and space from the factor producing the impact.

6.1 ACTIVITIES IN THE CUMULATIVE SCENARIO

Activities included in the cumulative scenario are as follows:

- Cape Wind Energy Project
- Offshore Wind Energy Projects
- Offshore Sand and Gravel Mining
- Tidal Energy Projects
- Marina Development

- Onshore Wind Energy Projects
- Submarine Cable and Pipeline Projects
- Maintenance Dredging and Beach Nourishment
- Upland Pipeline Projects
- Commercial Fishing Activities
- Small Marine Projects
- Vessel Traffic
- Population Growth and Onshore Development
- Wave Energy Projects

6.1.1 Cape Wind Energy Project

The Cape Wind Energy Project (the proposed action) is included in the cumulative scenario in order to evaluate the impacts of the proposed action along with other projects that make up the cumulative scenario described in the remainder of Section 6.1. The location of the proposed action is shown in Figure E-1, the description of the proposed action is provided in Section 2, and its existing environment and potential impacts are described in Sections 4 and 5 of this EIS, respectively.

6.1.2 Offshore Wind Projects

Currently there is only one other known offshore wind project proposed within the spatial scope of this analysis, for which there is potential for cumulative impacts on environmental resources. This is the South Coast Offshore Wind Project, which is proposed by Patriot Renewables, LLC. The South Coast Offshore Wind Project would be located in the Cape and Islands Ocean Sanctuary of Buzzards Bay (Figure 6.1-1). M.G.L Chapter 132A, Section 15, prohibits among other things, the construction of "electrical generation stations" in an ocean sanctuary. As such, the approval and schedule of the South Coast Offshore Wind Project will depend on if and when the ocean sanctuary legislation can be amended to allow for the construction of wind facilities in an ocean sanctuary.

Patriot Renewables proposes to construct between 90 and 120 WTGs within three general study areas of Buzzards Bay. Study area 1 is an area south of Sconticut Neck and Weset Island and north of Buzzards Bay navigational channel, running from the east edge of the channel to New Bedford Harbor to the east of West Island and terminating at Nasketucket Bay. Study area 2 is located between the Buzzards Bay navigational channel and the Elizabeth Islands, running from Sow and Pigs Reef to Wood's Hole. Study area 3 is located between the mainland of Dartmouth and Westport and the north edge of the Buzzards Bay Navigational channel, running from Hen and Chickens Reef to the west edge of the channel to New Bedford Harbor. The project is expected to produce 300 MW of electricity. Electricity would be transmitted to the mainland electrical transmission system via a submarine cable interconnection to a location in Fairhaven (Patriot Renewables, LLC, 2006). Due to the distance of this project away from the proposed action (approximately 17 miles [27.4 km]) away at its closest point), cumulative impacts are expected to be minor, with the exception of impact to the roseate tern, as discussed in more detail in the BA in Appendix G, where the Patriot Renewables project has the potential to add direct effects to the breeding islands and breeding activities that would not occur with the proposed action.

In addition to the above project, the state of Rhode Island has recently selected a developer for an offshore wind facility off Rhode Island's coast in designated offshore wind development locations. While Rhode Island would not finance the project, the State is looking to expedite the process by conducting its

own environmental assessments of these locations, and to support this, the State has designated several million dollars for various studies, some of which are underway.

6.1.3 Offshore Sand and Gravel Mining

In September 2003 Massachusetts entered into a multi-year cooperative agreement with the MMS to locate and assess the quality of sand and gravel resources situated on the continental shelf offshore of Massachusetts. Initial efforts are to document sand and gravel deposits in the inner continental shelf of the Merrimack embayment using geophysical techniques and grab sampling from small vessels. Numerous beaches along the embayment have experienced long-term erosion. Sand and gravel resources on the inner shelf could be found suitable and available for future public works projects to restore beaches or wetlands in this region. The Merrimack embayment is north of Cape Cod and not within the cumulative impact study area, but future characterization activities conceivably could be extended to include the southern inner shelf area of Cape Cod, Martha's Vineyard, and Nantucket Island. For sand and gravel mining in Federal waters beyond 3.5 miles (5.6 km) from shore, a permit from the MMS is needed.

Presently there is one proposal for an offshore sand mining project in the vicinity of Nantucket Sound within state waters. The Sconset Beach Nourishment Project is proposing that approximately 2.6 million cubic yards of beach compatible sediment be hydraulically dredged from a 195 acre (0.78 km^2) borrow site located approximately 2.9 miles 4.6 km) east of Nantucket Island in water that is 30-60 ft deep. The material would then be transported to Sconset Beach on Nantucket and pumped onto the project shoreline from a barge or dredge as a slurry of sand and water. This project would provide beach and dune nourishment for approximately 3.1 miles (4.9 km) of shoreline on eastern Nantucket extending south from Sesachacha Pond, past Sankaty Head Lighthouse to Codfish Park and the Village of Siasconset, and includes dune restoration at Codfish Park and dune construction at the Town Sewer Beds. This sand mining project is in development and environmental review and is contingent upon approval and permitting from several state agencies and the USACE. The start date is uncertain as this will depend on when and if the Project gets permitted (Kotelly, 2008).

The Town of Barnstable has expressed interest in conducting sand mining projects outside the Cape Cod Ocean Sanctuary boundaries for future beach nourishment. Although there are presently no approvals for sand mining projects, the potential for future activities and associated construction do exist. In the event that two projects occur concurrently in close proximity, there is a potential risk for cumulative impacts associated with the proposed action on environmental and socioeconomic resources, which are discussed in Section 6.2.

6.1.4 Tidal Energy Projects

At present there are two proposed TISEC technology development projects within the cumulative impact study area: one proposed by the Massachusetts Tidal Energy Company (MATidal) in Vineyard Sound called the Cape and Islands Tidal Energy Project, and one proposed by the Town of Edgartown in Muskeget Channel called the Nantucket Tidal Energy Plant Water Power Project.

6.1.4.1 Cape and Islands Tidal Energy Project

The Massachusetts Tidal Energy Company proposes to construct one or more clusters of TISEC devices to generate electricity via tidal currents in Vineyard Sound and sell the electricity to the grid. The project is located in navigable waters of the United States in Vineyard Sound in approximately 40 to 75 ft (12.2 to 22.9 m) of water. The underwater area begins at the southeast end of Naushon Island in Vineyard Sound and extends northeast in two separate areas located on either side of Lucas Shoal and Middle Ground, to their terminus at an existing underwater cable crossing that runs between Nobska point in

Falmouth and an area west of Lake Tashmoo on Martha's Vineyard. Potential transmission line routes to the shore would intersect an existing underwater cable crossing and would come ashore in Falmouth and/or on the north shore of Tisbury, in Martha's Vineyard (FERC Preliminary Permit Application, 2006).

The project would consist of 50 to 150 TISEC devices, each having the generating capacity of 500 kW to 2 MW (FERC Preliminary Permit Application, 2006). The proponent has stated that the TISEC devices would consist of: (1) rotating propeller blades, approximately 20 to 50 ft (6.1 to 15.2 m) each in diameter; (2) an integrated generator, producing 500 kW to 2 MW of electricity; (3) anchoring systems supporting the TISEC device at varying depths underwater; (4) a mooring umbilical line to an anchor on the sea bottom; and (5) an interconnection transmission line to shore. Monitoring systems for parameters including but not necessarily limited to pressure, temperature, vibration, revolutions per minute, and power output may be located on the TISEC devices and onshore. Transmission from the TISEC device cluster to shore would also be by submerged cable, which may be buried beneath the seabed in its inshore portion. Onshore underground transmission cables would carry the electricity to where it would be fed into the land-based electrical use infrastructure (FERC Preliminary Permit Application, 2006). Potential transmission line routes to the shore would intersect an existing underwater cable crossing and would come ashore in Falmouth and/or on the north shore of Tisbury, in Martha's Vineyard. Information regarding the location of on-land interconnects is not provided in the FERC preliminary permit filing (FERC Preliminary Permit Application, 2006).

The schedule indicates that the project would take place in three phases. The first phase would involve testing the devices and would take approximately 20 months to permit, followed by approximately 17 months of testing. The schedule shows that this in turn would be followed by permitting and installation of a partial build-out, followed by permitting and installation of the full build-out. The entire timeline for the project from start to completion of permitting for full build-out is approximately 51 months (FERC Preliminary Permit Application, 2006). This tidal energy project is 10 miles (16.1 km) away from the proposed action at its closest point.

6.1.4.2 Nantucket Tidal Energy Plant Water Power Project

On September 12, 2007, the Town of Edgartown applied to FERC for a preliminary permit for a tidal energy plant entitled Nantucket Tidal Energy Plant Water Power Project. FERC's statement that a preliminary permit would be issued to Edgartown was issued on March 31, 2008. The project proposed by Edgartown would be located in Nantucket Sound and Muskeget Channel, between Nantucket Island and Martha's Vineyard, in Nantucket and Dukes Counties, Massachusetts. Muskeget Channel is a six-mile wide stretch of open ocean between Martha's Vineyard and Nantucket with strong tides. The area is mostly shoal, but there is an underwater trough approximately 1.5 miles (2.4 km) off Wasque Point on Martha's Vineyard. The project would be approximately 10 miles south of the proposed action. The project would consist of 50 horizontal hydrokinetic cross flow turbine generation units from Ocean and Renewable Power Company, LLC, or a similar technology, having a total installed capacity of 20 MW. It would also include a proposed 3 mile long transmission line connected to a 4.8 kV circuit and appurtenant facilities. The project would have an estimated average annual generation of 50.48 gigawatt-hours, which would be sold to a local utility.

6.1.5 Marina Development

Local marina development was also considered when determining the spatial and temporal scope of the cumulative impact analysis. Whether this activity involves new marina development or maintenance of existing locations, the environmental impacts associated with this activity do exist, but are expected to be relatively small and generally far-field relative to the majority of the proposed action location.

6.1.6 Onshore Wind Energy Projects

The Massachusetts Technology Collaborative's (MTC) Community Wind Collaborative is likely to result in a number of small community initiated wind projects for additional onshore wind power installations. These community based projects are small scale (generally only one or two WTGs). The environmental impacts associated with the construction, operation, and maintenance of these distributed and small land based projects are expected to be localized.

6.1.7 Submarine Cable and Pipeline Projects

Presently, there are three existing submarine cable systems located in Nantucket Sound that connect the mainland with the offshore islands to provide reliable island-wide power supply. There are no known active proposals for new submarine pipelines in the Nantucket Sound area. There are five 25 kV distribution cables that connect Martha's Vineyard with Cape Cod, the closest being 13 miles (21 km) to the west of the area of the proposed action. There are two 46 kV submarine cable systems that connect the mainland transmission system from Harwich and Barnstable (Lewis Bay) to Nantucket Island located approximately 8 miles (13 km) east of the proposed action area. There are no publicly available plans at this time for any future submarine cable system installations in Nantucket Sound or Vineyard Sound except for those associated with the proposed action.

6.1.8 Maintenance Dredging and Beach Nourishment

Another marine construction activity analyzed for cumulative impacts to environmental resources is the maintenance dredging of navigational channels and the disposal of dredged materials for beach nourishment in and around the shores of Nantucket Sound. As part of the U.S. Army Corps of Engineers nationwide program, the New England District reviews approximately 200 dredging and dredged material disposal permit applications each year, as well as ensures maintenance dredging of, and improvements to, more than 100 congressionally authorized Federal navigation projects serving the five coastal states in New England (USACOE, 1992). The only active dredge material disposal site is Cleveland's Ledge in Buzzards Bay that receives dredged material from activities in the Cape Cod Canal and most recently material from Falmouth Harbor (Buzzards Bay National Marine Estuary, 1991).

Maintenance dredging is defined by 301 C.M.R. 11.02 as "any maintenance work or activity carried out on a regular or periodic basis in a manner that has no potential for damage to the environment or for which performance standards have been developed that avoid, minimize, or mitigate potential environmental impacts to the maximum extent possible." About 90 to 95 percent of dredged material is considered to have low or undetectable contaminant levels and can be used in a variety of beneficial projects. Such dredged sediments have been used to create new islands and marshes which serve as breeding grounds for birds and marine animals. Clean sand from dredging operations also is used for beach nourishment. In urban areas, dredged materials have been used as landfill for the creation of industrial developments and municipal projects, such as Boston's Logan Airport, and as sanitary landfill cover (USACOE, 1992).

The County of Barnstable carries on maintenance dredging in dozens of harbors and inlets for the various waterfront communities around Cape Cod on a rotational basis using the cutterhead DRAGON dredge "*Cod Fish*". Because of the high boat traffic peaking in late June, dredging halts for the summer and does not start again until October. On Martha's Vineyard, the dredge "*Edgartown*" carries out scheduled maintenance dredging of channels, tidal inlets, and pools.

The submarine cable system for the proposed action would be placed adjacent to the eastern edge of the Federal Navigation Project in Hyannis Harbor. Hyannis Harbor was dredged in 1985, 1991, 1998, and 1999. No future dredging activities are currently scheduled. Nonetheless, if dredging activities were

to occur concurrently with the jet-plow installation of the submarine cable system into Lewis Bay, and due to the close proximity of the two activities; they could potentially result in cumulative impacts. Another example is Oak Bluffs Harbor dredging, which is a project consisting of dredging the entrance to Oak Bluffs Harbor with beneficial use of the dredged sand as nourishment on an adjacent town beach.[31] Sediment suspension, deposition, and some mortality of benthos and shellfish in the area of temporary disturbance could take place with concurrent construction activities. Therefore, geology and sediment conditions, benthic and shellfish conditions, and fish resources and commercial/recreational fisheries are discussed in detail in Section 6.3.

6.1.9 Upland Pipeline Projects

This cumulative impact analysis has also taken into consideration the proposed onshore KeySpan Sagamore Line Reinforcement Project with respect to the onshore components of the onshore cable system for the proposed action. KeySpan proposes the construction of approximately 13.1 miles (21.1 km) of a new high-pressure, distribution gas pipeline that is planned to be constructed from the present up until 2013. This reinforcement project is an upgrade to an existing pipeline and the proposed route would be constructed in three segments: Western, Middle, and Eastern. The Western Segment would begin near the intersection of Route 130 and Service Road in Sandwich and extend along Service Road to Route 149 in Barnstable, approximately 5 miles (8 km) from the nearest point along the onshore cable route of the proposed action. The Middle Segment installation runs from KeySpan's South Yarmouth LNG facility on White's Path to the Depot Street and Main Street intersection in Harwich, nearly 2 miles (3.2 km) from the nearest point along the onshore cable route of the proposed action. The Eastern Segment, the farthest segment from the proposed action (approximately 12 miles [19.3 km]), would involve the installation of 1.6 miles (2.6 km) of pipeline from the Depot Road and Route 139 intersection in Harwich to the intersection of Church Street and Route 39 in Harwich. The three segments of the KeySpan Sagamore Line Reinforcement Project do not intersect the proposed onshore cable route and therefore there would be no gas line construction in the vicinity of the proposed action's onshore cable route.

6.1.10 Commercial Fishing Activities

Nantucket Sound experiences a wide range of disturbances on a regular basis in and around the study area. Anthropomorphic disturbances (commercial fishing, anchoring, etc.) repeatedly and regularly affect the environmental resources associated with the water column and the seabed. For example, Churchill (1989) has measured near-bottom TSS to be up to 1,500 mg/liter as a result of trawling operations. With the seafloor conditions found in portions of Nantucket Sound, it is possible that upwards of 1.32 yd^3 (1.01 m^3) of sediment could be re-suspended in the water column for every foot of commercial trawling. Commercial fishing is a baseline disturbance factor in Nantucket Sound, resulting in minor temporary disturbances to benthos and brief episodic increases in suspended solids, along with the harvesting of fish, and shellfish. The WTGs represent a new set of navigation obstacles that would need to be avoided, but they should not significantly alter the ability to undertake commercial fishing within the boundary of the WTGs given the turning radius for commercial fishing vessels even while trawling.

6.1.11 Small Marine Projects

Other marine projects that could be considered in the cumulative impact scenario include the construction of sea walls, docks, piers, shoreline stabilization/erosion control measures, etc, which collectively are considered as part of the cumulative scenario.

[31] The referenced dredging projects are reflective of near-shore sediment transport, deposition and erosion that occurs in these relatively near-shore areas and are not necessarily reflective of sediment transport, deposition and erosion that takes place in the area of the proposed action. Refer to Section 4.1.3 for information on physical marine processes that take place in the area of the proposed action.

6.1.12 Vessel Traffic

Vessel traffic associated with Nantucket Sound includes ferry services between Cape Cod and the Islands, limited cruise ship traffic, use of the area by commercial fishing vessels, and recreational boating use. The SSA operates up to 56 transits per day between Wood's Hole and Martha's Vineyard and 28 between Hyannis and Nantucket during the summer months and Hyline cruises operates an additional 30 transits with high speed and traditional ferries during the peak season. The majority of boating traffic travels along channels setback from the proposed Project (i.e., commercial ferry traffic, cruise ships, large recreational vessels) with boating traffic limited to some recreational boating and commercial fishing in the specific area of the proposed turbine array. Cumulative impacts on vessel traffic are generally expected to be minor due to the limited vessel traffic in the specific area of the proposed action. However, in the instance of navigation safety relative to the operation of radar within the WTG array, the USCG sponsored radar impact study (see Appendix M) found that navigation safety impacts are moderate, and additional mitigation has been developed (see Section 9.0).

6.1.13 Population Growth and Onshore Development

Land-based activities near the ocean may contribute to indirect or associated cumulative impacts on a particular sensitive coastal resource area and may include power plant cooling water intake and discharge facilities, non-point and point source runoff, agricultural activities, storm water runoff, and accidental pollutant discharges. Such far-field impacts can have varying degrees of impact on the marine environment in the geographic area of the proposed action depending on the location, extent, and type of activity to the adjacent receiving waters in Nantucket Sound. They are included as a general group of impacts called Population Growth and Onshore Development.

The Massachusetts statewide population over the last century has been continually increasing. Cape Cod and the Islands are no exception. Specifically, Barnstable, Dukes and Nantucket County populations have increased by 19, 29, and 58 percent, respectively between 1990 and 2000. Table 6.1.13-1 gives the population and housing unit estimates from the U.S. Census Bureau for 2000 and 2004. Barnstable County gained 6,453 residents from 2000 to 2004 to reach an estimated total population of 228,683 (a 2.9 percent increase over 4 years), according to the U.S. Census. Nantucket County had a 3.5 percent increase and Dukes County increased its total population by 7.5 percent from 2000 to 2004. From 2000 to 2005 the number of housing units in Barnstable County increased by an estimated 6,715 from the U.S. Census count of 147,083 in April 2000 to reach 153,798 in 2005. This 4.6 percent housing growth rate (in 5 years) led the state's 12 mainland counties topped only by Nantucket County's 9 percent growth rate up from 9,210 in 2000 to 10,042 in 2004 and Dukes County's 5.6 percent, where homes on Martha's Vineyard and the Elizabeth islands increased from 14,836 in 2000 to 15,670 in 2004 (see Section 4.3.3.1 for further discussion of Cape Cod population trends). This trend of fast-growing population suggests that onshore residential and commercial development would also continue to increase. This increase in onshore development would in turn result in point and non-point source discharges and increased air pollution, which in turn may contribute cumulatively to water and air pollution in the area. The possible contribution of the proposed action to pollution associated with population growth and onshore development is discussed in Section 6.3 as applicable. The alteration of native vegetation, increased human activity on area beaches, and greater recreational boating on the Sound, all have the potential to create cumulative impacts on birds, protected species, aesthetics, noise, wildlife, and air quality.

6.1.14 Wave Energy Projects

Offshore wave energy devices are typically tethered to the seafloor, and could use either suction or gravity anchors. Cables are then connected between the wave energy device and the anchors. Larger wave energy projects would have the devices positioned in an array to take maximum advantage of the prevailing wave direction. Some impacts associated with wave energy devices may include impacts to

the benthic environment as a result of anchoring device used, potential for collision or entanglement between marine mammals and device hardware or fishery impacts, impacts associated with navigation, and impacts associated with the public use of the waterway.

At present there is a Rhode Island state-funded pilot wave energy project proposed off of Block Island, which is just beyond the southwest edge of the cumulative impact study area. After this is constructed, there are plans for another larger wave energy facility at an unspecified location off of Rhode Island. The developer of the two Projects, Oceanlinx Limited, proposes to first generate 1.5 MW with the pilot project, and then subsequently generate between 15 and 20 MWs as part of the larger project. The wave energy project would use oscillating water technology, whereby waves compress air to drive a turbine. The device includes computers to measure the air pressure and alter the angle of blades in the turbine so that, although the wave action ebbs and flows at different speeds, the turbine spins at a constant rate in a single direction. The wave energy project is anticipated to result in negligible cumulative impacts with the proposed action because it is located far from the area of the proposed action.

In addition to the above referenced wave energy project, two other wave energy projects are proposed south of the cumulative impact study area. These two wave energy projects are both proposed by Grays Harbor Ocean Energy Company, LLC and both would be 100 MWs in size. The wave energy projects may also generate power from wind turbines on the wave energy converters. One of the projects is located south of Block Island, approximately 12 to 25 miles (19.3 to 40.2 km) from shore, and the other is located south of Nantucket, approximately 12 to 25 miles (19.3 to 40.2 km) from shore. Both projects would proceed in phases, beginning with a pilot program phase (i.e., construction of two 1 MW wave energy conversion platforms at each site) and then proceeding to full buildout. The wave energy projects are anticipated to result in negligible cumulative impacts with the proposed action because they are located far from the area of the proposed action.

The small wave energy associated with the waters of Nantucket Sound relative to other locations makes it unlikely that a wave energy Project would be constructed near the area of the proposed action.

6.1.15 Ocean Development/Construction Projects Located Outside the Cumulative Impact Study Area

In addition to the projects and activities discussed above, there are numerous ocean development/construction projects located outside of the cumulative impact study area for this proposed action. These include a floating wind turbine project proposed by Blue H USA, LLC located approximately 23 miles (37 km) south of the coast of Martha's Vineyard and 45 miles south of New Bedford, several proposals for meteorological towers in locations outside the cumulative impact study area, that are proposed by wind power developers under the MMS interim limited leasing policy for resource data collection and technology testing, and other wind projects proposed off the coast of Long Island. In addition to wind projects, several LNG projects are proposed or are in development that are located beyond the study area including Broadwater LNG facility in Long Island Sound, and the Neptune and Northeast Gateway LNG projects north of Boston. All of these projects are geographically distant from the proposed action and the cumulative impact study area.

Although MMS understands that some migratory marine and avian species could conceivably pass through the areas of these activities as well as through the area of the proposed action, migratory passages by sea and air are one more competing, but temporary, use of the OCS and cumulative impacts resulting from migratory passages would be negligible on the species transiting these areas. Radar studies of migrating birds have shown that they tend to avoid the existing Danish wind parks at Horns Rev and Nysted (Danish Energy Authority, 2006, p. 102). Monitoring of marine mammals at the Danish wind parks was reported in 2006 (Danish Energy Authority, 2006). Harbor seals that were resident or transited

the areas around Horns Rev and Nysted returned to pre-construction numbers soon after construction ended at both locations. Porpoises had returned to pre-construction numbers at Horns Rev shortly after construction ended, but had not returned to Nysted in numbers recorded before construction began (Danish Energy Authority, 2006, p. 90).

6.2 CUMULATIVE IMPACT ANALYSIS

The following section discusses impacts of the cumulative scenario and then assesses the extent that the proposed action would incrementally contribute to that impact. The discussion addresses the proposed action and each of the main impact areas discussed in this EIS including: geology and sediment conditions; physical oceanographic conditions; benthic and shellfish resources; fish resources and commercial/recreational fisheries; protected marine species; terrestrial ecology; wildlife and protected species; marine mammals; avian resources; coastal and freshwater resources; water quality; cultural/recreational resources and visual studies; noise; transportation and navigation; electric and magnetic fields; telecommunications; air and climate; and socioeconomics.

6.2.1 Geology and Soft Sediments

Activities that are part of the cumulative scenario that may impact physical oceanographic conditions within the cumulative impacts study area include: (1) sand and gravel mining; (2) undersea pipeline or cable installation; (3) channel maintenance; (4) commercial fishing activities (trawling); (5) other tidal, wave, or wind energy projects; (6) other small marine projects; and (7) the proposed action. Direct impacts for all activities have the potential to disturb sediment by contacting the surface, by temporarily suspending sediments, or by temporarily increasing biologic oxygen demand in the water column from re-suspended organic matter in the sediment.

Impacts to the geology and sediment conditions within Nantucket Sound are likely to occur during construction and decommissioning of the proposed action (i.e., installation and removal of undersea cables and monopiles). Given the dynamic sediment transport and depositional/erosional environments within and surrounding the area of the proposed action, natural processes are anticipated to rapidly restore seabed topography and benthic biology following completion of all construction phases. This would include all proposed phases of construction, operation, and decommissioning including pile-driving, jet plow embedment of submarine cable systems, landfall transition interconnections and onshore cabling and conduit installations, including anchoring, winching and spudding activities associated with construction vessels, and cutting and structure removal. Mitigation measures, such as scour mats would also be implemented to reduce the impacts on geology and sediments (see Section 9.3). Given the implementation of mitigation techniques used in the construction activities of the proposed action, the impacts would be localized and short-term, and therefore the incremental cumulative impacts on geology and soft sediment conditions as a result of the proposed action are expected to be minor, even if such impacts occur at the same time as activities that are part of the cumulative scenario.

No existing bottom-founded infrastructure exists within the area of the proposed action for which setback could be established, with the exception of the meteorological data tower. If sand borrowing is an activity that takes place on Horseshoe Shoal over the next 20 years, borrow areas would require setbacks from monopiles that typically are determined on the basis of a specific dredge plan. Direct impacts from sand dredging that could occur would be equipment that punctures or strikes bottom-founded or buried infrastructure, particularly if locations are poorly known or if transmission cables have moved as a result of storm activity. Indirect impacts from sand dredging could be partial exhumation or spanning of transmission cables when the slopes at the edges of burrow pits undergo erosion to re-equilibrate with the slope of the surrounding sea floor over time. Pipelines or cables buried in the sediment could have cover reduced or be exhumed if sand dredging takes place too close to infrastructure, making them vulnerable to commercial fishers who bottom trawl, or recreational boaters dropping anchors, for example.

Setback distances from existing infrastructure are needed in the event of dredging or sand mining on Horseshoe Shoal. MMS (USDOI, MMS, 2005) determined that bottom substrates that are sandy need shorter setback distances; on the order of 150 ft (50 m) for borrow pits that are 15 ft (5 m) deep. The time periods needed for borrow pits to either fill or re-equilibrate with the sea bottom are generally on the order of three to six years for sandy bottom substrates (USDOI, MMS, 2005, p. 161). The area of the sea bottom disturbed by the 130 WTG monopoles and the piles for the ESP totals 0.67 acre (2,711 m^2). Additionally scour mats would cover 1.96 acres (7,946 m^2) and rock armoring, 8.75 acres (35,417 m2). Rock armor would replace scour mats in any areas for which the mats do not prove effective. This would be up to 47.8 acres (0.19 km^2) of rock armoring if all 130 turbines and the ESP use rock armoring. The sea bottom disturbed by construction or decommissioning vessels, either by direct contact or increased turbidity, is estimated to be 0.25 acre per monopile or 32 acres (0.12 km^2) for 130 monopiles.

The area of sea bottom disturbed by constructing or decommissioning the proposed action is very small in comparison to the available area of sandy bottom on Horseshoe Shoal that would remain undisturbed between the monopiles as well as the area outside the wind park envelope. Bedrock geology below soft sediments will be completely undisturbed by the proposed action and the activities that are part of the cumulative scenario.

Conclusion

Minor long-term impacts to geology and soft sediments as a whole are expected as a result of the proposed action and the activities that are part of the cumulative scenario. 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) and the total area of temporary impact for the cable that connects the WTGs to the ESP is 580 acres (2.3 km^2). The temporary impact of the area disturbed from installation of the cable from the ESP to the shore is 86 acres (0.3 km^2). The majority of the impacts are temporary and localized relative to the size of Nantucket Sound.

6.2.2 Physical Oceanographic Conditions

Activities that are part of the cumulative scenario that may impact physical oceanographic conditions within the cumulative impacts study area include: (1) sand and gravel mining; (2) pipeline projects; (3) submarine cable projects; (4) the South Coast Offshore Wind Project, or other offshore tidal, wave or wind energy projects; and (5) the proposed action.

In the unlikely event that a nearby sand and gravel mining project was approved in proximity to the proposed action it would not be expected to have any impact on waves, currents, tides or other physical oceanographic conditions because of the design parameters for the proposed action. The proposed action is not expected to result in changes to existing erosion patterns on the sea bed or on adjacent coastlines or beaches. Studies have determined that the zone of influence of each WTG pile on current conditions is estimated to be limited to an area of several pile diameters around each WTG (Report No. 4.1.1-4).

Conclusion

Negligible long-term impacts on physical oceanographic conditions are expected as a result of the proposed action or the activities that are part of the cumulative scenario, since none of these potential activities would have anything other than a very small and localized affect on features such as tides, waves, or currents.

6.2.3 Benthic Fauna and Shellfish

Activities that are part of the cumulative scenario that may impact benthic fauna and shellfish include: (1) sand and gravel mining; (2) maintenance dredging; (3) pipeline projects; (4) submarine cable projects;

(5) commercial fishing activities; (6) other tidal, wave, or wind energy projects; (7) small marine projects; and (8) the proposed action. Direct impacts from all of these activities are limited to the area in which the activity takes place.

If the proposed action was permitted and constructed, sand and gravel extraction within the designated MMS lease area would be precluded, but sand mining could possibly take place near the perimeter of the leased area. In the unlikely event that sand and gravel extraction was approved by MMS over the next 20 years, and took place in proximity to the proposed action, there is the potential for cumulative impacts on the benthic fauna and shellfish resources within the cumulative study area.

Potential impacts to benthic and shellfish resources associated with the construction, operation and maintenance of the proposed action relate directly to that area of the seafloor either displaced by monopiles and scour control systems, or temporarily disturbed during construction and decommissioning. Direct impacts would include crushing or smothering of benthic infauna and epifauna by construction equipment and anchors, monopile foundations, and scour mats. Indirect impacts could be increased turbidity that interferes with filter-feeding organs of benthic invertebrates. These impacts on benthic and shellfish conditions would be localized and short-term.

The applicant has attempted to plan, site, and design the proposed action to avoid and/or minimize impacts to benthic and shellfish resources. In addition, jet-plow embedment for the submarine cable system is minimally intrusive on the seabed and natural conditions are quickly restored after completion of construction due to the predominantly sandy bottom of Nantucket Sound and Lewis Bay (see Section 9.0 for more mitigation discussion).

The sea bottom area is living space for invertebrates living in, and on, the sediment surface. The degrees of disturbance of benthic area by the proposed action are discussed in 6.3.3. Benthic recolonization and succession have been reviewed to varying extents for a wide variety of habitats throughout the world (e.g., Thistle, 1981; Thayer, 1983; Hall, 1994; Coastline Surveys Limited, 1998; Newell et al., 1998). Re-colonization is highly variable and ranges from within months (e.g., Saloman et al., 1982) to more than 12 years (e.g., Wright, 1977), depending on the habitat type and other physical and biological factors. Focusing on dredging, Coastline Surveys Limited (1998) and Newell et al. (1998) suggested that in general, recovery times of six to eight months are characteristic for many estuarine muds, two to three years for sand and gravel, and five to ten years as the deposits become coarser.

Once installed and operating, monopile foundations would offer hard substrates in an area that otherwise consists of predominantly soft sediments. Each monopile is expected to increase the habitat heterogeneity from what had been only soft bottom communities of invertebrates living in or on the sediment surface to hardground communities having increased abundance of individual species as well as species diversity. The 130 monopiles and rock armor of the proposed action are expected to become encrusted by attached epifauna such as mussels, but could also include barnacles, sponges, bryozoans, and macroalgae, within 5 to 6 years. Abundance and biomass of benthic communities increased 50-150 times at the Danish wind park sites at Horns Rev and Nysted compared with the biomass of native soft bottom communities existing before emplacement of foundation structures (Danish Energy Authority, 2006, p. 44).

Upon decommissioning and removal, what had been a net benefit to benthic community biomass, will be conversely degraded unless artificial reefing of monopiles takes place to some degree.

Conclusion

Minor long-term impacts to the benthic community as a whole are expected as a result of the proposed action and the activities that are part of the cumulative scenario. Recolonization of sediment

disturbed after the proposed WTG monopile and scour system installation and other bottom-disturbing work that could occur over the next 20 years, such as sand borrowing on Horseshoe Shoal, would occur rapidly. Although the number of individuals, species, and biomass of benthic infauna may approach pre-disturbance levels within two to three years on sandy substrates, recovery of community composition and trophic structure may take somewhat longer. Undisturbed areas between monopiles and outside of the wind park envelope are sources for faunal in migration and larval recruitment for recolonizing the small areas that are disturbed. The increase in benthic biomass from installation of hard substrate will be degraded in a converse manner after monopiles are decommissioned and removed unless artificial reefing of monopiles takes place to some degree.

6.2.4 Fish Resources and Commercial/Recreational Fisheries

Activities that are part of the cumulative scenario that may impact fish and commercial or recreational fisheries within the cumulative impacts study area include: (1) sand and gravel mining; (2) commercial fishing activities; (3) maintenance dredging; (4) other offshore tidal, wave, or wind energy projects; and (5) the proposed action. Direct and indirect impacts are the result of habitat conversion that may improve or degrade existing bottom substrates.

Sand mining would have the potential of disturbing bottom substrates used by shellfish that are commercially fished; however, these disturbances would be limited to the mined area. Construction of the proposed action is not expected to result in measurable direct mortality to adult and juvenile pelagic fish since these life stages are mobile in the water column and are capable of avoiding or moving away from any disturbances associated with construction. Once installed and operating, the presence of the WTGs and ESP may make it more difficult for commercial trawling in the immediate vicinity of each structure. Any adverse impacts to commercial/recreational fisheries would be localized and minor given that commercial fishing activities would still occur in the area of the proposed action. In addition, it is likely that recreational fishing may increase due to the potential for the wind turbine bases to become FADs. As a result, incremental cumulative impacts to fish resources and commercial/recreational fisheries from the Project are expected to be minor.

Once installed and operating monopiles would be hard substrates in an area that otherwise consists of soft sediments. Each monopile is expected to increase the habitat heterogeneity from what had been only soft bottom communities of invertebrates living in, or on, the sediment to hardground communities having increased abundance of individual species as well as species diversity. At the Danish offshore wind parks at Horns Rev in the North Sea and Nysted in the Baltic Sea, the submerged WTG foundations became colonized and encrusted by the common mussel *Mytilus* within 5-6 years after emplacement (Danish Energy Authority, 2006, p. 53). At this latitude and marine setting the mussel is a superior competitor for space compared to other sedentary invertebrate species or algae. Abundance and biomass of benthic communities increased 50-150 times at both Danish wind park sites compared with the biomass of native soft bottom communities existing before emplacement of foundation structures (Danish Energy Authority, 2006, p. 44). Artificial hard substrates are generally considered beneficial to the reproduction and growth of some native mobile species, such as crab, by providing shelter and nursery habitat. At Horns Rev the edible crab *Cancer* colonized the foundation structures as juveniles and adults.

Environmental monitoring studies at Horns Rev and Nysted showed few effects on the fish fauna that could be attributed to the establishment and operation of the wind parks. The use of advanced survey techniques and intensive surveys did not document any clear effects on fish communities. Fish abundance and diversity were not higher inside the wind parks than in the areas outside. At Nysted the effect of the wind park was inferred to be weak because the hard substrate monocultures of mussels encrusted on the foundation elements are only moderately attractive to fish. At Horns Rev investigators performed the fish surveys during the early stages of colonization of the turbine foundations, where a

correlation between fish and the wind park may not have been measurable (Danish Energy Authority, 2006, p. 64).

Over the operating lifetime of the wind park, monopiles are expected to cause net increases in biomass on Horseshoe Shoal. In effect these small islands will be enriched ecosystems for duration of the project and are attractants to the invertebrates that live within and among encrusting mussels as well as birds and fish that could favor these associated communities as opposed to mussels alone. The degree of correlation between fish and monopiles in cold water has yet to be firmly established. If monopiles do attract fish they may also be attractants for recreational or commercial fishers.

Upon decommissioning and removal, what had been a net benefit to benthic community biomass, and possibly to fish and birds, will be removed from the setting of Horseshoe Shoal, and these resources will be conversely degraded unless artificial reefing of monopiles takes place to some degree.

Conclusion

Minor long-term impacts on fish and commercial and recreational fisheries as a whole are expected as a result of the proposed action and the activities that are part of the cumulative scenario. Environmental monitoring at Danish offshore wind parks to date has been inconclusive as to whether or not wind parks are net attractants for fish. Whether or not monopile foundations would serve as attractants for recreational or commercial fishers is equally inconclusive at this time.

6.2.5 Sea Turtles and Marine Mammals

Activities that are part of the cumulative scenario that may impact sea turtles and marine mammals within the cumulative impacts study area include: (1) vessel traffic and potential vessel strikes; and (2) underwater noise. Loss of habitat or access to food sources is not anticipated. The main potential for deterring marine mammals from an area under this proposed action is related mostly to acoustic harassment from construction noise. However, this noise will be confined within Nantucket Sound which is an area of relatively low marine turtle and marine mammal density and therefore not expected to significantly alter sea turtle or marine mammal presence and habitat use.

These impacts could originate from construction and service vessel traffic in support of the proposed action as well as vessel traffic that is not part of the proposed action, including that which is routine traffic, ferries for example, and vessel traffic supporting installation of other offshore tidal, wave, and wind energy projects. All vessel traffic activity, regardless of origin, can cause direct impact by accidentally striking a marine mammal or turtle with consequences that could range from lacerations and broken bones to internal injuries and death. Direct impacts caused by underwater noise could cause short- to medium-term habitat displacement (i.e., harassment due to decibel level) if marine mammals or sea turtles avoid the wind park area during construction, as a result of underwater noise. It is likely that only marine turtles and marine mammals in immediate proximity to pile driving could experience physically harmful sound levels.

Increased vessel traffic could be due to construction and operation of the proposed action or for other marine renewable energy projects (i.e., South Coast Offshore Wind Project or the Cape and Islands Tidal Energy Project), marina development or other marine related work. The proposed action has been sited and designed to avoid, minimize, or mitigate potential impacts to marine turtles and marine mammals. Some mitigation measures include having a NOAA Fisheries-approved observer on-site during all pile driving activities and using state-of-the-art hydraulic jet plow technology for cable installation and monopile foundations for the WTGs (see Section 9.0 for more mitigation discussion). If marine mammals or sea turtles are present in the area of the proposed action, they are likely to temporarily avoid the area during construction activities. Given the low densities of sea turtles and marine mammals in

Nantucket Sound and the significant distances between activities within the turbine array and seal haul-out and breeding sites, the potential impacts to these species is further reduced.

During construction of the Danish wind parks at Horns Rev and Nysted, general changes were noted in porpoise and seal behavior during and after construction activities. At Horns Rev porpoises showed a weak negative effect (avoidance) during the construction period as a whole and a strong, but short lived reaction (absence), to monopile driving operations (Danish Energy Authority, 2006, p. 90). At Nysted porpoises showed a strong negative reaction (absence) during the construction phase (emplacing gravity caissons). Porpoise avoidance of the area around Nysted has occurred over the first two years of operation of the wind park and was unexpected (Danish Energy Authority, 2006, p. 91). During construction there was a fall off in the number of harbor seals at haul out sites during pile driving operations at Horns Rev and no significant effects on seal use of the Nysted area (Danish Energy Authority, 2006, p. 90).

Conclusion

Minor long-term impacts on sea turtles and marine mammals are expected as a result of the proposed action and the activities that are part of the cumulative scenario. Mitigation is expected to effectively minimize the chance for vessel strikes during support of the proposed action as well as reduce the potential for acoustic and other types of harassment during the construction and operation of the proposed facility. Increased commercial fishing, recreational fishing, and pleasure boat activity as a consequence of gradually increasing population and economic activity in the area over the next 20 years could result in several unreported or unrealized collisions with protected marine species, primarily turtles or seals.

6.2.6 Terrestrial Ecology, Wildlife and Protected Species

Activities that are part of the cumulative scenario that may impact terrestrial ecology, wildlife and protected species within the cumulative impacts study area include: (1) onshore sand and gravel mining; (2) beach nourishment; (3) upland pipeline projects; (4) onshore wind energy projects; (5) other offshore tidal, wave or wind energy projects with onshore connections; (6) population growth and onshore development; and (7) the proposed action.

Sand and gravel mining and beach nourishment onshore, upland pipeline projects, other offshore tidal, wave, and wind energy projects with onshore connections, and onshore wind energy projects have the effect of converting land to these uses making less land available for undisturbed terrestrial ecosystems, wildlife, and wildlife habitat. Residential and commercial development can cause loss of wildlife habitat due to vegetation clearing. General population growth and increased intensity of land use may pressure wildlife habitat. Bats are subject to the additional hazard of lethal collision with WTGs. The collision hazard is discussed in further detail below in section 6.2.7.

The proposed action has been planned, sited, and designed to avoid or minimize impacts to terrestrial ecology, wildlife and protected species and their mapped habitats within the area of the proposed action. For example the proposed onshore route for the cable system is configured to utilize previously developed or disturbed transportation and utility corridors.

Conclusion

Negligible to minor long-term impacts on terrestrial ecology, wildlife and protected species are expected as a result of the proposed action and the activities that are part of the cumulative scenario. The growth of population and economic activity over the next 20 years is expected to place conversion pressure on land now available for terrestrial ecosystems and wildlife. Land conversions would create degraded habitats in some areas that are disturbed, completely displace habitat and wildlife within the

footprints of constructed structures, and cause wildlife accustomed to wild habitat to adjust to a more intense human influence and presence.

6.2.7 Avian Resources and Protected Bird Species

Activities that are part of the cumulative scenario that may impact avian resources within the cumulative impacts study area include: (1) sand and gravel mining; (2) other offshore tidal, wave, or wind energy projects; (3) onshore wind projects; (4) onshore development; and (5) the proposed action. Direct effects would be restricted to lethal collision hazard to birds or bats posed by operating WTGs. Indirect effects would include the wind park serving as a barrier to movement as a result of the 25 mi^2 (64.7 km^2) area of the proposed action and temporary disturbance of avian resources in the area during construction and decommissioning activities.

The increase in biomass expected by colonization of the monopile foundations by monocultures of mussels and the invertebrates that live among them could enrich local food sources around monopiles that could attract coastal and marine birds. Environmental monitoring at the Danish wind parks has shown that most of the more numerous bird species showed avoidance responses at both Horns Rev and Nysted (Danish Energy Authority, 2006, p. 15). Radar tracking has shown that birds tended to avoid the wind parks and individual WTG structures and that individual bird tracks wrapped around the periphery of the wind parks. Post-construction studies showed almost complete absence of divers and scoters within the wind park at Horns Rev and significant reductions in long-tailed duck densities within Nysted. Other species showed no significant change or occurred in too few numbers to allow statistical analysis (Danish Energy Authority, 2006, p. 15).

Although the type and extent of impacts to migratory birds are not yet well defined for offshore wind projects in the United States, some level of bird-strike impacts and mortality associated with the turbine structures from the proposed action and any future offshore projects should be anticipated.

Sand mining could temporarily degrade sea bottom conditions by disturbing the substrate. If birds relied upon elements of the soft bottom fauna for food, they could be displaced from the sand borrow area until re-establishment of the normal community in two to three years time.

Onshore wind projects in Massachusetts are limited in size and scope due, in part, to a lack of large tracts of available land with adequate wind resources. As a result, all of the proposed onshore projects range from single turbine installations to less than ten WTGs. These projects are proposed in near-shore communities and in towns further inland that have forested hills or ridge tops. The addition of small numbers of widely scattered onshore wind turbines, each of which would have to go through regulatory review to determine appropriate siting and levels of environmental impacts, is not expected to have a significant cumulative effect in combination with the proposed action.

The estuaries, shoals, salt marshes, tidal flats, dunes, and beaches that comprise the Nantucket Sound ecosystem provide important breeding, nesting, and foraging habitat for many species of resident and migratory birds. Nantucket Sound is located along the Atlantic flyway and is recognized as an important migratory stopover area for millions of birds each year. General impacts on birds associated with human activities occurs wherever land development happens and where there is a high level of outdoor recreation, such as on Cape Cod and the Islands. Therefore, human activity results in ongoing and continuous minor impacts on birds that can have a large cumulative effect as bird habitat is being altered by residential and commercial development, hundreds of thousands of people visiting coastal beaches, myriads of watercraft (more so in summer months than winter) traversing the ocean and resources being harvested from the ocean. The range of anthropogenic causes of bird mortality is broad and is primarily the result of collisions with man-made structures that include: cars, trains, and airplanes; buildings and windows; high tension wires; communication towers; and wind turbines. Other non-collision causes of

bird mortality include cat predation, pesticides, oil spills, fishing by-catch, and electrocutions. Annual bird mortality from anthropogenic sources may easily approach 1 billion birds a year in the U.S. alone (Erickson, et al., 2005). Erickson et al. (2005, Table 2) estimated that 28,500 birds are killed each year by wind turbines, and 550,000,000 in collisions with buildings and windows.

In contrast, the incremental impact of the proposed action on birds during construction and decommissioning of the project are short-duration effects that would only occur twice. Based the discussion in Section 5.3.2-4 operational impacts of the proposed action on birds with respect to habitat modification, human disturbance, and risk of collision, is expected to be moderate. Avian populations are expected to exhibit some avoidance behavior as has been documented at the Danish wind parks. Whether or not birds become habituated to marine WTGs over time is unknown at this time.

One of the avian populations of most concern is the roseate tern, and studies have shown that several areas adjacent to the proposed South Coast Offshore Wind Project in Buzzards Bay (specifically Bird Island and Ram Island) are important breeding areas for endangered roseate terns. Mortality to breeding terns at these locations in Buzzards Bay may have a significant impact on the species. Therefore, although the exact location of the South Coast Offshore Wind Project is unknown, it is reasonable to anticipate that, if constructed, it would have substantially greater impacts than the proposed action on roseate terns. Thus, while the proposed action has the potential for some cumulative impacts, future evaluation and approval of the South Coast Offshore Wind Project would need to undertake the necessary evaluations for potential impacts on the roseate tern. The incremental cumulative impact from the proposed action combined with the South Coast Offshore Wind Project on the roseate tern population could range from minor to at least moderate. Cumulative impacts to the existing predator-prey relationships in Nantucket Sound are expected to be negligible.

Future onshore development would lead to more clearing and, therefore, less avian habitat, but the incremental impacts from the proposed action would be negligible. The greatest threat to birds, in general, continues to be loss or degradation of habitat due to human development and disturbance. For migratory birds requiring multiple areas for wintering, breeding, and stopover points, the effects of habitat loss can be complex (USFWS, 2002). The greatest threats to birds would be collisions with buildings and obstructions such as communication towers and collision or electrocution by high-tension transmission lines (USFWS, 2002). On the water, bird deaths would not result from domestic or feral cats and collision hazard with marine vessels and structures built upon the water would be accentuated.

Conclusion

Minor long-term impacts on birds as a whole are expected as a result of the proposed action and the activities that are part of the cumulative scenario, especially in comparison to accepted causes of bird losses that result from anthropogenic influences. The proposed action would result in minor to moderate cumulative impacts on roseate terns. The addition of the potential activities that are part of the cumulative scenario (i.e., the South Coast Offshore Wind Project, refer to Section 6.1.1 for details on this proposed project) has the potential to result in greater cumulative impacts to this species. Existing monitoring devices for bird mortality, such as infra-red detectors, may not uniquely identify an individual species, nor can radar monitoring uniquely identify individual species within a resources area. If individual deaths occur within these populations they may not be able to be conclusively attributed to construction or operation of the proposed action. Monitoring may provide circumstantial evidence, for example, bird carcasses on the water.

6.2.8 Coastal and Freshwater Wetland Resources

Activities that are part of the cumulative scenario that may impact coastal and freshwater wetland resources within the cumulative impacts study area include: (1) sand and gravel mining; (2) pipeline

projects; (3) other offshore tidal, wave, or wind energy projects; (4) onshore development, and (5) the proposed action. Direct impacts from all of these activities are limited to the area in which the activity takes place.

It is highly unlikely that any sand mining projects would be permitted and approved by Massachusetts inside the state 3.5-mile (5.6 km) limit and Cape and Islands Ocean Sanctuary that would have the potential to affect coastal and freshwater wetland resources. Other offshore wind projects are expected to have similar coastal and freshwater resource impacts (as the proposed action) and implement similar mitigation measures in order to avoid or minimize any coastal or wetland resource impacts. Wetlands have been identified in the vicinity of the area of the proposed action seaward and within the state territorial limit of Nantucket Sound and Lewis Bay, and along the onshore transmission cable route. The proposed action does not directly impact freshwater wetlands.

Conclusion

Negligible long-term impacts on coastal and freshwater wetlands as a whole are expected as a result of the proposed action and the activities that are part of the cumulative scenario.

6.2.9 Water Quality

Activities that are part of the cumulative scenario that may impact water quality resources within the cumulative impacts study area include: (1) other offshore tidal, wave, or wind energy projects; (2) sand and gravel mining; (3) tidal or wave energy demonstration projects; (4) small marine projects and marina development; (5) submarine cable and pipeline projects; (6) maintenance dredging and beach nourishment; (7) vessel traffic; (8) population growth and onshore development; and (9) the proposed action. All of these activities have potential for direct impacts that degrade water quality as a result of increased nutrient inputs, biological oxygen demand, and turbidity. These direct impacts occur from multiple and mobile point sources, are spatially dispersed, and range from temporary to semi-permanent.

Oil and grease can enter the water from vessel discharges, machinery sumps, deck wash, and bilge discharges. Accidental diesel fuel spills and spills of fluids in the nacelles of the WTGs and spills on the Electrical Service Platform. Increased turbidity and biological oxygen demand can result from dredging or sand mining operations that disturb the bottom to re-suspend sediment and organic matter. Increased marina activity as well as population growth and onshore development could result in more storm and septic system runoff that may have enriched nutrient contents. In addition to these non-point sources, vessel traffic from marine construction projects or pipelines and more fishing or pleasure boats on the water increase the likelihood that deficient, poorly maintained, or out of compliance waste treatment systems could leak untreated human waste or biodegradable materials. The cumulative impact can include: degraded water quality, odors, floating debris, poor underwater visibility, and beach closings from higher bacterial counts on popular beaches.

Potential marine water quality impacts from the proposed action would be limited to sediment disturbance along the cable corridors and at monopile locations from construction vessel anchoring, anchor line sweep, and installation of the scour protection, foundation and cables. Potential impacts to water quality associated with construction and operation of the proposed action and the submarine cable system across Lewis Bay and within Nantucket Sound would be short-term and localized. Further, water quality impacts related to sediment disturbance from installation would be comparable to disturbance already occurring within Nantucket Sound from natural events and fishing gear (see Section 5.3.1.6).

Conclusion

Minor long-term impacts on water quality are expected as a result of the proposed action and the activities described above that are part of the cumulative scenario (i.e., other offshore renewable energy

projects, sand and gravel mining, small marine projects, etcetera). Direct impacts, such as increased turbidity as a result of monopole emplacement or decommissioning and removal are temporary and distributed among 130 monopile sites. The operation of onboard waste treatment systems can help to minimize water quality impacts (for further information on mitigation, refer to Section 9.0).

6.2.10 Visual Impacts

Activities that are part of the cumulative scenario that may affect visual resources within the cumulative impacts study area include: (1) other offshore tidal, wave, or wind energy projects; (2) onshore wind projects; (3) increased vessel traffic; (4) onshore development; and (5) the proposed action. Direct impacts result from the presence of offshore infrastructure that can be seen from shore. Direct impacts can be temporary as vessels come and go, short-term as construction vessels temporarily anchor for monopile construction or removal, and continuously over the operating lifetimes of renewable energy projects located offshore or on land.

Visual alteration to the historic Nantucket Sound setting caused by the WTGs and related structures would affect historic properties, tribal areas of traditional cultural and religious importance, and recreational areas (see Section 5.3.3.4). However, at this time the only other large scale wind farm proposed, the South Coast Offshore Wind Project, would be located in Buzzards Bay more than 17 miles (27.4 km) north and separated from the proposed action area by the Elizabethan Islands. Thus, most areas that have a view of the proposed action would not likely have a view of the South Coast Offshore Wind Project. No information is available at this time about whether the Cape and Islands Tidal Energy Project would require the installation of above water moorings or structures that could cause visual impact. The above discussion also applies to the historic properties and tribal areas of traditional cultural and religious importance analyses discussed in Section 5 in that there are unlikely to be significant cumulative visual impacts on historic structures or tribal areas from those other projects known to be proposed at this time (i.e., South Coast Offshore Wind Project and Cape and Islands Tidal Energy Project).

Within the cumulative impact study area, no other activity in the cumulative scenario other than the proposed action or onshore wind projects includes activity that has more than a temporary presence on Horseshoe Shoal. Construction or decommissioning vessels will be seen as monopiles are installed or removed and WTGs will be visible from land and on the water over the operating lifetime of the project.

Conclusion

Moderate long-term visual effects are expected as a result of the proposed action and the activities that are part of the cumulative scenario. Perceptions of visual effects are highly subjective. Some people believe that WTGs on the water are relatively unobtrusive, while others believe that WTGs represent an unwelcome presence by intruding on a vista with comparatively little man-made infrastructure upon it.

6.2.11 Cultural Resources

Activities that are part of the cumulative scenario within the cumulative impacts study area that may impact prehistoric and historic cultural resources, and areas of traditional cultural and religious importance to local Indian tribes include: (1) sand mining; (2) other offshore tidal, wave, or wind energy projects; (3) submarine pipeline or cable projects; (4) onshore wind projects; (5) onshore development; (6) small marine projects; and (7) the proposed action.

Sand mining is an extractive process that could have physical effects on submerged historic and prehistoric (i.e., ancestral Tribal) resources that include ground disturbance, disruption of important contextual relationships, or destruction of the resource itself. The MMS requires that any submerged land approved for sand and gravel mining be assessed for cultural resources prior to the start of any mining

activities. The authorities responsible for tidal, wave, or wind energy projects (MMS on the OCS), or pipeline or submarine cable projects have similar requirements stemming from the National Historical Preservation Act.

Similar to the proposed action, sand and gravel activities would be sited and designed to avoid adverse impacts on cultural resources. Based on results of the terrestrial archaeological intensive survey, no significant prehistoric or historic archaeological resources have been identified within the Project's APE for ground disturbance along the onshore transmission line route (see Section 5.3.3.5). The proposed action has been sited and designed to avoid disturbance or destruction of submerged prehistoric and historic resources. An archaeological survey has been carried out over the footprint of the proposed action and cable route and has been reviewed by MMS.

Conclusion

Negligible long-term impacts on cultural or archaeological resources are expected as a result of the proposed action and the activities that are part of the cumulative scenario (with the exception of visual impacts on historic properties and Tribal areas of traditional cultural and religious importance, which will be evaluated pending Section 106 review).

6.2.12 Recreational Resources

Activities that are part of the cumulative scenario that may impact recreational resources, such as beach-centric activity, touring, birding, and recreational fishing, boating or diving, within the cumulative impacts study area include: (1) sand mining; (2) other offshore tidal, wave, or wind energy projects; (3) submarine pipeline or cable projects; (4) onshore wind projects; (5) onshore development; (6) small marine projects; and (7) the proposed action.

Increased vessel traffic from these various projects, to the extent they occur concurrently, could cause some marine traffic and temporarily affect recreational boating. Offshore construction of more than one project at the same time could require temporary access restrictions to recreational boaters of small areas in the immediate vicinity of the construction work, for example in deepwater areas of the Gulf of Mexico The USCG typically assigns a 1,000 ft safety zone around producing platforms. While the proposed action would have visual impacts, they are not expected to affect tourism or the general use and enjoyment of recreational areas including beaches, parks, and use of Nantucket Sound (see Section 4.3.4). The proposed action has been sited and designed to avoid recreational disturbance to the extent possible. Furthermore, sand mining, onshore wind projects, other offshore tidal, wave, and wind energy projects, pipeline, and cable projects would also be sited and designed to avoid or minimize potential recreational impacts according to permit requirements of the various applicable regulatory agencies.

Conclusion

Minor long-term impacts on recreational resources are expected as a result of the proposed action and the activities that are part of the cumulative scenario since the proposed action does not preclude any existing recreation and only creates a minor change in the navigation scenario for recreational boaters.

6.2.13 Noise

Activities that are part of the cumulative scenario that may impact above or below-water noise level within the cumulative impacts study area include: (1) vessel traffic; (2) vessel traffic and construction activity for the South Coast Offshore Wind Project, the Cape and Islands Tidal Energy Project; (3) sand and gravel mining; (3) dredging; (4) other marine construction activity such as beach nourishment, submarine pipeline or cable construction, or small marine projects; and (5) the proposed action. Direct

impacts would involve hearing damage, annoyance, or change in behavior patterns as a result of noise above or below water.

Direct impacts caused by underwater noise could cause short to medium-term habitat displacement if marine mammals or sea turtles avoid the wind park area during construction, either as a result of underwater noise or otherwise. However, given the low densities of marine mammals and sea turtles within the proposed action area where the potential for vessel strikes, acoustic and other types of harassment and habitat displacement are greatest, impacts to sea turtles and marine mammals are expected to be minimal. The Danes monitored behaviors in the resident marine mammal populations during and following construction at the wind parks at Horns Rev and Nysted. At Horns Rev porpoises showed a weak negative effect (avoidance) during the construction period as a whole and a strong, but short lived reaction (absence), to monopile driving operations (Danish Energy Authority, 2006, p. 90). At Nysted porpoises showed a strong negative reaction (absence) during the construction phase (emplacing gravity caissons). Porpoise avoidance of the area around Nysted has occurred over the first two years of operation of this wind park and was unexpected (Danish Energy Authority, 2006, p. 91). During construction there was a fall off in the number of harbor seals at haul out sites during pile driving operations at Horns Rev and no significant effects on seal use of the Nysted area (Danish Energy Authority, 2006, p. 90).

It is expected that similar construction vessel noise from mining and channel maintenance vessels would be comparable to normal vessel traffic existing within Nantucket Sound. Mining equipment noise associated with offshore sand mining projects is likely to have sound levels above and below water that is less than the pile driving sounds from the construction of the proposed action. The South Coast Offshore Wind Project is expected to have similar noise impacts during construction and decommissioning as the proposed action, though it is located 17 miles (27.4 km) away and would not likely result in cumulative noise impacts. Operation of the South Coast Offshore Wind Project could also create low intensity noise above water or vibrations below water.

The sound impacts of construction of the proposed action would be temporary and are associated with the installation of the monopiles, installation of six smaller diameter piles for the ESP, and vessel traffic for transporting equipment, piles, and workers to and from the site. The jet plow embedment process for laying submarine power cables with a cable barge produces no sound beyond typical vessel traffic in Nantucket Sound. Therefore, the principal sound from construction would be temporary pile driving of the WTG monopiles. There would be no significant underwater sound from the proposed action beyond the general area of the WTG array. Project construction and decommissioning is expected to have minor noise impacts. Operating wind turbines would not be heard from shore, but they would be audible to boaters in proximity to them and marine mammals are likely to sense vibrations from the WTGs underwater.

Conclusion

Minor long-term impacts on above- or below-water noise are expected as a result of the proposed action and the activities that are part of the cumulative scenario.

6.2.14 Transportation and Navigation

Activities that are part of the cumulative scenario that may impact transportation and navigation within the cumulative impact study area include: (1) sand and gravel mining; (2) channel maintenance; (3) submarine pipeline or cable projects; (4) other offshore tidal, wave, or wind energy projects; (5) commercial fishing activities; (6) vessel traffic, and (7) the proposed action.

For example, impacts associated with sand mining projects would only be short-term and temporary during the time of mining activities. It would be expected that any approved mining activities would not

occur in authorized shipping channels. If projects were constructed at the same time, they could result in minor cumulative impacts on navigation, namely a degree of increased congestion. For example, to the extent the South Coast Offshore Wind Project, the Cape and Islands Tidal Energy Project, sand mining projects and other projects were to occur at the same time, construction vessels may have to share navigational channels. However, such contractors would follow required safe vessel navigational practices and channel widths and water depths in these areas allow for ample room for navigation. There would be minimal temporary impacts to navigation in the immediate vicinity of ongoing construction of the proposed action. Any restrictions that are necessary during construction to protect the safety of mariners would be implemented in coordination with the USCG. Details of the marine-based construction would be closely coordinated with the USCG and local Harbor Pilots. However, in the instance of navigation safety relative to the operation of radar within the WTG array once constructed, the USCG sponsored radar impact study (see Appendix M) found that navigation safety impacts are moderate, and additional mitigation has been developed (see Section 9.0). This level of impact on navigation safety occurs regardless of what other types of projects are assessed in a cumulative manner with the proposed action, but because other activities would occur outside of the WTG array, they are unlikely to further exacerbate navigation safety impacts.

Conclusion

Minor long-term impacts on airborne, marine transportation or navigation activities are expected as a result of the proposed action and the activities that are part of the cumulative scenario. WTG lighting and audible proximity warnings provide adequate surface identification of the location of the wind park structures. Adequate lighting of commercial and pleasure vessels are a Coast Guard requirement. The proposed action would not be located in aircraft ascent/decent corridors and its presence would not interfere with military radar. However, in the instance of navigation safety relative to the operation of radar within the WTG array once constructed, the navigation safety impacts are moderate, and additional mitigation has been developed (see Section 9.0 and the December 30, 2008 findings of the USCG in Appendix M).

6.2.15 Electrical and Magnetic Fields

Activities that are part of the cumulative scenario that may impact electrical and magnetic fields within the cumulative impacts study area include: (1) submarine electrical cable installation; (2) other offshore tidal, wave, or wind energy projects requiring electrical cable connections, and (3) the proposed action. A direct impact would be demonstrable link between electromagnetic field strength and a detrimental effect on fish or benthic communities. Direct impacts are limited to behavior changes when in proximity to, or when crossing over, an electromagnetic field from a buried submarine electrical cable that may or may not be correlative with harmful effects or distress.

There are no existing sources of power frequency fields present in the offshore area of the proposed action or underground cables that are proposed near the site other than the proposed action. Electric cables for the South Coast Offshore Project and the Cape and Islands Tidal Energy Project would be 17 and 10 miles (27.4 and 16.1 km) away from the area of the proposed action, respectively, and would not interact with electric or magnetic fields from the proposed action. The addition of the onshore transmission line would not change the existing electric field levels. The new underground transmission line electric fields within the ROW are anticipated to be approximately the same as the existing condition, which is due to the presence of the overhead 115 kV lines. The predominant fields within the existing NSTAR ROW are those generated by the existing overhead lines, whose loading under this interconnection option is not changed by the addition of the proposed action. The predicted impact of adding the underground transmission lines is a negligible change from existing conditions within the ROW and no change in field strength at the ROW edges. The proposed submarine cable system for the transmission line would create no perceptible electric field. Therefore, impacts on humans and marine

life from electric and magnetic fields would be negligible. The proposed action would not produce or add to any electric-field exposures in offshore waters or onshore; and any localized affect of magnetic fields is weak and localized to the immediate area around the cables.

The investigation performed at Nysted to detect any effects from the electromagnetic fields on migration and behavior of fish were characterized by a high degree of complexity and many challenges and difficulties in collecting and interpreting the data. The investigations along the cable route show some effects from the cable on fish behavior, but the analysis of these data have only shown a very limited correlation between behaviors and the strength of the electromagnetic field (Danish Energy Authority, 2006, p. 76). In the study above, observed fish behaviors appear to indicate that some types are able to detect electromagnetic fields from buried cables, but it is not indicative that electromagnetic fields cause deleterious effects or biologic damage to the fish.

Conclusion

Negligible long-term impacts on electrical and magnetic fields as a whole are expected as a result of the proposed action and the activities that are part of the cumulative scenario. There may be a demonstrable effect between electromagnetic field strength and fish behavior for certain bottom oriented fish, but such behavior cannot be shown to be detrimental to the individual or interfere with life activities.

6.2.16 Telecommunication Systems

Activities that are part of the cumulative scenario that may impact telecommunication systems within the cumulative impacts study area include: (1) other offshore tidal, wave, or wind energy projects; and (2) vessel traffic such as effects to sea-borne radio communications on marine vessels, and aircraft communications; and (3) the proposed action. A direct impact would be a demonstrable link between the proposed action or other offshore wind parks and interference or degradation of communication signals for existing and necessary means of communications on land, air, or water.

Most telecommunication devices operate on a line-of-sight basis; therefore only large physical obstructions can impede the transmission line-of-sight signals. These large physical obstructions could include multi-story buildings, wind turbines, communication towers, etc. Existing and proposed land based FCC licensed communications towers have been evaluated and were determined not to negatively impact these communication systems. Future projects, such as the South Coast Offshore Energy Project would also be required to obtain FAA approval to ensure they would not interfere with radar communications and to also ensure that they do not interfere with other forms of communications.

Conclusion

Minor long-term impacts on telecommunications systems are expected as a result of the proposed action and the activities that are part of the cumulative scenario.

6.2.17 Air and Climate

Activities that are part of the cumulative scenario that may impact air quality or climate within the cumulative impacts study area include: (1) vessel traffic such as commercial and recreational marine vessel emissions, air traffic emissions, personal and commercial vehicle emissions, construction equipment emissions; (2) population growth and onshore development such as power generation, industrial processing; and (3) emissions from the activities of sand and gravel mining, submarine pipeline and cable emplacement, onshore renewable energy facilities, other offshore tidal, wave, or wind energy projects, small marine projects, channel dredging, beach nourishment, and marina development; and (4) the proposed action. Direct impacts constitute the emission of NO_x, SO_x, VOCs, particulate matter, and CO_2. All of the activities in the cumulative scenario produce incremental emission because all activities rely on the combustion of fossil fuels in one form or another. Indirect impacts would include

the results of the build-up of air emissions over time, or displacement in time or space for impacts based on these emissions.

The turning of the WTG rotors, which react to the wind rather than create or modify it, would not affect the wind speed and/or wind direction in the waters of Nantucket Sound. Overall, the proposed action by itself would have a minor positive, beneficial effect on air quality by generating electricity for use in New England without producing emissions from the burning of fuel (see Air Benefits Analysis in Section 5.3.1.5.2). The activities associated with the construction, maintenance, and decommissioning would result in some temporary level of emissions over Nantucket Sound due to the fossil fuel fired mobile sources (e.g., material supply vessels, crew boats, cranes, pile drivers, and other powered construction equipment). However all of the vessels and equipment would comply with applicable air emission standards.

Conclusion

Minor long-term impacts on air quality and climatic conditions are expected as a result of the proposed action and the activities that are part of the cumulative scenario.

6.2.18 Socioeconomics

Activities that are part of the cumulative scenario that may impact air quality or climate within the cumulative impacts study area include: (1) sand and gravel mining; (2) other offshore tidal, wave, and wind energy projects; (3) onshore wind projects; (4) commercial fishing activities; (5) small marine projects; (6) onshore development; and (7) the proposed action. Direct impacts would be the number of jobs and paychecks attributable to all of the people directly employed who perform these activities. Indirect impacts are the multiplier effects that would result from goods and services purchased to support these activities, or the number of jobs attributable to employers that are needed to supply goods and services.

Overall, the proposed action would have a positive socioeconomic effect. During the 27-month construction and installation phase, an estimated 371 full-time positions would result from the proposed action in Massachusetts and Rhode Island. In addition to this employment benefit, IMPLAN input/output economic model predicts secondary induced employment benefit of 206 to 622 jobs in Massachusetts and 388 to 1,150 jobs in Rhode Island. While there may be some minor economic losses should commercial fisherman find they are unable to fish some areas of Horseshoe Shoal during construction, recreational fishing and related spending would likely increase and become an economic benefit. The proposed action's incremental cumulative impact on socioeconomics relative to the other projects mentioned would be minor.

If environmental monitoring shows that monopiles that have been colonized by mussels which then serve to act as fish attracting devices, there would be a small incremental effect on commercial or recreational fishers who direct some of their activity to the areas around monopiles. Monitoring at Horns Rev and Nysted has not convincingly established that fish are attracted to the hard substrate benthic invertebrate community that formed on WTG foundations (Danish Energy Authority, 2006, p. 77).

Conclusion

Minor long-term impacts on socioeconomic resources as a whole are expected as a result of the proposed action and the activities that are part of the cumulative scenario.

6.3 CUMULATIVE IMPACT ASSESSMENT OF ALTERNATIVES

In addition to assessing the potential cumulative impacts of the proposed action relative to other potential activities and developments that might occur in the cumulative study area, a cumulative impact

assessment has been undertaken of the alternatives to the proposed action. The following subsections provide cumulative impact discussion of the alternatives that have been studied in detail in this FEIS in a comparative manner with the proposed action.

6.3.1 Monomoy Shoals Alternative

Assessing cumulative impacts of the Monomoy Shoals Alternative takes into account all past, present, and reasonably foreseeable future actions that will or may occur in the cumulative impact study area. The cumulative impact study area described above in the introduction, encompasses the proposed action and the Monomoy Shoals Alternative. As a result, the location of the Monomoy Shoals Alternative within the study area suggests that the impacts described in Section 6 for the proposed action, would be similar in a geographic and temporal sense as for the Monomoy Shoals Alternative. This assumption is based upon the similarity between the proposed action and the Monomoy Shoals Alternative in facility design, construction methodology, service area, installation timing, environmental effects and geographic proximity. Should the Monomoy Shoals Alternative be selected, it is not anticipated that in the aggregate, the cumulative effects, as described in Section 6.2, would be significantly different than that for the proposed action.

Although cumulative impacts are generally expected to be similar overall between the Monomoy Shoals Alternative and the proposed action as described above, there are likely some specific cumulative impacts that may differ depending on the particular resource in question. The alternatives analysis at Section 5.4.2.2 shows that the Monomoy Shoals Alternative would have greater environmental impacts 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. These differences in environmental impacts are likely to result in similar corresponding differences in cumulative impacts between the Monomoy Shoals Alternative and the proposed action. Another important issue with the Monomoy Shoals Alternative site is that it is located adjacent to the northwestern extent of a designated Northern Right Whale Critical Habitat, and thus within the context of other activities that have the potential to impact whales, such as commercial shipping, there is a greater potential for cumulative environmental impacts to whales than at the area of the proposed action. Another important difference between Monomoy Shoals Alternative and the proposed action is that the Monomoy Shoals Alternative is in close proximity to Monomoy Island, which provides important resting, nesting and feeding habitat for migratory birds, and thus there would be greater potential for cumulative environmental impacts than the proposed action with respect to terrestrial, coastal, and marine birds as well as T&E avian species. With respect to subtidal offshore resources, cumulative impacts from construction and decommissioning would be greater at the Monomoy Shoals Alternative because of the additional interconnection line length resulting in more acreage of temporary bottom disturbance associated with installation, and the greater wave heights, which would tend to prolong the construction time frame.

6.3.2 South of Tuckernuck Island Alternative

Assessing cumulative impacts of the South of Tuckernuck Island Alternative takes into account all past, present, and reasonably foreseeable future actions that will or may occur in the cumulative impact study area. The cumulative impact study area described above in the introduction encompasses the proposed action and the South of Tuckernuck Island Alternative. As a result, the location of the South of Tuckernuck Island Alternative within the study area suggests that the impacts described in Section 6 for the proposed action, would be similar in a geographic and temporal sense as for the South of Tuckernuck Island Alternative. This assumption is based upon the similarity between the proposed action and the South of Tuckernuck Island Alternative in facility design, construction methodology, service area, installation timing, environmental effects and geographic proximity. Should the South of Tuckernuck

Island Alternative be selected, it is not anticipated that in the aggregate, the cumulative effects, as described in Section 6.2, would be significantly different than that for the proposed action.

Although cumulative impacts are generally expected to be similar overall between the South of Tuckernuck Island Alternative and the proposed action as described above, there are likely some specific cumulative impacts that may differ depending on the particular resource in question. Section 5.4.1.2 of the alternative analysis shows that the South of Tuckernuck Island Alternative would have greater impact 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. These differences in environmental impacts are likely to result in similar corresponding differences in cumulative impacts between the South of Tuckernuck Island Alternative and the proposed action.

One difference that exists with respect to cumulative impacts is on avifauna. The South of Tuckernuck Island Alternative would have a greater potential for cumulative impacts to terrestrial, coastal, and marine birds than the proposed action, 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 mi^2 (93.2 km^2) versus the area of the proposed action, which is 25 mi^2 (64.7 km^2). The larger area of disturbance increases the potential for avian impacts, and thus to the extent other construction projects affect avian impacts in the area, the South of Tuckernuck Island Alternative would contribute more toward cumulative impacts than the proposed action. Another cumulative impact that would be greater is with respect to subtidal resources as the South of Tuckernuck Island Alternative would be constructed in deeper water and contribute more toward cumulative impacts of benthic habitat (as a result of larger foundation sizes and related alteration of the seafloor) than the proposed action.

6.3.3 Condensed Array Alternative

Assessing cumulative impacts of the Condensed Array Alternative takes into account all past, present, and reasonably foreseeable future actions that will or may occur in the cumulative impact study area. The cumulative impact study area described in the introduction above encompasses the proposed action and the Condensed Array Alternative. As a result, the location of the Condensed Array Alternative within the study area suggests that the impacts described in Section 6.2 for the proposed action, would be similar in a geographic and temporal sense as for the Condensed Array Alternative. This assumption is based upon the similarity between the proposed action and the Condensed Array Alternative in facility design, construction methodology, service area, installation timing, environmental effects and geographic proximity. Should the Condensed Array Alternative be selected, it is not anticipated that in the aggregate, the cumulative effects, as described in Section 6.2, would be significantly different than that for the proposed action.

Although cumulative impacts are generally expected to be similar overall between the Condensed Array Alternative and the proposed action as described above, there are likely some specific cumulative impacts that may differ depending on the particular resource in question. Section 5.4.5.2 of the alternative analysis shows that the Condensed Array Alternative would have greater impacts than the proposed action with respect to the competing uses resource category (i.e., commercial and recreational fishing and boating, mining, etc.) during construction, operation, and decommissioning, and less impact during construction for eight resource categories: noise, water quality, avifauna, subtidal offshore resources, non-ESA marine mammals, fish and fisheries, essential fish habitat, and threatened and endangered species. These differences in environmental impacts are likely to result in the similar corresponding differences in cumulative impacts between the Condensed Array Alternative and the proposed action. One difference that exists with respect to cumulative impacts is that the Condensed Array Alternative may further exacerbate radar impacts and increase navigation safety concerns, since the side lobes created by the WTGs may cover a greater percentage of the area within the array under the

Condensed Array Alternave. Another difference would be the decrease in 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. Therefore to the extent other projects occur at the same time or near the same location, the Condensed Array Alternative would contribute less toward cumulative impacts on these resources than the proposed action. Cumulative 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. The tendency for birds to avoid a wind park as a unit, as documented by radar-tacking at the Danish wind parks, may be enhanced by a denser WTG array (Danish Energy Authority, 2006, p. 102-103).

6.3.4 Phased Development Alternative

Assessing cumulative impacts of the Phased Development Alternative takes into account all past, present, and reasonably foreseeable future actions that will or may occur in the cumulative impact study area. The cumulative impact study area described in the introduction above encompasses the proposed action and the Phased Development Alternative. As a result, the location of the Phased Development Alternative within the study area suggests that the impacts described in Section 6.2 for the proposed action, would be similar in a geographic and temporal sense as for the Phased Development Alternative. This assumption is based upon the similarity between the proposed action and the Phased Development Alternative in facility design, construction methodology, service area, installation timing, environmental effects and geographic proximity. Should the Phased Development Alternative be selected, it is not anticipated that in the aggregate the cumulative effects, as described in Section 6.2, would be significantly different than that for the proposed action.

Although cumulative impacts are generally expected to be similar overall between the Phased Development Alternative and the proposed action as described above, there is the potential that some specific cumulative impacts that may differ depending on the particular resource in question. Section 5.4.4.2 of the alternative analysis shows that the Phase Development Alternative would have greater impact during construction and decommissioning than the proposed action for 10 of 28 resource 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). These differences in environmental impacts are likely to result in similar corresponding differences in cumulative impacts between the Phased Development Alternative and the proposed action. One difference is with respect to cumulative impacts on avifauna. Avifauna 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. There may be additional benefits, based upon assessment of impacts and mitigation strategies between phases, which cannot currently be anticipated. 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. The longer duration of the phased construction work would result in greater chance of cumulative impacts to avifauna with other ocean related construction projects. For this same reason the longer construction time frame would also increase the chances of additional cumulative impacts to subtidal resources, marine mammals, and fishery resources.

6.3.5 Smaller Project Alternative

Assessing cumulative impacts of the Smaller Project Alternative takes into account all past, present, and reasonably foreseeable future actions that will or may occur in the cumulative impact study area. The

cumulative impact study area described in the introduction above encompasses the proposed action and the Smaller Project Alternative. As a result, the location of the Smaller Project Alternative within the study area suggests that the impacts described in Section 6.2 for the proposed action, would be similar in a geographic and temporal sense as for the Smaller Project Alternative. This assumption is based upon the similarity between the proposed action and the Smaller Project Alternative in facility design, construction methodology, service area, installation timing, environmental effects and geographic proximity. Should the Smaller Project Alternative be selected, it is not anticipated that in the aggregate the cumulative effects, as described in Section 6.2, would be significantly different than that for the proposed action.

Although cumulative impacts are generally expected to be similar overall between the Smaller Project Alternative and the proposed action as described above, there are likely some specific cumulative impacts that may differ depending on the particular resource in question. Section 5.4.3.2 shows that the Smaller Project Alternative has less impact than the proposed action in 13 resource categories including: noise, air quality, water quality, avifauna, subtidal offshore resources, non-T&E 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. These smaller impacts are likely to result in corresponding smaller cumulative impacts. One notable difference in cumulative impacts would be with respect to benthic impacts, which would be reduced by half (an area roughly proportional to the reduction in the number of WTGs). Thus to the extent other projects are taking place that could result in cumulative impacts, the contribution of impacts from the smaller project toward cumulative impacts would be much less. For this same reason, the difference in benthic disturbance is much smaller and results in a similar reduction in cumulative water quality impacts and cumulative fishery impacts.

6.3.6 No Action Alternative

Assessing cumulative impacts of the No Action Alternative includes analysis of past, present, and reasonably foreseeable future actions that will continue or may occur in the cumulative impact study area of the proposed action. Cumulative impacts associated with adopting this alternative instead of the proposed action would be derived from the absence of an alternative energy source to contribute to the Massachusetts RPS. The extent and degree of impact would be measured by how the loss of energy anticipated by the proposed action would be replaced by other renewable and/or non-renewable sources, and the cumulative impact of those energy sources. The continuation of the development of new non-renewable energy producing facilities would be more likely due to the lack of technology to produce renewable energy other than wind at the scale proposed.

If this energy is replaced by non-renewable sources (fossil fuel), cumulative impacts would be the sum total of the difference between energy facility development in a future that includes the proposed action, and one that does not. That is, the total projected facility development that would occur along with and including the proposed action, compared to the incremental increase of facility development due to the proposed action not being developed. The Massachusetts Energy Facilities Siting Board has indicated an increasing need for energy in the New England area over the project lifespan of the proposed action. The Independent System Operator, New England 2005 Regional System Plan found that New England needed to supply its own resources to minimize its dependence on neighboring systems throughout the planning period (2009-13). Therefore, it is concluded that this demand will have to be met by the development of some type of energy production facility in the New England area.

The cumulative effect of the No Action Alternative on physical, biological, socioeconomic and human resources would be apportioned to the number and kind of facilities that would be developed to replace the loss of the proposed action's 454 MW of electricity. Impacts from new facility operation

attributed to no action taken on the proposed project would be an increase of air emissions to those from existing sources that affect air quality; an increased demand for cooling water with the potential to contribute to water quality impacts in surrounding water bodies with associated environmental degradation; plots of land or sea bed upon which facilities are built that cause inaccessibility for competing uses, and an expansion in the adverse socioeconomic impact zone from the placement of a variety of fossil fuel (natural gas, oil, coal) or nuclear facilities at multiple locations that may or may not be in proximity to the cumulative impact study area. An extensive analysis of impacts associated with the No Action Alternative is included in Section 5.4.6.2.