Table A.8.1-1: Summary of Activities and the Associated Impact-Producing Factors for Air Quality

Baseline Conditions: Air quality within a region is measured in comparison to the NAAQS, which are standards established by the USEPA pursuant to the CAA (42 USC § 7409) for criteria pollutants to protect human health and welfare. The criteria pollutants are CO, NO_2, PM_{10}, $PM_{2.5}$, SO_2, ozone, and lead. The overall geographic analysis area for air quality covers most of Rhode Island, southeastern Massachusetts eastward across Cape Cod, southward across Martha's Vineyard and over the open ocean south of Martha's Vineyard.

This air quality geographic analysis area is changed from that described in the DEIS due to removal of ports. At its nearest point, the WDA is just over 14 miles (23 kilometers) from the southeast corner of Martha's Vineyard, in Dukes County. All of southeastern Massachusetts is presently designated as unclassifiable or attainment for all criteria pollutants. The exception is Dukes County on Martha's Vineyard, which is designated as marginally nonattainment for the 2008 ozone NAAQS. This designation was based on data collected at the Herring Creek Road Aquinnah monitor (Monitor #25-007-0001) from 2009 to 2011, which showed a monitored concentration of 76 ppb versus the 2008 NAAQS of 75 ppb. While the 2008 NAAQS is still technically in effect, Dukes County was recently (August 2018) designated attainment against the more stringent 2015 ozone NAAQS of 70 ppb, based on the 2014 to 2016 monitored concentration of 64.3 ppb. Thus, while the 2008 designation has not yet been changed, monitored values in Dukes County have significantly improved since 2011 and are now in attainment with the 2008 ozone NAAQS standard.

The entire state of Rhode Island is currently in attainment for all criteria pollutants.

Associated IPFs: Sub-IPFs	Ongoing Activities	Future Non-Offshore Wind Activities Intensity/Extent	Future Offshore Wind-related Activities Intensity/Extent	Vineyard Wind 1 Project-related Activities Intensity/Extent	Conclusion
Accidental releases: Fuel/fluids/ hazmat	Accidental releases of air toxics HAPs are due to potential chemical spills. Ongoing releases occur in low frequencies. These may lead to short-term periods of toxic pollutant emissions through surface evaporation. According to the U.S. Department of Energy, 31,000 barrels (4.9 million liters) of petroleum are spilled into U.S. waters from vessels and pipelines in a typical year. Approximately 40.5 million barrels (6.4 billion liters) of oil were lost as a result of tanker incidents from 1970 to 2009, according to International Tanker Owners Pollution Federation Limited, which collects data on oil spills from tankers and other sources. From 1990 to1999, the average annual input to the coastal Northeast was 220,000 barrels of petroleum and offshore it was up to less than 70,000 barrels.	Accidental releases of air toxics or HAPs would be due to potential chemical spills. Table A.8.2-1 provides a quantitative analysis of these risks. Gradually increasing vessel traffic over the next 30 years would increase the risk of accidental releases. These may lead to short-term periods of toxic pollutant emissions through evaporation. Air quality impacts would be short-term and limited to the local area at and around the accidental release location.	Accidental releases of air toxics or HAPs would be due to potential chemical spills over the next 30 years infrequently during construction, but could also occur during operations. Up to about 246,069 gallons (931,473 liters) of coolants, 2,959,524 (11.2 million liters) of oils and lubricants, and 494,632 gallons (1.8 million liters) of diesel fuel would be contained in the 581 foundations (WTGs and ESPs) for the wind energy projects within the air quality analysis area, excluding the Proposed Action. These may lead to short-term periods of toxic pollutant emissions through evaporation. The risk of any type of accidental release would be increased primarily during construction, but also during operations and decommissioning of offshore wind facilities. Air quality impacts would be short-term and limited to the local area at and around the accidental release location. Accidental releases from future offshore wind development would not be expected to contribute appreciably to overall impacts on air quality.	Accidental releases of air toxics or HAPs would be due to potential chemical spills. The Proposed Action would have up to about 42,346 gallons (160,297 liters) of coolants, 506,559 gallons (1.9 million liters) of oils and lubricants, and 84,996 gallons (321,745 liters) of diesel fuel in its 102 foundations (WTGs and ESPs). These may lead to short-term periods of toxic pollutant emissions through evaporation. The risk of any type of accidental release would be increased primarily during construction, but also during operations and decommissioning of offshore wind facilities. Air quality impacts would be short-term and limited to the local area at and around the accidental release location. Accidental releases from future offshore wind development would not be expected to contribute appreciably to overall impacts on air quality. BOEM anticipates that these activities would have a **negligible** air quality impact on the proposed Project area and the surrounding region.	The accidental release of air toxics or HAPs from the Proposed Action would be due to potential spills. These may lead to short-term periods of toxic pollutant emissions through surface evaporation. Air quality impacts would be short-term and limited to the local area at and around the accidental release location. Air quality impacts due to accidental releases associated with the Proposed Action would be **negligible**. The impacts from ongoing activities and future non-offshore wind activities would also be due to the potential for chemical spills and may lead to short-term periods of toxic pollutant emissions through evaporation. Future offshore wind activities would contribute a small amount to the change in risk or impact on air quality as the frequency of accidental release events would be very small and likely infrequent. If a release were to occur, the air quality impact would be short-term and spatially limited. The contribution from future offshore wind and the Proposed Action would be a low percentage of the overall spill risk from ongoing activities. In context of reasonably foreseeable environmental trends, the combined accidental impacts on air quality are expected to be localized and temporary due to the likely limited extent and duration of a release. Accidental releases would not be expected to contribute appreciably to overall impacts on air quality. BOEM expects that impacts from ongoing and planned actions, including the Proposed Action, would have **negligible** impacts from this sub-IPF due to the short-term nature and localized potential effects, if they occur.
Air emissions: Construction and decommissioning	Air emissions originate from combustion engines and electric power generated by burning fuel. These activities are regulated under the CAA to meet set standards. Air quality has generally improved over the last 30 years; however, some areas in the Northeast have experienced a decline in air quality over the last 2 years. Some areas of the Atlantic coast remain in nonattainment for ozone, with the source of this pollution from power generation. Many of these states have made commitments toward cleaner energy goals to improve this, and offshore wind is part of these	The largest air quality impacts over the next 30 years would occur during the construction phase of any one project; however, projects would be required to comply with the CAA. During the limited construction and decommissioning phases, emissions may occur that are above *de minimis* thresholds and would require offsets and mitigation. Primary emission sources would be increased commercial vehicular traffic, air traffic, public vehicular traffic, and combustion emissions from construction equipment and fugitive emissions from	Projects will be required to comply with the CAA. During the limited construction and decommissioning phases, emissions may occur that are above *de minimis* thresholds and will require offsets and mitigation. Primary emission sources from future offshore wind activities would be increased commercial vessel traffic, air traffic, public vehicular traffic, and combustion emissions from construction equipment. The wind projects under development or planned within the air quality geographic analysis area are all located adjacent to each other and would increase the air quality impacts in general during the construction phase. The magnitude of the air quality emissions would vary and be dependent on which projects overlap during the construction	The Proposed Action would result in up to 325,255 tons of construction emissions. Because the construction and installation phase of the offshore components would likely not extend past 2 years and because the emissions would vary throughout the phase, BOEM does not expect projected air quality impacts to exceed the NAAQS for these pollutants. Overall, BOEM anticipates **minor** air quality impacts due to the construction and installation of offshore components due to the limited time of the activities. As the Proposed Action comes online, power generation emissions in the region overall would reduce emissions and this would contribute to a net benefit on air quality regionally.	The Proposed Action would result in 325,255 tons of construction emissions. Although there would be some air quality impacts due to various activities associated with construction and eventual decommissioning, these emissions would be relatively small and limited in duration. Overall, BOEM anticipates **minor** air quality impacts during the limited time of construction and installation of offshore components. The impacts from ongoing activities and future non-offshore wind activities would also result in construction-related emissions primarily from increased commercial vehicular traffic, air traffic, public vehicular traffic, and combustion emissions from construction equipment and fugitive emissions from construction-generated dust. Future offshore wind activities would contribute construction-related emissions, but would also be relatively small and limited in duration similar to the Vineyard Wind 1 Project. Short-term and variable collective impacts on air quality are possible during the construction and decommissioning phase. The overall construction-related air quality impacts due to offshore wind projects are anticipated to be small relative to larger emission sources such as fossil-fuel facilities.

Associated IPFs: Sub-IPFs	Ongoing Activities	Future Non-Offshore Wind Activities Intensity/Extent	Future Offshore Wind-related Activities Intensity/Extent	Vineyard Wind 1 Project-related Activities Intensity/Extent	Conclusion
	goals. Primary processes and activities that can affect the air quality impacts are expansions and modifications to existing fossil-fuel power plants, onshore and offshore activities involving renewable energy facilities, and various construction activities.	construction-generated dust. As projects come online, power generation emissions overall would decline and the industry as a whole would have a net benefit on air quality.	phase. It is anticipated that Sunrise Wind and Revolution Wind projects would overlap within 1 year of the Proposed Action's construction phase. The other offshore wind projects within the air quality geographic analysis area would overlap during the operations phase. As projects come online, power generation emissions overall would decline and the industry as a whole would have a net benefit on air quality. For all the construction-phase emissions of criteria pollutants (CO, NO_X, PM_{10}, $PM_{2.5}$, SO_2, and VOCs) within the geographic analysis area, the percentage of CO is approximately 17%, NO_X is approximately 75%, particulates are approximately 5%, SO_2 is approximately 1%, and VOC are approximately 2% of the total construction criteria pollutant emissions (38,220 tons) for the construction phase. The CO_2 construction emissions make up the largest percentage of total construction-phase emissions, resulting in about 1.9 million tons of CO_2 emissions for the projects within the air quality geographic analysis area. Based on the assumed construction schedule presented in Appendix A Table A-4, projects within the analysis area would have overlapping construction periods beginning from 2023 through 2027.		In context of reasonably foreseeable environmental trends, the combined air emissions on air quality from ongoing and planned actions, including the Proposed Action, could generate up to approximately 2,215,929 tons of construction emissions within the air quality geographic analysis area between 2021 and 2030. The largest air quality impacts are anticipated during the construction phase with smaller and more infrequent impacts anticipated during decommissioning. The largest and most spatially widespread air quality impacts would occur during overlapping construction/ decommissioning phases of multiple wind projects. Based on the assumptions in Table A-6, the Vineyard Wind 1 Project, Sunrise Wind Project, and Revolution Wind are anticipated to overlap for 2 years of construction beginning in 2023, resulting in a total of about 10,362 tons of criteria pollutants and about 502,208 tons of CO_2 construction emissions. The other wind projects within the geographic analysis area would overlap with the Vineyard Wind 1 Project operations phase. Anticipated collective air quality impacts would be transient, small in magnitude, and localized. In context of reasonably foreseeable environmental trends, the combined air emissions on air quality from ongoing and planned actions, including the Proposed Action, from construction air emissions would be **minor** during construction and decommissioning. During overlapping construction activities there could be increased impacts, but these effects would be short-term in nature as the overlap in the air quality geographic analysis area would be limited in time.
Air emissions: O&M		Activities associated with operation and maintenance of onshore wind projects would have a proportionally very small contribution to emissions compared to the construction and decommissioning activities over the next 30 years. Emissions would largely be due to commercial vehicular traffic and operation of emergency diesel generators. Such activity would result in short-term, intermittent, and widely dispersed emissions and small air quality impacts.	Operations and maintenance activities would have a proportionally very small contribution to emissions compared to the construction and decommissioning phases, but could occur each month during operations and maintenance. Emissions would largely be due to commercial vessel traffic and operation of emergency diesel generators. Such activities would result in short-term, intermittent, and widely dispersed emissions. Anticipated air quality impacts would be transient and small in magnitude. The largest air quality impacts would occur during overlapping operational activities. Anticipated air quality impacts would be transient and small in magnitude. Operational phase air emissions of criteria pollutants (CO, NO_X, SO_2, PM_{10}, $PM_{2.5}$, and VOC) within the air quality geographic analysis area show that most of the emissions would be from NO_X (412 tons per year [74% of the total operational criteria pollutant emissions]) and CO (105 tons per year [19% of the total operational criteria pollutant emissions]) due to	Operations and maintenance activities would have a proportionally very small contribution to emissions compared to the construction and decommissioning phases, but could occur each month during operations and maintenance. The air emissions from operation of the Proposed Action would begin in 2023 and continue through 2030. Emissions would largely be due to commercial vessel traffic, air traffic such as helicopters, and operation of emergency diesel generators. Such activity would result in short-term, intermittent, and widely dispersed emissions. Anticipated air quality impacts would be transient, small in magnitude, and localized. Possible use of larger but fewer turbines would reduce the air quality impacts. The operations and maintenance of the Proposed Action would be less than the construction phase since it would only involve limited vessel and commercial traffic and operation of emergency equipment that would not occur frequently. The Proposed Action's incremental contribution of up to 5,583 tons per year of operations emissions, of which 96 tons per year would be from criteria pollutants, would be additive with the impact(s) of any and all	The operations and maintenance of the Proposed Action would generate fewer emissions than the construction phase since it would only involve limited vessel and commercial traffic and emergency equipment operation would occur infrequently. The Proposed Action would result in 5,583 tons per year of operations emissions during the proposed 30 years. BOEM anticipates that air quality impacts of operations and maintenance of the Proposed Action would be **minor**, occurring for short blocks of time several times per year. The impacts from ongoing activities and future non-offshore wind activities would largely be due to commercial vehicular traffic and operation of emergency diesel generators. Such activities would result in short-term, intermittent, and widely dispersed emissions and small air quality impacts. Future offshore wind activities would contribute operations-related emissions, but would have a proportionally very small contribution to emissions compared to the construction and decommissioning phases. Emissions would largely be due to commercial vessel traffic and operation of emergency diesel generators. In context of reasonably foreseeable environmental trends, the combined air emissions on air quality from ongoing and planned actions, including the Proposed Action, from operations and maintenance air emissions could be up to approximately 38,038 tons per year of operations emissions in the air quality geographic analysis area beginning in 2023 and continuing through 2030 (Table A-6). Emissions would largely be due to commercial vessel traffic, air traffic such as helicopters, and operation of emergency diesel generators. Such activity would result in short-term, intermittent, and widely dispersed emissions. In context of reasonably foreseeable environmental trends, the combined air emissions on air quality from ongoing and planned

Associated IPFs: Sub-IPFs	Ongoing Activities	Future Non-Offshore Wind Activities Intensity/Extent	Future Offshore Wind-related Activities Intensity/Extent	Vineyard Wind 1 Project-related Activities Intensity/Extent	Conclusion
			combustion emissions. The other criteria pollutants for the future offshore wind projects within the air quality geographic analysis area, such as PM_{10}, $PM_{2.5}$, and SO_2, each account for approximately 7% of the total operational emissions for all future offshore wind projects within the air quality analysis area.	other operations activities, including offshore wind activities, that occur within the air quality geographic analysis area. BOEM anticipates that air quality impacts of operations and maintenance of offshore components would be **minor**, occurring for short blocks of time several times per year during the proposed 30 years.	actions, including the Proposed Action, from operations and maintenance air emissions would be localized, transient, and **minor**. The largest magnitude air quality impacts and largest spatial extent would result from the overlapping operations activities from the multiple wind projects within the air quality geographic analysis area. Additionally, some emissions associated with operations and maintenance activities could overlap with other projects' offshore construction-related emissions (Table A-6). A net improvement in air quality is expected on a regional scale as projects come online and offset emissions from fossil-fuel-type sources.
Air emissions: Power generation emissions reductions		Many Atlantic states have committed to clean energy goals, with offshore wind being a large part of that. Other reductions include transitioning to onshore wind and solar. The No Action Alternative without implementation of other future offshore wind projects would likely result in increased air quality impacts regionally due to the need to construct and operate new energy generation facilities to meet future power demands. These facilities may consist of new natural-gas-fired power plants, coal-fired, oil-fired, or clean-coal-fired plants. These types of facilities would likely have larger and continuous emissions and result in greater regional scale impacts on air quality.	Significant reductions in fossil-fuel-type emissions can result from the increases in renewable energy. Based on an analysis by Katzenstein and Apt (2009), CO_2 emissions can be reduced by up to 80% and NO_X emissions can be reduced up to 50% due to implementation of wind energy projects. A quantitative emissions inventory analysis is needed to more accurately assess these overall emissions reductions. Since fossil-fuel-type emissions are much higher than emissions due to renewable energy sources, a relatively small percentage reduction in fossil-fuel emissions can lead to much larger emissions reductions relative to the smaller emissions increases that would result from implementation of offshore wind projects.	Once operational, the Proposed Action would have annual avoided emissions of 1,632,822 tons CO_2, 1,046 tons NOx, and 855 tons SO_2. Accounting for construction emissions and assuming decommissioning emissions would be the same, the Proposed Action would offset emissions related to its development and eventual decommissioning within 8 years of operation, which is a conservative estimate;[7] from that point, the Proposed Action would be offsetting emissions that would otherwise be generated from another source. BOEM anticipates that air emissions would result in a small reduction of fossil-fuel emissions and would result in a **minor beneficial** impact on air quality.	The Proposed Action would result in avoided emissions that would be generated otherwise by another power source. Once operational, the Vineyard Wind 1 Project would avoid annual emissions of 1,632,822 tons CO_2, 1,046 tons NO_x, and 855 tons SO_2. BOEM anticipates that air emissions would result in a small reduction of fossil-fuel emissions and would result in a **minor beneficial** impact on air quality. The impacts from ongoing activities and future non-offshore wind activities would continue to contribute emissions from non-renewable sources until states meet their committed clean energy goals. Future offshore wind activities would contribute an increase in renewable energy production ultimately leading to reductions in fossil-fuel emissions similar to the Vineyard Wind 1 Project. Based on an analysis by Katzenstein and Apt (2009), CO_2 emissions can be reduced by up to 80% and NO_x emissions can be reduced up to 50% due to implementation of wind energy projects. Since fossil-fuel-type emissions are typically much higher than emissions from renewable energy sources, a relatively small percentage reduction can lead to much larger emissions reductions relative to the smaller emissions increases that would result from implementation of offshore wind projects. In context of reasonably foreseeable environmental trends, the combined air emissions on air quality from ongoing and planned actions, including the Proposed Action, would help to reduce fossil-fuel emissions and result in a net **minor beneficial** impact on air quality.

[7] Other estimates have found that the offset would exceed project emissions in as little as 4 years (Nugent and Sovacool 2014).

Associated IPFs: Sub-IPFs	Ongoing Activities	Future Non-Offshore Wind Activities Intensity/Extent	Future Offshore Wind-related Activities Intensity/Extent	Vineyard Wind 1 Project-related Activities Intensity/Extent	Conclusion
Climate change	The construction, operation, and decommissioning of offshore wind projects would produce GHG emissions (nearly all CO_2) that can contribute to climate change; however, these contributions would be minuscule compared to aggregate global emissions. CO_2 is relatively stable in the atmosphere and generally mixed uniformly throughout the troposphere and stratosphere. Hence the impact of GHG emissions does not depend upon the source location. Increasing energy production from offshore wind projects would likely decrease GHGs emissions by replacing energy from fossil fuels.	Development of future onshore wind projects would produce a small overall increase in GHG emissions over the next 30 years. However, these contributions would be very small compared to the aggregate global emissions. The impact on climate change from these activities would be very small. As more projects come online, some reduction in GHG emissions would be expected from modifications of existing fossil-fuel facilities to reduce power generation. Overall, it is anticipated that there would be no collective impact on global warming as a result of onshore wind project activities.	Development of offshore wind projects and the construction, implementation, operation, maintenance, and the eventual decommissioning would cause some minuscule GHG emissions increases primarily through emissions of CO_2. Overall there should be some net reduction on both GHG emissions and criteria pollutants, including ozone precursors such as NOx, through reduction in emissions from fossil-fuel power generating facilities. In general, the GHG emissions associated with the construction, maintenance, and eventual decommissioning of future offshore wind projects can be assumed to contribute to climate change. However, these contributions would be minuscule compared to the aggregate global emissions of GHGs; therefore, they cannot be deemed significant, if their impact could even be detected.	The construction, operation, and decommissioning activities associated with the Proposed Action would produce GHG emissions (nearly all CO_2) that can contribute to climate change; however, these contributions would be minuscule compared to aggregate global emissions. CO_2 is relatively stable in the atmosphere and generally mixed uniformly throughout the troposphere and stratosphere. Hence the impact of GHG emissions does not depend upon the source location. Increasing energy production from offshore wind projects would likely decrease GHGs emissions by replacing energy from fossil fuels. In general, the GHG emissions associated with the construction, maintenance, and eventual decommissioning of the Proposed Action can be assumed to contribute to climate change. However, these contributions would be small compared to the aggregate global emissions of GHGs; therefore, they cannot be deemed significant, if their impact could even be detected. The additional GHG emissions anticipated from the Proposed Action over the 30-year period would have a **negligible** incremental contribution to existing GHG emissions. Therefore, the Proposed Action would have **negligible** impacts on climate change during these activities and an overall **minor beneficial** impact on both GHG emissions and criteria pollutants, including ozone precursors such as NOx, compared to a similarly sized fossil-fuel power generating station or to the generation of the same amount of energy by the existing grids.	The Proposed Action would produce GHG emissions as stated above; however, the contributions would be minuscule compared to aggregate global emissions. The additional GHG emissions anticipated from the Proposed Action over the 30-year period would have a **negligible** incremental contribution on existing GHG emissions. Therefore, the Proposed Action would have **negligible** impacts on climate change during these activities and an overall **minor beneficial** impact on GHG emissions compared to the generation of the same amount of energy by the existing grids. Because GHG emissions spread out and mix within the troposphere, the climatic impact of GHG emissions does not depend on the source location. Therefore, regional climatic impacts are a function of global emissions. Development of offshore wind projects and the construction, implementation, operation, maintenance, and the eventual decommissioning activities would cause some GHG emissions increases primarily through emissions of CO_2. However, these contributions would be minuscule compared to aggregate global emissions. In context of reasonably foreseeable environmental trends, the combined GHG emissions on air quality from ongoing and planned actions, including the Proposed Action, would likely result in a **minor beneficial** impact from the net decrease in both GHG emissions and criteria pollutants, including ozone precursors such as NO_x, as fossil-fuel-type facilities reduce operations as a result of increased energy generation from offshore wind projects. Overall, it is anticipated that there would be no collective impact on global warming as a result of offshore wind projects, including the Proposed Action alone, though they may beneficially contribute to a broader combination of actions to reduce future impacts from climate change.

% = percent; BOEM = Bureau of Ocean Energy Management; CAA = Clean Air Act; CO = carbon monoxide; CO_2 = carbon dioxide; DEIS = Draft Environmental Impact Statement; GHG = greenhouse gas; HAP = hazardous air pollutant; hazmat = hazardous materials; IPF = impact producing factor; NAAQS = National Ambient Air Quality Standards; NO_2 = nitrogen dioxide; NO_x = nitrogen oxides; O&M = operations and maintenance; $PM_{2.5}$ = particulate matter with diameters 2.5 microns or smaller; PM_{10} = particulate matter with diameters 10 microns or smaller; ppb = parts per billion; SO_2 = sulfur dioxide; USC = United States Code; USEPA = U.S. Environmental Protection Agency; VOC = volatile organic compounds; WDA = Wind Development Area

A.8.2. Water Quality

A.8.2.1. No Action Alternative and Affected Environment

This section identifies existing water quality in the geographic analysis area for water quality, as described in Table A-1 and shown on Figure A.7-15. Specifically, this includes a 10-mile (16.1-kilometer) radius around the WDA, the OECC, and vessel approach routes to port facilities that would be used by the proposed Project. Table A.8.2-1 describes baseline conditions and, based on the IPFs assessed, the impacts of ongoing and future offshore activities other than offshore wind on water quality, which is discussed below. This information comes primarily from the DEIS and SEIS, supplemented by information developed in responding to public comments and additional information.

The following are the key parameters characterizing ocean water quality, and are important measures of the ability to support and maintain a healthy ecosystem. Some of these parameters are accepted proxies for ecosystem health (e.g., dissolved oxygen [DO], nutrient levels), while others delineate coastal habitats from marine habitats (e.g., temperature, salinity):

- *Water temperature*: Water temperature heavily affects species distribution in the ocean. Large-scale changes to water temperature may impact seasonal phytoplankton blooms, an important part of New England marine ecosystems (Oviatt 2004).
- *Salinity*: Salinity, or salt concentration, also affects species distribution. In general, seasonal variation in the region is smaller than year-to-year variation and less predictable than temperature changes (Kaplan 2011).
- *Dissolved oxygen*: The amount of DO in water determines the amount of oxygen that is available for marine life to use. Temperature strongly influences DO content, which is further influenced by local biological processes. For a marine system to maintain a healthy environment, DO concentrations should be above 5 milligrams per liter (mg/L); lower levels may affect sensitive organisms (USEPA 2000).
- *Chlorophyll a*: Chlorophyll *a* is a measure of how much photosynthetic life is present. Chlorophyll *a* levels are sensitive to changes in other water parameters, making it a good indicator of ecosystem health. The USEPA considers estuarine and marine levels of chlorophyll *a* under 5 micrograms per liter (µg/L) to be good, 5 to 20 µg/L to be fair, and over 20 µg/L to be poor (USEPA 2015).
- *Turbidity:* Turbidity is a measure of water clarity. Turbid water lets less light reach the seafloor, which may be detrimental to photosynthetic marine life (CCS 2017). In estuaries, a turbidity level of 0 to 10 nephelometric turbidity units (NTU) is healthy while a turbidity level over 15 NTU is detrimental (NOAA 2018). Marine waters generally have less turbidity than estuaries.
- *Nutrients*: Key ocean nutrients include nitrogen and phosphorous. Photosynthetic marine organisms need nutrients to thrive (with nitrogen being the primary limiting nutrient), but excess nutrients can cause problematic algal blooms. Algal blooms can significantly lower DO concentration, and toxic algal blooms can contaminate human food sources. Both natural and human-derived sources of pollutants contribute to nutrient excess.

Large-scale regional water circulation is strongest in late spring and summer. The clockwise movement around Georges Bank and flow toward the equator dominates the regional water circulation (Gulf of Maine Census 2018). The edge of the continental shelf creates a shelf-break front that encourages upwelling. Weather-driven surface currents, tidal mixing, and estuarine outflow all contribute to driving water movement through the area (Kaplan 2011). Appendix E includes additional regional setting information.

The water quality geographic analysis area is a typical subset of the regional setting and includes coastal waters in nearshore areas where bottom depth is less than 98.4 feet (30 meters) and marine waters in deeper offshore areas. The 98.4-foot (30-meter) isobath delineates between these ecologically distinct nearshore and offshore systems (FGDC 2012). The OECC is located entirely within coastal waters, and the WDA is located within marine waters. Coastal waters include the OECC, parts of navigation routes to access the WDA from shore, and ports that Vineyard Wind may use during construction, operations, maintenance, and decommissioning.