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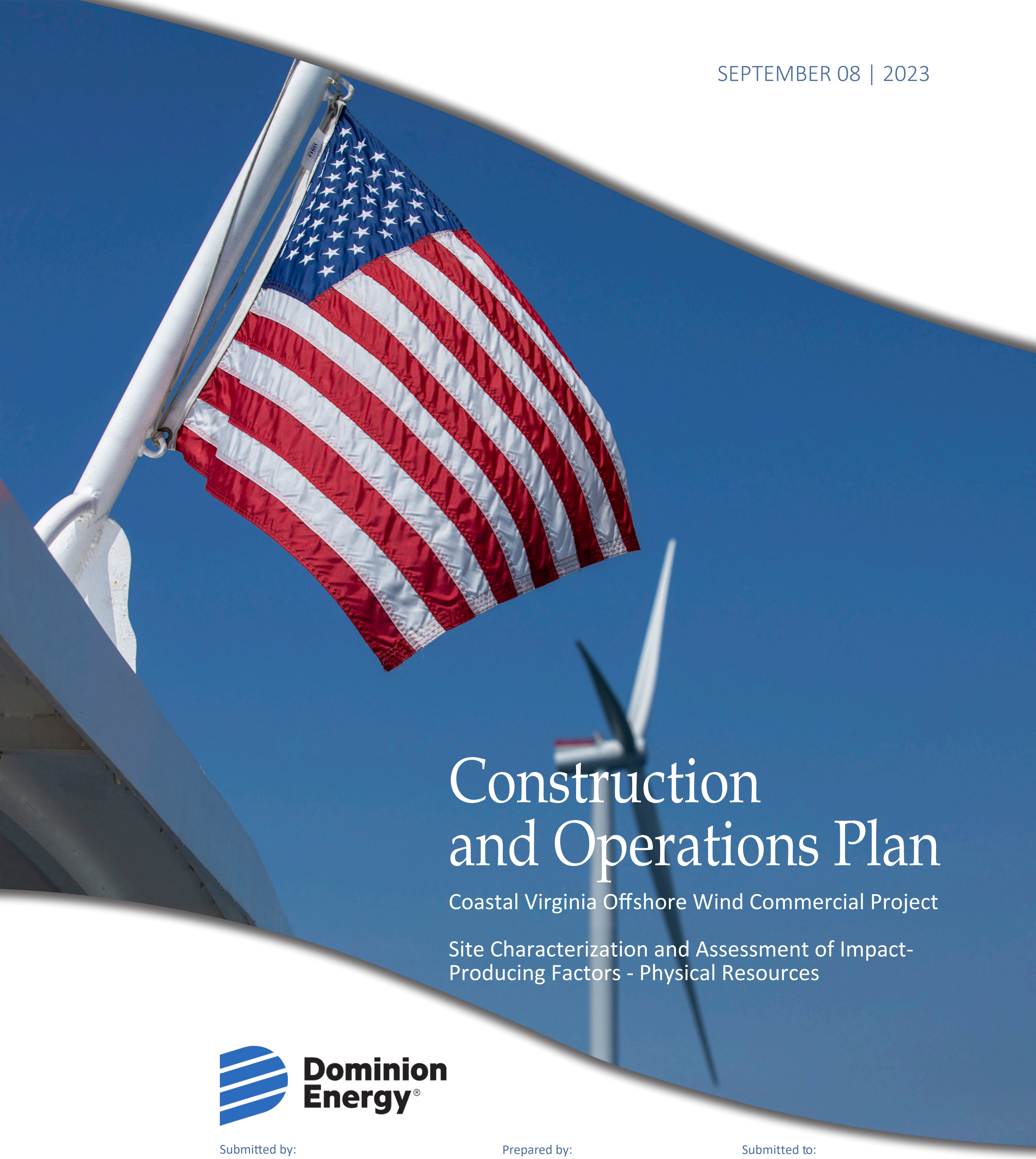

Construction and Operations Plan

Coastal Virginia Offshore Wind Commercial Project

Site Characterization and Assessment of Impact-Producing Factors - Physical Resources

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4.1 Physical Resources

4.1.1 Physical and Oceanographic Conditions

This section describes the existing physical and oceanographic conditions within and surrounding the Project Area. Physical and oceanographic conditions include meteorological and geologic conditions. Potential impacts to the Project from these conditions, resulting from construction, O&M, and decommissioning of the Project are further discussed below. Avoidance, minimization, and mitigation measures proposed by Dominion Energy are also described in this section.

Other assessments detailed within this COP, which are related to physical and oceanographic conditions, include:

- Water Quality (Section 4.1.2);
- Marine Archaeological Resources (Section 4.3.1);
- Terrestrial Archaeological Resources (Section 4.3.2);
- Marine Site Investigation Report (Appendix C);
- Marine Archaeological Resources Assessment (Appendix F);
- Sediment Transport Analysis (Appendix J);
- Metocean Assessment (Appendix X); and
- Seabed Morphology Study (Appendix CC).

Site specific HRG and geotechnical survey data was collected by Dominion Energy in 2020 and 2021, and a full data assessment and analysis is included in the Marine Site Investigation Report (MSIR) and the Marine Archaeological Resource Assessment (Appendices C and F, respectively), supplemented when necessary by desktop data.

4.1.1.1 Affected Environment

The affected environment is defined as areas within and surrounding the Project Area where the existing physical and oceanographic conditions may impact or be impacted, directly or indirectly, by the construction, O&M, and decommissioning of the Project. Ports and construction and staging areas are not assessed within this section as they will utilize existing facilities in which the associated Project uses will be consistent with the activities for which the existing facilities were permitted and developed. The affected environment is located offshore of Virginia along the Mid-Atlantic Bight and onshore in the Cities of Virginia Beach and Chesapeake, Virginia. Oceanographic conditions along the Mid-Atlantic Bight are comparable to conditions along the Mid-Atlantic East Coast, with warm summer months and cooler yet mild winter months.

Meteorological Conditions

A complete Metocean Site Investigation Report is included in Appendix X, Metocean Assessment. A brief description of the meteorological parameters most relevant to the construction, O&M, and decommissioning of the Project is provided below.

Wind

Wind data was analyzed from the Climate Forecast System Reanalysis data set established by the National Centers for Environmental Prediction (NOAA n.d. A). Both normal conditions and extreme conditions were assessed; normal conditions were considered the likely operational conditions for the Project construction, O&M, and decommissioning. Extreme conditions are discussed in the Storm Events section below. Operational wind parameters analyzed were from a height of 32.8 ft (10 m) above MSL; however, the data points were scaled from 32.8 ft (10 m) to hub height above MSL to account for the wind speeds that will impact the hub heights. Because the wind data as presented here represents conditions at hub height, the data likely presents a worst-case scenario than would be expected to occur on the more nearshore areas of the Project and those closer to sea level because of the more protected nature of those sites and the lower altitude. As such, wind speeds experienced by vessels conducting the installation or O&M along the nearshore portions of the Offshore Export Cable Route Corridor are anticipated to be lower than the values presented below.

Data analysis identified that while winds in the Lease Area occur from all directions, the strongest winds are from the north, and the highest frequency of winds are from the southwest. Average wind speed and direction are depicted as a wind rose in Figure 4.1-1 below.

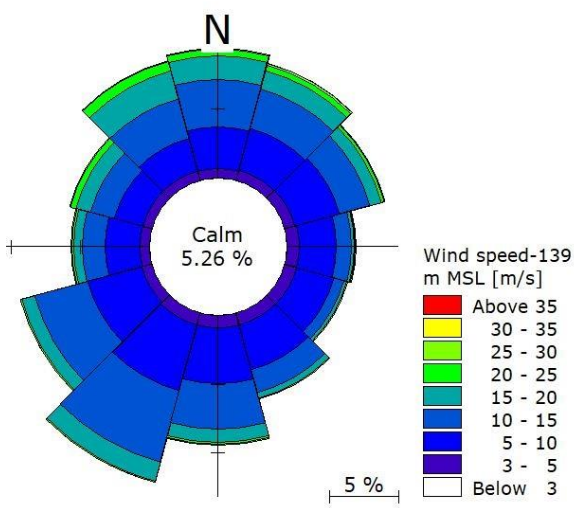


Figure 4.1-1. Wind Rose of Mean Wind Speeds and Directions at Hub Height

Waves

Wave data was analyzed from the MIKE 21 SW spectral wave model (DHI n.d.). Both normal conditions and extreme conditions were modeled based on this data, with normal conditions being considered the likely operational conditions for Project construction, O&M, and decommissioning. The highest waves flow from the northeast, and almost all waves flow from east to west. The highest average waves, flowing from the northeast, do not exceed 26 ft (8 m). Significant wave height and direction are depicted as a wave rose in Figure 4.1-2. Sea-state conditions impacting the construction, O&M, and decommissioning of the Project may be substantially less for the areas of the Project closer to shore than the conditions identified in Figure 4.1-2.

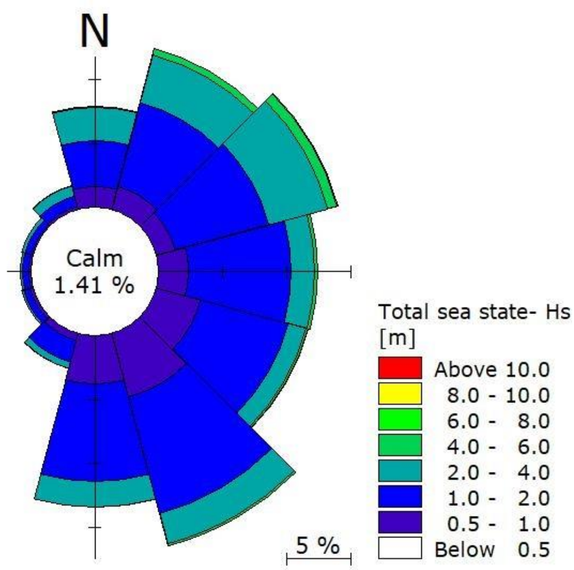


Figure 4.1-2. Wave Rose – Total Sea State

Water Chemistry

Water temperature data analyzed was taken from NOAA North West Atlantic regional climate information and NOAA National Data Buoy Center (NOAA NDBC) (NOAA n.d. B, NOAA 2020, respectively). Water temperatures were taken at the sea surface, although water temperatures typically remain the same or decrease with depth. Sea surface temperatures ranged from 31.6 to 84.2 degrees Fahrenheit (°F) (-0.2 to 29.0 degrees Celsius [°C]). The depth-averaged annual water temperature is 56.39 °F (13.55 °C) (NOAA n.d. B). Figure 4.1-3 details the monthly mean, standard deviation, and extreme sea temperatures from the NOAA NDBC buoy CHLV2 located offshore of the mouth of the Chesapeake Bay (NOAA 2020).

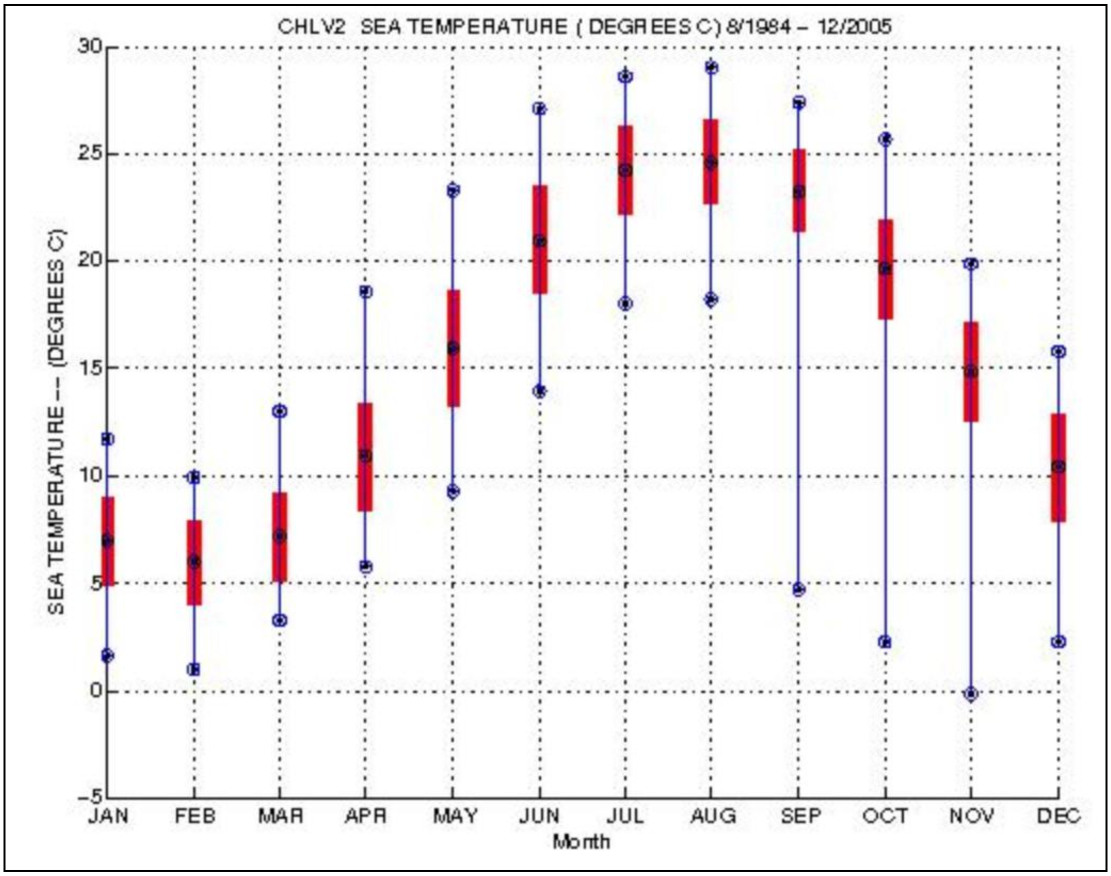


Figure 4.1-3. Monthly Mean (central blue dot within the circle), one Standard Deviation (red bar) above and below the Mean, and Monthly Extreme Sea Temperatures (high and low dots within the circles) at Station CHLV2

Water salinity data was assessed from NOAA's Northwest Atlantic Regional Climatology data (NOAA n.d. B). Data indicates that water nearer to Chesapeake Bay is lower in salinity than deeper waters offshore because of the outflow of freshwater. Historical annual mean salinities for the entire Mid-Atlantic Bight range from 32.70 to 34.53 Practical Salinity Units (PSU) (NOAA 2003).

Water density was assessed based on water temperature and salinity within the Offshore Project Area. Water density within the Offshore Project Area is expected to average 1,024 to 1,025 kilograms per cubic meter based on water temperature and salinity. Water density will vary seasonally as will temperature and salinity.

Additional information on water chemistry of the Offshore Project Area is included in Section 4.1.2, Water Quality.

Air Temperature

The air temperature data that was analyzed was derived from Project-specific data and the NOAA NDBC station CHLV2 (Ramboll 2020, NOAA 2020). Air temperatures ranged from 1.9 to 90.7 °F (-16.7 to 32.6 °C). Figure 4.1-4 below details the monthly mean, standard deviation, and extreme air temperatures from NOAA NDBC station CHLV2 (NOAA 2020).

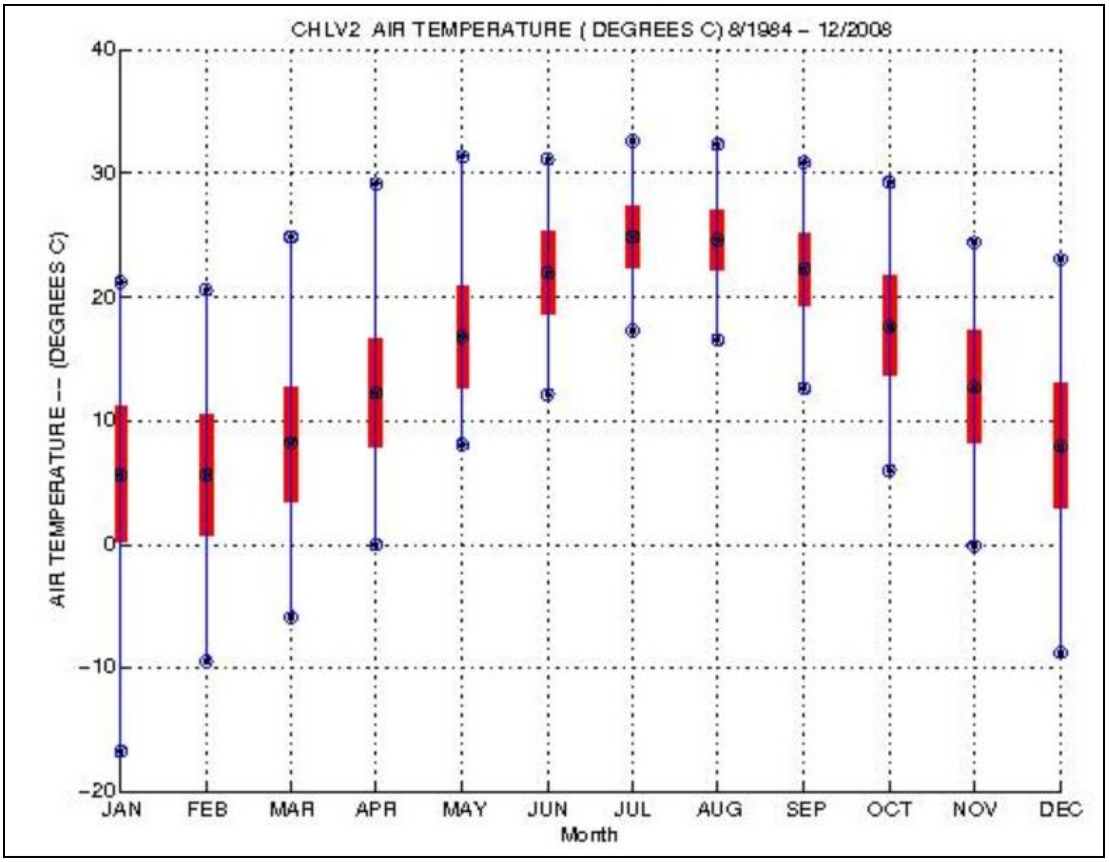


Figure 4.1-4. Monthly Mean (central blue dot within the circle), one Standard Deviation (red bar) above and below the Mean, and Monthly Extreme Air Temperatures (high and low dots within the circles) at Station CHLV2

Water Level

A description of water levels is provided in Table 4.1-1. Water levels are based on tidal time series statistical values (mean, minimum, and maximum) and determined based on peak values during spring and neap periods. Figure 4.1-5 illustrates tide water levels.

Table 4.1-1. Tidal Water Levels

Datum	Description	Tidal Levels	
		Mean Sea Level (meters)	Mean Lower-Low Water (meters)
HAT	Highest Astronomical Tide	0.86	1.37
MHWS	Mean High Water Spring	0.58	1.09
MHWN	Mean High Water Neaps	0.39	0.90
MWL	Mean Water Level	0.00	0.51
MLWN	Mean Low Water Neaps	-0.40	0.11
MLLW	Mean Lower Low Water	-0.51	0.00
MLWS	Mean Low Water Spring	-0.58	-0.07
MLLWS	Mean Lower-Low Water Spring	-0.63	-0.12
LAT	Lowest Astronomical Tide	-0.73	-0.22

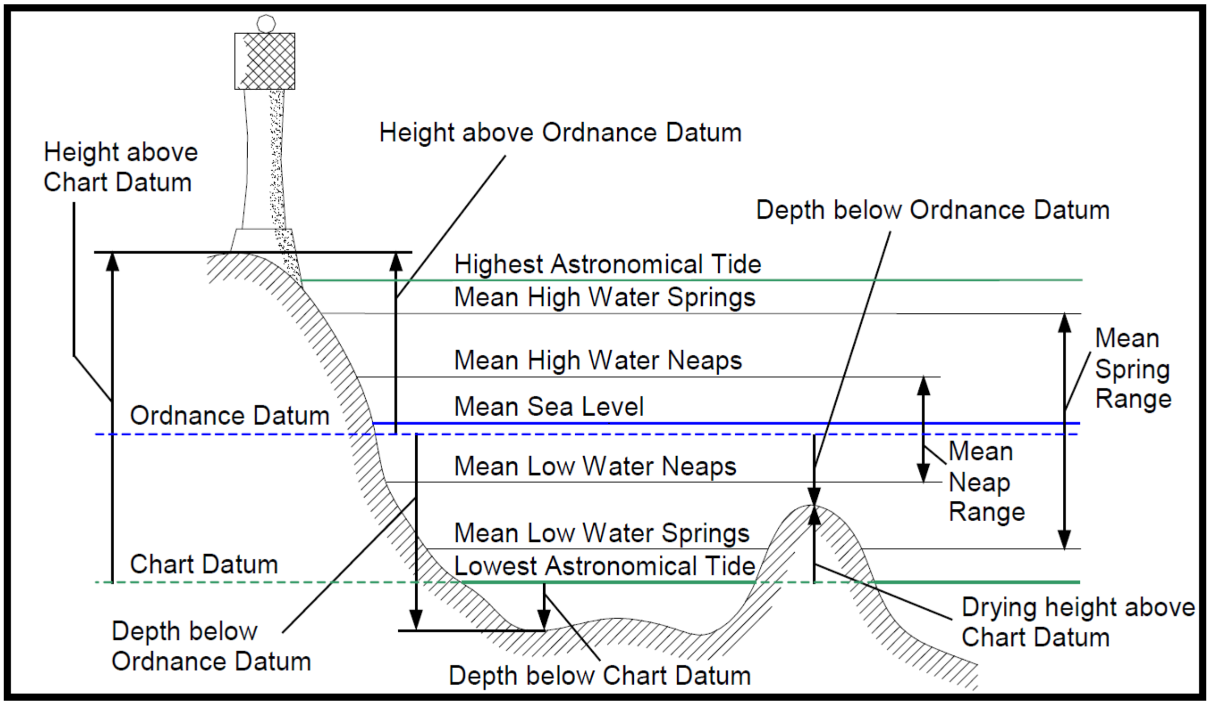


Figure 4.1-5. Illustration of Tidal Water Levels

Currents

Data used to model currents within the Lease Area are from a two-dimensional hydrodynamic model, MIKE 21 FM flow model (DHI n.d.). Total currents were modeled and are depicted in Figure 4.1-6, which shows the currents flowing from all directions. The currents flow most frequently from the east, and calm conditions, with regard to current, are almost 8 percent.

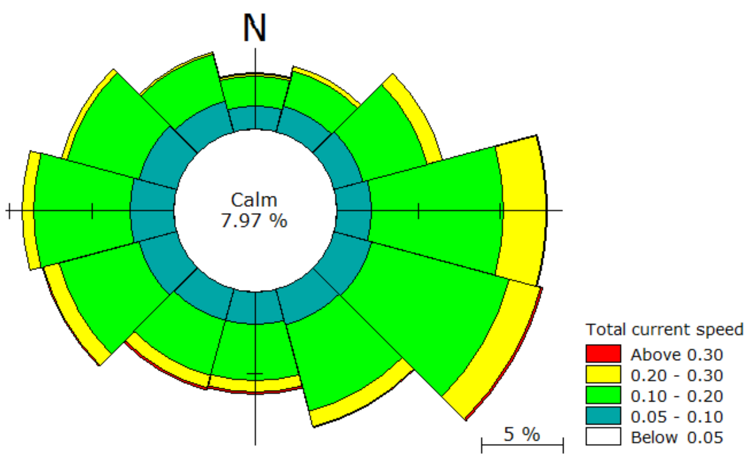
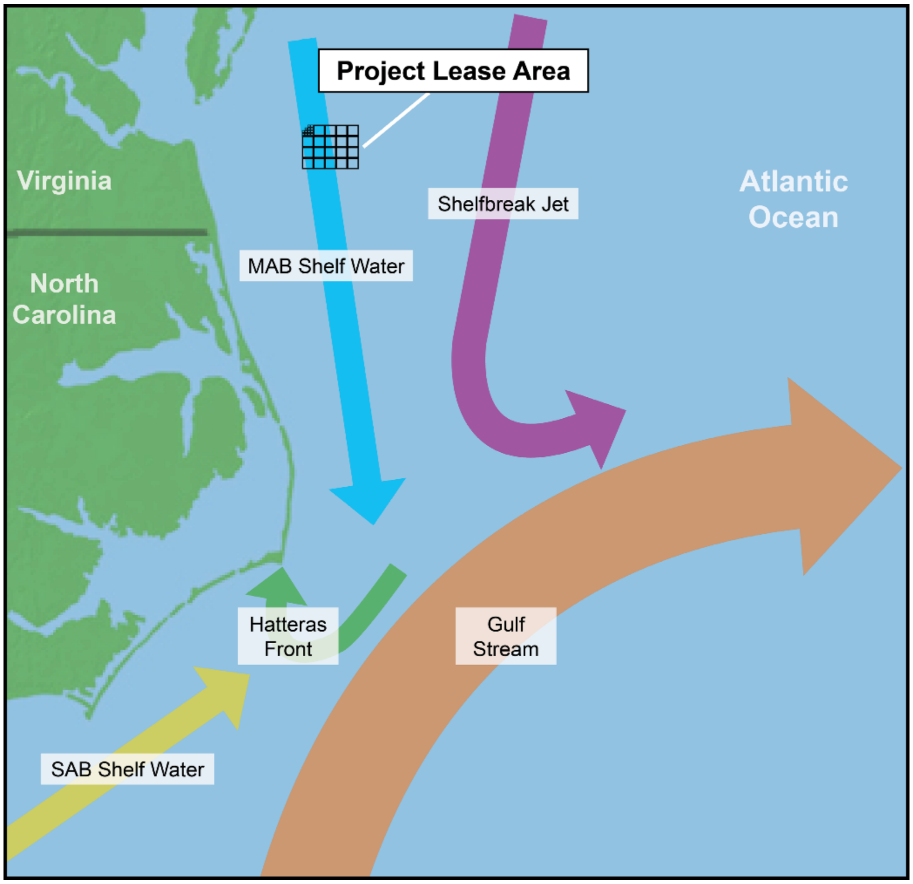


Figure 4.1-6. Total Current Speed Rose

Regional currents were assessed in addition to the currents modeled for the Offshore Project Area. The general trend of currents within the region offshore of the Mid-Atlantic Bight, including the Lease Area and Offshore Export Cable Route Corridor, is southward; other regional currents along the Mid-Atlantic

Bight trend in different directions and are not relevant to the Offshore Project Area (Skidaway Institute of Oceanography 2017). Currents within the region offshore of the Mid-Atlantic Bight are depicted in Figure 4.1-7.



Note: Figure redrawn based on Skidaway Institute of Oceanography (2017)

Figure 4.1-7. Representative Currents Offshore from the Mid-Atlantic Bight

Storm Events

Storm events are known to occur within the Mid-Atlantic Bight with an increase in intensity and frequency toward the southern portion of the East Coast. These storm events consist of tropical storms and hurricanes. The annual hurricane season typically occurs from the beginning of June to the end of November. During storm events, extreme waves and winds are observed. Storm events may also cause extreme tides and temporary shifts in the currents. Furthermore, tropical storms and hurricanes are known to build and intensify offshore, indicating that the Offshore Project Area may be subject to more extreme weather events than the East Coast experiences each year.

Climate Change

Sea level change resulting from climate change is expected to occur throughout the operational lifetime of the Project. This change is assumed to occur as an increase of about 1 foot (0.30 m) (Sea Level Rise.org n.d.). Climate change may also increase precipitation, change the frequency and intensity of storms, and increase water temperatures within the Project Area because of its coastal location (EPA 2017). Additional potential impacts resulting from climate change-related extremes include heat waves, droughts, floods, cyclones, and wildfires (IPCC 2014). The global change for surface temperatures as a result of climate change will likely exceed 2.7 °F (1.5 °C) by the end of the twenty-first century (IPCC 2014).

Geologic Conditions

Offshore Conditions

Dominion Energy contracted TerraSond Ltd (TerraSond), Geoquip Marine (Geoquip), and Alpine Ocean Seismic Survey, Inc. (Alpine) to conduct HRG and geotechnical survey campaigns and associated data analysis and reporting for the Offshore Project Area. The survey campaigns, data analysis, and reporting in support of the Marine Site Investigation Report were completed in September and October of 2021, with a revision to the Marine Site Investigation Report in 2023 to address agency comments. Additional geophysical and geotechnical data has been acquired and is being analyzed in support of the detailed design processes. This includes 2021 geotechnical campaigns in the Lease Area and the Offshore Export Cable Route Corridor as well as a 2021 shallow water geotechnical and geophysical survey for the Offshore Export Cable Route Corridor. This section provides an overview of the data and information on the conditions occurring within the Offshore Project Area as presented in detail within Appendix C, Marine Site Investigation Report.

An overview of the survey results from the geophysical and geotechnical survey campaign within the Offshore Project Area are provided in this section, and additional detail can be found in Appendix C, Marine Site Investigation Report. These results are based on the available data collected during geophysical and geotechnical survey campaigns. Geophysical survey campaigns occurred in 2020 and 2021 on board the following vessels:

- R/V Kommanodor Iona (2020),
- M/V Marcelle Bordelon (2020),
- M/V Sarah Bordelon (2020),
- R/V Kommandor Stuart (2021),
- M/V GO Discovery (2021),
- R/V Shearwater (2020), and
- R/V Minerva Uno (2020, 2021).

Geotechnical survey campaigns occurred in 2020 and 2021 on board the following vessels:

- Dina Polaris (2020 and 2021),
- Speer (2020 and 2021),
- Saentis (2020 and 2021), and
- R/V Shearwater (2021).

Surveys that occurred cover both the Lease Area and the Offshore Export Cable Route Corridor. Data collected during these campaigns consisted of multi-beam echosounder bathymetry, side scan sonar, subbottom profiler, magnetometer ultra-high resolution channel seismic (multi- and single-), grab samples, still photos, vibracores, seabed cone piezometer tests, and various other geotechnical testing.

The Offshore Project Area is located along a portion of the Mid-North Atlantic continental shelf that incurs various concurrent processes that shape the overall geology of the region. These processes include glacio-eustatic sea level changes, drainage from the Chesapeake Bay creating variation in the sediments, and storm-related effects to sedimentation. The Offshore Project Area is situated within the Baltimore Canyon Trough, a basin structure orientated northeast-southwest formed by the extensional tectonics that occurred during the Triassic and Jurassic periods. During the Late Cretaceous and through the Cenozoic, sedimentation and erosional processes formed the basin. Sedimentation and erosion were dominantly controlled by changes in sea level. The Baltimore Canyon Trough consists of a wedge of sediments that thickens to the east and overlies the crystalline basement.

Water depths within the Offshore Project Area range from 9.5 to 95.1 ft (2.9 to 29 m) mean lower low water in the Offshore Export Cable Route Corridor and from 57 to 139 ft (18 to 42 m) mean lower low water in the Lease Area. The shallowest depths are located in the western part of the Lease Area, and the deepest depths to the east, as depicted in Figure 4.1-8. Within the Lease Area, the most prominent seabed features are the pronounced sand ridges, which create a ridge and swale topography. These sand ridges are assumed to be the result of storm-related sediment dynamics and hydrodynamic interactions with transgressive/regressive relict features (Swift et al. 1973, 1986; Trowbridge 1995). Within the Lease Area, the prominent SSW-NNE ridges and swales typically are spaced about 4,900 to 13,000 ft (1,500 to 4,000 m) apart and their crests stand 13 to 20 ft (4 to 6 m) above the swales that flank the ridges. Farther to the northeast, the heights of the ridges decrease, the topographic variation across the ridges reduces, the seafloor bathymetry deepens, and the water depths become slightly less variable.

Within the Lease Area, six distinguishable primary subsurface stratigraphic units and six associated horizons have been identified. These seismic units have been detailed in Table 4.1-2 and Table 4.1-3 below and further depicted in Figure 4.1-9. Five distinguishable primary subsurface stratigraphic have been identified in the Offshore Export Cable Route Corridor which are detailed in Figure 4.1-8 below.

Detailed mapping and discussion of the seabed and subsurface conditions can be found in Appendix C, Marine Site Investigation Report.

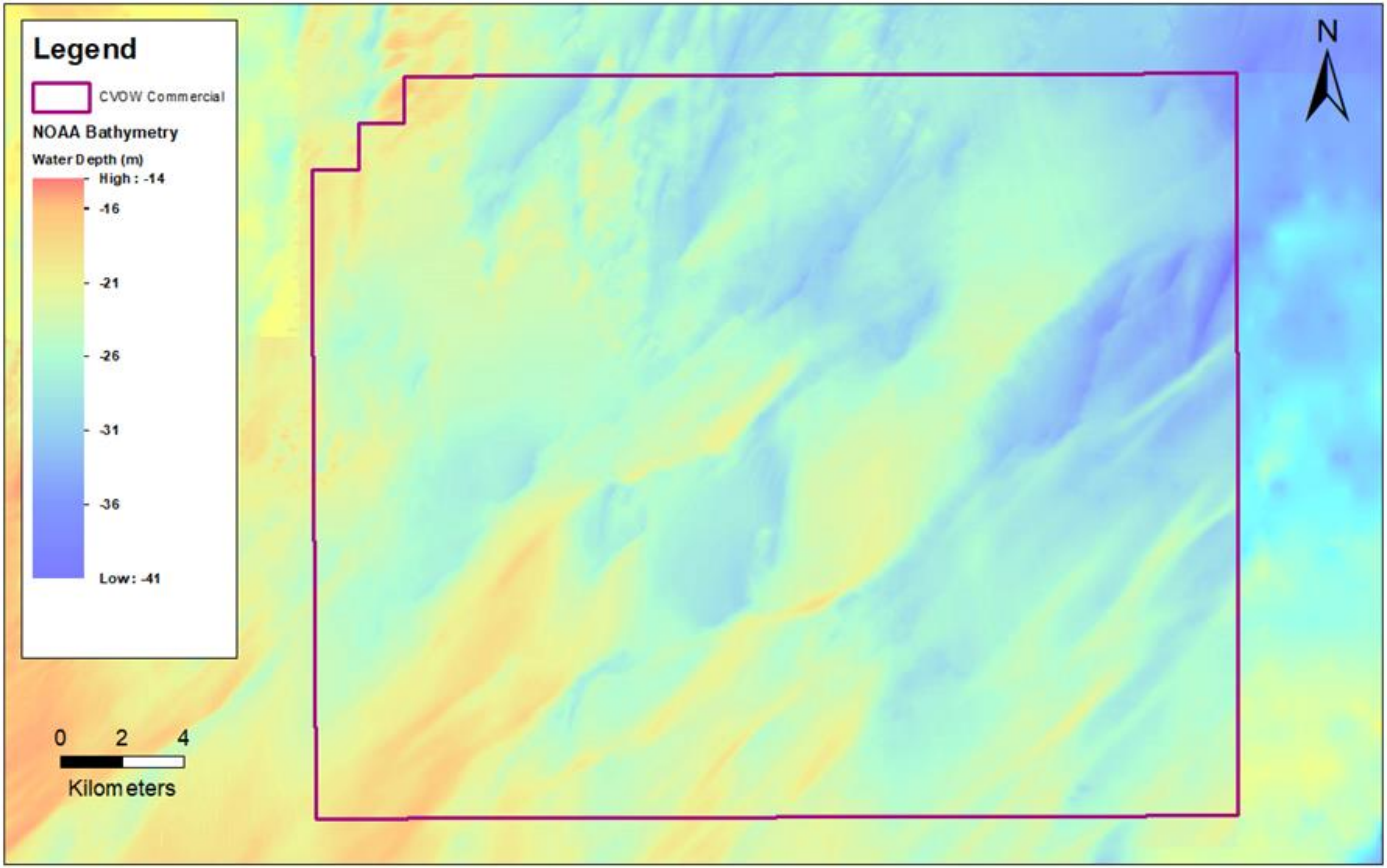


Figure 4.1-8. Lease Area Overlaid on NOAA Bathymetry with Elevations in Meters (Mean Sea Level)

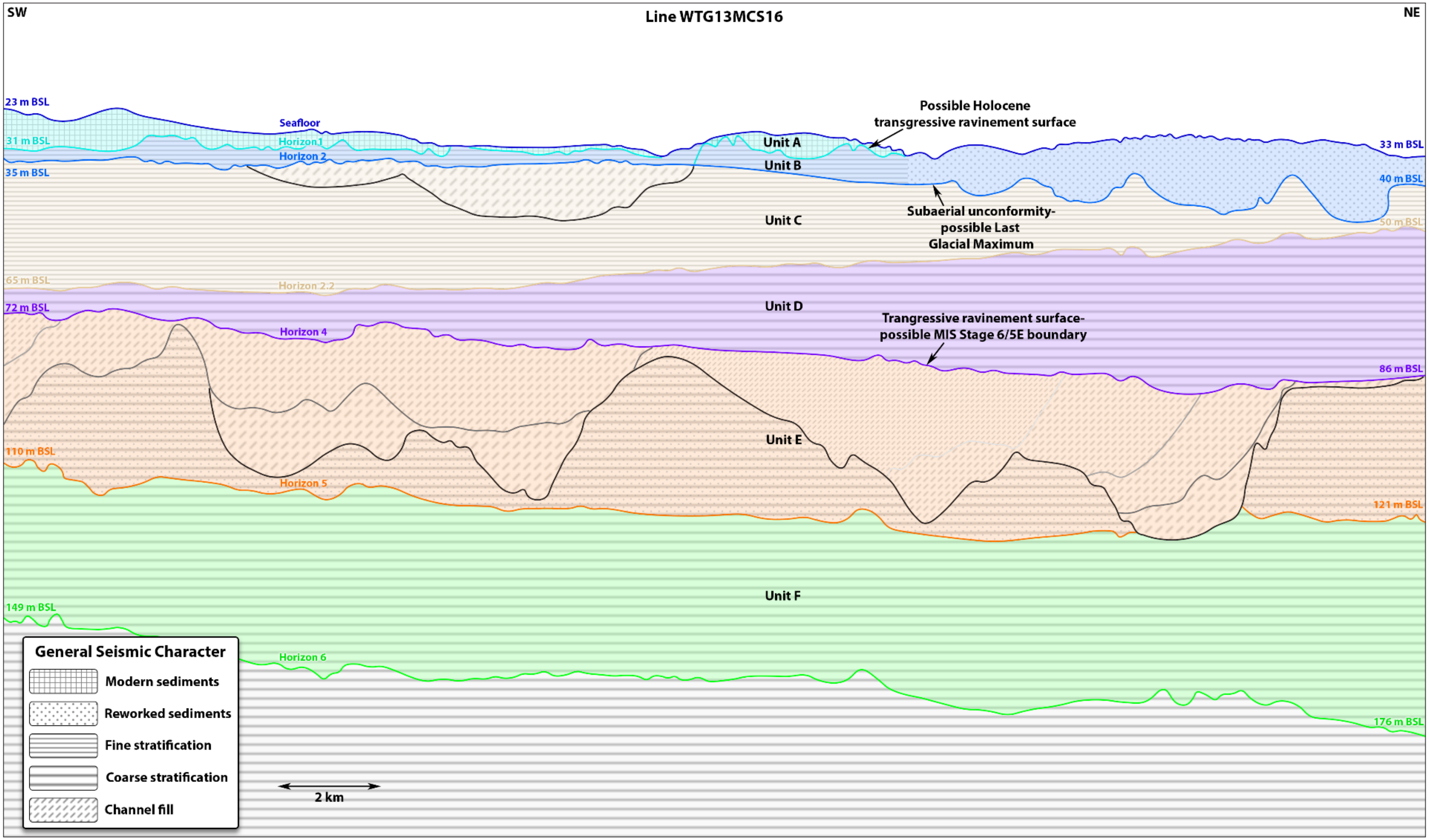


Figure 4.1-9. Schematic of stratigraphic framework along a representative survey line within the Lease Area

Table 4.1-2. Lease Area Units

Unit	Stratigraphy	Range of Unit Thickness
Seafloor		
Unit A	Upper Holocene	0-39 ft (0-12 m)
Separated by Horizon H1		
Unit B	Lower Holocene and presumably Upper Pleistocene	0-52 ft (0-16 m)
Separated by Horizon H2		
Unit C	Presumably Pleistocene	0-154 ft (0-47 m)
Separated by Horizon H2.2		
Unit D	Presumably Neogene	13-144 ft (4-44 m)
Separated by Horizon H4		
Unit E	Presumably Neogene	76-190 ft (23-58 m)
Separated by Horizon H5		
Unit F	Presumably Neogene	108-207 ft (33-63 m)
Separated by Horizon H6		

Table 4.1-3. Offshore Export Cable Route Corridor Units

Unit	Stratigraphy	Material Description	Range of Unit Thickness
Unit 1	Upper Holocene	Sand with silt to silty clay	0-39 ft (0-12 m)
Unit 2	Lower Holocene	Sand with silt to silty clay	0-52 ft (0-16 m)
Unit 3	Late Pleistocene transgressive deposit	Firm to stiff lean clay occasionally with sand	0-154 ft (0-47 m)
Unit 4	Pleistocene Paleochannel infill	Clayey sand, silty sand, and poorly graded sand	13-144 ft (4-44 m)
Unit 5	Pre-Quaternary marine deposits	Clayey sand	76-190 ft (23-58 m)

Onshore Geology

The Onshore Project Components are located within the younger easternmost portion of the terrestrial Coastal Plain geologic tectonic province of Virginia. The Coastal Plain of Virginia is characterized by a unique landscape of terraces made of topographic scarps having formed as ancient shorelines rose and fell over the last few million years (Virginia Division of Mineral Resources 1973). These terraces appear like stair steps eastward toward the Atlantic Ocean.

Underlying the Coastal Plain of Virginia is a sedimentary wedge that thickens with proximity to the eastern edge of the province (Virginia Division of Mineral Resources 1973). The sediments of this wedge are composed primarily of Jurassic and Cretaceous clay, sand, and gravel. All the primary sediments found in the sedimentary wedge formed through erosion of the Appalachian highlands. The most recent layer of sediments found on the wedge are fossiliferous marine sands of the Neogene and Paleogene periods (College of William and Mary 2020).

An onshore geotechnical survey campaign by Dominion Energy has been ongoing and is expected to be completed once the Onshore Project Components are finalized prior to construction. The purpose of the onshore geotechnical survey campaign was to confirm the conditions described in this section. Locations for the Onshore Project Components will factor in the existing geologic conditions and will avoid areas that will pose challenges to the installation and O&M of the Onshore Project Components, and geologic conditions will be considered during the development of Project installation methods and materials. Onshore soil data from the Natural Resources Conservation Service (NRCS) was used for a preliminary assessment of soils within the Onshore Project Area.

Natural Hazards

Natural and anthropogenic hazards in the Offshore Project Area have been identified through the geophysical and geotechnical survey campaigns. The following hazards have been identified as the most prominent in the Offshore Project Area:

- Seafloor boulders;
- Steep/unstable seafloor slopes;
- Bedforms, mobile sediments including seafloor sediment transport and scour;
- Soft soils;
- Buried boulders;
- Buried paleochannels
- Shallow gas; and
- Anthropogenic hazards.

A description of each is provided below. Additional details on these and other natural and anthropogenic hazards can be found in Appendix C, Marine Site Investigation Report.

Seafloor Boulders

Surface boulders may be obstructions for explorations, cable placements and foundations. Analysis of side scan sonar and multi-beam echosounder data have shown that only a relatively small number of boulders are interpreted to be present on the seafloor. A complete mapping of the seabed has identified a low number of boulders compared to the investigated area. Only 10 boulders and 110 seabed targets interpreted as possible boulders have sizes greater than 3 ft (1 m). No particular pattern was identified in the location of boulders across the Lease Area and Offshore Export Cable Route Corridor. Dominion Energy would avoid and/or relocate boulders that are too close to the installation of the Offshore Export Cable.

Steep/Unstable Seafloor Slopes

Steep slopes can be a limitation to the installation of foundations and to the use of certain burial tools for Offshore Export Cables. Furthermore, unstable slopes can result in local changes to the seabed caused by low impact forces. The majority of the Lease Area is relatively flat (very gentle to gentle slopes). Steeper slopes on the seabed are associated with the depositional side of sand ridges and sand waves. Local variations in the seafloor are primarily driven by mobile seafloor bedforms that lead to locally steeper seafloor gradients. Mitigation of the limited areas of steeper slopes is therefore fairly straight forward in positioning of the Offshore Project Components, and steeper slopes in the Lease Area are therefore in general not considered a hazard to turbine installation. Seabed slopes along the Offshore Export Cable Route Corridor are generally less than 1 degree corresponding to “very gentle” in the BOEM classification. The most significant slopes can be found on the flanks of morphological features and other topographic highs where the seabed gradient reaches up to 4 degrees corresponding to “gentle” in the BOEM classification. Isolated areas of increased slopes are associated with piles of dumped material within the Dam Neck Ocean Disposal Area. The Project would site Offshore Project Components to avoid areas of steep and/or unstable seabed where determined to prove a challenge to specific project features or installation methods during detailed design.

Bedforms, Mobile Sediments Including Seafloor Sediment Transport and Scour

The seafloor within the Offshore Project Area is a dynamic environment that changes over time due to currents, tidal flows, and waves conditions. Mobile seafloor sediments are important to consider, amongst others for scouring around WTG Monopile Foundations, Offshore Export Cables, and Inter-Array Cables. Presence of bedforms, mobile sediments, and the potential for scouring exist across the Offshore Project Area. These findings are documented in Appendix C, Marine Site Investigation Report. Dominion Energy would incorporate information on the location of mobile sediments and potential for scour into the design and installation of the Offshore Project Components.

Soft Soils

Soft soils reduce geotechnical parameters and may be a potential health, safety, or environmental risk to geotechnical explorations. Sediments with low strength will impact foundation design and the installation of offshore structures. Investigations using geotechnical and geophysical data have been carried out in a macro-siting analysis for the WTG positions in order to identify layers and areas with potential punch-through risk. The results show a potential punch-through risk is limited to only two specific soil units (H1-C1 and H2-C1; fine soils [i.e., clays]). Other more deeply buried clay layers result in increased shear strength, which is expected to limit risk of punch through; the risk of any punch through in these areas is low or no punch through is expected. Locations with high clay percentage are not considered an issue for foundation design. These findings are documented in Appendix C, Marine Site Investigation Report. The risk related to soft soils would be thoroughly considered when the jack-up vessel is deployed.

Buried Boulders

Large subsurface boulders are defined as a hazard for installation purposes. Boulders in the sub-surface can be risks to foundation installation as obstacles for the foundation, seabed penetrating jack-up vessel legs and may increase risk of cable damage during installation. Very few boulders have been interpreted on or below the seafloor and it has been concluded that the risk of buried boulders is low.

Buried Paleochannels

During sea-level changes, fluvial systems can be altered. Sea-level rise above an existing channel causes this channel to become filled with sediments. The infilling sediments are typically different from those of the surrounding area as they were deposited in a different depositional environment. This may result in local variations in the geotechnical properties. With the complete mapping of paleochannels in both the Lease Area and Offshore Export Cable Route Corridor using geophysical data and additional geotechnical (cone piezometer test) surveys targeting paleochannels, a comprehensive understanding of the paleochannel sediments have been obtained. The cone piezometer test-based geotechnical properties have shown that both stiffness and strength values are within normal ranges within paleochannel strata and therefore it is not considered a particularly weak layer, nor a hazard to cable or foundation installation.

Shallow Gas

The accumulation of shallow gas in sediments is a potential risk to project operations due to the following reasons:

- Gas in the porous sediments has a potential to weaken the mechanical properties; and,
- Potential leakage of the gas can result in subsidence of the sediments and in rare occasions the gas can be over pressured and will lead to dangerous situations if released.

Shallow gas has been identified in the Lease Area and the presence of shallow gas has been thoroughly investigated and evaluated. The gas is seen on the seismic data as phase reversal and seismic blanking. The accumulations of shallow gas are very strongly correlated to the presence of buried paleochannels. The combination of mapped shallow gas and a strong correlation with the presence of buried channels has led to a good understanding of the location of shallow gas in the Offshore Project Area. Additional geotechnical investigations were targeted in areas of potential shallow gas, but no large deviations in geotechnical properties were detected in relation to the effect of the potential presence of shallow gas. These results are documented in Appendix C, Marine Site Investigation Report. While the mapping and properties of potential shallow gas indicates this is not a significant risk to the Project, Dominion Energy has moved or eliminated some WTGs locations near potential shallow gas from consideration for the Project.

Anthropogenic Hazards

Anthropogenic hazards identified within the Offshore Project Area include shipwrecks and artificial reefs, debris, pipelines and cables, and munitions and explosives of concern (MEC).

Shipwrecks and Artificial Reefs

Sixteen wrecks/potential wrecks have been identified in the Offshore Project Area, most of which are found in the Triangle Reef/Fish Haven in the north-western corner of the Lease Area. One wreck and one potential wreck have been mapped within the Offshore Export Cable Route Corridor. Based on this assessment and based on the extensive geophysical data coverage of the full Offshore Project Area additional wrecks are generally not expected to be present in the Lease Area or along the Offshore Export Cable Route Corridor. The Project would implement an avoidance buffer around all wrecks, to the extent possible. Shipwrecks of cultural significance would be avoided in accordance with recommendations from the Project’s Qualified Marine Archaeologist (QMA) and are discussed in detail in Appendix F, Marine Archaeological Resources Assessment.

Debris

Debris can be an obstruction or impediment to offshore installation works. Debris is present at numerous locations in the Offshore Project Area. In most instances specific identification of the origin or the debris has not been possible, but human debris on the seafloor can be related to fishing activities. In some cases the fishing gear may be connected on the seafloor resulting in elongated linear debris on the seabed. The Project would avoid identified debris during Project installation, to the extent possible. In the event that avoidance is not feasible, individual targets may be inspected by a remotely operated vehicle (ROV) to determine if the object poses a risk to operations and if it may be removed from the seabed.

Pipelines and Cables

Existing infrastructure such as cables and pipelines represent a risk and are an obstruction to installation works. Four existing cables are present in the vicinity of the Offshore Export Cable Route Corridor, and three of them cross the Offshore Export Cable Route Corridor (Table 4.1-4). Between KP0-19.5, the Offshore Export Cable Route Corridor runs parallel to the Dominion Energy CVOW Pilot Project export cable, which is located approximately 750 m north of the centerline of the Offshore Export Cable Route Corridor survey corridor. At about KP19.5, the CVOW Pilot Project export cable deviates to the north away from the Offshore Export Cable Route Corridor. All of the installed cables (BRUSA, MAREA and DUNANT) that cross the Offshore Export Cable Route Corridor are buried but were readily identified in the marine magnetic survey data. The as-found locations correlate well with known cable positions. Dominion Energy will engage with asset owners in order to complete crossing agreements which will detail the conditions and methodology for each cable crossing.

Table 4.1-4. Cables Crossings along the Offshore Export Cable Corridor

Cable	Crossing Location (KP)
CVOW Pilot Project Export Cable	N/A
BRUSA	32.3
MAREA	33.5
DUNANT	34.5

Munitions and Explosives of Concern

Munitions and Explosives of Concern (MEC) is a hazard to the installation of the Offshore Project Components. In 2020, Ordtek developed a MEC risk assessment and risk mitigation strategy in relation to the Project. The desktop assessment concluded that MEC presents a potential risk to placement of Offshore Project Components due to several recorded training areas intersecting the Offshore Project Area, and the legacy of historical warfare activities along the U.S. East Coast.

Based on the recommendations of the desktop assessment, and in coordination with BOEM and the U.S. Army Corps of Engineers, a MEC survey campaign and data associated analysis began in mid-2022 and will continue through 2023. Data acquisition consists of five areas covering the Offshore Export Cable Route Corridor and the Lease Area, with a planned completion in the second quarter of 2023. Potential targets identified will be further interpreted and analyzed for risk as potential MEC. The potential MEC items will be documented in a series of As Low As Reasonably Practicable (ALARP) Certificates. These potential MEC items will then be subject to further investigation through additional offshore campaigns if they are not otherwise avoidable through cable routing. If these investigations determine MEC is present, MEC mitigation featuring relocation will be considered by the Project, subject to agency approval.

Disposal Sites

From about KP5.3 to KP8.5, the Offshore Export Cable Route Corridor crosses the Dam Neck Ocean Disposal Site (DNODS), an active offshore dredge material disposal area, co-managed by the U.S. Environmental Protection Agency (EPA) and U.S. Army Corps of Engineers (USACE). This area has been actively used since 1967. The DNODS receives approximately 0.92 million cubic meters of dredged material every two years in support of federal navigation channel maintenance, including the nearby Atlantic Ocean Channel. The Offshore Export Cable Route Corridor has been reduced in width while crossing the DNODS in order to minimize the portion of the DNODS impacted by the Project. While seabed processes are likely to disperse dumped sediment through time, the accumulation of deposited dredge material overlying the buried cables could result in thermal and ampacity changes. This would be considered during the detailed design of the Offshore Project Components and installation works.

4.1.1.2 Impacts Analysis for Construction, Operations and Maintenance, and Decommissioning

The potential impacts resulting from the construction, O&M, and decommissioning of the Project are based on the maximum design scenario from the PDE (see Section 3, Description of Proposed Activity). In general, long-term impacts are due to the installation of new infrastructure.

Construction

During construction, the potential impact-producing factors to physical and oceanographic conditions may include installation of Inter-Array Cables, Interconnection Cables, WTG Monopile Foundations, and Offshore Substation Jacket Foundations within the Lease Area, installation of Offshore Export Cables in the Offshore Export Cable Route Corridor, and installation of Onshore Project Components. Dominion Energy proposes to implement measures, as appropriate, to avoid, minimize, and mitigate impacts during Project construction. The following impacts may occur as a consequence of the factors identified above:

- Disturbance to seabed;
- Disturbance to objects along the seabed; and
- Disturbance to onshore geology.

Disturbance to seabed. During installation of the Offshore Export Cables, Inter-Array Cables, and the WTG Monopile and Offshore Substation Jacket Foundations, the seabed and sub-seabed would be disturbed. Dominion Energy would identify the most appropriate locations, based on geologic conditions, for installation that would require the least disturbance to the seabed. By opting for locations that avoid the most challenging geology, Dominion Energy would be able to utilize the least invasive tools for Project installation to the extent practicable.

Disturbance to objects along seabed. Objects along the seabed that could be disturbed during installation of the Offshore Project Components include wrecks, existing cables and pipelines, MEC, and debris. These objects on or under the seabed, especially those with a cultural or historical significance or identified as a significant potential hazard, will be identified during geophysical and geotechnical survey campaigns. Appropriate avoidance buffers would be implemented to avoid contact with objects on the seabed to the extent practicable. Objects that cannot be avoided would be further investigated and an appropriate mitigation measure would be implemented. For cable crossings, this would include optimization of the crossing geometry as well as engineering of the crossing and associated Cable Protection. For potential MEC, this would include investigation of contacts and micrositing if possible and through further action and mitigation if necessary.

Disturbance to onshore geology. Installation of Onshore Project Components may impact the existing onshore geology. Dominion Energy would minimize disturbance to onshore geology during the installation of Onshore Project Components by optimizing routes along previously disturbed onshore locations to the extent practicable.

In addition, Dominion Energy has considered the potential for extreme weather events to impact the construction stage of the Project. Dominion Energy would consider weather forecasts at all times during the construction stage and would halt operations if extreme weather events are likely to impact construction activities.

Operations and Maintenance

Because the equipment associated with the Offshore Project Area is exposed to the elements, there is potential for physical and oceanographic conditions to impact the O&M of the Project. All Project infrastructure would be designed to withstand normal and reasonably foreseeable extreme weather conditions during the operational lifetime of the Project. The design of all offshore infrastructure would take into consideration the design code guidance provided in International Electrotechnical Commission 614003-1, which accounts for the potential occurrence of tropical weather events. In addition to consideration of weather conditions, Project design would also account for the potential of scour around the Inter-Array Cables, Offshore Export Cables, Cable Protection Systems, and WTG Monopile and Offshore Jacket Substation Foundations. Scour protection would be utilized to minimize scour effects from ocean currents. Localized wake is known to occur as a result of the presence of foundations in the ocean; however, the localized wake is not expected to have any large-scale impacts on wake and current patterns in the region.

Onshore Project infrastructure design would also consider extreme weather events, and design would adhere to the 2015 International Building Code, American Society of Civil Engineers (ASCE) Standard 7-10, ASCE 113, ASCE 24-14, any relevant Institute of Electrical and Electronics Engineers standards, and relevant Virginia building codes.

During O&M, the potential impact-producing factors to physical and oceanographic conditions may include repairs on the Offshore Export Cables and Inter-Array Cables and maintenance and repairs to WTGs and the Offshore Substation. Dominion Energy proposes to implement measures, as appropriate, to avoid, minimize, and mitigate impacts during Project O&M. The following impacts may occur as a consequence of factors identified above:

- Disturbance to seabed; and
- Disturbance to objects along the seabed.

Disturbance to seabed. During operation of the Offshore Project Components, the seabed has the potential to be disturbed. Operations would occur at locations of previously disturbed seabed to minimize the potential for disturbing new seabed whenever possible.

Disturbance to objects along seabed. Objects along the seabed that could be disturbed during operation of the Offshore Project Components include shipwrecks, existing cables and pipelines, MEC, and debris. Whenever possible, O&M would occur at locations of previously disturbed seabed to minimize the potential for disturbing new objects along the seabed whenever possible. In addition, the Project would conduct routine geophysical surveys to monitor the status of the installed cable on the seabed as discussed in Section 3, Description of Proposed Activity.

Decommissioning

Impacts resulting from decommissioning of the Project are expected to be similar or less than those experienced during construction. Decommissioning techniques are further expected to advance during the lifetime of the Project. A full decommissioning plan will be provided to the appropriate regulatory agencies for approval prior to decommissioning activities.

4.1.1.3 Summary of Avoidance, Minimization, and Mitigation Measures

Dominion Energy proposes to implement the following measures to avoid, minimize, and mitigate the potential impact-producing factors described (Table 4.1-5). Dominion Energy will continue discussion and engagement with the appropriate regulatory agencies and other organizations throughout the life of the Project to develop an adaptive mitigation approach that provides the most flexible and protective mitigation measures.

Table 4.1-5. Summary of Avoidance, Minimization, and Mitigation Measures

Project Stage	Location	Impact	Avoidance, Minimization, and Mitigation
Construction; Decommissioning	Offshore Project Area	Disturbance to seabed Disturbance to objects along the seabed Disturbance to onshore geology	• Dominion Energy would identify the most appropriate locations, based on geologic conditions, for installation that would require the least disturbance to the seabed. By opting for locations that avoid the most challenging geology, Dominion Energy would be able to utilize the least-invasive tools for Project installation to the extent practicable; • Dominion Energy would implement appropriate avoidance buffers to avoid contact with any objects on the seabed, to the extent practicable. Objects that cannot be avoided would be further investigated and an appropriate mitigation would be implemented. For cable crossings, this would include optimization of the crossing geometry as well as engineering of the crossing and associated protection. For potential unexploded ordnance, this would include investigation of contacts and micrositing if possible and further action and mitigation if necessary; and • Dominion Energy would minimize disturbance to onshore geology during the installation of Onshore Project Components by optimizing routes along previously disturbed onshore locations to the extent practicable. • Dominion Energy would consider weather forecasts at all times during the construction stage, and would halt operations in the event that extreme weather events are likely to occur. • Dominion Energy would avoid and/or relocate boulders that are too close to the installation of the Offshore Export Cable.

Project Stage	Location	Impact	Avoidance, Minimization, and Mitigation
			• The Project would site Offshore Project Components to avoid areas of steep and/or unstable seabed where determined to prove a challenge to specific Project features or installation methods during detailed design. • Dominion Energy would incorporate information on the location of mobile sediments and potential for scour into the design and installation of the Offshore Project Components. • The risk related to soft soils would be thoroughly considered when the jack-up vessel is deployed. • Dominion Energy has moved or eliminated some WTGs locations near potential shallow gas from consideration for the Project. • The Project would implement an avoidance buffer around all wrecks, to the extent possible. Shipwrecks of cultural significance would be avoided in accordance to recommendations from the Project's QMA and are discussed in detail in Appendix F, Marine Archaeological Resources Assessment. • The Project would avoid identified debris during Project installation, to the extent possible. In the event that avoidance is not feasible, individual targets may be inspected by a ROV to determine if the object poses a risk to operations and if it may be removed from the seabed. • Dominion Energy will engage with asset owners in order to complete crossing agreements which will detail the conditions and methodology for each cable crossing. • If MEC investigation and identification surveys determine MEC is present, and MEC cannot be avoided through micrositing, MEC mitigation featuring relocation will be considered by the Project, subject to agency approval. • The Offshore Export Cable Route Corridor has been reduced in width while crossing the DNODS in order to minimize the portion of the DNODS impacted by the Project. While seabed processes are likely to disperse dumped sediment through time, the accumulation of deposited dredge material overlying the buried cables could result in thermal and ampacity changes. This would be considered during the detailed design of the Offshore Project Components and installation works.
Operations and Maintenance	Offshore Project Area	Disturbance to seabed	• Operations would occur at locations of previously disturbed seabed to minimize the potential for disturbing new seabed whenever possible; and
		Disturbance to objects on the seabed	• Whenever possible, operations and maintenance would occur at locations of previously disturbed seabed to minimize the potential for disturbing new objects along the seabed whenever possible. In addition, the Project would conduct routine geophysical surveys to monitor the status of the installed cable on the seabed as discussed in Section 3, Description of Proposed Activity.

4.1.2 Water Quality

This section includes information on water quality within the Onshore Project Area, Nearshore Trenchless Installation Area, and the Offshore Project Area (collectively referred to as the Project Area); discusses impact-producing factors associated with the Project relative to water quality; and identifies means to protect water quality during Project construction, O&M, and decommissioning. Waters in the Offshore Project Area and Nearshore Trenchless Installation Area include marine water resources, while waters of the Onshore Project Area include groundwater and surface water resources.

This section draws on other assessments relevant to water quality, including but not limited to the sections and appendices below:

- Physical and Oceanographic Conditions (Section 4.1.1);
- Wetlands and Waterbodies (Section 4.2.1);
- Benthic Resources, and Fishes, Invertebrates, and Essential Fish Habitat (Section 4.2.4);
- Benthic Resources Characterization Report (Appendix D);
- Sediment Transport Analysis (Appendix J);
- Oil Spill Response Plan (Appendix Q); and
- Compiled USACE Preliminary Jurisdictional Determination Package (Appendix U).

Water quality in the Project Area is managed at the federal, state, and municipal levels. The CWA (33 U.S.C. §§ 1251, *et seq*.) regulates water quality, specifically discharges of pollutants into the waters of the United States including excavation and discharge of material, throughout the Project Area. Under Section 401 of the CWA, applicants for a federal license or permit must obtain certification from the regulating agency in the state in which the discharge would originate to ensure the projects would not violate the state's water quality standards or stream designated uses.

An assessment of impacts on water quality from turbidity and total suspended solids from construction activities is also a specific requirement of the BOEM's review of this COP (30 CFR § 585.627[a][2]). To satisfy the requirements of 30 CFR § 585.627(a)(2), a Sediment Transport Analysis (Appendix J) for the Project was conducted. As part of the Project, Dominion Energy would apply for a General Virginia Pollutant Discharge Elimination System (VPDES) Permit for Discharges of Stormwater from Construction Activities for onshore construction activities. The VPDES Construction General Permit authorizes operators of construction activities to discharge stormwater to surface waters (VDEQ 2019).

Publicly available resources describing the quality of the marine, groundwater, and surface water resources in the Project Area were consulted and assessed. Sources include the EPA National Coastal Condition Report IV (EPA 2012); NOAA Fisheries, NOAA CoastWatch, National Aquatic Resource Surveys, U.S. Geological Survey (USGS), and National Water Quality Monitoring Council reports; Mid-Atlantic Regional Ocean Assessment (MAROA 2020); Virginia Department of Health (VDH), VDEQ, City of Chesapeake, and City of Virginia Beach assessments; Battlefield Golf Club feasibility study (URS Corporation 2009); and peer-reviewed literature. Additional resources from prior Dominion Energy studies and the Navy studies within and adjacent to the Offshore Project Area were also incorporated, where applicable. Information relative to the existing water quality conditions of the Project Area is characterized below.

4.1.2.1 Affected Environment

Water quality generally refers to the physical, chemical, and biological attributes of water. For the purposes of this section, water quality specifically refers to the ability of waters in the Project Area to maintain their ecosystems. Factors, such as pollutant loading from both natural and anthropogenic sources, can contribute to changes in water quality, which can be detrimental to marine and freshwater ecosystems. Natural pollutants, such as high nutrient loadings from marshes, can be delivered into water systems via freshwater drainage, transport of offsite marine waters, and influx of sediment. Anthropogenic pollutant sources often include those from direct discharges, runoff from urban land uses, disposal, seabed activities, and spills. Water resources in the Project Area include coastal and ocean, groundwater, and surface water resources. The general state of water quality for each of these resources is discussed below.

Coastal and Ocean Water Quality

The Offshore Project Area is located within the Atlantic Ocean (nearshore and offshore waters) and Virginia State Coastal Waters. The Offshore Project Components are located in the area of the Atlantic Ocean referred to as the Mid-Atlantic Bight. The Offshore Export Cable Route Corridor crosses Virginia State Coastal Waters to make landfall at Virginia Beach, Virginia.

Mid-Atlantic Bight

Section 4.1.1.2 of the MAROA references the National Coastal Condition Report III (EPA 2008), which rated the water quality along the mid-Atlantic coastal and harbor areas. In 2012, the EPA released the National Coastal Condition Report IV, which assessed dissolved inorganic nitrogen (DIN), dissolved inorganic phosphorous (DIP), chlorophyll *a*, water clarity, and dissolved oxygen (DO) for the Northeast Coastal Region ocean waters (EPA 2012). For coastal waters, the EPA used measured values and determined thresholds to develop water quality index ratings as “good,” “fair,” or “poor” for various components. However, the EPA did not develop specific water quality index ratings for the Mid-Atlantic Bight ocean waters as a whole because index rating thresholds for ocean waters did not exist for DIN, DIP, chlorophyll *a*, total suspended solids (TSS), and DO (EPA 2012).

For the Mid-Atlantic Bight, the EPA reported average DIN concentrations in ocean surface waters of 0.04 milligram per liter (mg/L), and near-bottom DIN concentrations averaged 0.13 mg/L. Average DIP concentrations were reported as 0.04 mg/L. Chlorophyll *a* surface concentrations averaged 0.23 microgram per liter (µg/L), and near-bottom concentrations averaged 0.30 µg/L. Ocean water clarity was assessed using measurements of TSS concentrations. TSS averaged 5.6 mg/L, and near-bottom concentrations averaged 6.9 mg/L. DO surface concentrations averaged 8.9 mg/L, and near-bottom concentrations averaged 9.1 mg/L.

Water temperatures were taken at the sea surface, although water temperatures typically remain the same or decrease with depth. Sea surface temperatures ranged from 32 to 88°F (0 to 31°C). The depth-averaged annual water temperature is 56.39°F (13.55°C) (NOAA, n.d.). Section 4.1.1, Physical and Oceanographic Conditions, provides additional information on water temperatures.

A persistent cross-shelf salinity gradient exists in the Mid-Atlantic Bight because of freshwater runoff from the Hudson-Raritan Estuary System, Delaware Bay, and Chesapeake Bay (Castelao et al. 2010). Following periods of high runoff, a strong vertical salinity gradient has been observed across much of the 62 mi (100 km)-wide shelf (Wilkin and Hunter 2013). Stratification starts in early June and often lasts until October (Stevenson et al. 2004). NOAA Fisheries reports mean surface salinity in 2019 as 32.6 PSU and mean bottom salinity as 33.2 PSU (2020). Seasonal variations in salinity are smaller than variations in temperature (Castelao et al. 2010). At the shelf edge, strong horizontal gradients in salinity occur separating the shelf water from the warmer saltier sea water (Csanady and Hamilton 1988).

Most data collected in the Offshore Project Area in recent years consists of satellite imagery, although some research agencies have collected infrequent water quality grab sample data. The NOAA CoastWatch uses satellite imagery to predict primary production (radiation, chlorophyll *a* surface concentration, and sea surface temperature), turbidity, and sediment concentrations in the Offshore Project Area (NOAA 2018a, 2018b).

NOAA's Northeast Fisheries Science Center (NEFSC) maintains a database of conductivity, temperature, and depth (CTD) records taken at depth intervals of 3.3 ft (1 m), collected during various NEFSC cruises within the Offshore Project Area. This data was summarized by season within the Lease Area between 2003 and 2016 in Guida et al. (2017), with a median salinity of 32.1 PSU (ranging from 29.8 to 33.9 PSU). Water temperatures during this period exhibited approximately 36°F (20 °C) seasonal range swings at the surface and 27°F (15°C) seasonal range swings at the bottom, with thermal stratification between April and August during most years (Guida et al. 2017).

Virginia State Coastal Waters

Virginia State Coastal Waters include coastal estuaries, intertidal zones, and coastal ocean waters. The EPA National Coastal Condition Report IV rated the coastal waters of the Northeast Coastal Region as "fair" for water quality (EPA 2012). The Northeast Coastal Region includes the Virginia State Coastal Waters and extends northward up to the coast of Maine. Site water quality indices are rated as "fair" for data points near the Cable Landing Location (EPA 2012). Water quality ratings were based on measurements of DIN, DIP, chlorophyll *a*, water clarity, and DO.

An assessment of the National Aquatic Resource Surveys 2010 water quality data for 23 stations along Virginia coastal estuaries show that DIN concentrations averaged 0.05 mg/L, DIP concentrations averaged 0.02 mg/L, chlorophyll *a* concentrations averaged 13.4 µg/L, and DO concentrations averaged 5.6 mg/L (EPA 2016). Light transmissivity was measured to assess water clarity and reported as percent of incident light transmitted through 3.3 ft (1 m) of water. Light transmissivity ranged from 60.6 percent to 3.52 percent at a depth of 3.3 ft (1 m), with an average of 32 percent (EPA 2016). The EPA National Coastal Condition Report IV rated Virginia coastal estuaries as "good" for DIN and DO concentrations and "fair" for DIP and chlorophyll *a*. Light transmissivity has the largest variability across stations, ranging from "poor" to "good" (EPA 2016).

From 2016 to 2017, the Navy performed water quality sampling in the nearshore and offshore areas of the Naval Air Station Oceana Dam Neck Annex (NASO-DNA) in Virginia Beach, Virginia. The sampling area overlaps a portion of the Nearshore Trenchless Installation Area; therefore, water quality measurements collected during the survey are relevant to the Project. Figure 4.1-10 shows the Nearshore Trenchless

Installation Area in relation to the NASO-DNA nearshore, offshore range 1, and offshore range 2 sampling areas. Table 4.1-6 summarizes the seasonal water chemistry measurements for Kjeldahl nitrogen, nitrate-nitrite, total phosphorous, and TSS. Virginia has not set numeric nitrogen, phosphorous, or TSS standards for estuaries or open ocean (Virginia Administrative Code, Criteria for Surface Water 9VAC25-260).

Table 4.1-6. Seasonal Water Chemistry Data for Samples Collected for the Naval Air Station Oceana Dam Neck Annex

NASO-DNA Sampling Area	Season	Kjeldahl Nitrogen (milligrams per liter [mg/L])	Nitrate-Nitrite Nitrogen (mg/L)	Total Phosphorous (mg/L)	Total Suspended Solids (mg/L)
Nearshore (Nearshore Trenchless Installation Area)	Spring 2016	0.51	0.10	1.07	0.05
	Summer 2016	0.50	0.00	1.68	0.11
	Fall 2016	0.50	0.00	0.69	0.03
	Winter 2017	0.50	0.00	1.43	0.03
Offshore Range 1 (Nearshore Trenchless Installation Area)	Spring 2016	0.51	0.10	1.03	0.03
	Summer 2016	0.50	0.00	0.62	0.04
	Fall 2016	0.50	0.00	0.92	0.08
	Winter 2017	0.50	0.00	1.45	0.03
Offshore Range 2 (Nearshore Trenchless Installation Area)	Spring 2016	0.50	0.00	1.70	0.06
	Summer 2016	0.50	0.00	0.80	0.04
	Fall 2016	0.50	0.00	0.96	0.03
	Winter 2017	0.50	0.00	1.53	0.08

Note: Sample depth was 3.3 ft (1 m) below the surface.
Source: Navy 2017

Table 4.1-7 summarizes the reported seasonal in-situ water quality data from spring 2016 to winter 2017 for NASO-DNA. In-situ water quality parameters measured in the study were found to be significantly influenced by season and/or location. DO, pH, and temperature are within acceptable levels compared to Commonwealth of Virginia standards (Virginia Administrative Code, Criteria for Surface Water 9VAC25-260). The Commonwealth of Virginia has not set numeric DO percent saturation, specific conductance, salinity, or turbidity standards for estuaries or open ocean (Virginia Administrative Code, Criteria for Surface Water 9VAC25-260).

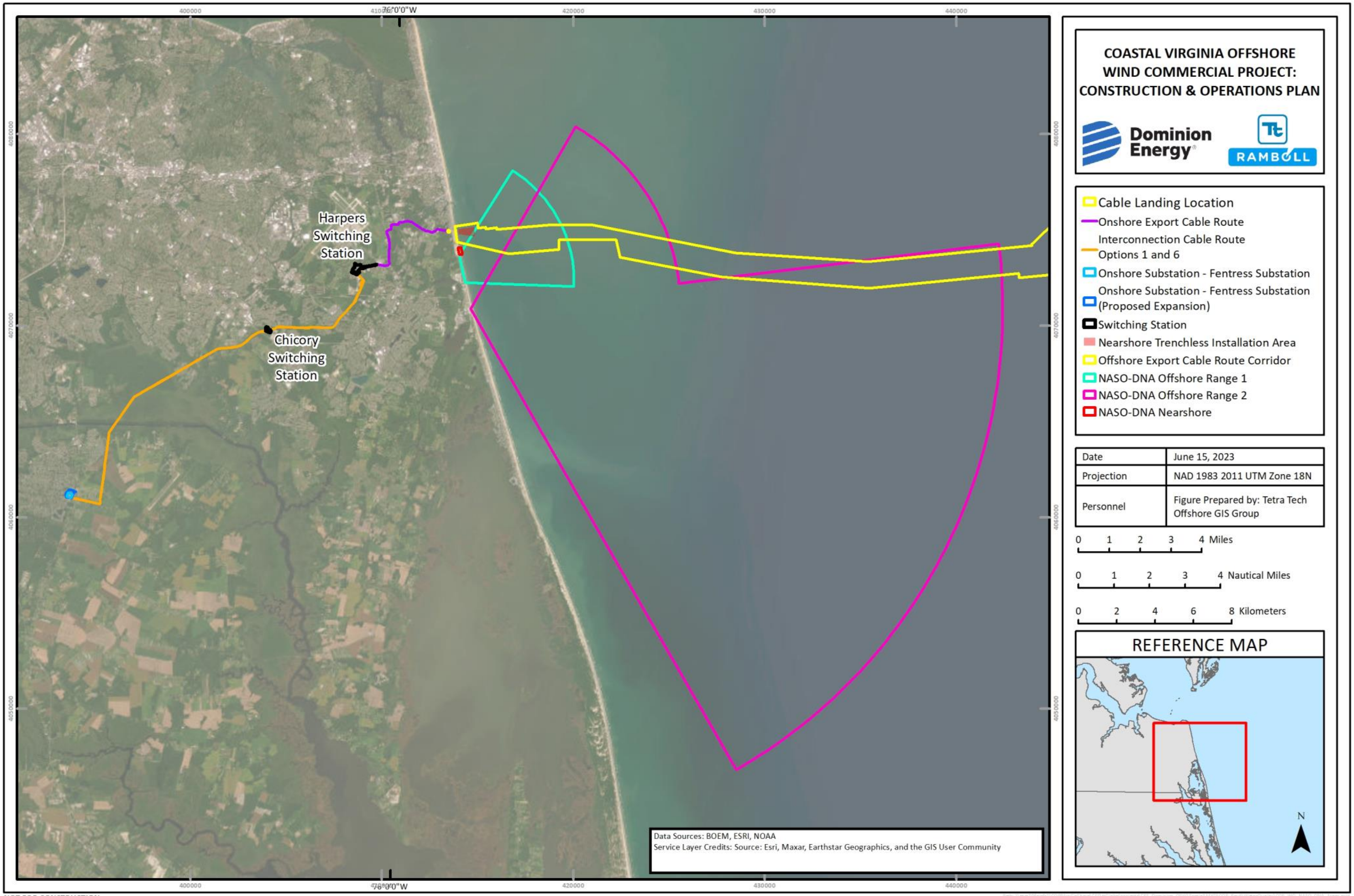


Figure 4.1-10. **Nearshore Trenchless Installation Area and Offshore Export Cable Route Corridor in Relation to the Study Area for the Naval Air Station Oceana Dam Neck Annex**

Table 4.1-7. Summary of Seasonal In Situ Water Quality Data for NASO-DNA (2016–2017) and the Offshore Project Area (2020) During the Past 5 Years

Area	Season	n	Temperature (ºC)			Dissolved oxygen (mg/L)			Dissolved oxygen percent saturated (%)			pH			Specific conductance (mS/cm)			Salinity (ppt)			Turbidity (NTU)		
			Mean	Min	Max	Mean	Min	Max	Mean	Min	Max	Mean	Min	Max	Mean	Min	Max	Mean	Min	Max	Mean	Min	Max
NASO-DNA Nearshore (Nearshore Trenchless Installation Area)	Spring 2016	22	20.6	18.3	22.8	7.4	6.6	8.2	98.5	83.5	109.9	7.9	7.8	8.0	45.0	38.5	51.6	29.1	24.5	34.0	3.6	1.0	9.6
	Summer 2016	30	24.8	21.4	27.5	6.7	5.7	7.4	96.3	79.5	105.0	8.0	7.3	8.6	44.8	41.4	48.2	29.0	26.4	31.4	5.4	0.7	15.8
	Fall 2016	30	16.7	14.5	20.5	8.4	6.3	9.3	101.3	82.4	118.6	8.1	7.9	8.2	43.1	37.4	46.4	27.8	23.8	30.2	24.8	4.9	77.3
	Winter 2017	28	6.3	5.8	6.7	10.1	9.6	11.0	100.4	97.2	106.0	8.1	8.0	8.1	48.5	43.3	51.1	31.2	27.5	33.1	10.5	2.9	26.9
NASO-DNA Offshore Range 1 (Nearshore Trenchless Installation Area)	Spring 2016	16	19.9	15.7	23.2	7.5	5.8	10.1	98.5	75.7	137.5	7.9	7.7	8.0	45.9	39.1	55.1	29.9	24.9	36.6	2.5	1.2	6.5
	Summer 2016	16	22.2	17.5	27.2	7.1	6.6	7.6	97.5	89.8	104.5	8.4	8.2	8.6	47.2	41.6	52.0	30.7	26.5	34.2	1.0	0.3	3.2
	Fall 2016	16	17.6	14.8	20.1	8.2	6.8	9.1	100.5	89.0	110.1	8.1	7.9	8.2	43.1	36.8	47.4	27.8	23.4	30.9	18.9	3.8	78.3
	Winter 2017	16	6.4	5.9	6.9	10.2	9.5	11.0	101.5	97.0	105.9	8.1	8.0	8.1	47.4	44.0	51.4	30.5	28.0	33.3	5.4	2.5	22.6
NASO-DNA Offshore Range 2 (Nearshore Trenchless Installation Area)	Spring 2016	16	18.2	14.6	22.5	7.7	6.9	8.1	98.0	84.7	106.8	7.9	7.7	7.9	47.2	40.8	52.4	30.7	26.1	34.5	1.2	0.3	2.5
	Summer 2016	16	21.2	14.3	27.4	7.5	6.8	8.0	101.1	92.5	108.4	8.5	7.7	8.7	48.5	42.4	52.7	31.7	27.3	34.7	0.8	0.0	6.1
	Fall 2016	16	17.9	14.3	21.0	8.1	6.6	9.3	101.9	88.1	120.0	8.1	8.0	8.2	46.4	39.4	49.4	30.2	25.2	32.4	9.7	1.3	39.7
	Winter 2017	16	7.1	6.1	8.0	9.8	8.7	10.8	99.6	90.8	105.7	8.1	8.1	8.2	49.7	45.4	52.8	32.1	29.0	34.4	3.4	1.0	15.9
Offshore Project Area (Lease Area & Offshore Export Cable Route Corridor)	Summer 2020	76	15.2	12.6	19.2	8.1	6.7	8.7	86.9	99.1	101.8	8.0	7.8	8.0	48.8	49.5	50.1	32.4	31.9	32.8	0.0	0.0	13.7

Notes: °C = degree Celsius; % = percent; mg/L = milligrams per liter; mS/cm = milli Siemens per centimeter; NTU = nephelometric turbidity unit; ppt = part(s) per thousand; NASO-DNA = Naval Air Station Oceana, Dam Neck Annex

Surface and bottom measurements were used to calculate mean and range.

To convert degrees Celsius to degrees Fahrenheit, multiple by 9/5 and add 32.

Sources: Navy 2017; Tetra Tech 2020

VDH conducts routine *Enterococcus* bacteria water quality sampling at the SMR monitoring station (Station 21VABCH-VA514504), which is also near the Cable Landing Location (VDH 2020a). Monitoring results are available beginning in 2003 through 2020 through the National Water Quality Monitoring Council (NWQMC 2020a). For transition and saltwater waterbodies, state water quality standards state that *Enterococci* bacteria shall not exceed a geometric mean of 35 counts/100 milliliter (mL) and shall not have greater than a 1-percent excursion frequency of a statistical threshold value of 130 counts/100 mL, both in an assessment period of up to 90 days (VDEQ 2020a). Samples at Station 21VABCH-VA514504 did not exceed state water quality standards in 2019 (VDH 2020a).

The VDH Algal Bloom Surveillance Map is updated regularly from May through October to map algal blooms in the Commonwealth (VDH 2020b). An algal bloom was reported on August 4, 2020 at the 1st Street Jetty, which is approximately 1.0 mile (1.6 km) from the Cable Landing Location. VDH determined the algae to be *Margalefidinium polykrikoides* with a concentration 6,990 cells/mL. *Margalefidinium polykrikoides* produces compounds that are toxic to finfish, shellfish, and planktonic organisms; however, it is not known to be harmful to humans. Other algal blooms were reported north of the project and primarily in the coastal waters during August and September 2020.

Marine Sediment Quality

Mid-Atlantic Bight

The EPA used measurements of sediment contaminants and total organic carbon (TOC) to assess ocean sediment conditions in the Mid-Atlantic Bight. High TOC concentrations can indicate adverse conditions because some chemical pollutants tend to bind to organic matter (EPA 2012). Increasing proportions of fine-grain sediments, such as silts and clays, are often associated with high TOC concentration in ocean waters. Index rating cutpoints were not available for ocean sediment conditions; therefore, no index rating was reported. Grain-size data from grab samples collected as part of the 2020 benthic survey indicate that sediments in the Offshore Project Area are dominated by fine- to medium-grain sands, with a low average organic content of 0.31 percent, ranging from 0.08 to 1.2 percent (Tetra Tech 2020). The EPA reported sediment in the Mid-Atlantic Bight as relatively uncontaminated, and ocean sediments had very low TOC concentrations (2012).

Virginia State Coastal Waters

The EPA rated sediment quality for the Northeast Coastal Region as “fair” (2012). Data at sites north of the Cable Landing Location and near the Chesapeake Bay shows a sediment quality index of “fair.” Data at sites south of the Offshore Project Area shows a sediment quality index of “good.” Contaminated sediment index is rated “fair” north of the Project Area and “good” at sites south of the Offshore Project Area.

Onshore Groundwater Quality

The Onshore Project Components are underlain by the Northern Atlantic Coastal Plain aquifer system (USGS 2020a). The Northern Atlantic Coastal Plain aquifer system is a large aquifer that extends from New Jersey through North Carolina and contains multiple aquifer and confining units (USGS 2020a). The surficial aquifer is the uppermost aquifer in the system and is made up of many small-scale aquifers. In Virginia, the surficial aquifer is used for domestic and agricultural water supplies (USGS 2020a). The surficial aquifer is susceptible to contamination from anthropogenic sources because of its proximity to the surface. The water quality of the surficial aquifer is variable (USGS 2020a). The surficial aquifer is used for small-scale irrigation (lawn watering) because water quality limitations such as high iron content and low pH (causing corrosion), and low well yield potential (Siudyla et al. 1981).

The regional Chesapeake aquifer lies below the surficial aquifer; the aquifers are separated by a confining layer in most locations. Water supply yield from the Chesapeake aquifer is greatest in the parts of the aquifer near the coast, and most withdrawals are for public water supply, domestic uses, commercial uses, and agricultural uses. The aquifers below the Chesapeake aquifer include the Castle Hayne-Aquia aquifer, Peedee-upper Cape Fear aquifer, and the Potomac aquifer.

Several USGS groundwater monitoring wells are located around the Onshore Export Cable Route, Switching Station, Interconnection Cable Route, and Onshore Substation. Table 4.1-8 provides details about the eight USGS monitoring well sites closest to the Onshore Project Area (Figure 4.1-11). Data collected for the period from September 24, 2019, to September 24, 2020, shows that wells in the surficial aquifer had water depths ranging from 3 ft to 9.5 ft (0.9 m to 2.9 m) from the surface. USGS Well Site Name 62C 12 SOW 172D is screened in the confining unit. Wells in the Chesapeake aquifer measured water depths ranging from 3 ft to 15 ft (0.9 m to 4.6 m) for this same period. Water quality samples were analyzed in 2019 at USGS 62C 10 SOW 172B, 62C 11 SOW 172C, and 62C 12 SOW 172D.

Table 4.1-8. U.S. Geologic Survey Groundwater Monitoring Sites in the Vicinity of the Project

Site Name	Well depth, feet	Longitude	Latitude	Start Daily Depth Measurements	Water Depth from Surface feet a/	Aquifer
62C 5 SOW 093	65	-76.04993190	36.749066540	2004-02-12	3–6	Surficial (Quaternary System)
61C 44 SOW 210B	107	-76.12862069	36.766204600	2001-04-12	3–10	Chesapeake (Upper Chesapeake Group)
61C 43 SOW 210A	197.5	-76.12868740	36.766185180	2001-04-12	4–9	Chesapeake (Upper Chesapeake Group)
62C 2 SOW 092A	102	-76.05153760	36.787385380	2005-03-11	9–15	Chesapeake (Upper Chesapeake Group)
62C 3 SOW 092B	58	-76.05153760	36.787377040	2005-03-11	6–9.5	Surficial (Quaternary System)
62C 10 SOW 172B	280	-76.01155000	36.796161100	2008-08-16	9–13.5	Chesapeake (Upper Chesapeake Group)
62C 11 SOW 172C	35	-76.01160830	36.796316670	2005-06-16	5.5–8	Surficial (Quaternary System)
62C 12 SOW 172D	75	-76.01197500	36.796452780	2005-06-16	4–7	Confining Unit (Pliocene Series)

a/ Data downloaded for 9/25/2019 to 9/24/2020 (USGS 2020b).

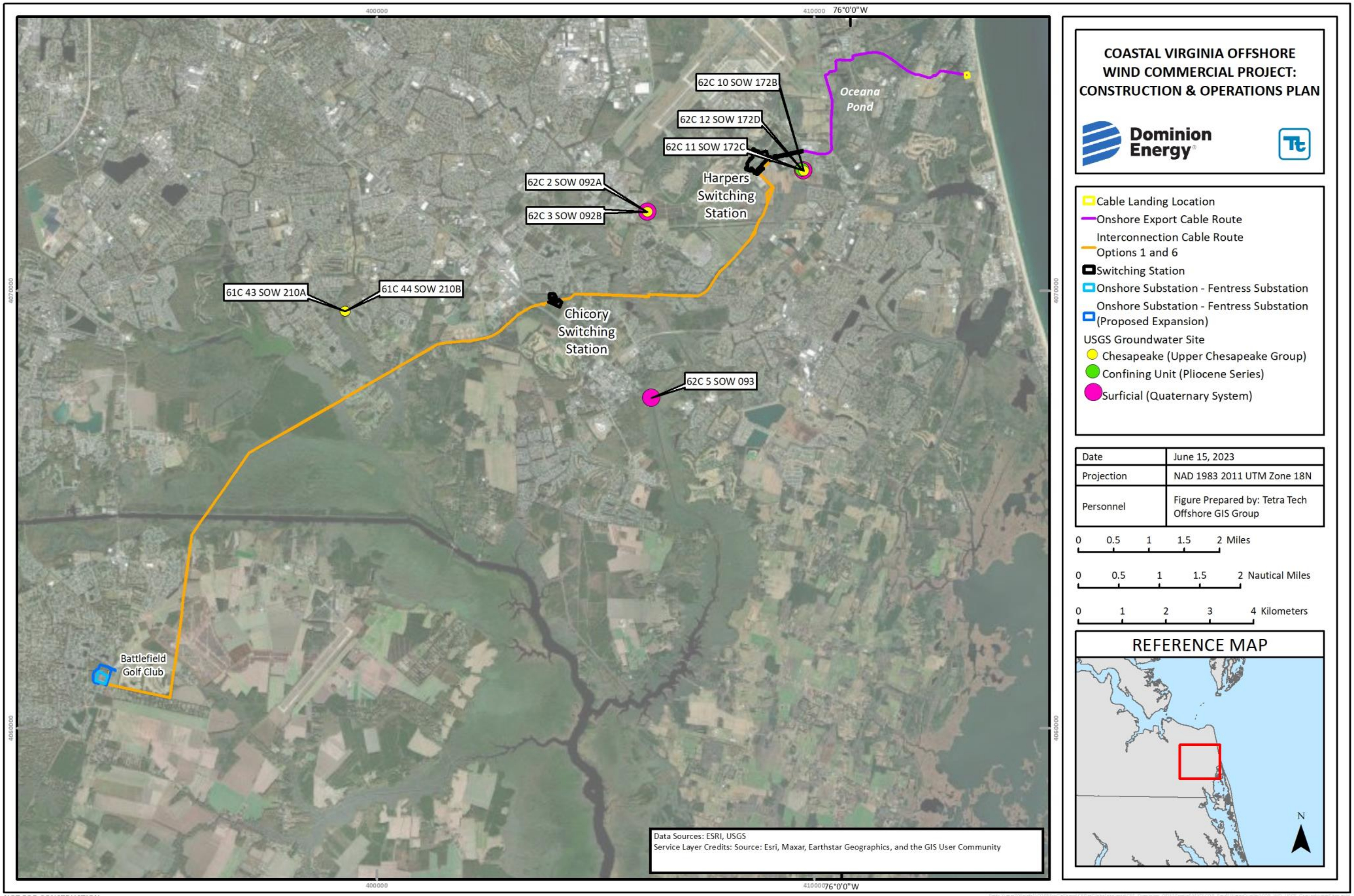


Figure 4.1-11. U.S. Geological Survey Monitoring Well Sites Closest to the Project

Groundwater quality in the area of the Onshore Substation has been studied extensively during environmental assessments related to the construction of the Battlefield Golf Club, which is located to the east of the Onshore Substation across the Centerville Turnpike. Groundwater, surface water, and soil samples from 2001 to 2009 were collected at or near the Battlefield Golf Club (Tetra Tech 2010). In 2001, Stokes Environmental Associates, Ltd. collected 40 groundwater samples during a baseline surface water quality survey investigation (Tetra Tech 2010; URS Corporation 2009). Arsenic, beryllium, cadmium, chromium, copper, lead, manganese, mercury, thallium, and zinc were detected in some of the groundwater samples. Two wells produced samples with copper levels above EPA's MCL or action level, and one well had thallium levels above the MCL (Tetra Tech 2010; URS Corporation 2009). All other inorganic substances were below EPA's MCL.

In 2008, Tetra Tech and EPA collected groundwater samples from 55 residential wells in the vicinity of the Battlefield Golf Club (Tetra Tech 2010). Locations of the residential wells were not included in the redacted report. The samples were analyzed for dissolved and total target analyte list metals, boron, and molybdenum. Four of the sampled wells measured lead above the EPA MCL (Tetra Tech 2010). All other compounds analyzed were below EPA's MCL.

Onshore Surface Water Quality

The assessment of surface water quality is primarily focused on the water resources that could potentially be affected by activities at the Onshore Export Cable Route, Switching Station, Interconnection Cable Route, and Onshore Substation. Section 2, Project Siting and Design Development, and Section 3, Description of Proposed Activity, provide further details on these Project Components.

The Onshore Export Cable Route is located within three USGS Hydrologic Unit Code 10 watersheds (Figure 4.1-12). Stormwater runoff from the northern portion of the Onshore Export Cable Route discharges to the Atlantic Ocean via Owl's Creek into Rudee Inlet. Oceana Pond was monitored as part of a one-time (June 2014) assessment for the following parameters: DO (7.78 mg/L), temperature (79.3°F [26.3°C]), pH (7.78), and specific conductance (0.172 mS/cm^2) (Tetra Tech 2015a). The Virginia Aquarium maintains a water quality monitoring station within the estuarine portion of Owl's Creek, with data from 1998 to 2010 for the following parameters (annual mean): DO (7.64 mg/L), temperature (63.1°F [17.3°C]), pH (7.68), salinity (24 PSU), and fecal coliform (37 counts/100 mL) (Virginia Aquarium [unpublished data], cited in Tetra Tech 2015a). DO, temperature, and pH are within acceptable levels (Virginia Administrative Code 9VAC25-260). Fecal coliform exceeds the State standards for geometric mean for shellfish waters (Virginia Administrative Code 9VAC25-260). Owl Creek is listed on the Draft 2020 303D List of Impaired Waters for dissolved oxygen impairment, fecal coliform impairment and *Enterococcus* impairment (VDEQ 2020b). Total maximum daily load (TMDL) studies have not been completed.

Stormwater runoff from the southern portion of the Onshore Export Cable Route discharges to Ashville Bridge Creek into the Currituck Sound. Ashville Bridge Creek is listed on the 2020 303D List of Impaired Waters for pH impairment, DO impairment, and *Enterococcus* impairment (VDEQ 2020b). TMDL studies have been completed for both DO impairment and *Enterococcus* impairment.

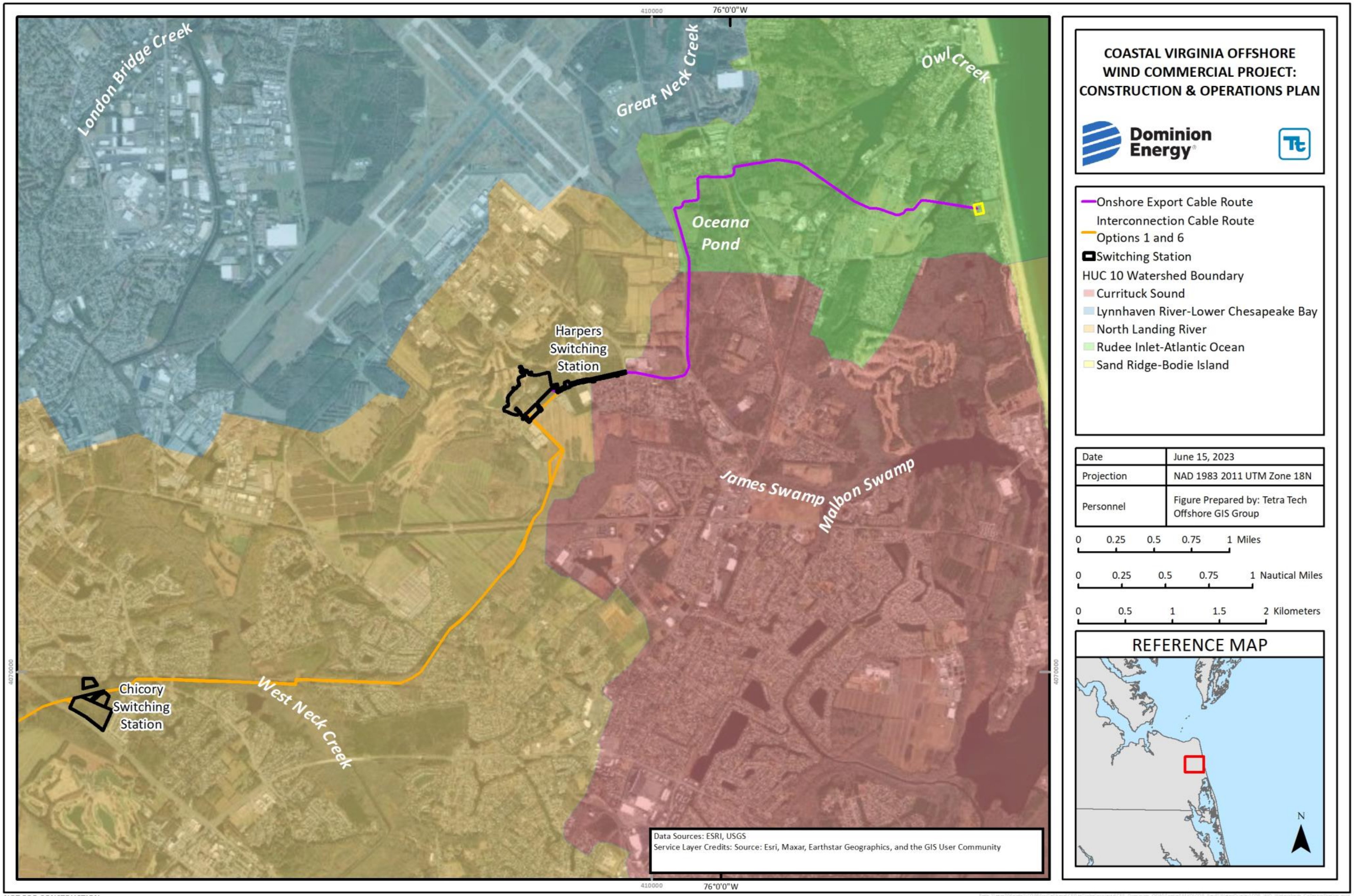


Figure 4.1-12. Onshore Export Cable Route, Cable Landing Location, and Switching Station within the Rudee Inlet—Atlantic Ocean and Currituck Sound U.S. Geologic Survey Hydrologic Unit Code 10 Watersheds

Interconnection Cable Route Options (1 and 6) cross over the Chesapeake-Albemarle Canal (Intracoastal Waterway) (Figure 4.1-13). The Switching Station and Interconnection Cable Route Options 1 and 6 are located in the North Landing River watershed. While the Implementation Plan for Bacterial TMDLs in the North Landing River Watershed is in place, water quality in the North Landing River has either remained the same or declined since publication of that Implementation Plan (City of Virginia Beach 2018). VDEQ has not completed a TMDL study for the pH impairment. The 2020 Annual Water Quality Monitoring Plan includes one Ashville Bridge Creek monitoring station located at latitude 36.7269 and longitude -75.9861 (VDEQ 2020c). The Ashville Bridge Creek station (VDEQ Station 5BASH002.20) is an ambient long-term trend monitoring station site for permanent monitoring to detect short-, medium- and long-term water quality trends. Samples at this station are collected six times per year and include measurements of nutrients, bacteria, and suspended solids.

The Onshore Substation parcel and a portion of the Interconnection Cable Route is within the Pocaty River subwatershed of the North Landing River (City of Chesapeake 2007), with the majority of the Interconnection Cable Route occurring within the North Landing River watershed (Figure 4.1-13). The Pocaty River is listed on the 2020 303D List of Impaired Waters for DO impairment, *Escherichia coli* (E. coli) impairment, and for benthic macroinvertebrates bioassessments impairment (VDEQ 2020b). TMDL studies have been completed for both DO impairment and E. coli impairment. VDEQ has not completed a TMDL study for the benthic macroinvertebrates bioassessments impairment.

Table 4.1-9 lists the Pocaty River monitoring stations in the 2020 Monitoring Plan and parameters that are measured. Station VA-1289 is an ambient freshwater probabilistic monitoring station and samples are conducted randomly. The location of Station VA-1289 is less than 0.5 mi (0.8 km) southeast of the Onshore Substation. Data for Station VA-1289 was not readily available. Station 5BPCT001.79 is an ambient long-term trend monitoring station site for permanent monitoring to detect short-, medium- and long-term water quality trends. The monitoring station is located at the Blackwater Road Bridge. Data are available from 1972 to 2020 at Station 5BPCT001.79. Averages from data collected in 2019 and 2020 are listed in Table 4.1-10.

Table 4.1-9. Virginia Department of Environmental Quality Pocaty River Monitoring Stations Listed in the 2020 Monitoring Plan

Latitude	Longitude	Program	Station ID	Parameters Measured in 2020
36.68754138	-76.18329027	Ambient Freshwater Probabilistic	VA-1289	Nutrients, bacteria, suspended solids, metals, sediment, ions, benthic, habitat, bed stability
36.67333333	-76.10000000	Ambient Long-Term Trend Program	5BPCT001.79—Blackwater Road Bridge	Nutrients, bacteria, suspended solids

Source: VDEQ 2020c

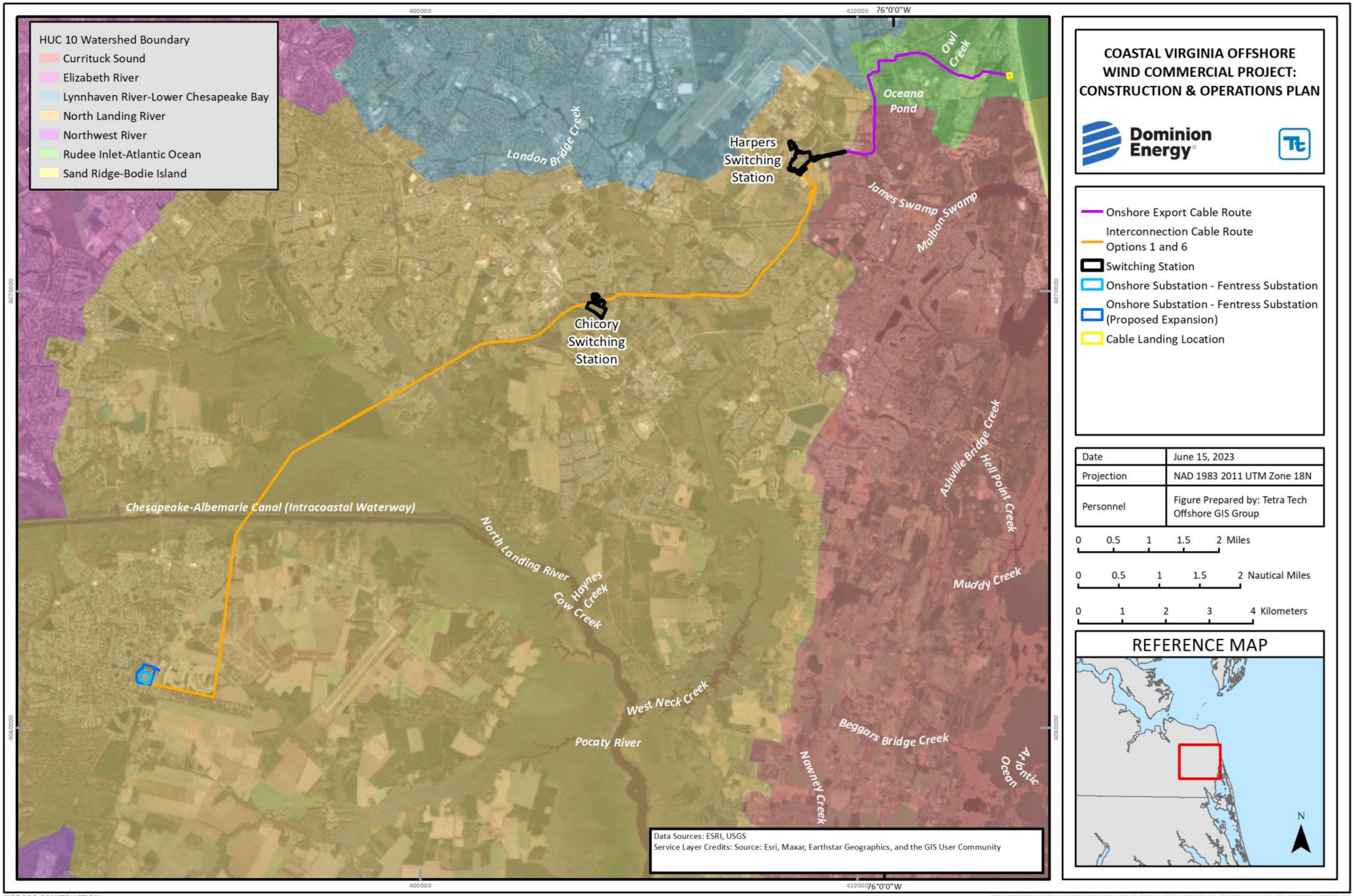


Figure 4.1-13. Onshore Substation Parcel and Interconnection Cable Route within the North Landing River Watershed

Table 4.1-10. Average Water Quality Parameters at Pocaty River Station 5BPCT001.79—Blackwater Road Bridge (2019–2020)

Parameter	Number of Measurements	Average of 2019 and 2020 Measurements
Enterococcus	11	468.18 cfu/100mL
Escherichia coli	21	925.10 MPN/100mL
Fecal Coliform	11	477.27 cfu/100mL
Kjeldahl nitrogen	11	1.52 mg/L
Nitrogen	9	1.73 mg/L
pH	18	6.57
Phosphorus	11	0.38 mg/L
Salinity	20	0.40 ppt
Specific conductance	20	804.95 uS/cm
Temperature, water	20	20.36 °C
Total solids	9	279.56 mg/L
Total suspended solids	9	15.78 mg/L
Turbidity	9	20.54 NTU

Notes: cfu = °C = degree Celsius; mg/L = milligrams per liter; mL = milliliter; MPN = most probable number; NTU = nephelometric turbidity unit; ppt = parts per thousand; uS/cm =micro-Siemens per centimeter

Source: NWQMC 2020b

Of the parameters in Table 4.110, the Commonwealth of Virginia has developed numeric water quality criteria for pH, temperature, and *E.coli* in freshwater streams. pH and temperature are within acceptable levels (Virginia Administrative Code 9VAC25-260). *E. coli* exceeds the Commonwealth's standards for geometric mean to protect recreation (Virginia Administrative Code 9VAC25-260).

Additional surface water quality data was collected in 2014 and 2015 within the upper portion of the Pocaty River watershed that overlaps the Naval Auxiliary Landing Field Fentress for the following average parameters: DO (7.57 mg/L), temperature (72.1°F [22.3°C]), pH (7.60), and specific conductance (0.406 mS/cm^2) (Tetra Tech 2015b). DO, temperature, and pH are within acceptable levels (Virginia Administrative Code 9VAC25-260).

4.1.2.2 Impacts Analysis for Construction, Operations and Maintenance, and Decommissioning

The potential impacts during the construction, O&M, and decommissioning of the Project, as they relate to water quality in the Project Area, are based on the maximum design scenario from the Project Design Envelope (PDE) (see Section 3, Description of Proposed Activity). The maximum design scenario represents the greatest amount of disturbance to the water column, surface water, and groundwater through the installation of Offshore and Onshore Project Components.

For offshore water quality, the maximum design scenario is represented by monopile foundations with maximum scour protection, as this scenario represents the greatest area of seafloor impacted during construction. In addition, the maximum design scenario includes the maximum length of Offshore Export Cable and Inter-Array Cable, installed via jet trencher and/or other available technologies, the installation method which would result in the maximum amount of seabed sediment disturbance and potential turbidity. A trenchless installation strategy would be used for cable installation from the Nearshore Trenchless Installation Area to the Cable Landing Location.

For onshore water quality, the maximum design scenario is represented by the greatest area of land disturbed during construction of the Onshore Export Cable Route, Switching Station, Interconnection Cable Route, and upgrades/expansions to the Onshore Substation. This scenario represents the greatest potential for stormwater runoff from disturbed areas to be transported to streams, lakes, or wetlands with potential for turbidity and sedimentation impacts.

Construction

During construction, the potential impact-producing factors to water quality include the installation of Offshore and Onshore Project Components, and stormwater management within onshore construction areas. Dominion Energy proposes to implement measures, as appropriate, to avoid, minimize, and mitigate impacts during Project construction. The following impacts may occur as a consequence of the factors identified above:

- Short-term disturbance of seabed sediment due to installation of the WTG Monopile Foundations and Offshore Substation Jacket Foundations, Inter-Array Cables, Offshore Export Cables, and site preparation for installation of scour protection;
- Short-term increase in erosion and runoff due to land disturbance;
- Short-term impacts due to dewatering trenches and excavations;
- Short-term potential for inadvertent release of drilling fluids during nearshore trenchless installation;
- Short-term potential for accidental releases from onshore construction vehicles or equipment; and
- Short-term impacts due to accidental spills and/or releases offshore.

Short-term disturbance of seabed sediment due to installation of the WTG Monopile Foundations and Offshore Substation Jacket Foundations, Inter-Array Cables, Offshore Export Cables, and site preparation for installation of scour protection. Suspension of sediments in the water column may occur as a result of installation of the WTG Monopile Foundations and Offshore Substation Jacket Foundations, Inter-Array Cables, Offshore Export Cables, and site preparation for scour protection installation. To evaluate the impacts of Offshore Export Cable and Inter-Array Cable installation, a conservative analytical sediment transport model was developed to evaluate the potential suspended sediment transport and deposition (see Appendix J, Sediment Transport Analysis).

The analytical sediment transport model determined that the suspended sediment concentration, deposition depth, and area of influence is dependent upon flood and ebb current velocities, burial depth, and the percentage of fine sediments in the sediment sample. The model also determined that the very fine sediments particles (silt and clay) remain in suspension for about 4 hours after being mobilized in the water column. Coarser particles (fine sand) settle at a faster rate, about 1 minute after being mobilized. During peak flood and ebb tides, the suspended sediment concentrations diminish rapidly away from the release point, and at most stations over 85 percent of the suspended particles deposit within 16 ft (5 m) of the trench centerline. The typical concentration at 328 ft (100 m) is about 2,400 mg/L above background concentration for flood tides and about 290 mg/L above background concentration for ebb tides. Deposition thicknesses were predicted to decrease rapidly away from the trench. Average deposition thicknesses were less than 0.4 in (1 cm) within 82 ft (25 m) of the trench centerline for flood tides and less than 0.4 in (1 cm) within 82 ft

(25 m) of the trench centerline for ebb tides. Deposition thicknesses were less than 0.004 in (0.01 cm) at all stations within 8,202 ft (2,500 m) of the trench centerline.

Construction activities associated with installation of WTG Monopile Foundations and Offshore Substation Jacket Foundations, including site preparation and the installation of scour protection, may increase water column suspended sediment concentrations in proximity to a foundation.

Short-term increase in erosion and runoff due to land disturbance. Clearing, excavation, soil stockpile, and grading associated with construction of the Onshore Substation, Interconnection Cable Route, Switching Station, Onshore Export Cable, and supporting infrastructure could temporarily impact the water quality and quantity of the stormwater runoff from the work areas. Clearing and grading for construction of the Onshore Substation and Switching Station would expose soil to wind and rain erosion until the site is fully stabilized after construction is complete. If picked up by stormwater flow, sediment may be transported to downstream surface waters. Dominion Energy would develop a SWPPP for construction activities that would conform with the VDEQ Construction General Permit, Dominion Energy’s approved Annual Standards and Specifications for Erosion and Sediment Control (ESC) and Stormwater Management (SWM) for Electric Transmission Line Development, and local pollution prevention and spill response procedures. Dominion Energy would restrict access through wetlands and waterbodies to identified construction sites, access roads, and work zones. Dominion Energy would restrict access to only existing paved roads and approved access roads at wetland and stream crossings where possible.

Short-term impacts due to dewatering trenches and excavations. Disturbance of soils during construction of the Onshore Export Cables, Interconnection Cable Route, Switching Station, and the Onshore Substation could temporarily impact the water quality of surface or groundwater resources. There is also the potential to encounter contaminated groundwater during excavation near the Battlefield Golf Club. Final engineering design would determine if groundwater would need to be managed during construction activities, requiring digging of pits or trenches for the Onshore Project Components. Dominion Energy would avoid or minimize excavation dewatering in the location of the Battlefield Golf Club. Dominion Energy would develop a SWPPP for construction activities that would conform with the VDEQ Construction General Permit and Dominion Energy’s approved Annual Standards and Specifications for ESC and SWM for Electric Transmission Line Development. The SWPPP would include steps Dominion Energy must take to comply with the permit, including water quality requirements, and discuss the potential to encounter contaminated groundwater during excavation near the Battlefield Golf Club. The SWPPP would discuss how to protect surface water and groundwater quality if contaminated groundwater is encountered.

Short-term potential for inadvertent release of drilling fluids during Nearshore Trenchless Installation. The Nearshore Trenchless Installation process involves pumping a drilling fluid, usually water mixed with bentonite, into the borehole to maintain borehole stability, remove cuttings, and cool the drilling tools. The bentonite mixture is mainly inert, non-toxic clays, and rock particles consisting predominantly of clay with quartz, feldspars, and accessory material such as calcite and gypsum. An inadvertent return/release can occur if the drilling fluids migrate unpredictably to the land or seabed surface through fractures, fissures, or other conduits in the underlying rock or unconsolidated sediments. An inadvertent return/release could potentially increase turbidity in marine, groundwater, and/or surface water. Should an inadvertent return/release occur, it would likely result in short-term and localized impacts on water quality in the shallow marine environment associated with underground portions of the Interconnection Cable, the Onshore Export Cables that cross wetlands or streams, and the Cable Landing Location. Dominion Energy would implement an Inadvertent Release Plan to be reviewed and approved by the appropriate regulatory agencies as needed.

Short-term potential for accidental releases from onshore construction vehicles or equipment. Construction vehicles and equipment may be accessing regulated areas during construction activities and would be refueled and potentially serviced within the Project Area. Dominion Energy would conduct onshore refueling and/or maintenance of construction equipment and vehicles outside resource areas to the extent practicable.

Short-term impacts due to accidental spills and/or releases offshore. During construction, water quality could be impacted through the introduction of pollutants, including oil and fuel spills and releases; for example, from grout used to seal the monopile to the transition piece. Project-related construction vessels also have the potential to release oil and fuels. Dominion Energy would manage accidental spills or releases of oils or other hazardous wastes through the Oil Spill Response Plan (Appendix Q). Project-related vessels would be subject to USCG wastewater and discharge regulations and would operate in compliance with oil spill prevention and response plans that meet USCG requirements. Specifically, all Project vessels would comply with USCG standards in U.S. territorial waters to legally discharge uncontaminated ballast and bilge water as well as standards regarding ballast water management. While outside the 3.0 nm (5.6 km) state-border/no-discharge zone (NDZ), vessels would deploy a USCG-certified marine sanitation device (MSD) with certifications displayed. While inside the 3.0 nm (5.6 km) state-border/NDZ, vessels would take normal vessel procedures to close off MSD-effluence discharge piping and redirect it to onboard "Zero-Discharge Tanks" for appropriate disposal either at dock or outside of an NDZ. Additionally, all vessels less than 79 ft (24 m) would comply with the Small Vessel General Permit issued by EPA on September 10, 2014, for compliance with National Pollutant Discharge Elimination System (NPDES) permitting. Prevention and response measures for accidental spills and releases are further described in Appendix Q, Oil Spill Response Plan.

Operations and Maintenance

During O&M, the potential impact-producing factors to water quality in the Offshore Project Area may include the presence of vessels. It is not anticipated that onshore-related activities in association with O&M would result in new impacts to water quality. Any ongoing concern regarding accidental releases would be continually evaluated via the agency-approved spill prevention, control, and countermeasures (SPCC) plan. Any activities that require a land disturbance, such as inspection via excavation, would follow similar proposed mitigation and avoidance practices as described above for construction. Dominion Energy proposes to implement measures, as appropriate, to avoid, minimize, and mitigate impacts during Project O&M. The following impacts may occur as a consequence of the factors identified above:

- Long-term effects due to WTG Monopile Foundations and Offshore Substation Jacket Foundations and associated scour protection;
- Short-term change in water quality due to oil spills or accidental release of fluids from vessels required during operations; and

- Long-term effects due to stormwater runoff.

Long-term effects due to WTG Monopile Foundations and Offshore Substation Jacket Foundations and associated scour protection. During operations, scour around WTG Monopile Foundations, Offshore Substation Jacket Foundations, and cable protection may potentially impact water quality through the formation of suspended sediment plumes. The relatively low current velocities in the Offshore Project Area, combined with scour mitigation, would limit scour potential around the WTG Monopile Foundations and Offshore Substation Jacket Foundations. Furthermore, scour is not expected to occur around the Offshore Export Cable and Inter-Array Cables where the cable burial target depth is achieved. However, cable protection would be used in areas where the Offshore Export Cables would cross existing cables. One study observed scour around the concrete cable protection mats placed on unburied cable where the cable connects to the WTG (BOEM 2018). The scour was observed at two of the five WTGs. Dominion Energy would use scour protection as necessary around the WTG Monopile Foundations and Offshore Substation Jacket Foundations and cable protection mats to minimize effects of local sediment transport.

Scour around foundations is dependent on water currents, wave action, and water depths, and scour depth can range from 0.3 to 2.0 times the pile diameter, or greater. Water currents are typically the largest indicator of the amount of expected scour (Tempel et al. 2004). In general, studies have shown the maximum scour depth around most piles is 1.3 times the diameter of the pile (DNV GL 2016; Whitehouse et al. 2011). The WTG Monopile Foundations and Offshore Substation Jacket Foundations would be in deep water with typical current speeds of 0.7 ft (0.2 m) per second (see Appendix J, Sediment Transport Analysis), and piles located in areas of similar depths and currents have minimal scour (Epsilon Associates, Inc. 2018; Nielsen et al. 2014; Whitehouse et al. 2011).

Several studies have shown that most scour tends to occur within the first month of installation (Harris et al. 2011; Tempel et al. 2004). However, scouring is a continuous process that can change over a period of years (Harris et al. 2011; Whitehouse et al. 2011). In addition, large storms with strong currents can temporarily increase the scour rate (Harris et al. 2011; Whitehouse et al. 2011; Tempel et al. 2004). At some sites, backfilling occurs in the scour hole around the pile when there are changes in current conditions (Peterson 2014).

The magnitude of scour around the edge of scour protection is related to the size of the rock and the depth and tapering of the protection, with smaller rock and shallower protections with more tapering resulting in less edge scour (Peterson 2014). Edge scour has been shown to be approximately 0.12 times the diameter of the pile (Whitehouse et al. 2011) and, depending on the scour protection and currents, could be half of that value (Peterson 2014; Tempel et al. 2004). In some areas, specifically in deep areas and those with small waves, scour is minimal and scour protection can be foregone (Whitehouse et al. 2011).

Short-term change in water quality due to oil spills or accidental release of fluids from vessels required during operations. During O&M, water quality could be impacted through the introduction of pollutants from vessels performing O&M work, including oil and fuel spills and releases. Project-related vessels would be subject to USCG wastewater and discharge regulations and would operate in compliance with oil spill prevention and response plans that meet USCG requirements. Specifically, all Project vessels would comply with USCG standards in U.S. territorial waters to legally discharge uncontaminated ballast and bilge water as well as standards regarding ballast water management. While outside the 3.0 nm (5.6

km) state-border/NDZ, vessels would deploy a USCG-certified MSD with certifications displayed. While inside the 3.0 nm (5.6 km) state-border/NDZ, vessels would take normal vessel procedures to close off MSD-effluence discharge piping and redirect it to onboard "Zero-Discharge Tanks" for the appropriate disposal either at dock or outside of an NDZ. Additionally, all vessels less than 79 ft (24 m) would comply with the Small Vessel General Permit issued by EPA on September 10, 2014, for compliance with NPDES permitting. Prevention and response measures for accidental spills and releases are further described in Appendix Q, Oil Spill Response Plan.

Long-term effects due to stormwater runoff. The presence of the Switching Station and expansion of the Onshore Substation may increase the stormwater runoff volume and peak flows because of the permanent changes of the land cover from an undeveloped vegetated site to a more compacted surface with less vegetation. Changes in land use from existing open space to developed area may increase the pollutant load over existing conditions and impact water quality. If not properly managed, increased peak flows may cause increased channel erosion or flooding downstream of the Switching Station and Onshore Substation. Dominion Energy would develop a Stormwater Management (SWM) Plan and Erosion and Sedimentation Control (ESC) Plan in accordance with Dominion Energy's approved Annual Standards and Specifications for SWM and ESC for Electric Transmission Line Development, and local ordinances as applicable. Dominion Energy would routinely inspect and clean on-site stormwater control features to remove debris or excess vegetation that may impede the designed functionality. The SWM plan would describe how the stormwater control facilities would be operated and maintained after construction is complete.

Decommissioning

Impacts from decommissioning the Project are expected to be similar to or less than those experienced during construction. Therefore, avoidance, minimization, mitigation, and monitoring measures proposed to be implemented during decommissioning are expected to be similar to those experienced during construction, as described above. Decommissioning techniques are expected to advance during the lifetime of the Project. A full decommissioning plan will be provided to the appropriate regulatory agencies for approval prior to decommissioning activities.

4.1.2.3 Summary of Avoidance, Minimization, and Mitigation Measures

Dominion Energy proposes to implement the following measures to avoid, minimize, and mitigate the potential impact-producing factors described (Table 4.1-11). Dominion Energy will continue discussion and engagement with the appropriate regulatory agencies and environmental non-governmental organizations throughout the life of the Project to develop an adaptive mitigation approach that provides the most flexible and protective mitigation measures.

Table 4.1-11. Summary of Avoidance, Minimization, and Mitigation Measures

Project Stage	Location	Impact	Avoidance, Minimization and Mitigation
Construction; Decommissioning	Offshore Project Area	Short-term disturbance of seabed sediment due to installation of the Wind Turbine Generator (WTG) Monopile Foundations and Offshore Substation Jacket Foundations, Inter-Array Cables, Offshore Export	• Dominion Energy would develop and implement a horizontal directional drilling inadvertent release plan. Local pollution prevention and spill response procedures would be included in the Stormwater Pollution Prevention Plan (SWPPP) submitted to State agencies for the portions of the land-disturbing activity covered by the Virginia Pollutant

Project Stage	Location	Impact	Avoidance, Minimization and Mitigation
		Cables, and site preparation for installation of scour protection	Discharge Elimination System Construction General Permit; • Dominion Energy would manage accidental spills or releases of oils or other hazardous wastes through the Oil Spill Response Plan (Appendix Q). Project-related vessels would be subject to U.S. Coast Guard (USCG) wastewater and discharge regulations and would operate in compliance with oil spill prevention and response plans that meet USCG requirements. Specifically, all Project vessels would comply with USCG standards in U.S. territorial waters to legally discharge uncontaminated ballast and bilge water as well as standards regarding ballast water management. While outside the 3.0 nautical mile (nm) (5.6 kilometer [km]) state-border/no-discharge zone (NDZ), vessels would deploy a USCG-certified marine sanitation device (MSD) with certifications displayed. While inside the 3.0 nm (5.6 km) state-border/NDZ, vessels would take normal vessel procedures to close off MSD-effluence discharge piping and redirect it to onboard "Zero-Discharge Tanks" for appropriate disposal either at dock or outside of an NDZ. Additionally, all vessels less than 79 feet (24 meters) would comply with the Small Vessel General Permit issued by U.S. Environmental Protection Agency on September 10, 2014, for compliance with National Pollutant Discharge Elimination System permitting. Prevention and response measures for accidental spills and releases are further described in Appendix Q, Oil Spill Response Plan; • Dominion Energy would avoid or minimize excavation dewatering in the location of the Battlefield Golf Club; • Dominion Energy would develop a SWPPP for construction activities that would conform with the Virginia Department of Environmental Quality Construction General Permit, Dominion Energy's approved Annual Standards and Specifications for Erosion and Sediment Control (ESC) and Stormwater Management (SWM) for Electric Transmission Line Development, and local pollution prevention and spill response procedures. The SWPPP would include steps that Dominion Energy must take to comply with the permit, including water quality requirements, and discuss the potential to encounter contaminated groundwater during excavation near the Battlefield Golf Club. The SWPPP would discuss how to protect surface water and groundwater quality if contaminated groundwater is encountered; • Dominion Energy would restrict access to only existing paved roads and approved access roads at wetland and stream crossings where possible; • Dominion Energy would restrict access through wetlands and waterbodies to identified construction sites, access roads, and work zones;
		Short-term potential for inadvertent release of drilling fluids during horizontal directional drilling	
		Short-term impacts due to accidental spills and/or releases offshore	
	Onshore Project Area	Short-term increase in erosion and runoff due to land disturbance	
		Short-term impacts due to dewatering trenches and excavations	
		Short-term potential for accidental releases from onshore construction vehicles or equipment	

Project Stage	Location	Impact	Avoidance, Minimization and Mitigation
			• Dominion Energy would conduct onshore refueling and/or maintenance of construction equipment and vehicles outside resource areas to the extent practicable; and • Dominion Energy would implement an inadvertent release plan to be reviewed and approved by the appropriate regulatory agencies as needed.
Operations and Maintenance	Offshore Project Area	Long-term effects due to WTG Monopile Foundations and Offshore Substation Jacket Foundations and associated scour protection	• Dominion Energy would use scour protection as necessary around the WTG Monopile Foundations and Offshore Substation Jacket Foundations and cable protection mats to minimize effects of local sediment transport; • Dominion Energy would subject Project-related vessels to USCG wastewater and discharge regulations and ensure they operate in compliance with oil spill prevention and response plans that meet USCG requirements. Specifically, all Project vessels would comply with USCG standards in U.S. territorial waters to legally discharge uncontaminated ballast and bilge water as well as standards regarding ballast water management. While outside the 3.0 nm (5.6 km) state-border/NDZ, vessels would deploy a USCG-certified MSD with certifications displayed. While inside the 3.0 nm (5.6 km) state-border/NDZ, vessels would take normal vessel procedures to close off MSD-effluence discharge piping and redirect it to onboard “Zero-Discharge Tanks” for the appropriate disposal either at dock or outside of an NDZ. Additionally, all vessels less than 79 feet (24 meters) would comply with the Small Vessel General Permit issued by the U.S. Environmental Protection Agency on September 10, 2014, for compliance with National Pollutant Discharge Elimination System permitting. Prevention and response measures for accidental spills and releases are further described in Appendix Q, Oil Spill Response Plan; and • Dominion Energy would develop an SWM Plan and ESC Plan ESC in accordance with Dominion Energy’s approved Annual Standards and Specifications for SWM and ESC for Electric Transmission Line Development, and local ordinances as applicable. Routinely inspect and clean on-site stormwater control features to remove debris or excess vegetation that may impede the designed functionality. The SWM plan would describe how the stormwater control facilities would be operated and maintained after construction is complete.
		Short-term change in water quality due to oil spills or accidental release of fluids from vessels required during operations	
	Onshore Project Area	Long-term effects due to stormwater runoff	

4.1.3 Air Quality

This section describes the regulatory framework for air quality, as applicable to the Project, and the affected air environment. Potential impacts to air quality resulting from construction, O&M, and decommissioning of the Project are discussed. Proposed Project-specific measures adopted by Dominion Energy also are described, which are intended to avoid, minimize, and/or mitigate potential impacts to air quality.

Other resources and assessments detailed within this COP that are related to air quality include:

- Air Emissions Calculations and Methodology (Appendix N).

4.1.3.1 Regulatory Context

Under the federal Clean Air Act (CAA), the EPA is responsible for developing and enforcing the regulations protecting air quality in the U.S. Project emissions associated with construction, O&M, and decommissioning are subject to EPA regulations governing air quality within both the Onshore Project Area and Offshore Project Area.

The federal CAA established the National Ambient Air Quality Standards (NAAQS) for the following common pollutants, known as criteria pollutants: carbon monoxide (CO), lead, nitrogen dioxide (NO_2), ozone, particulate matter, and sulfur dioxide (SO_2). The standards are set by EPA to protect public health and the environment from harmful air pollutants. To achieve this, EPA sets both primary and secondary standards. The primary standards protect public health, including the health of sensitive populations, such as asthmatics, children, and the elderly (EPA 2016). The secondary standards protect the environment and public welfare from adverse effects associated with pollution, including decreased visibility and damage to animals, crops, vegetation, and buildings (EPA 2016).

Although many of the criteria pollutants are directly emitted into the atmosphere by industrial and combustion processes, some criteria pollutants form in the atmosphere by chemical reactions. Ozone, for example, is formed in the atmosphere by reactions between volatile organic compounds (VOCs) and nitrogen oxides (NO_X), which include nitric oxide (NO), NO_2, and other NO_X. In this context, VOCs and NO_X, referred to as ozone precursors, are regulated by EPA to achieve ambient ozone reductions.

Similarly, particulate matter is a mixture of solid particles and liquid droplets of varying size found in the atmosphere. The EPA has established NAAQS for two different particles sizes—particulate matter less than 10 microns in diameter (PM_{10}) and particulate matter less than 2.5 microns in diameter ($PM_{2.5}$). While some particulate matter is emitted directly, $PM_{2.5}$ can form in the atmosphere by chemical reactions between SO_2, NO_X, VOCs, and ammonia. As with ozone, $PM_{2.5}$ precursors are regulated by EPA to achieve ambient $PM_{2.5}$ reductions.

The NAAQS for each criteria pollutant are presented in Table 4.1-12. Every 5 years, EPA conducts a comprehensive review of the NAAQS and revises the standards based on the most recent scientific information available, as necessary. EPA monitors compliance with the NAAQS through a network of air pollution monitoring stations measuring the concentration of each criteria pollutant. If ambient concentrations do not exceed the NAAQS, the monitored area is designated an attainment area and no further action is required. If ambient concentrations exceed the NAAQS for one or more pollutants, the monitored area is designated a nonattainment area for those pollutants, and the state is required to develop an implementation plan to achieve compliance with the NAAQS. Once a nonattainment area demonstrates compliance with the NAAQS standard, the EPA will designate the area a maintenance area (EPA 2017a).

Table 4.1-12. National Ambient Air Quality Standards

Pollutant	Averaging Period	Standard
$PM_{2.5}$	24 hours Annual	98th percentile concentration averaged over 3 years ≤ 35 µg/m^3 Annual mean, averaged over 3 years ≤ 12.0 µg/m^3 (primary) Annual mean averaged over 3 years ≤ 15.0 µg/m^3 (secondary)
PM_{10}	24 hours	150 µg/m^3, not to be exceeded more than once per year on average over 3 years
Ozone	8 hours	4th highest daily maximum value, averaged over 3 years ≤ 0.070 ppm
NO_2	1 hour Annual	98th percentile daily maximum, averaged over 3 years ≤ 0.100 ppm Not to exceed 0.053 ppm
SO_2	1 hour 3 hours	99th percentile daily maximum, averaged over 3 years ≤ 0.075 ppm 0.5 ppm, not to be exceeded more than once per year
CO	1 hour 8 hours	35 ppm, not to be exceeded more than once per year 9 ppm, not to be exceeded more than once per year
Lead	Rolling 3-month average	Not to exceed 0.15 µg/m^3

Source: 40 CFR Part 50

CO – carbon monoxide; µg/m^3 – micrograms per (standard) cubic meter; NO_2 – nitrogen dioxide; $PM_{2.5}$ – particulate matter less than 2.5 microns in diameter; PM_{10} – particulate matter less than 10 microns in diameter; ppm – parts per million (by volume); SO_2 – sulfur dioxide

In addition to regulating criteria pollutants through the NAAQS, EPA is also responsible for developing and enforcing regulations governing other air pollutants, including hazardous air pollutants (HAPs) and greenhouse gases (GHGs).

HAPs are pollutants known or suspected to cause adverse health and environmental effects. Adverse health effects associated with exposure to HAPs include increased likelihood of developing cancer and other serious impacts to neurological, reproductive, respiratory, and immune system health and early childhood development (EPA 2017b).

GHGs are gases that trap heat in the atmosphere and contribute to global warming by retaining heat in the atmosphere (EPA 2020a). Common GHGs include carbon dioxide (CO_2), methane, and nitrous oxide, which can be released into the atmosphere through the production, transportation, and burning of fossil fuels, and through emissions from livestock and other agricultural and industrial practices (EPA 2020a). In the U.S., CO_2 accounted for approximately 81 percent of all GHG emissions in 2018 (EPA 2020b).

Although EPA has not established ambient air quality standards for HAPs or GHGs, emissions of HAPs and GHGs are regulated through national and state emissions standards and permit requirements.

Outer Continental Shelf Air Regulations

The federal CAA authorizes the EPA to regulate air quality on portions of the OCS, including offshore the east coast of the U.S. The EPA has promulgated OCS air regulations at 40 CFR Part 55, which establish air pollution control and permitting requirements for emissions sources and activities occurring on the OCS.

According to Section 328 of the CAA (at 42 U.S.C § 7627(a)(4)(c)), an OCS source includes the following: (i) any equipment, activity, or facility that emits, or has the potential to emit, any air pollutant; (ii) is regulated or authorized under the OCS Lands Act (43 U.S.C § 1331); and (iii) is located on the OCS or in or on waters above the OCS. This includes vessels only when they are (1) permanently or temporarily attached to the seabed and used for the purpose of exploring, developing or producing resources therefrom, within the meaning of section 4(a)(1) of OCSLA (43 U.S.C. §§ 1331 *et seq.*); or (2) physically attached to an OCS facility, in which case only the stationary sources aspects of the vessels will be regulated. (40 CFR § 55.2).

In support of the Project's OCS air permit application, Dominion Energy developed and continues to refine an inventory of anticipated emissions from Offshore Project Area-related construction, O&M vessels operating at or within 25 nm (46 km) of the OCS source. This inventory does not quantify emissions associated with Offshore Project Area decommissioning activities, given the uncertainty of future technology and regulations. These future decommissioning emissions may be the subject of a future OCS air permit application.

In addition to the federal OCS air regulations, the OCS sources located within 25 nm (46 km) of the seaward boundary of a state are subject to the requirements applicable to the Corresponding Onshore Area (COA), as determined by EPA. The full extent of the Offshore Project Area boundary is located within and beyond 25 nm (46 km) of the seaward boundary of Virginia. As such, any OCS air sources located within 25 nm (46 km) of the seaward boundary will also be subject to the state specific air permitting regulatory requirements of the COA, which has been determined to be Virginia. Since the Offshore Project Area is located within and beyond 25 nm (46 km) of the seaward boundary, the EPA is the regulatory authority administering and issuing the OCS air permit, which will incorporate the applicable air permitting requirements of the COA for those OCS sources located within 25 nm (46 km) of seaward boundary.

As stipulated in 30 CFR § 585.659 and BOEM guidelines, Dominion Energy will follow the OCS air regulations and, in accordance with 40 CFR § 55.6, has developed and continues to refine a Project-specific emissions inventory in support of an OCS air permit application, which was submitted to EPA on January 12, 2023. A similar Project-specific emissions inventory has been developed for this COP, as presented in Appendix N, Air Emissions Calculations and Methodology. The OCS air permit emissions inventory only includes emissions that occur after the first Project-related OCS source has been established, and that are located within 25 nm of the Project-related OCS source. By comparison, the emissions inventory presented in Appendix N includes potential emissions that are both subject to and not subject to the OCS air regulations (see the "General Conformity Applicability" subheading in this section for additional discussion).

In addition to the information provided pursuant to 30 CFR § 585.659, Dominion Energy submitted an OCS Notice of Intent on November 30, 2021 to EPA Region 3 and to the air pollution control agencies of the nearest onshore area (NOA) and neighboring areas (i.e., VDEQ, North Carolina Department of Environmental Quality, and the Maryland Department of the Environment), in accordance with the OCS air regulations. On January 31, 2021, Virginia was designated as the COA and due to the Project being located 25 nm beyond the Virginia state seaward boundary, it was determined that EPA would be the regulatory authority and that Dominion Energy would submit the OCS air permit application to EPA Region 3. Dominion Energy submitted the initial OCS air permit application for the Project to EPA on September 15, 2022, which was deemed incomplete by EPA on October 11, 2022. EPA identified additional information that needed to be provided in order for EPA to continue processing the permit application. Dominion Energy submitted an updated OCS air permit application to EPA on January 12, 2023, which included the additional information requested. EPA determined that the January 12, 2023 application was complete on February 7, 2023. EPA provided comments on June 29, 2023 and Dominion Energy intends to submit a revised application on July 31, 2023.

As part of the OCS air permit application, Dominion Energy developed an inventory of anticipated emissions by year for the construction and O&M stages of the Project, based on the best available information, with a degree of conservatism to account for unknown conditions. As previously explained, the Project decommissioning emissions will be subject to a future OCS air permit application. Dominion Energy compared the anticipated emissions to EPA's New Source Review (NSR) permitting thresholds to determine the Project-specific permitting requirements. NSR is a federal pre-construction permitting program responsible for ensuring new emissions sources do not contribute to a violation of the NAAQS (EPA 2006). Pollutants regulated by the NSR permitting program include the criteria pollutants, VOCs, and GHGs. If the Project's anticipated emissions do not exceed the NSR major source permitting thresholds for one or more pollutant, the Project will be considered a minor source and subject to minor NSR source permitting.

The major source thresholds for attainment areas (which include maintenance areas) are 100 tons per year (90.7 metric tons) for any NSR-regulated pollutant if a source falls into one of 28 listed source categories, and 250 tons per year (227 metric tons per year) for any NSR-regulated pollutant at sources not in one of the listed categories. The Project does not fall into any of the listed source categories, and therefore, will be subject to a major source threshold of 250 tons per year (227 metric tons). As NSR permitting is pollutant specific, the Project can be considered a major source for some pollutants and a minor source for others. If the Project's anticipated emissions exceed the NSR permitting threshold for one or more pollutants, the Project will be considered a major source and subject to major source permitting for those pollutants as well as any other NSR pollutant emitted that exceeds their respective significant emission rate. The Project's potential stationary source emissions exceed the NSR major source permitting thresholds for NO_X, CO, SO_2, PM, PM_{10}, $PM_{2.5}$, VOC, and GHGs during construction, and NO_X, CO, PM_{10}, and $PM_{2.5}$ during O&M. Therefore, the Project is considered a major source and subject to major source permitting for those pollutants.

General Conformity Applicability

The General Conformity rule requires federal agencies to demonstrate that proposed actions comply with the NAAQS (EPA 2017a). Section 176(c)(1) of the CAA defines conformity as the upholding of "an implementation plan's purpose of eliminating or reducing the severity and number of violations of the NAAQS and achieving expeditious attainment of such standards." Therefore, in nonattainment or maintenance areas, federal agencies must demonstrate that proposed actions conform to the applicable EPA-approved state implementation plan to achieve and/or maintain the NAAQS (EPA 2017a). In attainment areas without state implementation plans, federal agencies must demonstrate that proposed actions will not cause new violations of the NAAQS and/or increase the frequency or severity of previous violations (EPA 2017a). As a result, Project emissions should not cause or contribute to new violations of the NAAQS, increase the frequency or severity of a previous violation of the NAAQS, or prevent or delay attainment of the NAAQS or interim emission reductions.

In accordance with 40 CFR Part 51 Subpart W and 40 CFR Part 93 Subpart B, BOEM must conduct a General Conformity analysis for any emissions related to construction and operation of the Project that will occur in a nonattainment or maintenance area, and if any General Conformity threshold will be exceeded, BOEM must issue a General Conformity Determination, stating how construction and operation of the Project will conform with the applicable state and/or federal implementation plan. The General Conformity thresholds are presented in Table 4.1-13 and only apply to nonattainment areas or maintenance areas.

Table 4.1-13. General Conformity Thresholds

Pollutant	Designation	Threshold, tons per year
Nonattainment Area (NAA) Thresholds		
Ozone (VOC or NO_x as precursors)	Extreme NAA	10
	Severe NAA	25
	Serious NAA	50
	Other ozone NAA outside an ozone transport region	100
	Other ozone NAAs inside an ozone transport region	50 (VOC)
		100 (NO_x)
CO	All NAAs	100
SO_2	All NAAs	100
NO_2	All NAAs	100
PM_{10}	Moderate NAA	100
	Serious NAA	70
$PM_{2.5}$ (direct emissions; and SO_2, NO_x, VOC, or ammonia as precursors)	Moderate NAA	100
	Serious NAA	70
Lead	All NAAs	25
Maintenance Area Thresholds		
Ozone (VOCs or NO_x precursors)	All maintenance areas	100 (NO_x)
	Maintenance areas outside an ozone transport region	100 (VOC)
	Maintenance areas inside an ozone transport region	50 (VOC)
CO	All maintenance areas	100
SO_2	All maintenance areas	100
NO_2	All maintenance areas	100
PM_{10}	All maintenance areas	100
$PM_{2.5}$ (direct emissions; and SO_2, NO_x, VOC, or ammonia as precursors)	All maintenance areas	100
Lead	All maintenance areas	25

Source: 40 CFR § 93.153(b)

CO - Carbon monoxide; NO_x – nitrogen oxides; NO_2 – nitrogen dioxide; $PM_{2.5}$ – particulate matter less than 2.5 microns in diameter; PM_{10} – particulate matter less than 10 microns in diameter; SO_2 – sulfur dioxide; VOC – Volatile organic compound

The emissions inventory for the General Conformity analysis (and General Conformity Determination, if required) does not include emissions subject to the OCS air regulations, which are included in the OCS air permit application (i.e., emissions that occur at or within 25 nm [46 km] of an OCS source). The only designated area anticipated to be relevant to the Project is the Norfolk-Virginia Beach-Newport News (Hampton Roads) Air Quality Control Region. The Hampton Roads Air Quality Control Region is a maintenance area for the 1997 8-hour ozone standard, and Dominion Energy has been informed by EPA and VDEQ that General Conformity requirements apply. VDEQ is currently in the process of updating its State Implementation Plan, which includes a maintenance plan for the Hampton Roads Air Quality Control Region, and Dominion Energy has submitted estimated emissions for inclusion in the State Implementation Plan. Accordingly, Dominion Energy has provided VDEQ with estimated annual and ozone season emissions of NO_X and VOC that will occur inside the boundaries of the Hampton Roads Air Quality Control Region during construction and operation of the Project. VDEQ submitted its final proposed maintenance plan update to EPA for review and approval on September 9, 2022.

These relevant air quality control regions include the following jurisdictions where Project-related emissions from vessel operations, onshore construction, or onshore staging might occur:

- Chesapeake, VA;
- Hampton, VA;
- Newport News, VA;
- Norfolk, VA;
- Portsmouth, VA; and
- Virginia Beach, VA.

Virginia Air Quality Regulations for Emergency Generators

The emergency generator engines located onshore at the Switching Station and Onshore Substation will be fired with either natural gas or propane. It is anticipated that these engines will be exempt from Virginia's minor NSR permitting program as uncontrolled annual emissions are not anticipated to exceed the minor NSR thresholds for each pollutant specified in 9VAC5-80-1105.C.1. However, the onshore emergency generators will still be subject to the applicable federal emissions standards for spark-ignition stationary engines under 40 CFR Part 60 Subpart JJJJ and 40 CFR Part 63 Subpart ZZZZ.

Data Relied Upon and Studies Completed

This section was prepared in accordance with:

- BOEM guidance and guidelines, as applicable; and
- BOEM's site characterization requirements in 30 CFR § 585.626.

As required by the regulations and guidance described herein, the following analyses are also provided in this COP:

- An air emissions analysis addressing 40 CFR Part 55, OCS Air Regulations; and
- An air quality analysis supporting BOEM's National Environmental Policy Act (NEPA) and CAA review with respect to 40 CFR Part 51(W), "Requirements for Preparation, Adoption, and Submittal of Implementation Plans," and 40 CFR Part 93(B), "Determining Conformity of General Federal Actions to State or Federal Implementation Plans."

4.1.3.2 Affected Environment

This section describes the affected environment, inclusive of the Project Area potentially impacted by construction, O&M, and decommissioning activities; this includes areas associated with permanent Project facilities and O&M ports, as well as areas that will temporarily host construction activities. These areas include the OCS area located at or within 25 nm (46 km) of the centroid of the three Offshore Substations within the Lease Area, and the Hampton Roads Air Quality Control Region.

The VDEQ Air Pollution Control Board is responsible for ensuring clean air and managing the state and federal air pollution control programs. Within this department, the Office of Air Quality Monitoring compiles meteorological data and ambient concentrations of criteria pollutants, VOCs, and other air toxics from 38 ambient monitoring sites in the state of Virginia, operated by VDEQ, the City of Alexandria, the U.S. Department of Agriculture Forest Service, and the National Park Service (VDEQ 2019). The data collected at these monitoring stations informs air pollution control programs and policies. Of the 38 monitoring stations, five collect air quality data in the Tidewater District in southeastern Virginia, including stations in Hampton, Norfolk, and Virginia Beach (VDEQ 2019).

As described above, the following jurisdictions in Virginia where Project emissions could potentially occur during construction or O&M are part of the Hampton Roads maintenance area for the 1997 8-hour ozone NAAQS:

- Chesapeake;
- Hampton;
- Newport News;
- Norfolk;
- Portsmouth; and
- Virginia Beach.

Ambient monitoring data from the most recent three years available (2016 through 2018) indicate that no exceedances of any NAAQS (including the 2015 8-hour ozone standard) have occurred in the Hampton Roads area in the past three years, and that concentrations for all pollutants have either gradually decreased or remained roughly the same (VDEQ 2019).

VDEQ has published an economy-wide inventory of GHG emissions in Virginia, which indicates that for 2019, statewide GHG emissions were 83.8 million metric tons of CO_2e. This is a reduction from VDEQ’s baseline emission inventories of 172.1 million metric tons of CO_2e in 2005, and 160.3 million metric tons of CO_2e in 2010 (VDEQ 2023).

4.1.3.3 Impacts Analysis for Construction, Operations and Maintenance, and Decommissioning

The potential impacts resulting from the construction, O&M, and decommissioning of the Project are based on the preferred layout design scenario from the Project Design Envelope (see Section 3, Description of Proposed Activity), consistent with the OCS air permit. For air quality, this design scenario results from the emissions associated with the estimated number of combustion engines required to perform the construction work, as well as to transport personnel, equipment, and materials, both onshore and offshore, and from the emissions associated with the anticipated O&M sources both onshore and offshore, as described in Table 4.1-14.

Table 4.1-14. Summary of Design Scenario for Air Quality

Parameter	Realistic Maximum Design Scenario	Rationale
Construction		
Wind Turbine Generators (WTGs)	176 14-Megawatt (MW) to 16-MW WTGs	Representative of the number of structures (176 WTGs and three Offshore Substations) in the Preferred Layout, resulting in the estimated maximum number of trips during construction for this design scenario).
WTG Monopile Foundations	176 monopile foundations	Representative of the number of foundations (176 monopile foundations) in the Preferred Layout, resulting in the estimated maximum Project-related emissions for this design scenario.
WTG transition pieces (TPs)	176 TPs	Representative of the number of TPs in the Preferred Layout, resulting in the estimated maximum amount of Project-related emissions for this design scenario.
Offshore Substation Jacket Foundations	Three piled jacket foundations, with 4 piles per jacket	Representative of the maximum number of foundations and pilings that will result in the maximum amount of Project-related emissions.
Offshore Substation topsides	3	Representative of the maximum number of Offshore Substation topsides that will result in the maximum amount of Project-related emissions.
Number of Offshore Export Cables	9	Representative of the maximum number of cables, which will result in the maximum amount of Project-related emissions.
Length of Offshore Export Cable Route Corridor	49 miles (mi) (79 kilometers [km])	Representative of the maximum corridor length that will result in the maximum amount of Project-related emissions.
Number of Inter-Array Cables	230	Representative of the maximum number of cables that will result in the maximum amount of Project-related emissions.
Length of Inter-Array Cables	31,804 feet (ft) (9,694 meters [m]) each	Representative of the maximum cable length that will result in the maximum amount of Project-related emissions.
Project-related vessels	Based on construction of 176 WTGs and three Offshore Substations, plus Offshore Export Cables and Inter-Array Cables	Representative of a construction and installation scenario, including conservative vessel fuel consumption and operating day assumptions, that will result in the estimated maximum amount of Project-related emissions for the Preferred Layout design scenario.
Offshore construction duration	Based on construction of 176 WTGs and three Offshore Substations, plus Offshore Export Cables and Inter-Array Cables	Representative of the maximum period required to install the Offshore Project Area components that will result in the estimated maximum amount of Project-related emissions for the Preferred Layout design scenario.

Parameter	Realistic Maximum Design Scenario	Rationale
Number of Offshore Export Cables at Cable Landing Location	9	Representative of the maximum number of cables that will result in the maximum amount of Project-related emissions.
Length of Nearshore Trenchless Installation Area	2,500 ft (762 m)	Conservative assumption provided by the Project.
Duration of trenchless installation in Nearshore Trenchless Installation Area	4 months	Conservative assumption provided by the Project.
Duration of Cable Landing Location construction	9 to 12 months	Conservative assumption provided by the Project.
Cable Landing Location footprint	2.8 acres (ac) (1.1 hectares [ha])	Conservative assumption provided by the Project.
Length of Onshore Project Area cable HDD	4.4 mi (7.1 km)	Conservative assumption provided by the Project.
Duration of Onshore Project Area cable HDD	1 month	Conservative assumption provided by the Project.
Duration of Onshore Project Area cable construction	18 to 24 months to Switching Station; 1 to 2 years to Onshore Substation	Conservative assumption provided by the Project.
Onshore Substation workspace	26.9 ac (10.9 ha)	Conservative assumption provided by the Project.
Switching Station workspace (Preferred Option)	45.4 ac (18.4 ha)	Conservative assumption provided by the Project.
Duration of Onshore Substation construction	9 months	Conservative assumption provided by the Project.
Duration of Switching Station construction	12 months	Conservative assumption provided by the Project.
Operations		
WTGs	Based on operation of 176 WTGs	Representative of the number of WTGs in the Preferred Layout design scenario.
Offshore Substations	Based on operation of three Offshore Substations	Representative of the maximum number of Offshore Substation topsides.
Offshore Project Area-related vessels	Based on operation of 176 WTGs and three Offshore Substation topsides, plus Export and Inter-Array Cables. Based on the maximum number of vessels and movements for servicing and inspections.	Representative of an operations and maintenance scenario that includes conservative vessel fuel consumption and operating day assumptions that will result in the estimated maximum amount of Project-related emissions based on the Preferred Layout design scenario.
Offshore Substation emergency generators	563-KW (one generator per Offshore Substation)	Conservative assumption provided by the Project.
Onshore Substation emergency generator	Three generator engines (410 kW, 310 kW, and 150 kW)	Conservative assumption provided by the Project.
Switching Station emergency generator	Three 260-kW generator engines	Conservative assumption provided by the Project.
Onshore Substation electric switchgear sulfur hexafluoride quantity	35,137 pounds	Conservative assumption provided by the Project.
Switching Station electric switchgear sulfur hexafluoride quantity	26,000 pounds	Conservative assumption provided by the Project.
Onshore Project Area O&M activities	One 250-kW generator engine	Conservative assumption provided by the Project.

Construction

During construction, the impact-producing factors related to air quality may include an increase in air emissions from equipment during construction activities. Dominion Energy proposes to implement measures, as appropriate, to avoid, minimize, and mitigate impacts during Project construction. The following impact may occur as a consequence of the impact-producing factors identified above:

- Short-term increase in Project-related emissions.

Short-term increase in Project-related emissions. During construction, Project-related air emissions could have short-term impacts to air quality. Primary Offshore Project Area emissions sources include marine vessels, which will potentially transit waters of Virginia, with the majority of Project-related construction emissions expected to occur offshore, within the Lease Area and along the Offshore Export Cable Route Corridor. Most of these vessels and the onboard construction equipment will utilize diesel engines burning ultra-low sulfur fuel, while some larger construction vessels may use fuel containing up to 1,000 ppm sulfur by weight. Construction staging and laydown for the Onshore Project Area and Offshore Project Area construction is anticipated to occur at port facilities located in the Hampton Roads area of Virginia, as well as the Cable Landing Location, Onshore Export Cable Route Corridor, Switching Station, Interconnection Cable Route, and Onshore Substation, all located within the boundaries of the Cities of Virginia Beach and Chesapeake. Onshore Project Area construction activities will primarily utilize diesel-powered equipment, including HDD, microtunneling and Nearshore Trenchless Installation operations, trenching/duct bank construction, and cable pulling and termination. In addition, a localized increase in fugitive dust may result during Onshore Project Area construction activities. Any fugitive dust generated during construction of the Onshore Project Components will be managed in accordance with the Project's Fugitive Dust Control Plan. Finally, a helicopter may be used to support commissioning of the Offshore Substations, with Norfolk International Airport as the assumed departure point for all trips. For more information see Appendix N, Air Emissions Calculations and Methodology.

Dominion Energy will ensure the following measures were taken:

- Vessels constructed on or after January 1, 2016, will meet Tier III NO_x requirements when operating within the North American Emission Control Area (200 nm [370.4 km] established by the International Maritime Organization (IMO);
- Project-related vessels will use ultra-low sulfur diesel fuel where possible and be at or below the maximum fuel sulfur content requirement of 1,000 parts per million established per the requirements of 40 CFR § 80.510(k);
- Project-related vessels will comply with applicable EPA or equivalent emission standards;
- The Project will provide EPA with data on horsepower rating of all propulsion and auxiliary engines, duration of time operating, load factor, and fuel consumption for Project-related vessels to determine actual emissions from Project-related vessels, as applicable; and
- The Project will provide vessel engines and emissions control equipment information to BOEM and the EPA, as applicable, in accordance with the requirements set forth in the Record of Decision and/or the issued OCS air permit.

An emissions inventory has been developed and continues to be refined for the construction stage, including underlying assumptions for engine type and rating, engine use (hours), number of trips, and emission factors. The current emissions inventory, which aligns with the revised OCS air permit application submitted to EPA on July 31, 2023, is provided in Appendix N, Air Emissions Calculations and Methodology. The avoidance, minimization, mitigation, and monitoring measures that have been incorporated in the emissions inventory assumptions are also provided in the revised OCS air permit application submitted to EPA on July 31, 2023, and include, but are not limited to, use of ultra-low-sulfur fuels, use of Best Available Control Technology, as applicable, and efficient engine operation.

Estimated emissions are presented as total annual emissions for comparing to stationary source air permitting thresholds. OCS air permit emissions include those from OCS sources, vessels meeting the definition of an OCS source (40 CFR § 55.2), and vessels traveling to and from the OCS source when within 25 nm (46 km) of an OCS source. Vessel transit emissions occurring within 25 nm (46 km) of the OCS source have conservatively been estimated and are included as part of the Potential to Emit emissions for the OCS air permit. General Conformity requirements (40 CFR Part 93 Subpart B) have been determined to apply to construction emissions that occur in the Hampton Roads Air Quality Control Region, after discussion with EPA and VDEQ. For the purpose of aiding BOEM's NEPA review, air emissions have been apportioned to the geographic areas in which they will occur, including the Onshore Project Area and state waters of the Commonwealth of Virginia extending out to the state seaward boundary; federal waters located within 25 nm (46 km) of the centroid of the three Offshore Substations (described in Table 4.1-16 through Table 4.1-20 below as "Inside OCS Radius"); and federal waters located beyond 25 nm (46 km) of the centroid of the three Offshore Substations (described in Table 4.1-16 through Table 4.1-20 below as "Federal Waters outside the OCS Radius"). Emissions are apportioned to the geographic area where they will occur based on the assumed routes for vessel trips between ports and the Lease Area, as well as the location of the Offshore Export Cable Route Corridor. Emissions are presented by the pollutants identified in technical guidance. Total emissions include all combustion sources anticipated to be used for both Onshore Project Area- and Offshore Project Area-related construction activities.

It was assumed that construction tasks will occur in alignment with the indicative construction schedule presented in Table 4.1-15 (although the exact calendar windows for some of the specific subtasks may differ slightly from those shown below). Table 4.1-16 through Table 4.1-20 presents the potential emissions for construction, by calendar year, for each geographic area considered. The emissions in each area include total emissions from both Onshore Project Area and Offshore Project Area construction, including vessel transits.

Table 4.1-15. Indicative Construction Schedule

Activity	2023		2024				2025				2026				2027	
	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2
Scour protection pre-installation			X	X	X	X										
Monopile and transition piece transport and onshore staging		X	X	X	X	X	X	X	X	X	X					
Monopile installation (piling between May 1 and October 31)				X	X	X		X	X	X						

Activity	2023		2024				2025				2026				2027	
	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2
Scour protection post-installation							X	X	X	X						
Transition piece installation				X	X	X	X	X	X	X	X					
Wind Turbine Generator pre-assembly and installation								X	X	X	X	X	X	X	X	X
Inter-Array Cable installation								X	X	X	X	X				
Offshore Substation installation (piling between May 1 and October 31)					X	X	X	X	X							
Offshore Export Cable installation			X	X	X	X	X	X								
Onshore Export and Interconnection Cable installation		X	X	X	X	X	X	X	X							
Switching Station construction		X	X	X	X	X	X	X								
Onshore Substation upgrade construction		X	X	X	X	X	X	X								
Commissioning							X	X	X	X	X	X	X	X	X	X

Note: This table has been modified to be consistent with the Indicative Construction Schedule provided in Section 1, Introduction, Table 1.1-2.

Table 4.1-16. Calendar Year 2023 Potential Emissions (tons)

Geographic Area	VOC	NO_x	CO	PM/ PM_{10}	$PM_{2.5}$	SO_2	HAP	GHG (CO_2e)
Onshore Project Area (Virginia Beach)	1.34	19.53	5.30	0.98	0.95	0.06	0.32	8,565
Onshore Project Area (Chesapeake)	0.37	8.35	1.39	0.28	0.27	0.02	0.09	2,652
Onshore Project Area (Norfolk)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Onshore Project Area (Portsmouth)	0.09	3.16	0.32	0.07	0.06	0.00	0.02	657
Virginia State waters	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Federal waters outside the Outer Continental Shelf radius	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Inside Outer Continental Shelf radius	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Total, All Areas	**1.80**	**31.05**	**7.01**	**1.32**	**1.28**	**0.08**	**0.43**	**11,873**

CO – carbon monoxide; CO_2e – carbon dioxide equivalent; HAP – hazardous air pollutant; GHG – greenhouse gas; $PM_{2.5}$ – particulate matter less than 2.5 microns in diameter; PM_{10} – particulate matter less than 10 microns in diameter; SO_2 – sulfur dioxide; NO_x – nitrogen oxides; VOC – volatile organic compound

Table 4.1-17. Calendar Year 2024 Potential Emissions (tons)

Geographic Area	VOC	NO_x	CO	PM/ PM_{10}	$PM_{2.5}$	SO_2	HAP	GHG (CO_2e)
Onshore Project Area (Virginia Beach)	2.68	39.06	10.59	1.96	1.90	0.12	0.64	17,129
Onshore Project Area (Chesapeake)	0.75	16.70	2.79	0.56	0.54	0.04	0.18	5,304
Onshore Project Area (Norfolk)	3.60E-02	2.64E-02	8.40E-04	7.56E-04	7.56E-04	4.20E-03	1.39E-04	13
Onshore Project Area (Portsmouth)	0.36	12.65	1.29	0.26	0.25	0.02	0.09	2,627
Virginia State waters	9.96	219.98	107.76	11.50	11.15	0.55	1.04	15,440
Federal waters outside the Outer Continental Shelf radius	0.13	3.24	1.16	0.10	0.10	0.05	1.26E-02	205
Inside Outer Continental Shelf radius	71.36	1,228.35	791.78	49.64	48.15	32.58	6.77	110,322
Total, All Areas	**85.27**	**1,520.02**	**915.36**	**64.02**	**62.10**	**33.36**	**8.73**	**151,042**

CO – carbon monoxide; CO_2e – carbon dioxide equivalent; HAP – hazardous air pollutant; GHG – greenhouse gas; $PM_{2.5}$ – particulate matter less than 2.5 microns in diameter; PM_{10} – particulate matter less than 10 microns in diameter; SO_2 – sulfur dioxide; NO_x – nitrogen oxides; VOC – volatile organic compound

Table 4.1-18. Calendar Year 2025 Potential Emissions (tons)

Geographic Area	VOC	NO_x	CO	PM/ PM_{10}	$PM_{2.5}$	SO_2	HAP	GHG (CO_2e)
Onshore Project Area (Virginia Beach)	2.01	29.30	7.94	1.47	1.43	0.09	0.48	12,847
Onshore Project Area (Chesapeake)	0.37	8.35	1.39	0.28	0.27	0.02	0.09	2,652
Onshore Project Area (Norfolk)	0.22	0.16	5.04E-03	4.54E-03	4.54E-03	0.03	8.34E-04	81
Onshore Project Area (Portsmouth)	0.56	16.35	2.44	0.45	0.43	0.03	0.14	4,873
Virginia State waters	28.02	573.91	303.66	31.33	30.39	2.56	2.90	42,709
Federal waters outside the Outer Continental Shelf radius	0.50	7.23	4.90	0.35	0.34	0.25	0.05	716
Inside Outer Continental Shelf radius	166.25	2,382.17	1,774.59	108.28	105.04	83.26	15.47	245,023
Total, All Areas	**197.95**	**3,017.47**	**2,094.93**	**142.16**	**137.89**	**86.24**	**19.12**	**308,900**

CO – carbon monoxide; CO_2e – carbon dioxide equivalent; HAP – hazardous air pollutant; GHG – greenhouse gas; $PM_{2.5}$ – particulate matter less than 2.5 microns in diameter; PM_{10} – particulate matter less than 10 microns in diameter; SO_2 – sulfur dioxide; NO_x – nitrogen oxides; VOC – volatile organic compound

Table 4.1-19. Calendar Year 2026 Potential Emissions (tons)

Geographic Area	VOC	NO_x	CO	PM/ PM_{10}	$PM_{2.5}$	SO_2	HAP	GHG (CO_2e)
Onshore Project Area (Virginia Beach)	0	0	0	0	0	0	0	0
Onshore Project Area (Chesapeake)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Onshore Project Area (Norfolk)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Onshore Project Area (Portsmouth)	0.36	8.10	1.86	0.31	0.30	0.03	0.09	3,651.4
Virginia State waters	6.28	72.16	60.35	3.98	3.86	3.45	0.59	8,578
Federal waters outside the Outer Continental Shelf radius	0.70	8.02	6.71	0.44	0.43	0.38	0.07	953
Inside Outer Continental Shelf radius	133.98	1,638.32	1,369.25	87.80	85.16	70.41	12.62	187,656
Total, All Areas	**141.32**	**1,726.60**	**1,438.15**	**92.53**	**89.76**	**74.27**	**13.36**	**200,838**

CO – carbon monoxide; CO_2e – carbon dioxide equivalent; HAP – hazardous air pollutant; GHG – greenhouse gas; $PM_{2.5}$ – particulate matter less than 2.5 microns in diameter; PM_{10} – particulate matter less than 10 microns in diameter; SO_2 – sulfur dioxide; NO_x – nitrogen oxides; VOC – volatile organic compound

Table 4.1-20. Calendar Year 2027 Potential Emissions (tons)

Geographic Area	VOC	NO_x	CO	PM/ PM_{10}	$PM_{2.5}$	SO_2	HAP	GHG (CO_2e)
Onshore Project Area (Virginia Beach)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Onshore Project Area (Chesapeake)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Onshore Project Area (Norfolk)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Onshore Project Area (Portsmouth)	0.14	2.47	0.77	0.12	0.12	1.05E-02	0.03	1,497
Virginia State waters	2.59	29.65	24.91	1.64	1.59	1.43	0.24	3,541
Federal waters outside the Outer Continental Shelf radius	0.29	3.29	2.77	0.18	0.18	0.16	0.03	393
Inside Outer Continental Shelf radius	49.94	565.71	507.17	32.90	31.91	26.15	4.71	69,615
Total, All Areas	**52.96**	**601.13**	**535.61**	**34.84**	**33.79**	**27.75**	**5.01**	**75,047**

CO – carbon monoxide; CO_2e – carbon dioxide equivalent; HAP – hazardous air pollutant; GHG – greenhouse gas; $PM_{2.5}$ – particulate matter less than 2.5 microns in diameter; PM_{10} – particulate matter less than 10 microns in diameter; SO_2 – sulfur dioxide; NO_x – nitrogen oxides; VOC – volatile organic compound

Operations and Maintenance

During O&M, the impact-producing factors related to air quality may include long-term increases in air emissions from Project components and O&M vessels/vehicles. Dominion Energy proposes to implement measures, as appropriate, to avoid, minimize, and mitigate impacts during Project O&M. The following impact may occur as a consequence of the impact-producing factors identified above:

- Long-term increase in Project-related emissions.

Long-term increase in Project-related emissions. During the O&M stage, potential Project-related emissions will result from Project-related vessels servicing the WTGs and Offshore Substation topsides and the operation of emergency generators at each Offshore Substation topside, the Switching Station, and the Onshore Substation. GHG emissions of sulfur hexafluoride from gas-insulated switchgear installed at the Offshore Substation topsides, Switching Station, and Onshore Substation are also a source of Project-related emissions. However, Onshore Project Area activities are not considered for the purposes of the OCS air permitting threshold assessment because the OCS air regulations at 40 CFR Part 55 only apply to emission sources located on the OCS as well as vessels traveling to and from the OCS source within 25 nm of the OCS source.

As detailed in Appendix N, Air Emissions Calculations and Methodology, O&M activities are assumed to include one service operations vessel and two crew transfer vessels in routine operation, as well as limited-duration annual activities for one survey vessel, one WTG maintenance jack-up vessel, one scour protection vessel, and one cable lay vessel over the operational life of the Project. O&M support vessels are assumed to operate out of a port located in the Hampton Roads area of Virginia (Lambert's Point in Norfolk, Virginia has been used for the purpose of estimating emissions). Table 4.1-21 presents the potential O&M emissions for the Project.

Table 4.1-21. Operations and Maintenance Potential Emissions for Calendar Year 2028 Onward (tons)

Geographic Area	VOC	NO_x	CO	PM/ PM_{10}	$PM_{2.5}$	SO_2	HAP	GHG (CO_2e)
Onshore Project Area (Virginia)	0.02	1.15	55.89	0.02	0.02	1.08E-03	0.06	1,737
Onshore Project Area (Chesapeake)	0.02	1.28	62.33	0.02	0.02	1.20E-03	0.07	2,287
Onshore Project Area (Norfolk)	0.02	0.53	17.97	0.02	0.02	1.43E-03	0.02	241
Virginia State Waters	0.42	7.36	4.96	0.32	0.31	0.16	0.04	675
Federal waters outside the Outer Continental Shelf radius	0.05	0.82	0.55	0.04	0.03	0.02	4.50E-03	75
Inside Outer Continental Shelf radius	23.01	385.21	277.17	17.93	17.39	8.01	2.22	40,261
Total, All Areas	**23.53**	**396.34**	**418.87**	**18.33**	**17.79**	**8.19**	**2.41**	**45,276**

CO – carbon monoxide; CO_2e – carbon dioxide equivalent; HAP – hazardous air pollutant; GHG – greenhouse gas; $PM_{2.5}$ – particulate matter less than 2.5 microns in diameter; PM_{10} – particulate matter less than 10 microns in diameter; SO_2 – sulfur dioxide; NO_x – nitrogen oxides; VOC – volatile organic compound

Dominion Energy will ensure the following measures are taken:

- Vessels constructed on or after January 1, 2016, will meet Tier III NO_x requirements when operating within the North American Emission Control Area (200 nm [370.4 km]) established by IMO;
- Project-related vessels that are fueled exclusively at U.S.-based terminals will use ultra-low sulfur diesel fuel (containing no more than 15 ppm sulfur by weight). Project-related vessels that are fueled elsewhere will use ultra-low sulfur diesel fuel where possible, and be at or below the

maximum fuel sulfur content requirement of 1,000 ppm established per the requirements of 40 CFR § 80.510(k);

- Project-related vessels will comply with applicable EPA, or equivalent, emission standards;
- The Project will provide EPA with data on horsepower rating of all propulsion and auxiliary engines, duration of time operating in state waters, load factor, and fuel consumption for Project-related vessels to determine actual emissions from Project-related vessels, as applicable; and
- The Project will provide vessel engines and emissions control equipment information to BOEM and the EPA, as applicable, in accordance with the requirements set forth in the ROD and/or the issued OCS air permit.

Under the assumed O&M scenario, construction of the Project will be completed by the end of calendar year 2027, and emissions for calendar year 2028 onward will only include routine O&M emissions from the Project.

Most of the ongoing O&M emissions will occur inside the OCS radius and will be covered by the OCS air permit. General Conformity may potentially apply for routine O&M emissions, to be determined after further discussion with EPA and VDEQ.

The estimated Project O&M emissions values in Table 4.1-21 are based on the following Project operating assumptions:

- 500 operating hours per year per engine, for the emergency generator engines at each Offshore Substation, and the emergency generator engines at the Switching Station, Onshore Substation, and O&M facility;
- Operation of SF6-containing electrical switchgear at each Offshore Substation, at the Switching Station, and at the Onshore Substation;
- 365 operating days for the service operations vessel, with 26 annual round trips to port;
- 365 operating days for each of two crew transfer vessels, with 26 annual round trips to port per vessel;
- 60 operating days for one survey vessel, with 6 annual round trips to port;
- 30 operating days for one WTG maintenance jack-up vessel, with 2 annual round trips to port; and
- 30 operating days each for one scour protection vessel, and one cable lay vessel, each with 4 annual round trips to port.

Estimated air emissions from O&M activities are not expected to have a significant impact on regional air quality over the operational life of the Project and are generally expected to be smaller compared to the impacts anticipated during construction activities. The use of wind to generate electricity may reduce the need for electricity generation from traditional fossil fuel-powered plants that produce GHG emissions, and may result in the displacement of marginal emissions of other pollutants from fossil fuel-fired power plants.

Decommissioning

Impacts from decommissioning the Project are expected to be similar to or less than those experienced during construction. Therefore, avoidance, minimization, mitigation, and monitoring measures proposed to be implemented during decommissioning are expected to be similar to those experienced during construction, as described above. Decommissioning techniques are expected to advance during the lifetime of the Project. A full decommissioning plan will be provided to the appropriate regulatory agencies for approval prior to decommissioning activities, and potential impacts will be re-evaluated at that time. Furthermore, any future decommissioning emissions may be the subject of a future OCS air permit application.

4.1.3.4 Summary of Avoidance, Minimization, and Mitigation Measures

Dominion Energy proposes to implement the following measures to avoid, minimize, and mitigate the potential impact-producing factors described (Table 4.1-22). Dominion Energy will continue discussion and engagement with the appropriate regulatory agencies and environmental non-governmental organizations throughout the life of the Project to develop an adaptive mitigation approach that provides the most flexible and protective mitigation measures.

Table 4.1-22. Summary of Avoidance, Minimization, and Mitigation Measures

Project Stage	Location	Impact	Avoidance, Minimization and Mitigation
Construction; Decommissioning	Onshore Project Area	Short-term increase in Project-related emissions	• Most of the vessels and the onboard construction equipment will utilize diesel engines burning ultra-low sulfur fuel, while some larger construction vessels may use fuel containing up to 1,000 ppm sulfur by weight; • Onshore Project Area construction activities will primarily utilize diesel-powered equipment, including horizontal directional drilling operations, trenching/duct bank construction, and cable pulling and termination; and • Any fugitive dust generated during construction of the Onshore Project Components will be managed in accordance with the Project's Fugitive Dust Control Plan.
	Offshore Project Area	Short-term increase in Project-related emissions	• Vessels constructed on or after January 1, 2016, will meet Tier III nitrogen oxides requirements when operating within the North American Emission Control Area (200 nautical miles (nm) [370.4 kilometers [km]) established by the International Maritime Organization; • Vessels will use the highest-tier marine engines available to the Project at the time of vessel deployment; • The jack-up vessel used for WTG installation will use selective catalytic reduction for control of NOx emissions from its main engines; • Project-related vessels that are fueled exclusively at U.S.-based terminals will use ultra-low sulfur diesel fuel, and vessels fueled at marine terminals outside the U.S. will, at a minimum, be at or below the maximum fuel sulfur content requirement of 1,000 parts per million established per the requirements of 40 Code of Federal Regulations (CFR) § 80.510(k); • Diesel generator engines (i.e., both permanent and temporary non-emergency and emergency engines) will comply with the applicable requirements in New Source Performance Standards for Stationary Compression Ignition Internal Combustion Engines in 40 CFR 60 Subpart IIII;

Project Stage	Location	Impact	Avoidance, Minimization and Mitigation
			• The Project will provide EPA with data on horsepower rating of all propulsion and auxiliary engines, duration of operating time , load factor, and fuel consumption for Project-related vessels to determine actual emissions from Project-related vessels, as applicable; and • The Project will provide vessel engines and emissions control equipment information to BOEM and the EPA, as applicable, in accordance with the requirements set forth in the Record of Decision and/or the issued Outer Continental Shelf air permit.
Operations and Maintenance	Offshore Project Area	Long-term increase in Project-related emissions	• As detailed in Appendix N, Air Emissions Calculations and Methodology, operations and maintenance activities are assumed to include one service operations vessel, two crew transfer vessels, and several vessels for periodic surveys and maintenance over the operational life of the Project; • Operations and maintenance support vessels are assumed to operate out of a port located in the Hampton Roads area of Virginia (Lambert's Point in Norfolk, Virginia has been used for the purpose of estimating emissions); • Vessels constructed on or after January 1, 2016, will meet Tier III nitrogen oxides requirements when operating within the North American Emission Control Area (200 nm [370.4 km]) established by International Maritime Organization; • Vessels will use the highest-tier marine engines available to the Project at the time of vessel deployment; • Project-related vessels that are fueled exclusively at U.S.-based terminals will use ultra-low sulfur diesel fuel, and vessels fueled at marine terminals outside the U.S. will, at a minimum, be at or below the maximum fuel sulfur content requirement of 1,000 parts per million established per the requirements of 40 CFR § 80.510(k); • Permanent diesel generator engines will comply with the applicable requirements in New Source Performance Standards for Stationary Compression Ignition Internal Combustion Engines in 40 CFR 60 Subpart IIII; • The Project will provide EPA with data on horsepower rating of all propulsion and auxiliary engines, duration of operating time, load factor, and fuel consumption for Project-related vessels to determine actual emissions from Project-related vessels, as applicable; and • The Project will provide vessel engines and emissions control equipment information to BOEM and the EPA, as applicable, in accordance with the requirements set forth in the ROD and/or the issued Outer Continental Shelf air permit.
	Onshore Project Area	Long-term increase in Project-related emissions	• Onshore emergency generators will comply with applicable emission standards in 40 CFR Part 60 Subpart JJJJ and 40 CFR Part 63 Subpart ZZZZ.

4.1.4 In-Air Acoustic Environment

This section describes the regulatory framework for in-air sound, as applicable to the Project, and the affected in-air sound environment. Potential impacts to the in-air sound environment resulting from construction, O&M, and decommissioning of the Project are discussed. Project-specific measures adopted by Dominion Energy that are intended to avoid, minimize, and/or mitigate potential impacts resulting from in-air noise also are described. It is Dominion Energy's objective to successfully demonstrate compliance with all applicable noise regulations and requirements; however, exceptions and/or variances may be sought, if needed, for construction-related activities. Other resources and assessments detailed within this COP that are related to sound include:

- Underwater Acoustic Environment (Section 4.1.5);
- In-Air Acoustic Assessment (Appendix Y); and
- Underwater Acoustic Assessment (Appendix Z).

4.1.4.1 Affected Environment

The affected environment, as described below, is defined as the coastal area and Onshore Project Area that have the potential to be directly or indirectly affected by the construction, O&M, and decommissioning of the Project.

There are no federal or state noise regulations directly applicable to assessing sound impacts resulting from the Project at off-site receptors; however, construction and O&M worker exposure to Project-related sound impacts is regulated through the Occupational Health and Safety Act of 1970.

The Cable Landing Location, Onshore Export Cable Route, and Switching Station will be located in Virginia Beach, Virginia, while the Onshore Substation will be located in Chesapeake, Virginia. The Interconnection Cable Route will traverse both Virginia Beach and Chesapeake. There are local noise requirements for the Cable Landing Location, Switching Station, Onshore Substation, Onshore Export Cable Route, and Interconnection Cable Route. These restrictions will be followed unless work outside of the permitted construction timeframes is authorized by the appropriate regulatory authority.

Article II (Noise) of Chapter 23 of the Virginia Beach City Code includes provisions regulating sounds considered to be a hazard to public health, welfare, peace and safety, and quality of life that are applicable to the Project. Article II § 23-69 (Maximum sound levels and residential dwellings) of the Virginia Beach City Code provides absolute noise limits for both the nighttime and daytime periods. This section of the Code also states the following regarding construction activities that are exempt from these provisions (subparts a, b, and d):

> (a) Nighttime. No person shall permit, operate or cause any source of sound to create a sound level that can be heard in another person's residential dwelling during the hours between 10:00 p.m. and 7:00 a.m. in excess of 55 A-weighted sound levels (dBA) when measured inside the residence at least 4 feet (ft) (1.2 meter [m]) from the wall nearest the source, with doors and windows to the receiving area closed;

(b) Daytime. No person shall permit, operate or cause any source of sound to create a sound level in another person's residential dwelling during the hours between 7:00 a.m. and 10:00 p.m. in excess of 65 dBA when measured inside the residence at least 4 ft (1 m) from the wall nearest the source, with doors and windows to the receiving area closed;

(d) Exemptions. The following activities or sources of noise shall be exempt from the daytime prohibition set forth in subsection (b) of this section (subpart (d) (3)); and

(3) Activities related to the construction, repair, maintenance, remodeling or demolition, grading or other improvement of real property.

Additionally, Article II § 23-71 (Specific Prohibitions) of the Code cites limits to noise activities within proximity to defined noise-sensitive areas (NSAs) and limits construction activities to between 7:00 a.m. and 9:00 p.m., as noted in subparts e and f:

(e) Noise-sensitive areas. The making of any unreasonably loud and raucous noise within 200 ft (61 m) of any school, place of worship, court, hospital, nursing home, or assisted-living facility while the same is being used as such, that substantially interferes with the workings of the institution; and

(f) Construction equipment. The operation of any bulldozer, crane, backhoe, front loader, pile driver, jackhammer, pneumatic drill, or other construction equipment between the hours of 9:00 p.m. and 7:00 a.m. except as provided in § 23-67, or as specifically deemed necessary and authorized by a written document issued by the City manager or his designee.

Article V (Noise) of Chapter 26 of the Chesapeake City Code also includes provisions regulating sounds considered to be a hazard to public health, welfare, peace and safety, and quality of life that are applicable to the Project. Article V § 26-124 (Prohibited acts between 10:00 p.m. and 6:30 a.m.) of the Chesapeake Code prohibits construction between the hours of 10:00 p.m. and 6:30 a.m. Monday through Saturday and between 10:00 p.m. on Saturday and 8:00 a.m. Sunday.

Article V § 26-130 (Measurement procedure; maximum permitted levels) of the Chesapeake Code provides absolute noise limits for both the nighttime and daytime periods. Table 4.1-23 shows the Chesapeake maximum sound limits.

Table 4.1-23. Chesapeake Maximum Sound Levels

Area Zoning Classification or Land Use Designation in Mixed Use and Planned Unit Developments	Maximum A-weighted decibel or Measurement of Overall Sound Pressure Level	Octave Band Limit Center Frequency (Hertz)	Maximum decibel or Measurement of Maximum Sound Pressure Level in Each Octave Band
Residential	55	31.5	70
		63	69
		125	64
		250	59
		500	53
		1,000	47
		2,000	42
		4,000	38
		8,000	35

Article V § 26-131 (Penalty) of Chapter 26 of the Chesapeake City Code states that noise limits do not apply to noises emanating from any area permitted by the Virginia Division of Energy (formerly the Virginia Department of Mines, Minerals and Energy), or any division thereof. Article V § 26-131 (Exemptions) goes on to list the following exemptions:

> (13) Noises created by the operation of any power generation facility, provided that such power generation facility is located within an industrial district, that the operation of such facility is conducted less than 2,000 cumulative hours per calendar year and causes no harm to adjacent properties or residents.
>
> (15) Noises generated by the operation of heating, ventilation and air conditioning units (HVAC units) attached to a building or structure.

However, the Onshore Substation is not located within an industrial district; therefore, § 26-131 (15) is not applicable to the Project.

The acoustical modeling for the Project was conducted with the Cadna-A® acoustic model from DataKustik GmbH (version 2021 MR1, DataKustik GmbH 2021). The acoustic model is based on the International Organization for Standardization (ISO) 9613, Part 1: "Calculation of the absorption of sound by the atmosphere" (ISO 1993), and Part 2: "General method of calculation" (ISO 1996). It is used by acoustical engineers to accurately describe sound emission and propagation from complex facilities (i.e., more than one sound source) and in most cases yields conservative results of operational sound levels in the surrounding community. Model predictions are accurate to within 1 decibel (dB) of calculations based on the ISO 9613 standard.

To characterize existing ambient conditions, baseline sound measurements were conducted at the Cable Landing Location and Onshore Substation over a period of four to five non-consecutive weekdays. Baseline ambient measurement locations were pre-selected to be representative of the surrounding community and other potential NSAs near the Cable Landing Location and Onshore Substation. The ambient sound measurement locations are shown in Figure 4.1-14 and Figure 4.1-15 and include residential areas in proximity to the Project. The acoustic environment at most locations was largely influenced by vehicular traffic. Localized traffic was steady during the daytime hours, though fewer cars traversed local roads at night. Noise from Navy aircraft was observed during both daytime and nighttime at the locations associated with the Cable Landing Location. Natural sounds from birds, trees, and other wildlife also were minor sound sources in the area, as were ocean waves in coastal areas.

Table 4.1-24 summarizes the measured sound levels for each of the time periods as well as location addresses. Sound-level monitoring shows that existing nighttime equivalent sound levels (L_{eq}) range from 34 to 45 dBA. Measured ambient sound levels exhibited typical diurnal patterns, with higher ambient sound levels during the daytime ranging from 42 to 62 L_{eq} dBA. Additional detailed noise monitoring results, modeling data, and maps are included in Appendix Y, In-Air Acoustic Assessment.

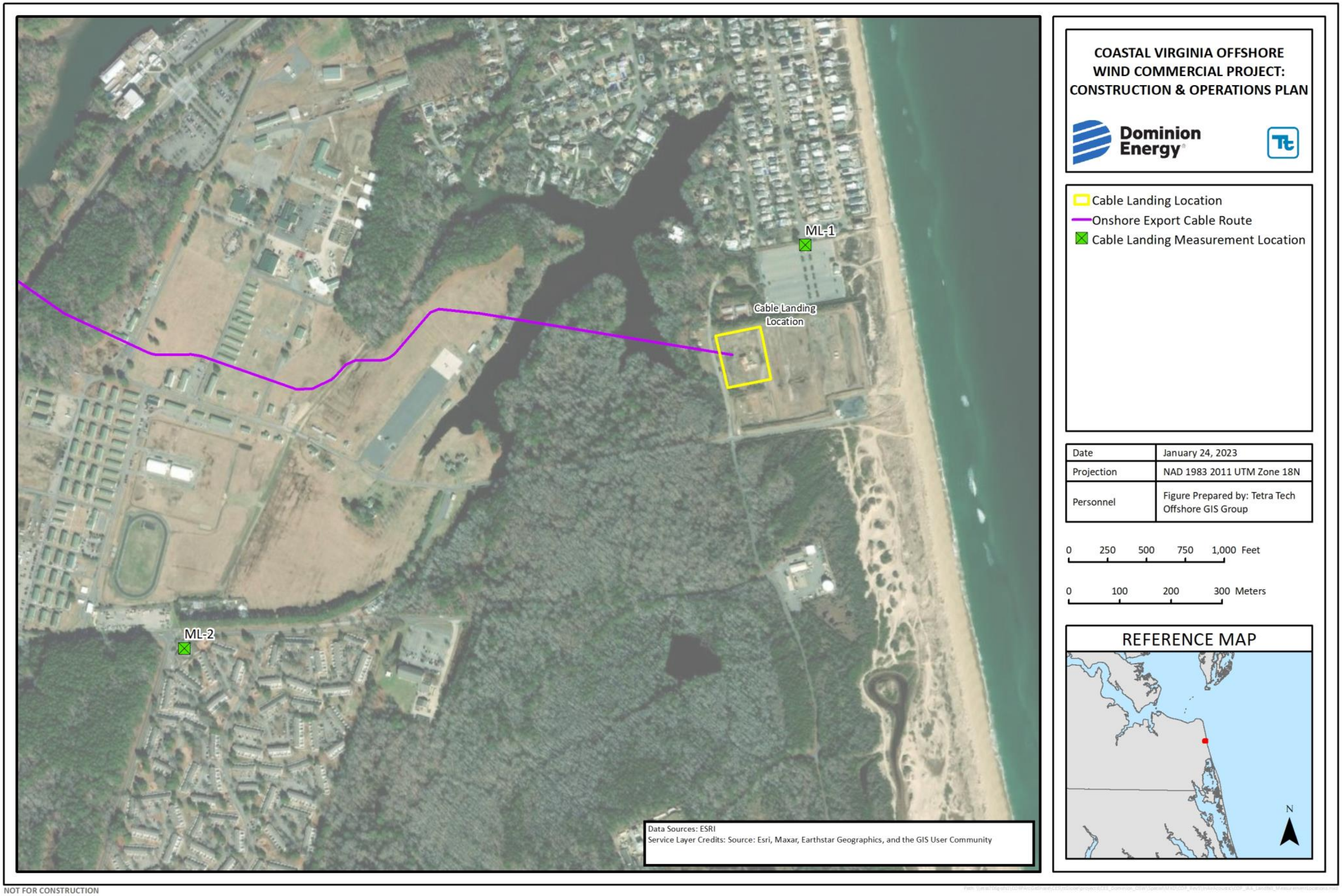
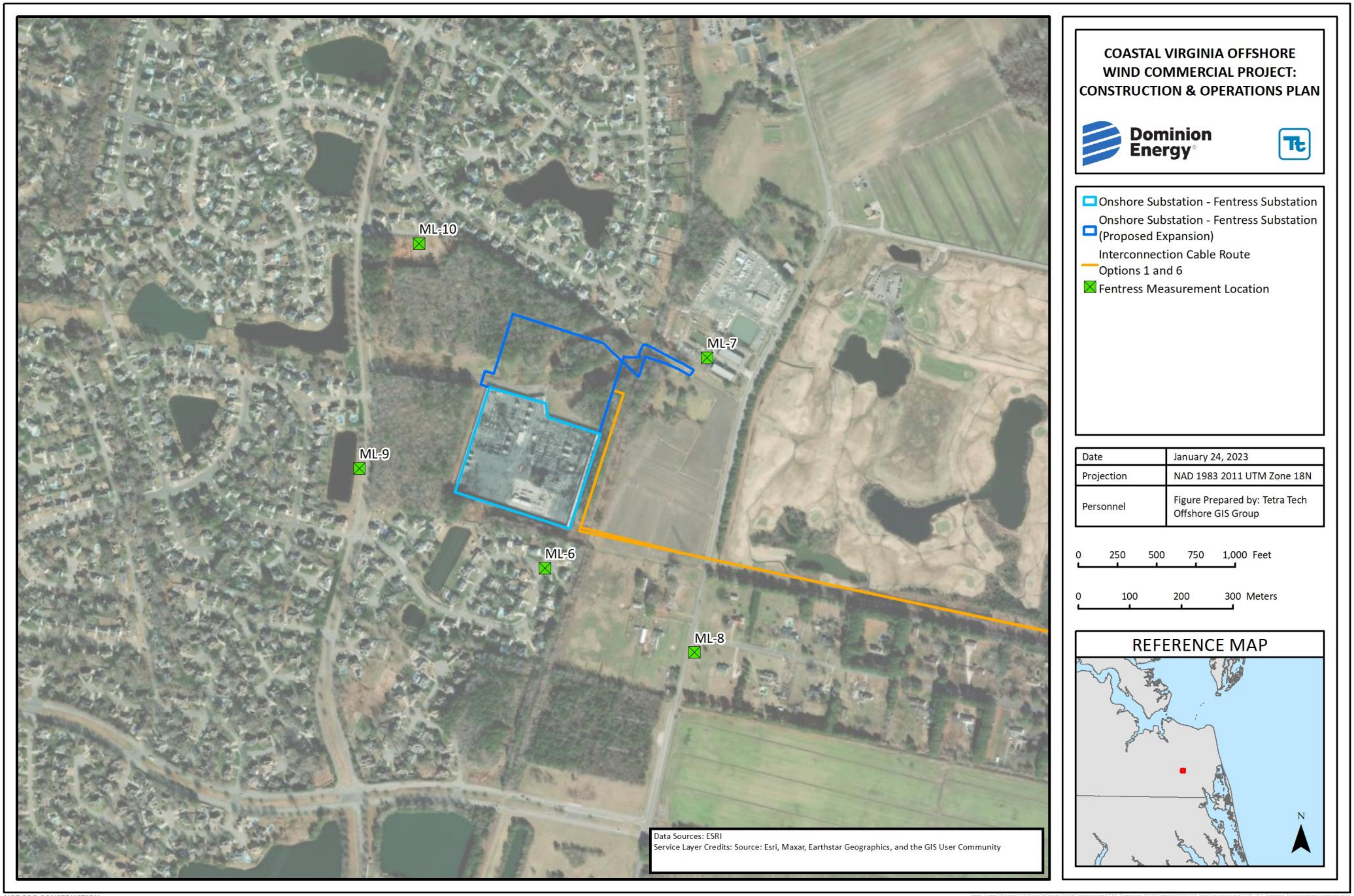


Figure 4.1-14. Cable Landing Measurement Locations



NOT FOR CONSTRUCTION

Figure 4.1-15. Onshore Substation Measurement Locations

Table 4.1-24. Sound Level Monitoring Results

Site	Monitoring Location	UTM Coordinates		Time Period	Sound Level (dBA L_{eq})
		Easting	Northing		
Cable Landing Location	ML-1	413605	4075152	Day	42
				Night	43
Cable Landing Location	ML-2	412387	4074361	Day	53
				Night	45
Onshore Substation	ML-6	393734	4060943	Day	46
				Night	35
Onshore Substation	ML-7	394049	4061352	Day	54
				Night	34
Onshore Substation	ML-8	394024	4060779	Day	62
				Night	39
Onshore Substation	ML-9	393373	4061137	Day	55
				Night	37
Onshore Substation	ML-10	393489	4061574	Day	44
				Night	39

dBA L_{eq} – A-weighted sound levels equivalent sound level; UTM – Universal Transverse Mercator
Note: Monitoring Locations are not numbered consecutively since locations ML-3, ML-4, and ML-5 are no longer included in the Project Design Envelope (PDE).

4.1.4.2 Impact Analysis for Construction, Operations and Maintenance, and Decommissioning

The potential impact-producing factors resulting from the construction, O&M, and decommissioning of the Project are based on the maximum design scenario from the Project Design Envelope (see Section 3, Description of Proposed Activity).

Construction

During construction, the potential impact-producing factors to the in-air sound environment may include construction of the Project Components. For in-air sound, the Onshore Project Area maximum design scenario is the construction, installation, and O&M of the Cable Landing Location, Onshore Export Cable Route, Switching Station, Onshore Substation, and Interconnection Cable Route. For the Offshore Project Area, the maximum design scenario is the maximum number of monopile foundations. Dominion Energy proposes to implement measures, as appropriate, to avoid, minimize, and mitigate impacts during Project construction. The following impacts may occur as a consequence of the factors identified above:

- Short-term elevated in-air noise levels associated with vibratory pile-driving at the cofferdam for the Trenchless Installation (Direct Steerable Pipe Thrusting [DSPT]) exit at the Offshore Trenchless Installation Punch-Out location;
- Short-term elevated in-air noise levels associated with nearshore Trenchless Installation at the Cable Landing Location and at the onshore cable crossing locations;
- Short-term elevated in-air noise levels associated with construction of the Onshore Export Cable Route, Switching Station, Interconnection Cable Route, and Onshore Substation;

- Short-term elevated in-air noise levels associated with impact pile-driving of the WTG Monopile Foundations and Offshore Substation Jacket Foundations; and
- Short-term elevated in-air noise levels associated with offshore support vessels.

Short-term elevated in-air noise levels associated with vibratory pile-driving at the cofferdam for Trenchless Installation exit at the Offshore Trenchless Installation Punch-Out location. The installation of sheet pile for the nearshore cofferdam would require the use of vibratory pile-driving installation, and is estimated to produce sound levels of 66 dBA in-air at the nearest onshore receptor at a distance of 1,070 ft (326 m). The schedule for vibratory pile-driving is expected to be from 1 to 2 days in duration. As this construction activity would last for a relatively short duration of time and would be limited to daytime periods unless deemed acceptable from the appropriate regulatory authority, it is not expected to constitute a violation of local nuisance by-laws or ordinances, nor result in a potential imminent hazard to public health or the environment; therefore, no mitigation measures are expected.

Short-term elevated in-air noise levels associated with Trenchless Installation at the Cable Landing Location and at the Onshore Cable Crossing Locations. Within the Cable Landing Location at the Proposed Parking Lot west of the Firing Range at SMR, there would be a total of nine Trenchless Installation locations that would be constructed consecutively and not concurrently. For the Cable Landing Location, the most northern and southern Trenchless Installation locations were modeled, which are the worst-case locations due to their proximity to receptors.

In addition to the trenchless construction at the landfall location, there will be five sections along the onshore cable route that will require Trenchless Installation for crossings. Each of the five sections will have an entry and exit Trenchless Installation location, which was assessed as operating simultaneously. The five sections will operate consecutively and not concurrently.

Trenchless Installation construction equipment consists of drill rigs and auxiliary support equipment, including electric mud pumps, portable generators, mud mixing and cleaning equipment, forklifts, loaders, cranes, trucks, and portable light plants. Table 4.1-25 presents the Trenchless Installation construction components included in the analysis. Once the Trenchless Installation and pull-back is complete, noise from the Cable Landing Location and cable crossing locations would be limited to typical construction activities associated with equipment such as tracked graders, backhoes, and pickup trucks.

Table 4.1-25. Trenchless Installation Construction Equipment Listing

Trenchless Installation Equipment Component	Sound Level without Acoustical Treatment (A-weighted decibel)	Sound Level with Acoustical Treatment (A-weighted decibel)
Trenchless Installation drill rig and power unit	102	88
Drilling mud mixer/recycling unit	90	85
Mud pumping unit	102	85
Generator set, 100 kilowatts	100	80
Generator set, 200 kilowatts	102	80
Vertical sump pump	75	75

Source: HFP Acoustic Consultant Corp., n.d.

Since construction activities would be limited to the daytime period, Trenchless Installation construction activities would occur during the daytime period unless a situation arises that would require operation to continue into the night or as deemed acceptable from the appropriate regulatory authority. Dominion Energy would consult with the appropriate regulatory agency regarding nighttime work in the case of an emergency, to the extent practicable. In the case of nighttime operations, only the drill rig, power unit, and light banks would be used unless otherwise deemed acceptable from the appropriate regulatory authority. The predicted sound levels at the closest NSAs for the Cable Landing Location is summarized in Table 4.1-26 and for the five cable crossing sections in Table 4.1-27. The distance from each NSA to the closest active Trenchless Installation location is also provided. Figures showing the NSA locations can be found in Appendix Y (Figures Y-9, Y-10, and Y-11).

Table 4.1-26. Sound Levels during Trenchless Installation

Noise-Sensitive Area	NSA Type	Proposed Parking Lot, West of the Firing Range at the State Military Reservation			
		Distance to Northern Trenchless Installation (feet)	Northern Trenchless Installation Sound Level/ (dBA)	Distance to Southern Trenchless Installation (feet)	Southern Trenchless Installation Sound Level (dBA)
NSA L-1	Residential	260	53	320	48
NSA L-2	Residential	225	55	290	53
NSA L-3	Residential	200	56	270	54
NSA L-4	Residential	170	57	245	55
NSA L-5	Residential	160	58	240	55
NSA L-6	Residential	155	56	245	52
NSA L-7	Residential	158	51	245	48
NSA L-8	Residential	245	51	300	47
NSA L-9	Residential	385	47	460	43
NSA L-10	Residential	960	38	915	40

Short-term elevated in-air noise levels associated with construction of the Onshore Export Cable Route, Switching Station, Interconnection Cable Route, and Onshore Substation. The construction of the Onshore Export Cable Route, Switching Station, Interconnection Cable Route, and Onshore Substation would result in a temporary increase in sound levels near these activities from the use of construction equipment. The noise levels resulting from construction activities would vary greatly depending on factors such as the type of equipment and the operations being performed and could be periodically audible from off-site locations at certain times.

The EPA has published data on the L_{eq} sound levels for typical construction stages (EPA 1971). Following the EPA method, sound levels were projected at four different distances that would encompass the neighborhoods surrounding the Onshore Export Cable Route, Switching Station, Interconnection Cable Route, and Onshore Substation. This calculation conservatively assumes all equipment operating concurrently on site for the specified construction stage and no sound attenuation for ground absorption or on-site shielding by the existing buildings or structures. The results of these calculations are presented in Table 4.1-28 and show how estimated construction sound levels would vary depending on construction stage and distance, with the highest levels expected in proximity to the closest neighborhoods during the site grading and compaction stage.

Table 4.1-27. Sound Levels during Onshore Route Trenchless Installation Construction

Noise-Sensitive Area	NSA Type	Section 1		Section 2		Section 3		Section 4		Section 5	
		Distance (feet)	Sound Level (dBA)	Distance (feet)	Sound Level (dBA)	Distance (feet)	Sound Level (dBA)	Distance (feet)	Sound Level (dBA)	Distance (feet)	Sound Level (dBA)
NSA HDD-1	Residential	380	47	758	38	-	-	-	-	-	-
NSA HDD-2	Residential	1,115	36	660	43	-	-	-	-	-	-
NSA HDD-3	Residential	-	-	575	44	-	-	-	-	-	-
NSA HDD-4	Residential	-	-	615	43	-	-	-	-	-	-
NSA HDD-5	Residential	-	-	-	-	465	47	-	-	-	-
NSA HDD-6	Residential	-	-	-	-	1,500	35	155	58	-	-
NSA HDD-7	Residential	-	-	-	-	1,350	36	60	64	-	-
NSA HDD-8	Residential	-	-	-	-	1,350	36	90	61	-	-
NSA HDD-9	Residential	-	-	-	-	1,420	35	64	65	-	-
NSA HDD-10	Residential	-	-	-	-	1,520	34	63	64	-	-
NSA HDD-11	Residential	-	-	-	-	1,680	33	62	57	-	-
NSA HDD-12	Residential	-	-	-	-	-	-	170	36	440	46
NSA HDD-13	Residential	-	-	-	-	-	-	-	-	280	51
NSA HDD-14	Residential	-	-	-	-	-	-	-	-	265	51
NSA HDD-15	Residential	-	-	-	-	-	-	-	-	265	52
NSA HDD-16	Residential	-	-	-	-	-	-	-	-	265	52
NSA HDD-17	Residential	-	-	-	-	-	-	-	-	450	46
NSA HDD-18	Residential	-	-	-	-	-	-	-	-	450	47
NSA HDD-19	Residential	-	-	-	-	-	-	-	-	415	48
NSA HDD-20	Residential	-	-	-	-	-	-	-	-	111	59
NSA HDD-21	Residential	-	-	-	-	-	-	-	-	105	59
NSA HDD-22	Residential	-	-	-	-	-	-	-	-	85	61
NSA HDD-23	Residential	-	-	-	-	-	-	-	-	95	60

Table 4.1-28. General Construction Noise Levels

Stage No.	Construction Stage	Example Construction Equipment	Equipment Noise Level at 50 feet (ft; 15 meters [m]) A-weighted decibels	Operational Usage Factor (%)	Composite Noise Level, dBA			
					50 ft (15 m)	250 ft (76 m)	500 ft (152 m)	1,000 ft (305 m)
1	Site Clearing	Tracked Dozer Skid Steer Excavator Wheeled Loader Water Truck	88 70 80 80 80	40 40 40 40 40	85	71	65	59
2	Site Grading	Excavator Tracked Dozer Skid Steer Off-Road Truck Grader Roller-Compactor Wheeled Loader Backhoe-Loader Water Truck	80 88 70 70 82 75 80 80 80	40 40 40 40 40 20 40 40 40	87	73	67	61
3	Excavation and Foundations	Excavator Backhoe-loader Skid-Steer loader Wheeled loader Auger rig Tracked dozer Cement mixer truck Water truck	80 80 70 80 85 88 80 80	40 40 40 40 20 40 40 40	87	73	67	61
4	Building Erection	Wheeled loader Mobile crane Forklift Flatbed truck Dump truck Cement mixer truck Water truck	80 82 80 75 80 80 80	40 16 40 40 40 40 40	84	70	64	58
5	Equipment Installation	Compressor Mobile crane Forklift Wheeled loader Dump truck Specialty truck Water truck	81 82 80 80 80 75 80	40 16 40 40 40 40 40	84	70	64	58

In addition to the above-listed construction equipment, pile driving may be needed to install the foundation for the Onshore Substation and Switching Station. The pile driving technique, vibratory or impact, has not been selected at this stage of Project design. In the event that vibratory pile driving is selected, noise levels would be expected to be consistent with those reported during the excavation stage of construction. If impact pile driving is required, higher noise levels may be produced for temporary short-term periods (Blackwell et al. 2004; Ghebreghzabiher 2017; Illingworth and Rodkin 2012; Laughlin 2007, 2010; U.S.

Navy 2015; Soderberg 2016; Soderberg and Laughlin 2016a, 2016b; U.S. Department of Transportation 2012).

Due to the character of the impulsive sound they produce, impact pile drivers are not typically analyzed in combination with non-impulsive construction sound sources such as heavy-duty vehicles. Impulsive sounds are typically transient, brief (less than one second), broadband, and consist of high peak sound pressure with rapid rise time and rapid decay. Non-impulsive sound can be broadband, narrowband or tonal, brief or prolonged, continuous or intermittent) and typically do not have a high peak sound pressure with rapid rise/decay time that impulsive sounds do. Noise is generated from pile drivers from both the ram striking the pile as well as the operating steam, air, or diesel exhaust as it is exhausted from the cylinder (this is not present with hydraulic impact hammers). Assuming an approximate impact rate of 1,400 blows per minute, a sound pressure level of 111 dBA at 20 ft (6 m) is estimated (Blackwell et al. 2004; Ghebreghzabiher 2017; Illingworth and Rodkin 2012; Laughlin 2007, 2010a; U.S. Navy 2015; Soderberg 2016; Soderberg and Laughlin 2016a, 2016b). Assuming a load or usage factor of 20 percent, it is expected that sound from pile driving would attenuate to 70 dBA at a distance of approximately 1,000 ft (305 m) and would attenuate to below 60 dBA within 1 mile (1.6 km) of this construction activity, depending on meteorological and topographical effects.

Construction is exempt from the City of Virginia Beach noise regulations during the day, and limited to daytime hours in the City of Chesapeake; however, Dominion Energy proposes to implement the following measures to avoid, minimize, and mitigate impacts:

- Construction would be limited to the daytime period unless deemed acceptable from the appropriate regulatory authority;
- Construction equipment would be well-maintained, and vehicles using internal combustion engines equipped with mufflers would be routinely checked to ensure they are in good working order;
- Construction equipment would be located as far as practicable from NSAs;
- If noise issues are identified, Dominion Energy would install moveable temporary noise barriers as close to the sound sources as possible, which have been shown to effectively reduce sound levels by 5 to 15 dBA; and
- A Project Communications Plan would be made available to help actively address all noise-related issues in a timely manner.

Short-term elevated in-air noise levels associated with impact pile-driving of WTG Monopile Foundations and Offshore Substation Jacket Foundations. During construction, pile-driving of the WTG Monopile Foundations and Offshore Substation Jacket Foundations would generate noise (see Section 4.1.5, Underwater Acoustic Environment, and Appendix Z, Underwater Acoustic Assessment, for details on the level of impact anticipated under water). Acoustic modeling was conducted for noise produced from impact pile-driving of two WTG monopile foundations at the closest and farthest representative location relative to the shoreline, as this is anticipated to represent the average impact scenario for this activity. Based on the modeling, pile-driving activities are estimated to produce sound pressure level (L_P) of 87 dBA in-air at a distance of 400 ft (122 m), with a corresponding L_w at the source of 137 dBA (U.S. Department of Transportation 2012).

The highest predicted in-air sound level at any onshore location during pile-driving is less than 30 dBA, which is well below all applicable noise regulations. Given the extended distances between the Offshore Project Area and coastal shorelines (approximately 28 and 42 miles [45 and 67 kilometers]), no negative impacts are expected. Offshore, mariners may be potentially disturbed due to the sound levels generated from pile-driving. However, these installation activities are anticipated to be short term and mariners are not expected to be in the immediate area during installation for safety. If the final design engineering requires sound mitigation measures, such measures would be implemented within the Project footprint, as necessary.

Short-term elevated in-air noise levels associated with offshore support vessels. During construction, Project-related vessels would be utilized to transport personnel and materials and to install Offshore Project Components. The International Maritime Organization (IMO) has established noise limits, which are detailed in the regulatory guidance document, “Noise Levels on Board Ships,” which contains the code for noise levels onboard ships (IMO 1981, 1975). In terms of sound generation limits of vessels, resolution A.468 limits received noise levels to 70 dBA at designated listening stations at the navigation bridge and windows during normal sail and operational conditions. In addition, the IMO further limits noise to 75 dBA at external areas and rescue stations. The vessels used for nearshore work and vessels transiting between Project ports and the Offshore Project Area would comply with these IMO noise standards, as applicable.

Nearshore, noise associated with Offshore Export Cable Route installation activities would occur within the established Offshore Export Cable Route Corridor. Therefore, no shoreline NSAs would be exposed to significant noise levels for an extended period of time as the equipment moves away from shore. Due to the relatively short duration, it is not anticipated that construction activities associated with the installation of the Offshore Export Cable Route would cause any significant impact in the communities located along the shoreline; therefore, no mitigation measures are expected.

Operations and Maintenance

During O&M, the potential impact-producing factors to the in-air acoustic environment may include O&M activities associated with the Project Components. Dominion Energy proposes to implement measures, as appropriate, to avoid, minimize, and mitigate impacts during Project O&M. The following impacts may occur as a consequence of the factors identified above:

- Long-term elevated in-air sound levels associated with the Switching Stations and Onshore Substation;
- Short-term elevated in-air sound levels associated with O&M activities; and
- Long-term elevated in-air sound levels associated with the WTGs, Offshore Substation, and, as necessary, operation of sound signals.

Long-term elevated in-air sound levels associated with the Switching Stations and Onshore Substation. During O&M, the Switching Station and Onshore Substation equipment is anticipated to generate operational sound. Acoustic modeling of the Switching Station and Onshore Substation components was completed in support of this COP and can be found in Appendix Y, In-Air Acoustic Assessment. The Switching Station and Onshore Substation were modeled as a conceptual layout because the final layout is not available at this time; therefore, it is possible that the final warranty sound specifications could vary slightly. Dominion Energy will only be installing new equipment in the expansion area for the Onshore Substation, and no new equipment will be installed within the current Onshore Substation footprint. The received sound levels were evaluated at the NSAs located closest to the Switching Station and Onshore Substation sites.

As shown in Table 4.1-29, Table 4.1-30, and Table 4.1-31, compliance is demonstrated with the most conservative applicable regulatory limit, the Virginia Beach nighttime noise limit of 55 dBA L_{eq} for the Switching Station and the Chesapeake nighttime noise limit of 55 dBA L_{eq} for the Onshore Substation. The Chesapeake octave-band noise limits are addressed in Table 4.1-32 for the Onshore Substation. During operations, the Project will be in compliance with relevant City of Virginia Beach and City of Chesapeake noise requirements. If the final design engineering requires sound mitigation measures, they will be implemented within the Project footprint, as necessary.

Table 4.1-29. Chicory Switching Station: Night-time L_{eq} Sound Levels at the Closest NSAs

Location	NSA Type	Distance (meters)	Regulatory Limit (dBA L_{eq})	Modeling Results (dBA L_{eq})
NSA-CH-1	Residential	510	55	31
NSA-CH-2	Residential	100	55	35
NSA-CH-3	Residential	35	55	53
NSA-CH-4	Residential	475	55	39
NSA-CH-5	Residential	560	55	36

Table 4.1-30. Harper's Switching Station: Night-time L_{eq} Sound Levels at the Closest NSAs

Location	NSA Type	Distance (meters)	Regulatory Limit (dBA L_{eq})	Modeling Results (dBA L_{eq})
NSA-HA-1	Residential	520	55	37
NSA-HA-2	Residential	370	55	40
NSA-HA-3	Residential	440	55	39
NSA-HA-4	Residential	100	55	43
NSA-HA-5	Residential	120	55	41
NSA-HA-6	Residential	220	55	37

Table 4.1-31. Fentress Onshore Substation (Expansion Only): Night-time L_{eq} Sound Levels at the Closest NSAs

Location	NSA Type	Distance (meters)	Regulatory Limit (dBA L_{eq})	Modeling Results (dBA L_{eq})
NSA-FE-1	Residential	110	55	48
NSA-FE-2	Residential	50	55	50
NSA-FE-3	Residential	85	55	48
NSA-FE-4	Residential	70	55	48
NSA-FE-5	Residential	80	55	47
NSA-FE-6	Residential	90	55	46
NSA-FE-7	Residential	90	55	45
NSA-FE-8	Residential	100	55	44
NSA-FE-9	Residential	110	55	42
NSA-FE-10	Residential	130	55	41

Location	NSA Type	Distance (meters)	Regulatory Limit (dBA L_{eq})	Modeling Results (dBA L_{eq})
NSA-FE-11	Residential	150	55	40
NSA-FE-12	Residential	160	55	40
NSA-FE-13	Residential	185	55	39
NSA-FE-14	Residential	210	55	39
NSA-FE-15	Residential	220	55	38
NSA-FE-16	Residential	255	55	38
NSA-FE-17	Residential	280	55	37
NSA-FE-18	Residential	295	55	37
NSA-FE-19	Residential	320	55	37
NSA-FE-20	Residential	370	55	37
NSA-FE-21	Residential	350	55	37
NSA-FE-22	Residential	375	55	37
NSA-FE-23	Residential	420	55	37
NSA-FE-24	Residential	400	55	37
NSA-FE-25	Residential	390	55	38
NSA-FE-26	Residential	360	55	38
NSA-FE-27	Residential	355	55	39
NSA-FE-28	Residential	355	55	39
NSA-FE-29	Residential	260	55	41
NSA-FE-30	Residential	275	55	40
NSA-FE-31	Residential	310	55	40
NSA-FE-32	Residential	340	55	39
NSA-FE-33	Residential	345	55	39
NSA-FE-34	Residential	355	55	39
NSA-FE-35	Residential	365	55	39
NSA-FE-36	Residential	380	55	39
NSA-FE-37	Residential	395	55	39
NSA-FE-38	Residential	420	55	38
NSA-FE-39	Residential	430	55	38
NSA-FE-40	Residential	410	55	39
NSA-FE-41	Residential	390	55	39
NSA-FE-42	Residential	350	55	40
NSA-FE-43	Residential	360	55	40
NSA-FE-44	Residential	315	55	41
NSA-FE-45	Residential	300	55	42
NSA-FE-46	Residential	310	55	42
NSA-FE-47	Residential	340	55	41
NSA-FE-48	Residential	370	55	40
NSA-FE-49	Residential	400	55	40
NSA-FE-50	Residential	360	55	40
NSA-FE-51	Residential	340	55	41
NSA-FE-52	Residential	290	55	42
NSA-FE-53	Residential	260	55	43
NSA-FE-54	Residential	240	55	43
NSA-FE-55	Residential	230	55	43

Location	NSA Type	Distance (meters)	Regulatory Limit (dBA L_{eq})	Modeling Results (dBA L_{eq})
NSA-FE-56	Residential	250	55	43
NSA-FE-57	Residential	230	55	43
NSA-FE-58	Residential	345	55	40
NSA-FE-59	Residential	490	55	37

Table 4.1-32. Fentress Onshore Substation: Night-time Octave Band L_{eq} Sound Levels at the Closest NSAs

Location	Distance (meters)	Modeling Results (dbA L_{eq}) per Octave Band (Hz)								
		31.5	63	125	250	500	1,000	2,000	4,000	8,000
Noise Limit		**70**	**69**	**64**	**59**	**53**	**47**	**42**	**38**	**35**
NSA-FE-1	110	9	28	38	37	43	42	38	28	3
NSA-FE-2	50	11	30	40	40	46	45	40	32	14
NSA-FE-3	85	10	28	38	38	44	42	38	29	8
NSA-FE-4	70	10	29	38	38	44	43	38	30	10
NSA-FE-5	80	9	28	37	37	43	42	37	28	6
NSA-FE-6	90	8	27	36	36	42	41	36	27	2
NSA-FE-7	90	7	26	35	35	41	40	35	25	0
NSA-FE-8	100	6	25	34	34	40	38	34	23	0
NSA-FE-9	110	5	24	33	32	38	37	32	21	0
NSA-FE-10	130	5	23	32	31	37	36	31	19	0
NSA-FE-11	150	4	22	31	30	36	35	29	17	0
NSA-FE-12	160	3	22	30	30	35	34	28	16	0
NSA-FE-13	185	3	21	30	29	35	33	27	14	0
NSA-FE-14	210	2	21	29	29	35	33	27	14	0
NSA-FE-15	220	2	20	28	28	34	32	26	12	0
NSA-FE-16	255	2	20	28	28	33	32	26	12	0
NSA-FE-17	280	1	20	28	27	33	31	25	10	0
NSA-FE-18	295	1	20	28	28	33	32	25	10	0
NSA-FE-19	320	1	20	28	28	33	31	25	9	0
NSA-FE-20	370	1	19	27	27	33	31	24	8	0
NSA-FE-21	350	1	20	28	28	34	32	25	9	0
NSA-FE-22	375	1	20	28	28	33	32	25	8	0
NSA-FE-23	420	1	19	27	27	33	31	24	7	0
NSA-FE-24	400	1	19	27	27	33	31	24	7	0
NSA-FE-25	390	1	20	28	28	34	32	25	9	0
NSA-FE-26	360	1	20	28	28	34	32	26	9	0
NSA-FE-27	355	2	21	29	29	35	33	27	10	0
NSA-FE-28	355	2	21	29	29	35	33	27	10	0
NSA-FE-29	260	3	22	31	31	37	35	29	15	0
NSA-FE-30	275	3	22	31	31	36	35	29	14	0
NSA-FE-31	310	2	21	30	30	36	34	28	12	0
NSA-FE-32	340	2	21	29	29	35	33	27	11	0
NSA-FE-33	345	2	21	29	29	35	33	27	11	0
NSA-FE-34	355	2	21	29	29	35	33	27	10	0
NSA-FE-35	365	2	21	29	29	35	33	27	10	0

Location	Distance (meters)	Modeling Results (dbA L_{eq}) per Octave Band (Hz)								
		31.5	63	125	250	500	1,000	2,000	4,000	8,000
Noise Limit		**70**	**69**	**64**	**59**	**53**	**47**	**42**	**38**	**35**
NSA-FE-36	380	1	20	29	29	35	33	26	9	0
NSA-FE-37	395	1	20	29	29	35	33	26	9	0
NSA-FE-38	420	1	20	29	29	35	33	26	8	0
NSA-FE-39	430	1	20	28	29	34	33	26	8	0
NSA-FE-40	410	1	20	29	29	35	33	26	9	0
NSA-FE-41	390	2	21	29	29	35	34	27	10	0
NSA-FE-42	350	2	21	30	30	36	34	28	12	0
NSA-FE-43	360	2	21	30	30	36	35	28	12	0
NSA-FE-44	315	3	22	31	31	37	36	29	15	0
NSA-FE-45	300	4	22	32	32	38	36	30	16	0
NSA-FE-46	310	4	22	32	32	38	36	30	16	0
NSA-FE-47	340	3	22	31	31	37	35	29	14	0
NSA-FE-48	370	3	21	31	31	36	35	28	13	0
NSA-FE-49	400	2	21	30	30	36	34	28	11	0
NSA-FE-50	360	3	22	31	31	37	35	29	13	0
NSA-FE-51	340	3	22	31	31	37	35	29	15	0
NSA-FE-52	290	4	22	32	32	38	36	30	16	0
NSA-FE-53	260	5	23	33	33	39	38	32	19	0
NSA-FE-54	240	5	24	34	33	39	38	32	20	0
NSA-FE-55	230	5	24	34	34	39	38	32	19	0
NSA-FE-56	250	5	23	34	34	39	38	32	19	0
NSA-FE-57	230	5	23	33	33	39	37	32	19	0
NSA-FE-58	345	2	21	30	30	36	34	28	12	0
NSA-FE-59	490	0	19	27	28	33	31	24	5	0

Short-term elevated in-air sound levels associated with O&M activities. Routine Project inspections and maintenance would occur periodically, but are not expected to result in significant noise generation. General maintenance would include on-site component safety inspections, including possible repair or replacement of equipment. Vehicular traffic noise generated during maintenance and inspection of Onshore Project Components would be of short duration and is not expected to result in adverse noise impacts. Project-related vessels and helicopters would be utilized to transport personnel to Offshore Project Components for maintenance activities but are not expected to result in significant noise generation or significantly add to offshore vessel traffic. As with construction, these vessels and helicopters transiting between Project ports and the Offshore Project Area would comply with IMO noise standards, as applicable; therefore, no mitigation measures are expected.

Long-term elevated in-air sound levels associated with WTGs, Offshore Substation, and, as necessary, operation of sound signals. During O&M, an increase in in-air sound levels resulting from the WTGs and Offshore Substation is expected; however, it would be below audibility thresholds at all coastal areas due to the distance from shore, as well as the masking effect (e.g., sound of waves and wind would mask the sound generated by the WTG rotation and Offshore Substation equipment). As necessary, sound signals specified by the USCG may be used during the operation of WTGs and the Offshore Substation.

Offshore, mariners may be impacted due to the slightly higher sound levels resulting from WTGs and Offshore Substation operation, depending on their distance relative to the structures, but this effect would be well below relevant Occupational Health and Safety Act health and safety requirements, even in immediate proximity of the WTGs and Offshore Substation; therefore, no mitigation measures are expected.

Decommissioning

Impacts from decommissioning the Project are expected to be similar to or less than those experienced during construction. Therefore, avoidance, minimization, mitigation, and monitoring measures proposed to be implemented during decommissioning are expected to be similar to those experienced during construction, as described above. Decommissioning techniques are expected to advance during the lifetime of the Project. A full decommissioning plan will be provided to the appropriate regulatory agencies for approval prior to decommissioning activities, and potential impacts would be re-evaluated at that time.

4.1.4.3 Summary of Avoidance, Minimization, and Mitigation Measures

Dominion Energy proposes to implement the following measures to avoid, minimize, and mitigate the potential impact-producing factors described (Table 4.1-33). Dominion Energy will continue discussions and engagement with the appropriate regulatory agencies and environmental non-governmental organizations throughout the life of the Project to develop an adaptive mitigation approach that provides the most flexible and protective mitigation measures.

Table 4.1-33. Summary of Avoidance, Minimization, and Mitigation Measures

Project Stage	Location	Impact	Avoidance, Minimization and Mitigation
Construction; Decommissioning	Onshore Project Area	Short-term elevated in-air noise levels associated with vibratory pile-driving at the cofferdam for Trenchless Installation exit at the Offshore Trenchless Installation Punch-Out location Short-term elevated in-air noise levels associated with Trenchless Installation at the Cable Landing Location and the onshore cable crossing locations Short-term elevated in-air noise levels associated with construction of the Onshore Export Cable Route, Switching Station, Interconnection Cable Route, and Onshore Substation	• Trenchless Installation activities would occur during the daytime period unless a situation arises that would require operation to continue into the night or as deemed acceptable from the appropriate regulatory authority; • Dominion Energy would consult with the appropriate regulatory agency regarding nighttime work in the case of an emergency. In the case of nighttime operations, only the onshore-based drill and hydraulic pipe thruster rig, pipe rigging/handling equipment, power unit(s), and light banks would be used unless otherwise deemed acceptable from the appropriate regulatory authority; • If necessary, subject to regulatory requirements and stakeholder engagement, Dominion Energy would install moveable temporary noise barriers as close to the sound sources as possible, which have been shown to effectively reduce sound levels by 5 to 15 A-weighted decibels (dBA); • Dominion Energy would limit construction to the daytime period unless deemed acceptable from the appropriate regulatory authority; • Dominion Energy would ensure construction equipment is well maintained and vehicles using internal combustion engines equipped

Project Stage	Location	Impact	Avoidance, Minimization and Mitigation
			with mufflers would be routinely checked to ensure they are in good working order; • Dominion Energy would ensure construction equipment is located as far as practicable from noise-sensitive areas; • and • Dominion Energy would make a Project Communications Plan available to help actively address all noise-related issues in a timely manner.
	Offshore Project Area	Short-term elevated in-air noise levels associated with impact pile-driving of Wind Turbine Generator Foundation and Offshore Substation Jacket Foundations	• If the final design engineering requires sound mitigation measures, Dominion Energy would implement such measures within the Project footprint, as necessary.
		Short-term elevated in-air noise levels associated with offshore support vessels	
Operations and Maintenance	Onshore Project Area	Long-term elevated in-air sound levels associated with Switching Station and Onshore Substation	• If the final design engineering requires sound mitigation measures, Dominion Energy would implement such measures within the Project footprint, as necessary.
		Short-term elevated in-air sound levels associated with operations and maintenance activities	
	Offshore Project Area	Long-term elevated in-air sound levels associated with the Wind Turbine Generators, Offshore Substation, and, as necessary, operation of sound signals.	• No mitigation measures are expected for the Offshore Project Area.

4.1.5 Underwater Acoustic Environment

This section describes the regulatory framework for underwater sound, as applicable to the Project, and the affected underwater acoustic environment. Potential impacts to the underwater sound environment resulting from construction, operation, and decommissioning of the Project are discussed. Avoidance, minimization, and mitigation measures proposed by Dominion Energy are also described in this section.

Other resources and assessments detailed within this COP that are related to sound include:

- In-Air Acoustic Environment (Section 4.1.4);
- Benthic Resources, Fishes, Invertebrates, and Essential Fish Habitat (Section 4.2.4);
- Marine Mammals (Section 4.2.5);
- Sea Turtles (Section 4.2.6);
- In-Air Acoustic Assessment (Appendix Y);
- Underwater Acoustic Assessment (Appendix Z);
- Construction Mitigation and Monitoring Plan (Appendix FF); and
- Underwater Acoustic Impact Assessment of Pile Driving During Construction (Appendix GG).

The Underwater Acoustic Assessment and modeling analysis reflects feedback provided by NOAA Fisheries and BOEM, where further detail was requested regarding pile driving sound source development and sound propagation modeling. Additional assumptions and information pertaining to pile driving sound source development and sound propagation modeling have been provided as Attachments Z-1, Z-2, and Z-3 in Appendix Z, Underwater Acoustic Assessment.

4.1.5.1 Regulatory Context

The Marine Mammal Protection Act (MMPA) of 1972 provides for the protection of all marine mammals. The MMPA prohibits, with certain exceptions, the "take" of marine mammals (NOAA Fisheries 2005). NOAA Fisheries has jurisdiction for overseeing the MMPA regulations as they pertain to most marine mammals; however, the U.S. Fish and Wildlife Service (USFWS) has jurisdiction over a select group of marine mammals, including manatees, otters, walruses, and polar bears.

Generally, the National Oceanic and Atmospheric Administration's National Marine Fisheries Service (NOAA Fisheries) is responsible for issuing take permits under the MMPA, upon a request, for authorization of incidental but not intentional "taking" of small numbers of marine mammals by U.S. citizens or agencies who engage in a specified activity (other than commercial fishing) within a specified geographical region. The USFWS would issue a take permit for manatees, but the criteria for evaluating the potential acoustic impacts to manatees has not yet been developed by the agency. The term "take," as defined in Section 3 of the MMPA (16 U.S.C.§ 1362[13]) of the MMPA, means "to harass, hunt, capture, or kill, or attempt to harass, hunt, capture, or kill any marine mammal." The term *'harass'* was then further defined in the 1994 amendments to the MMPA, with the designation of two levels of harassment: Level A and Level B.

By definition, Level A harassment is "any act of pursuit, torment, or annoyance that has the potential to injure a marine mammal or marine mammal stock," while Level B harassment defined as "any act of pursuit, torment, or annoyance which has the potential to disturb (but not injure) a marine mammal or marine mammal stock in the wild by causing disruption of behavioral patterns, including, but not limited to, migration, breathing, nursing, breeding, feeding, or sheltering." In reference to the underwater acoustic environment, NOAA Fisheries defines the threshold level for Level B harassment at 160 decibels (dB) sound pressure level (SPL) referenced at 1 micropascal (re 1 μPa) for impulsive sound, averaged over the duration of the signal, and at 120 dB re 1 μPa for non-impulsive sound, with no relevant acceptable distance specified.

NOAA Fisheries provided guidance for assessing the impacts of anthropogenic sound on marine mammals under its regulatory jurisdiction, including whales, dolphins, seals, and sea lions (sea turtles are addressed later in this section). The updated 2018 guidance (NOAA Fisheries 2018) specifically defines marine mammal hearing groups, develops auditory weighting functions, and identifies the received levels, or acoustic threshold levels, above which individual marine mammals are predicted to experience changes in their hearing sensitivity (permanent threshold shift (PTS) or temporary threshold shift (TTS) for acute, incidental exposure to underwater sound).

Under this guidance, any occurrence of PTS constitutes a Level A, or injury, take. The sound emitted by man-made sources may induce TTS or PTS in an animal in two ways: (1) peak sound pressure levels (Lpk) may cause damage to the inner ear, and (2) the accumulated sound energy the animal is exposed to (SEL) over the entire duration of a discrete or repeated noise exposure has the potential to induce auditory damage if it exceeds the relevant threshold levels.

Research has demonstrated that the frequency content of the sound plays a role in causing damage. In other words, sounds that are outside of the hearing range of the animal would be unlikely to affect its hearing, while the sound energy within the hearing range could be harmful. Under NOAA Fisheries guidance (2018), recognizing that marine mammal species do not have equal hearing capabilities, five hearing groups of marine mammals are defined as follows:

- Low-frequency (LF) Cetaceans—Consists of the baleen whales (*mysticetes*) with a collective generalized hearing range of 7 hertz (Hz) to 35 kilohertz (kHz);
- Mid-frequency (MF) Cetaceans—Includes most of the dolphins, all toothed whales except for *Kogia* spp., and all the beaked and bottlenose whales with a generalized hearing range of approximately 150 Hz to 160 kHz. (Renamed high-frequency cetaceans by Southall et al. [2019] because their best hearing sensitivity occurs at frequencies of several tens of kHz or higher);
- High-frequency (HF) Cetaceans—Incorporates all the true porpoises, the river dolphins, plus *Kogia* spp., *Cephalorhynchid* spp. (genus in the dolphin family Delphinidae), and two species of *Lagenorhynchus* (Peale's and hourglass dolphins) with a generalized hearing range estimated from 275 Hz to 160 kHz. (Renamed very high-frequency cetaceans by Southall et al. [2019] since some species have best sensitivity at frequencies exceeding 100 kHz);
- Phocids Underwater (PW)—Consists of true seals with a generalized underwater hearing range from 50 Hz to 86 kHz. (Renamed phocids carnivores in water by Southall et al. [2019]); and

- Otariids Underwater —Includes sea lions and fur seals with a generalized underwater hearing range from 60 Hz to 39 kHz (termed Other marine carnivores in water by Southall et al. (2019) and includes otariids, as well as walrus [*Odobenidae*] polar bear [*Ursus maritimus*], and sea and marine otters [*Mustelidae*]).

Within these generalized hearing ranges, the ability to hear sounds varies with frequency, as demonstrated by examining audiograms of hearing sensitivity (Southall et al. 2019; NOAA Fisheries 2018). To reflect higher noise sensitivities at particular frequencies, auditory weighting functions were developed for each functional hearing group that reflected the best available data on hearing ability (composite audiograms), susceptibility to noise-induced hearing loss, impacts of noise on hearing, and data on equal latency were developed for each functional hearing group (NOAA Fisheries 2018). These weighting functions are applied to individual sound received levels to reflect the susceptibility of each hearing group to noise-induced threshold shifts, which is not the same as the range of best hearing (Figure 4.1-16).

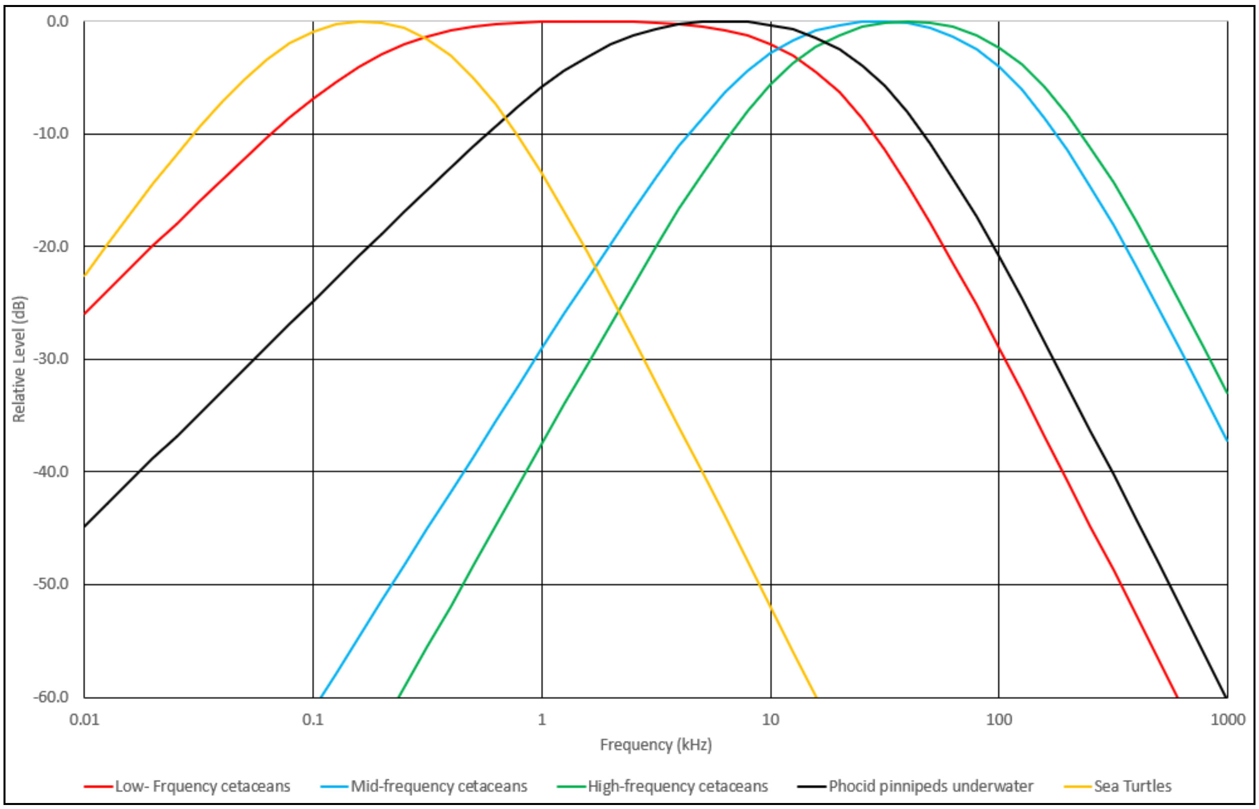


Figure 4.1-16. Auditory Weighting Functions for Cetaceans (Low-frequency, Mid-frequency, and High-frequency Species), Pinnipeds in water (PW), and Sea Turtles (DoN 2017)

NOAA Fisheries (2018) defined acoustic threshold levels at which PTS and TTS are predicted to occur for each hearing group for impulsive and non-impulsive signals (Table 4.1-34). These are presented in terms of dual metrics; SEL and Lpk. The Level B harassment thresholds are also provided in Table 4.1-34.

Table 4.1-34. Acoustic Threshold Levels for Marine Mammals

Hearing Group	Impulsive Sounds			Non-Impulsive Sounds		
	PTS Onset	TTS Onset	Behavior	PTS Onset	TTS Onset	Behavior
Low frequency cetaceans	219 dB ($L_{p,pk}$) 183 ($L_{E, LF, 24h}$)	213 dB ($L_{p,pk}$) 168 dB ($L_{E, LF, 24h}$)	160 dB (L_p)	199 dB ($L_{E, LF, 24h}$)	179 dB ($L_{E, LF, 24h}$)	120 dB (L_p)
Mid-frequency cetaceans	230 dB ($L_{p,pk}$) 185 dB ($L_{E, MF, 24h}$)	224 dB ($L_{p,pk}$) 170 dB ($L_{E, MF, 24h}$)		198 dB ($L_{E, MF, 24h}$)	178 dB ($L_{E, MF, 24h}$)	
High-frequency cetaceans	202 dB ($L_{p,pk}$) 155 dB ($L_{E, HF, 24h}$)	196 dB ($L_{p,pk}$) 140 dB ($L_{E, HF, 24h}$)		173 dB ($L_{E, HF, 24h}$)	153 dB ($L_{E, HF, 24h}$)	
Phocids underwater	218 dB ($L_{p,pk}$) 185 dB ($L_{E, PW, 24h}$)	212 dB ($L_{p,pk}$) 170 dB ($L_{E, PW, 24h}$)		201 dB ($L_{E, PW, 24h}$)	181 dB ($L_{E, PW, 24h}$)	

Sources: Southall et al. 2019; NOAA Fisheries 2018

PTS = permanent threshold shift; TTS = temporary threshold shift; dB = decibel; Lp,pk = peak sound pressure level; L_E = sound exposure level; MF = mid-frequency; HF = high frequency; PW = phocids underwater; 24h = 24-hour

NOAA Fisheries anticipates behavioral response for sea turtles from impulsive sources such as impact pile-driving to occur at SPL 175 dB, which has elicited avoidance behavior of sea turtles (Table 4.1-35; Blackstock et al. 2017). There is limited information available on the effects of noise on sea turtles, and the hearing capabilities of sea turtles are still poorly understood. In addition, the U.S. Navy introduced a weighting filter appropriate for sea turtle impact evaluation in their 2017 document titled "*Criteria and Thresholds for U.S. Navy Acoustic and Explosive Effects Analysis (Phase III)*" (DoN 2017). That weighting has been applied to impulsive criterion for PTS (204 dB SEL), impulsive criterion for TTS (189 dB SEL), and non-impulsive criteria for TTS (200 dB SEL and 226 dB Lpk) and PTS (220 dB SEL and 232 dB Lpk). The weighting for sea turtles is presented in Figure 4.1-16.

In a cooperative effort between federal and state agencies, interim criteria were developed to assess the potential for injury to fish and sea turtles exposed to pile-driving sounds. Noise thresholds have been established by the Fisheries Hydroacoustic Working Group, which was assembled by NOAA Fisheries. These thresholds have subsequently been adopted by NOAA Fisheries.

The NOAA Fisheries Greater Atlantic Regional Fisheries Office (GARFO) has applied these standards for assessing the potential effects of ESA-listed fish species exposed to elevated levels of underwater sound produced during pile-driving, which were just recently updated (NOAA Fisheries 2020) These noise thresholds have been adopted by GARFO are based on sound levels that have the potential to produce injury or elicit a behavioral response from fishes (Table 4.1-35).

Table 4.1-35. Acoustic Threshold Levels for Fishes and Sea Turtles

Hearing Group	Impulsive Signals		Non-impulsive Signals		Behavior (Impulsive and Non-impulsive)
	Injury	TTS Onset	Injury	TTS Onset	
Fishes	206 dB ($L_{p,pk}$) 187 dB ($L_{E,\,24h}$)	--	--	--	150 dB (L_p)
Sea turtles	232 dB ($L_{p,pk}$) 204 dB ($L_{E,\,TUW,\,24h}$)	226 dB ($L_{p,pk}$) 189 dB ($L_{E,\,TUW,\,24h}$)	220 dB ($L_{E,\,TUW,\,24h}$)	200 dB ($L_{E,\,TUW,\,24h}$)	175 dB (L_p)

Sources: Stadler and Woodbury 2009; NOAA Fisheries 2020; Blackstock et al. 2017; DoN 2017

TTS = temporary threshold shift; dB = decibel; Lp,pk = peak sound pressure level; TUW = sea turtles in water; L_E = sound exposure level; 24h = 24-hour

A Working Group organized under the American National Standards Institute-Accredited Standards Committee S3, Subcommittee 1, Animal Bioacoustics, also developed sound exposure guidelines for fish and sea turtles (Table 4.1-36; Popper et al. 2014). They identified three types of fish according to how they could potentially be affected by underwater sound. These categories include fish with no swim bladder or other gas chamber (e.g., dab and other flatfish), fish with swim bladders in which hearing does not involve the swim bladder or other gas chamber (e.g., salmonids), and fish with a swim bladder that is involved in hearing (e.g., channel catfish).

Table 4.1-36. Acoustic Threshold Levels for Fish and Sea Turtles, Impulsive and Non-Impulsive

Hearing Group	Impulsive Sounds			Non-Impulsive Sounds	
	Mortality and Potential Mortal Injury	Recoverable Injury	Temporary Threshold Shift	Recoverable Injury	Temporary Threshold Shift
Fish without swim bladders	> 213 dB ($L_{p,pk}$) > 219 dB ($L_{E,\,24h}$)	> 213 dB ($L_{p,pk}$) > 216 dB ($L_{E,\,24h}$)	> 186 dB ($L_{E,\,24h}$)	--	--
Fish with swim bladder not involved in hearing	207 dB ($L_{p,pk}$) 210 dB ($L_{E,\,24h}$)	> 207 dB ($L_{p,pk}$) 203 dB ($L_{E,\,24h}$)	> 186 dB ($L_{E,\,24h}$)	--	--
Fish with swim bladder involved in hearing	207 dB ($L_{p,pk}$) 207 dB ($L_{E,\,24h}$)	> 207 dB ($L_{p,pk}$) 203 dB ($L_{E,\,24h}$)	186 dB ($L_{E,\,24h}$)	170 dB (L_p)	158 dB (L_p)
Sea turtles	> 207 dB ($L_{p,pk}$) 210 dB ($L_{E,\,24h}$)	(N) High (I) Low (F) Low	(N) Moderate (I) Low (F) Low	--	--
Eggs and larvae	> 207 dB ($L_{p,pk}$) > 210 dB ($L_{E,\,24h}$)	(N) Moderate (I) Low (F) Low	(N) Moderate (I) Low (F) Low	--	--

Source: Popper et al. 2014

dB = decibel; Lp,pk = peak sound pressure level; L_E = sound exposure level; 24h = 24-hour

4.1.5.2 Affected Environment

The affected environment, as described below, is defined as the offshore underwater acoustic environment that has the potential to be directly and/or indirectly affected by the construction, O&M, and decommissioning of the Project, which includes the Offshore Project Area.

Existing Ambient Conditions

Noise in the ocean associated with natural sources is generated by physical and biological processes and non-natural sources such as shipping. Examples of physical noise sources are tectonic seismic activity, wind, and waves; examples of biological noise sources are the vocalizations of marine mammals and fish. There can be a strong minute-to-minute, hour-to-hour, or seasonal variability in sounds from biological sources. The ambient noise for frequencies above 1 kHz is due largely to waves, wind, and heavy precipitation (Simmonds et al. 2004). Surface wave interaction and breaking waves with spray have been identified as significant sources of noise. Wind-induced bubble oscillations and cavitation are also near-surface noise sources. At areas within distances of 4 to 5 nm (8 to 10 km) of the shoreline, surf noise will be prominent in the frequencies ranging up to a few hundred Hz (Richardson et al. 2013).

A considerable amount of background noise also may be caused by biological activities. Aquatic animals generate sounds for communication, echolocation, prey manipulation, and as by-products of other activities such as feeding. Biological sound production usually follows seasonal and diurnal patterns, dictated by variations in the activities and abundance of the vocal animals. The frequency content of underwater biological sounds ranges from less than 10 Hz to beyond 150 kHz. Source levels show a great variation, ranging from below 50 dB to more than 230 dB SPL. Likewise, there is a significant variation in other source characteristics such as the duration, temporal amplitude, frequency patterns, and the rate at which sounds are repeated (Wahlberg 2012). Typical underwater noise levels show a frequency dependency in relation to different noise sources; the classic curves are given in Wenz (1962).

Anthropogenic noise sources can consist of contributions related to industrial development, offshore oil industry activities, naval or other military operations, and marine research. A predominant contributing anthropogenic noise source is generated by commercial ships and recreational watercraft. Noise from these vessels dominates coastal waters and emanates from the ships' propellers and other dynamic positioning propulsion devices such as thrusters. The sound generated from main engines, gearboxes, and generators transmitted through the hull of the vessel into the water column is considered a secondary sound source to that of vessel propulsion systems, as is the use of sonar and depth sounders, which occur at generally high frequencies and attenuate rapidly. Commercial shipping vessels such as cargo ships, tankers, and passenger ferries produce sound at low frequencies, typically below 500 Hz, whereas smaller vessels such as fishing, recreational, and leisure craft may generate sound at somewhat higher frequencies ranging from 1 kHz up to 50 kHz (Hatch et al. 2008; Simmonds et al. 2004).

There is limited publicly available site-specific ambient sound information collected within the Offshore Project Area. NOAA's SoundMap (NOAA 2012), which is a mapping tool that provides maps of the temporal, spatial, and frequency characteristics of man-made underwater noise resulting from various activities, was consulted. Pressure fields associated with different contributors of underwater sound (i.e., shipping and passenger vessels) were summed and the sound pressure level values at frequencies ranging from 50 to 800 Hz were presented for various water column depths. Within the lower 50 Hz frequency range, underwater sound pressure levels were greatest, varying between approximately 80 to 100 dB depending on water depth and proximity to the coastline. The sound contribution and magnitude decreases with increasing frequency, indicating that the noise from shipping and passenger vessels is largely focused within the low frequency range.

4.1.5.3 Impacts Analysis for Construction, Operations and Maintenance, and Decommissioning

The potential impact-producing factors resulting from the construction, O&M, and decommissioning of the Project are based on the maximum design scenario from the PDE (see Section 3, Description of Proposed Activity). Underwater acoustic modeling was completed using dBSea, and site-specific parameters were incorporated to reflect the Offshore Project Area including bathymetry, geoacoustic sediment properties, and seasonal sound speed profiles.

A summary of construction and O&M scenarios included in the underwater acoustic modeling analysis is provided in Table 4.1-37. The model accommodates for differences in hammer energy, number of strikes, installation duration, sound source level, and pile progression as appropriate for the jacket pin piles and/or monopiles. This analysis also assumes a conservative duration for the use of the vibratory hammer. The pile diameters selected for the impact pile-driving modeling scenarios were based on maximum Project Design Envelope considerations provided by Dominion Energy. The subsections that follow provide more detailed information about the parameters used to model the noise sources associated with each scenario. Scenarios 1 through 3 occur at representative WTG locations while Scenario 4 occurs at a representative Offshore Substation location. Scenario 5 pertains to cofferdam installation and Scenario 6 pertains to goalpost installation.

The pile driving sound installation scenarios including the broadband sound source levels are summarized in Table 4.1-37. For the monopile modeling, the scenarios include a standard installation, hard-to-drive installation, and the installation of two monopiles per day. These modeling scenarios are assumed to cover the range of anticipated monopile installation scenarios without any mitigation measures. Scenario 1 covers the installation of one monopile using standard methods; Scenario 2 covers the installation of one monopile using hard-to-drive methods; and Scenario 3 corresponds to the installation of two monopiles in one day, which would not occur concurrently. The installation of the two monopiles per day scenario, Scenario 3, assumed a standard installation and a hard-to-drive installation at the same representative WTG location. For all of the monopile scenarios, it was assumed that the maximum rated hammer energy of 4,000 kilojoules (kJ) would be employed; however, that hammer energy assumption is considered conservative. The actual transferred energy to the pile during installation will be less than the maximum rated hammer energy, with losses in energy from sources such as heat and friction. For the pin pile modeling scenario, it is assumed that two pin piles would be installed per day with a maximum rated hammer energy of 3,000 kJ.

More detailed information regarding the underwater acoustic model and modeling inputs are presented in Appendix Z, Underwater Acoustic Assessment.

Construction

During construction, the potential impact-producing factor to the underwater noise environment may include installation of the Offshore Project Components. Dominion Energy proposes to implement measures, as appropriate, to avoid, minimize, and mitigate impacts during Project construction. The following impacts may occur as a consequence of the factor identified above:

Table 4.1-37. Underwater Acoustic Modeling Scenarios

Scenario	Activity Description	Maximum Hammer Energy (kilojoules)	Duration of Pile Installation (minutes)	Total Hammer Blows	Modeling Location (UTM Coordinates)	Sound Source Level (No Attenuation)
Scenario 1: Standard Driving Installation	Monopile Foundation (includes 1 pile per day): 9.5 m	Vibratory Pile Driving	60	N/A	Deep: 480666 m, 4089018 m Shallow: 459846 m, 4075324 m	202 $L_{E,\ 1sec}$
		Impact Pile Driving: 4,000	85	3,240		249 $L_{p,pk}$ 226 $L_{E,\ 1sec}$ 236 L_p
Scenario 2: Hard to Drive Installation	Monopile Foundation (includes 1 pile per day): 9.5 m	Vibratory Pile Driving	30	N/A	Deep: 480666 m, 4089018 m Shallow: 459,846 m, 4075324 m	202 $L_{E,\ 1sec}$
		Impact Pile Driving: 4,000	99	3,720		249 $L_{p,pk}$ 226 $L_{E,\ 1sec}$ 236 L_p
Scenario 3: One Standard and One Hard to Drive Installation	Monopile Foundation (includes 2 piles per day): 9.5 m	Vibratory Pile Driving	90	N/A	Deep: 480666 m, 4089018 m Shallow: 459846 m, 4075324 m	202 $L_{E,\ 1sec}$
		Impact Pile Driving: 4,000	184	6,960		249 $L_{p,pk}$ 226 $L_{E,\ 1sec}$ 236 L_p
Scenario 4: Offshore Substation Piled Jacket Foundation	Piled Jacket Foundation (includes 2 piles per day): 2.8 m	Vibratory Pile Driving	120	N/A	Offshore Substation: 474075 m, 4085595 m	194 $L_{E,\ 1sec}$
		Impact Pile Driving: 3,000	410	15,120		240 $L_{p,pk}$ 214 $L_{E,\ 1sec}$ 224 L_p
Scenario 5: Cofferdam Installation	Cofferdam Installation, Vibratory Pile-Driving	Vibratory Pile Driving	60	N/A	Cofferdam: 414213 m, 4074917	195 $L_{E,\ 1sec}$
Scenario 6: Goal Post Pile Installation	Goal Post Piles (2 per day)	Impact Pile Drive	130	260	Goal Post: 414396 m, 4074917 m	210 $L_{p,pk}$ a/ 183 $L_{E,\ 1sec}$ a/ 193 L_p a/

Notes:
a/ Source levels based on the SERO Pile Driving Noise Data Spreadsheet – Humboldt Bay Bridges (CALTRANS 2015)
N/A is included in the table for vibratory pile driving activities, which are not quantified in terms of total hammer blows.
dB = decibel; Lp,pk = peak sound pressure level; L_E = sound exposure level; 24h = 24-hour

- Short-term increase in underwater noise levels associated with WTG Monopile Foundations and/or pin pile impact and vibratory pile-driving activities required for the installation of WTG and Offshore Substation Jacket Foundations;
- Short-term increase in underwater noise levels associated with vibratory pile-driving for cofferdam installation;
- Short-term increase in underwater noise levels associated with impact pile-driving for goal post installation;
- Short-term increase in underwater noise levels associated with Offshore Export Cables and Inter-Array Cable laying activities; and
- Short-term increase in underwater noise levels associated with Project-related vessels.

Short-term increase in underwater noise levels associated with WTG Monopile Foundations and/or pin pile impact pile-driving activities required for the installation of WTG Monopile Foundations and Offshore Substation Jacket Foundations. A monopile foundation for WTGs and jacket pile foundation for Offshore Substations were included in the Project Design Envelope (Section 3, Description of Proposed Action). Installation of both foundation types using different hammer energy values were considered in the underwater acoustic analysis and are described as Scenarios 1 through 4 in Table 4.1-37. Since actual WTG locations have not been finalized, one location was selected in the shallowest water depth for a WTG within the Lease Area, while the other location was selected in the deepest water depth for a WTG within the Lease Area, 69 ft (21 m) and 121 ft (37 m) respectively. For the jacket pin pile installation, a representative location was selected. It is expected that by modeling these three locations (one Offshore Substation, one deep WTG Monopile Foundation, and one shallow WTG Monopile Foundation), the range of anticipated sound fields resulting from impact pile-driving and vibratory hammer activities will be represented.

The WTG Monopile Foundation and pin pile-driving scenarios were both modeled using a vertical array of point sources spaced at 1-meter intervals, distributing the sound emissions from pile-driving throughout the water column. The apparent sound levels developed for each scenario is provided in Table 4.1-37.

The vertical array was assigned third-octave-band sound characteristics adjusted for site-specific parameters discussed above including expected hammer energy and number of blows. Third-octave-band center frequencies from 12.5 Hz up to 20 kHz were used in the modeling. In addition, a constant 15 dB/decade roll-off was applied to the modeled spectra for the monopile scenario after the second (and last) spectral peak as to not eliminate any prevalent characteristics of the sound source spectrum that may influence sound propagation. A roll-off is a filter that can be imposed on a signal at either the low or high frequency range to more closely match expected sound propagation characteristics of that signal indicated by modeling or measurement results. Further details pertaining to the development of both the impact and vibratory pile driving sound source levels are provided in confidential Attachments Z-2 and Z-3, respectively.

The results for impact pile-driving (monopile and pin pile) for the representative WTG location at the greatest water depth (121 ft [37 m]) are shown in Table 4.1-38 through Table 4.1-46, and at the shallowest water depth (69 ft [21 m]) are shown in Table 4.1-47 through Table 4.1-55. The results for the jacket pin pile modeling scenario are provided in Table 4.1-56 through Table 4.1-64. Results are presented without mitigation and with two different levels of mitigation: a 6 dB reduction and a 10 dB reduction. Noise mitigation requirements and methods have not been finalized at this stage of permitting; therefore, these two levels of reduction were applied to potentially mimic the use of noise mitigation options such as bubble curtains.

Certain distances to the acoustic thresholds presented in Table 4.1-39, Table 4.1-41, Table 4.1-43, Table 4.1-45, and Table 4.1-54 contain minor irregularities. These irregularities have been identified for the deep and shallow locations when comparing the SEL metric for the different scenarios, and are considered inconsequential given that the differences in distances to thresholds are less than 50-meters, which is well within the uncertainty range of the model, and the differences in modeled sound levels are less than 1 dB.

Table 4.1-38. Marine Mammal PTS Onset Criteria Threshold Distances (meters) for Impact Pile-Driving - Deep Location (Monopile)

Scenario	Pile Type	Maximum Hammer Energy (kilojoules)	Installation Duration (minutes)	Mitigation (dB)	Hearing Group a/							
					Low-Frequency Cetaceans		Mid-Frequency Cetaceans		High-Frequency Cetaceans		Phocid Pinnipeds	
					219 $L_{p,pk}$	183 $L_{E,\ 24hr}$	230 $L_{p,pk}$	185 $L_{E,\ 24hr}$	202 $L_{p,pk}$	155 $L_{E,\ 24hr}$	218 $L_{p,pk}$	185 $L_{E,\ 24hr}$
Scenario 1: Standard Driving Scenario	9.5 m Monopile	4,000 b/	85	0	344	11,325	116	598	1,621	5,686	371	3,405
				6	182	6,020	67	320	927	2,946	213	1,852
				10	132	4,396	29	170	663	2,139	141	1,267
Scenario 2: Hard Driving Scenario	9.5 m Monopile	4,000 b/	99	0	344	12,423	116	664	1,621	6,273	371	3,809
				6	182	6,738	67	354	927	3,230	213	1,987
				10	132	4,980	29	187	663	2,304	141	1,358
Scenario 3: One Standard and One Hard Driving Scenario	9.5 m Monopile (2 piles per day)	4,000 b/	184	0	344	14,363	116	840	1,621	7,647	371	4,651
				6	182	7,997	67	443	927	3,933	213	2,570
				10	132	5,663	29	226	663	2,884	141	1,756

Source: NOAA Fisheries 2018

dB = decibel; Lp,pk = peak sound pressure level; L_E = sound exposure level; 24h = 24-hour

Notes:

Same information is presented in COP Section 4.2.5 and Appendix Z
a/ Level A Injury
b/ Corresponds to the maximum rated hammer energy; however, actual hammer energy transferred to the pile during installation will be less

Table 4.1-39. Sea Turtle and Fish Onset of Injury Threshold Distances (meters) for Impact Pile-Driving – Deep Location (Monopile)

Scenario	Pile Type	Hammer Energy (kilojoules)	Installation Duration (minutes)	Mitigation (dB)	Hearing Group a/									
					Fish: No Swim Bladder		Fish: Swim Bladder not Involved in Hearing		Fish: Swim Bladder Involved in Hearing		Eggs and Larvae		Sea Turtles	
					213 $L_{p,pk}$	219 $L_{E, 24hr}$	207 $L_{p,pk}$	210 $L_{E, 24hr}$	207 $L_{p,pk}$	207 $L_{E, 24hr}$	207 $L_{p,pk}$	210 $L_{E, 24hr}$	207 $L_{p,pk}$	210 $L_{E, 24hr}$
Scenario 1: Standard Driving Scenario	9.5 m Monopile	4,000 b/	85	0	605	810	1,007	1,729	1,007	2,348	1,007	1,729	1,007	1,729
				6	344	489	605	1,021	605	1,301	605	1,021	605	1,021 c/
				10	242	352	402	748	402	955	402	748	402	748
Scenario 2: Hard Driving Scenario	9.5 m Monopile	4,000 b/	99	0	605	906	1,007	1,968	1,007	2,683	1,007	1,968	1,007	1,968
				6	344	540	605	1,120	605	1,466	605	1,120	605	1,120
				10	242	389	402	829	402	1,041	402	829	402	829
Scenario 3: One Standard and One Hard Driving Scenario	9.5 m Monopile (2 piles per day)	4,000 b/	184	0	605	1,121	1,007	2,439	1,007	3,315	1,007	2,439	1,007	2,439
				6	344	672	605	1,386	605	1,860	605	1,386	605	1,386
				10	242	477	402	1,042	402	1,266	402	1,042	402	1,042 c/

Source: Popper et al. 2014

dB = decibel; Lp,pk = peak sound pressure level; L_E = sound exposure level; 24h = 24-hour

Notes:
Same information is presented in Appendix Z

a/ Level A Injury

b/ Corresponds to the maximum rated hammer energy; however, actual hammer energy transferred to the pile during installation will be less

c/ Refer to Appendix Z Section Z.7 for further details

Table 4.1-40. Fish Acoustic Injury Threshold Distances (meters) for Impact Pile-Driving – Deep Location (Monopile)

Scenario	Pile Type	Hammer Energy (kilojoules)	Installation Duration (minutes)	Mitigation (dB)	Hearing Group			
					Small Fish a/		Large Fish a/	
					206 $L_{p,pk}$	183 $L_{E,\ 24hr}$	206 $L_{p,pk}$	187 $L_{E,\ 24hr}$
Scenario 1: Standard Driving Scenario	9.5 m Monopile	4,000 b/	85	0	1,105	14,940	1,105	11,907
				6	663	8,653	663	6,131
				10	445	6,131	445	4,501
Scenario 2: Hard Driving Scenario	9.5 m Monopile	4,000 b/	99	0	1,105	16,655	1,105	12,722
				6	663	9,302	663	6,824
				10	445	6,824	445	5,085
Scenario 3: One Standard and One Hard Driving Scenario	9.5 m Monopile (2 piles per day)	4,000 b/	184	0	1,105	20,786	1,105	14,787
				6	663	11,508	663	8,291
				10	445	8,291	445	5,880

Source: Stadler and Woodbury 2009

dB = decibel; Lp,pk = peak sound pressure level; L_E = sound exposure level; 24h = 24-hour

Notes:

Same information is presented in Appendix Z
a/ Small fish are fish less than 2 grams in weight. Large fish are 2 grams or larger
b/ Corresponds to the maximum rated hammer energy; however, actual hammer energy transferred to the pile during installation will be less

Table 4.1-41. Sea Turtle Behavioral and Acoustic Injury Criteria Threshold Distances (meters) for Impact Pile-Driving – Deep Location (Monopile)

Scenario	Pile Type	Hammer Energy (kilojoule)	Installation Duration (minutes)	Mitigation (dB)	Species				
					Sea Turtle Behavioral	Sea Turtle Temporary Threshold Shift		Sea Turtle Permanent Threshold Shift	
					175 L_p	226 $L_{p,pk}$	189 $L_{E,\ TUW,\ 24hr}$	232 $L_{p,pk}$	204 $L_{E,\ TUW,\ 24hr}$
Scenario 1: Standard Driving Scenario	9.5 m Monopile	4,000 a/	85	0	5,162	180	8,985	104	2,628
				6	2,829	104	5,010	48	1,408 b/
				10	2,146	67	3,575	10	1,044
Scenario 2: Hard Driving Scenario	9.5 m Monopile	4,000 a/	99	0	5,162	180	9,762	104	2,918
				6	2,829	104	5,560	48	1,533
				10	2,146	67	3,902	10	1,142
Scenario 3: One Standard and One Hard Driving Scenario	9.5 m Monopile (2 piles per day)	4,000 a/	184	0	5,162	180	11,998	104	3,685
				6	2,829	104	7,037	48	2,053
				10	2,146	67	4,812	10	1,410 b/

Source: NOAA Fisheries 2020

dB = decibel; Lp = sound pressure; Lp,pk = peak sound pressure level; L_E = sound exposure level; TUW = sea turtles in water; 24h = 24-hour

Notes:

Same information is presented in COP Section 4.2.6 and Appendix Z
a/ Corresponds to the maximum rated hammer energy; however, actual hammer energy transferred to the pile during installation will be less
b/ Refer to Appendix Z Section Z.7 for further details

Table 4.1-42. Threshold Distances (meters) for Sound Pressure Levels (L_p) for Impact Pile-Driving at the Deep Location (Monopile)

Scenario	Pile Type	Hammer Energy (kilojoules)	Installation Duration (minutes)	Mitigation (dB)	Hearing Group					
					200 L_p	190 L_p	180 L_p	175 L_p	160 L_p	150 L_p
Scenario 1: Standard Driving Scenario	9.5 m Monopile	4,000 a/	85	0	661	1,495	3,817	5,162	15,010	36,030
				6	371	895	2,013	2,829	8,700	20,512
				10	266	661	1,495	2,146	6,182	15,010
Scenario 2: Hard Driving Scenario	9.5 m Monopile	4,000 a/	99	0	661	1,495	3,817	5,162	15,010	36,030
				6	371	895	2,013	2,829	8,700	20,512
				10	266	661	1,495	2,146	6,182	15,010
Scenario 3: One Standard and One Hard Driving Scenario	9.5 m Monopile (2 piles per day)	4,000 a/	184	0	661	1,495	3,817	5,162	15,010	36,030
				6	371	895	2,013	2,829	8,700	20,512
				10	266	661	1,495	2,146	6,182	15,010

Lp = sound pressure

Level B values presented here are the same as those presented in COP Section 4.2.5

Notes:

Same information is presented in Appendix Z

a/ Corresponds to the maximum rated hammer energy; however, actual hammer energy transferred to the pile during installation will be less

Table 4.1-43. Marine Mammal PTS Onset Criteria Threshold Distances (meters) for Vibratory Hammer – Deep Location (Monopile)

Scenario	Pile Type	Installation Duration (minutes)	Mitigation (dB)	Hearing Group a/			
				LF Cetaceans	MF Cetaceans	HF Cetaceans	Phocid Pinnipeds
				199 $L_{E, 24hr}$	198 $L_{E, 24hr}$	173 $L_{E, 24hr}$	201 $L_{E, 24hr}$
Scenario 1: Standard Driving Scenario	9.5 m Monopile	60	0	414	0	341	128
			6	199	0	161	51
			10	141	0	103	12
Scenario 2: Hard Driving Scenario	9.5 m Monopile	30	0	356	0	278	84
			6	150	0	129 b/	23
			10	113	0	87	3
Scenario 3: One Standard and One Hard Driving Scenario	9.5 m Monopile (2 piles per day)	90	0	488	0	409	146
			6	224	0	185	67
			10	158	0	125 b/	31

Source: NOAA Fisheries 2018

dB = decibel; LF = low frequency; MF = mid-frequency; HF = high frequency; Lp,pk = peak sound pressure level; L_E = sound exposure level; 24h = 24-hour

Notes:

Same information is presented in COP Section 4.2.5 and Appendix Z
a/ Level A Injury
b/ Refer to Appendix Z Section Z.7 for further details

Table 4.1-44. Fish Acoustic Injury Threshold Distances (meters) for Vibratory Hammer – Deep Location (Monopile)

Scenario	Pile Type	Installation Duration (minutes)	Mitigation (dB)	Hearing Group	
				Small Fish a/	Large Fish a/
				183 $L_{E,\ 24hr}$	187 $L_{E,\ 24hr}$
Scenario 1: Standard Driving Scenario	9.5 m Monopile	60	0	3,188	2,199
			6	1,831	1,216
			10	1,216	796
Scenario 2: Hard Driving Scenario	9.5 m Monopile	30	0	2,476	1,641
			6	1,338	886
			10	886	601
Scenario 3: One Standard and One Hard Driving Scenario	9.5 m Monopile (2 piles per day)	90	0	3,822	2,666
			6	2,191	1,442
			10	1,442	961

Source: Stadler and Woodbury 2009

dB = decibel; Lp,pk = peak sound pressure level; L_E = sound exposure level; 24h = 24-hour

Notes:

Same information is presented in Appendix Z

a/ Small fish are fish less than 2 grams in weight. Large fish are 2 grams or larger

Table 4.1-45. Sea Turtle Behavioral and Acoustic Injury Criteria Threshold Distances (meters) for Vibratory Hammer – Deep Location (Monopile)

Scenario	Pile Type	Installation Duration (minutes)	Mitigation (dB)	Species		
				Sea Turtle Behavioral	Sea Turtle TTS	Sea Turtle PTS
				175 L_p	200 $L_{E,\ TUW,\ 24hr}$	220 $L_{E,\ TUW,\ 24hr}$
Scenario 1: Standard Driving Scenario	9.5 m Monopile	60	0	189	522	65
			6	119	298	18
			10	82	179	6 a/
Scenario 2: Hard Driving Scenario	9.5 m Monopile	30	0	189	402	40
			6	119	241 a/	0 a/
			10	82	132	0
Scenario 3: One Standard and One Hard Driving Scenario	9.5 m Monopile (2 piles per day)	90	0	189	642	78
			6	119	358	24
			10	82	200 a/	8

Source: NOAA Fisheries 2020

dB = decibel; Lp = sound pressure; L_E = sound exposure level; TUW = sea turtles in water; 24h = 24-hour

Notes:

Same information is presented in COP Section 4.2.6 and Appendix Z

a/ Refer to Appendix Z Section Z.7 for further details

Table 4.1-46. Threshold Distances (meters) for Sound Pressure Levels (L_p) for Vibratory Hammer at the Deep Location (Monopile)

Scenario	Pile Type	Installation Duration (minutes)	Mitigation (dB)	Sound Pressure Level Thresholds (dB)					
				180 L_p	175 L_p	160 L_p	150 L_p	140 L_p	120 L_p
Scenario 1: Standard Driving Scenario	9.5 m Monopile	85	0	128	189	N/A	2,528	6,285	21,404
			6	73	119	N/A	1,359	3,618	12,267
			10	37	82	N/A	903	2,528	8,866
Scenario 2: Hard Driving Scenario	9.5 m Monopile	99	0	128	189	N/A	2,528	6,285	21,404
			6	73	119	N/A	1,359	3,618	12,267
			10	37	82	N/A	903	2,528	8,866
Scenario 3: One Standard and One Hard Driving Scenario	9.5 m Monopile (2 piles per day)	184	0	128	189	N/A	2,528	6,285	21,404
			6	73	119	N/A	1,359	3,618	12,267
			10	37	82	N/A	903	2,528	8,866

dB = decibel; Lp = sound pressure; LE = sound exposure level

Notes:

Level B values are presented in COP Section 4.2.5 and Appendix Z

a/ Corresponds to the maximum rated hammer energy; however, actual hammer energy transferred to the pile during installation will be less

Table 4.1-47. Marine Mammal PTS Onset Criteria Threshold Distances (meters) for Impact Pile-Driving - Shallow Location (Monopile)

Scenario	Pile Type	Maximum Hammer Energy (kilojoules)	Installation Duration (minutes)	Mitigation (dB)	Hearing Group a/							
					Low-Frequency Cetaceans		Mid-Frequency Cetaceans		High-Frequency Cetaceans		Phocid Pinnipeds	
					219 $L_{p,pk}$	183 $L_{E, 24hr}$	230 $L_{p,pk}$	185 $L_{E, 24hr}$	202 $L_{p,pk}$	155 $L_{E, 24hr}$	218 $L_{p,pk}$	185 $L_{E, 24hr}$
Scenario 1: Standard Driving Scenario	9.5 m Monopile	4,000 b/	85	0	326	7,406	117	411	1,583	4,056	355	2,707
				6	176	4,416	61	221	919	2,383	201	1,588
				10	128	3,138	26	99	607	1,659	138	1,059
Scenario 2: Hard Driving Scenario	9.5 m Monopile	4,000 b/	99	0	326	7,887	117	472	1,583	4,585	355	2,947
				6	176	4,587	61	254	919	2,560	201	1,735
				10	128	3,363	26	108	607	1,888	138	1,171
Scenario 3: One Standard and One Hard Driving Scenario	9.5 m Monopile (2 piles per day)	4,000 b/	184	0	326	9,925	117	570	1,583	5,587	355	3,759
				6	176	5,783	61	306	919	3,170	201	2,099
				10	128	4,152	26	134	607	2,314	138	1,464

Source: NOAA Fisheries 2018

dB = decibel; Lp,pk = peak sound pressure level; LE = sound exposure level; 24h = 24-hour

Notes:

Same information is presented in COP Section 4.2.5 and Appendix Z
a/ Level A Injury
b/ Corresponds to the maximum rated hammer energy; however, actual hammer energy transferred to the pile during installation will be less

Table 4.1-48. Sea Turtle and Fish Onset of Injury Threshold Distances (meters) for Impact Pile-Driving – Shallow Location (as per Popper et al. 2014) (Monopile)

Scenario	Pile Type	Hammer Energy (kilojoules)	Installation Duration (minutes)	Mitigation (dB)	Hearing Group a/									
					Fish: No Swim Bladder		Fish: Swim Bladder not involved in Hearing		Fish: Swim Bladder involved in Hearing		Eggs and Larvae		Sea Turtles	
					213 $L_{p,pk}$	219 $L_{E,24hr}$	207 $L_{p,pk}$	210 $L_{E,24hr}$	207 $L_{p,pk}$	207 $L_{E,24hr}$	207 $L_{p,pk}$	210 $L_{E,24hr}$	207 $L_{p,pk}$	210 $L_{E,24hr}$
Scenario 1: Standard Driving Scenario	9.5 m Monopile	4,000 b/	85	0	556	781	969	1,619	969	2,111	969	1,619	969	1,619
				6	326	437	556	987	556	1,203	556	987	556	987
				10	234	308	382	698	382	870	382	698	382	698
Scenario 2: Hard Driving Scenario	9.5 m Monopile	4,000 b/	99	0	556	856	969	1,852	969	2,288	969	1,852	969	1,852
				6	326	480	556	1,079	556	1,347	556	1,079	556	1,079
				10	234	337	382	770	382	942	382	770	382	770
Scenario 3: One Standard and One Hard Driving Scenario	9.5 m Monopile (2 piles per day)	4,000 b/	184	0	556	1,064	969	2,260	969	2,981	969	2,260	969	2,260
				6	326	629	556	1,299	556	1,704	556	1,299	556	1,299
				10	234	429	382	986	382	1,190	382	986	382	986

Source: Popper et al. 2014

dB = decibel; Lp,pk = peak sound pressure level; LE = sound exposure level; 24h = 24-hour

Notes:

Same information is presented in Appendix Z

a/ Level A Injury

b/ Corresponds to the maximum rated hammer energy; however, actual hammer energy transferred to the pile during installation will be less

Table 4.1-49. Fish Acoustic Injury Threshold Distances (meters) for Impact Pile-Driving – Shallow Location (as per Stadler and Woodbury 2009) (Monopile)

Scenario	Pile Type	Hammer Energy (kilojoules)	Installation Duration (minutes)	Mitigation (dB)	Hearing Group			
					Small Fish a/		Large Fish a/	
					206 $L_{p,pk}$	183 $L_{E,\ 24hr}$	206 $L_{p,pk}$	187 $L_{E,\ 24hr}$
Scenario 1: Standard Driving Scenario	9.5 m Monopile	4,000 b/	85	0	1,060	12,112	1,060	9,059
				6	607	7,072	607	5,199
				10	413	5,199	413	3,757
Scenario 2: Hard Driving Scenario	9.5 m Monopile	4,000 b/	99	0	1,060	13,486	1,060	10,185
				6	607	7,628	607	5,672
				10	413	5,672	413	4,149
Scenario 3: One Standard and One Hard Driving Scenario	9.5 m Monopile (2 piles per day)	4,000 b/	184	0	1,060	17,035	1,060	12,487
				6	607	9,410	607	7,045
				10	413	7,045	413	5,089

Source: Stadler and Woodbury 2009

dB = decibel; Lp,pk = peak sound pressure level; LE = sound exposure level; 24h = 24-hour

Notes:
Same information is presented in Appendix Z

a/ Small fish are fish less than 2 grams in weight. Large fish are 2 grams or larger
b/ Corresponds to the maximum rated hammer energy; however, actual hammer energy transferred to the pile during installation will be less

Table 4.1-50. Sea Turtle Behavioral and Acoustic Injury Criteria Threshold Distances (meters) for Impact Pile-Driving – Shallow Location (Monopile)

Scenario	Pile Type	Hammer Energy (kilojoule)	Installation Duration (minutes)	Mitigation (dB)	Species				
					Sea Turtle Behavioral	Sea Turtle Temporary Threshold Shift		Sea Turtle Permanent Threshold Shift	
					175 L_p	226 $L_{p,pk}$	189 $L_{E,\ TUW,\ 24hr}$	232 $L_{p,pk}$	204 $L_{E,\ TUW,\ 24hr}$
Scenario 1: Standard Driving Scenario	9.5 m Monopile	4,000 a/	85	0	4,776	162	6,897	90	2,150
				6	2,667	90	3,957	46	1,258
				10	1,951	61	2,758	7	900
Scenario 2: Hard Driving Scenario	9.5 m Monopile	4,000 a/	99	0	4,776	162	7,698	90	2,359
				6	2,667	90	4,334	46	1,482
				10	1,951	61	2,944	7	985
Scenario 3: One Standard and One Hard Driving Scenario	9.5 m Monopile (2 piles per day)	4,000 a/	184	0	4,776	162	9,136	90	3,024
				6	2,667	90	5,367	46	1,751
				10	1,951	61	3,607	7	1,225

Source: NOAA Fisheries 2020

dB = decibel; Lp = sound pressure level; Lp,pk = peak sound pressure level; LE = sound exposure level; TUW = sea turtles in water; 24h = 24-hour

Notes:

Same information is presented in COP Section 4.2.6 and Appendix Z

a/ Corresponds to the maximum rated hammer energy; however, actual hammer energy transferred to the pile during installation will be less

Table 4.1-51. Threshold Distances (meters) for Sound Pressure Levels (L_p) for Impact Pile Driving at the Shallow Location (Monopile)

Scenario	Pile Type	Hammer Energy (kilojoules)	Installation Duration (minutes)	Mitigation (dB)	Sound Pressure Level Thresholds (dB)					
					200 L_p	190 L_p	180 L_p	175 L_p	160 L_p	150 L_p
Scenario 1: Standard Driving Scenario	9.5 m Monopile	4,000 a/	85	0	601	1,483	3,471	4,776	12,976	30,041
				6	362	858	1,948	2,667	7,473	17,078
				10	260	601	1,483	1,951	5,503	12,976
Scenario 2: Hard Driving Scenario	9.5 m Monopile	4,000 a/	99	0	601	1,483	3,471	4,776	12,976	30,041
				6	362	858	1,948	2,667	7,473	17,078
				10	260	601	1,483	1,951	5,503	12,976
Scenario 3: One Standard and One Hard Driving Scenario	9.5 m Monopile (2 piles per day)	4,000 a/	184	0	601	1,483	3,471	4,776	12,976	30,041
				6	362	858	1,948	2,667	7,473	17,078
				10	260	601	1,483	1,951	5,503	12,976

dB = decibel; Lp = sound pressure level

Notes:

Level B values are presented in COP Section 4.2.5 and Appedix Z
a/ Corresponds to the maximum rated hammer energy; however, actual hammer energy transferred to the pile during installation will be less

Table 4.1-52. Marine Mammal PTS Onset Criteria Threshold Distances (meters) for Vibratory Hammer – Shallow Location (Monopile)

Scenario	Pile Type	Installation Duration (minutes)	Mitigation (dB)	Hearing Group a/			
				LF Cetaceans	MF Cetaceans	HF Cetaceans	Phocid Pinnipeds
				199 $L_{E,\ 24hr}$	198 $L_{E,\ 24hr}$	173 $L_{E,\ 24hr}$	201 $L_{E,\ 24hr}$
Scenario 1: Standard Driving Scenario	9.5 m Monopile	60	0	385	0	317	102
			6	149	0	133	44
			10	107	0	93	31
Scenario 2: Hard Driving Scenario	9.5 m Monopile	30	0	292	0	237	76
			6	112	0	99	33
			10	88	0	67	21
Scenario 3: One Standard and One Hard Driving Scenario	9.5 m Monopile (2 piles per day)	90	0	449	0	372	121
			6	174	0	160	51
			10	135	0	110	36

Source: NOAA Fisheries 2018

LE = sound exposure level; 24h = 24-hour

Notes:

Same information is presented in COP Section 4.2.5 and Appendix Z
a/ Level A Injury

Table 4.1-53. Fish Acoustic Injury Threshold Distances (meters) for Vibratory Hammer – Shallow Location (Monopile)

Scenario	Pile Type	Installation Duration (minutes)	Mitigation (dB)	Hearing Group	
				Small Fish a/	Large Fish a/
				183 $L_{E,\ 24hr}$	187 $L_{E,\ 24hr}$
Scenario 1: Standard Driving Scenario	9.5 m Monopile	60	0	3,013	2,025
			6	1,754	1,191
			10	1,191	771
Scenario 2: Hard Driving Scenario	9.5 m Monopile	30	0	2,239	1,512
			6	1,300	879
			10	879	580
Scenario 3: One Standard and One Hard Driving Scenario	9.5 m Monopile (2 piles per day)	90	0	3,587	2,407
			6	2,058	1,392
			10	1,392	911

Source: Stadler and Woodbury 2009
dB = decibel; LE = sound exposure level; 24h = 24-hour
Notes:
Same information is presented in Appendix Z
a/ Small fish are fish less than 2 grams in weight. Large fish are 2 grams or larger

Table 4.1-54. Sea Turtle Behavioral and Acoustic Injury Criteria Threshold Distances (meters) for Vibratory Hammer – Shallow Location (Monopile)

Scenario	Pile Type	Installation Duration (minutes)	Mitigation (dB)	Species		
				Sea Turtle Behavioral	Sea Turtle TTS	Sea Turtle PTS
				175 L_p	200 $L_{E,\ 24hr}$	220 $L_{E,\ 24hr}$
Scenario 1: Standard Driving Scenario	9.5 m Monopile	60	0	175	490	50
			6	98	275	16
			10	52	164	0
Scenario 2: Hard Driving Scenario	9.5 m Monopile	30	0	175	364	37
			6	98	203 a/	0
			10	52	120	0
Scenario 3: One Standard and One Hard Driving Scenario	9.5 m Monopile (2 piles per day)	90	0	175	581	61
			6	98	321	20
			10	52	195 a/	0

Source: NOAA Fisheries 2020

PTS = permanent threshold shift; TTS = temporary threshold shift; dB = decibel; Lp = sound pressure level; LE = sound exposure level; 24h = 24-hour

Notes:

Same information is presented in COP Section 4.2.6 and Appendix Z

a/ Refer to Appendix Z Section Z.7 for further details

Table 4.1-55. Threshold Distances (meters) for Sound Pressure Levels (L_p) for Vibratory Hammer at the Shallow Location (Monopile)

Scenario	Pile Type	Installation Duration (minutes)	Mitigation (dB)	Sound Pressure Level Thresholds (dB) a/					
				180 L_p	175 L_p	160 L_p	150 L_p	140 L_p	120 L_p
Scenario 1: Standard Driving Scenario	9.5 m Monopile	85	0	129	175	N/A	2,317	5,566	16,308
			6	76	98	N/A	1,375	3,251	9,508
			10	30	52	N/A	907	2,317	6,485
Scenario 2: Hard Driving Scenario	9.5 m Monopile	99	0	129	175	N/A	2,317	5,566	16,308
			6	76	98	N/A	1,375	3,251	9,508
			10	30	52	N/A	907	2,317	6,485
Scenario 3: One Standard and One Hard Driving Scenario	9.5 m Monopile (2 piles per day)	184	0	129	175	N/A	2,317	5,566	16,308
			6	76	98	N/A	1,375	3,251	9,508
			10	30	52	N/A	907	2,317	6,485

dB = decibel; Lp = sound pressure level

Notes:

Level B values presented here are the same as those presented in COP Section 4.2.5 and Appendix Z
a/ Corresponds to the maximum rated hammer energy; however, actual hammer energy transferred to the pile during installation will be less

Table 4.1-56. Marine Mammal PTS Onset Criteria Threshold Distances (meters) for Impact Pile-Driving - Offshore Substation Location

Scenario	Pile Type	Maximum Hammer Energy (kilojoules)	Installation Duration (minutes)	Mitigation (dB)	Hearing Group a/							
					Low-Frequency Cetaceans		Mid-Frequency Cetaceans		High-Frequency Cetaceans		Phocid Pinnipeds	
					219 $L_{p,pk}$	183 $L_{E, 24hr}$	230 $L_{p,pk}$	185 $L_{E, 24hr}$	202 $L_{p,pk}$	155 $L_{E, 24hr}$	218 $L_{p,pk}$	185 $L_{E, 24hr}$
Scenario 4: Offshore Substation Piled Jacket Foundation	2.8 m Pin Pile	3,000 b/	410	0	35	6,807	0	258	508	3,485	55	3,188
				6	0	3,697	0	121	284	1,938	0	1,746
				10	0	2,680	0	48	197	1,435	0	1,283

Source: NOAA Fisheries 2018

dB = decibel; Lp,pk = peak sound pressure level; LE = sound exposure level; 24h = 24-hour

Notes:

Same information is presented in COP Section 4.2.5 and Appendix Z
a/ Level A Injury
b/ Corresponds to the maximum rated hammer energy; however, actual hammer energy transferred to the pile during installation will be less

Table 4.1-57. Sea Turtle and Fish Onset of Injury Threshold Distances (meters) for Impact Pile-Driving – Offshore Substation Location (as per Popper et al. 2014)

Scenario	Pile Type	Hammer Energy (kilojoules)	Installation Duration (minutes)	Mitigation (dB)	Hearing Group a/									
					Fish: No Swim Bladder		Fish: Swim Bladder not involved in Hearing		Fish: Swim Bladder involved in Hearing		Eggs and Larvae		Sea Turtles	
					213 $L_{p,pk}$	219 $L_{E, 24hr}$	207 $L_{p,pk}$	210 $L_{E, 24hr}$	207 $L_{p,pk}$	207 $L_{E, 24hr}$	207 $L_{p,pk}$	210 $L_{E, 24hr}$	207 $L_{p,pk}$	210 $L_{E, 24hr}$
Scenario 4: Offshore Substation Piled Jacket Foundation	2.8 m Pin Pile	3,000 b/	410	0	172	536	311	1,231	311	1,599	311	1,231	311	1,231
				6	35	310	172	696	172	907	172	696	172	696
				10	0	213	74	488	74	633	74	488	74	488

Source: Popper et al. 2014

dB = decibel; Lp,pk = peak sound pressure level; LE = sound exposure level24h = 24-hour

Notes:
Same information is presented in Appendix Z.

a/ Level A Injury
b/ Corresponds to the maximum rated hammer energy; however, actual hammer energy transferred to the pile during installation will be less.

Table 4.1-58. Fish Acoustic Injury Threshold Distances (meters) for Impact Pile-Driving – Offshore Substation Location (as per Stadler and Woodbury 2009)

Scenario	Pile Type	Hammer Energy (kilojoules)	Installation Duration (minutes)	Mitigation (dB)	Hearing Group			
					Small Fish a/		Large Fish a/	
					206 $L_{p,pk}$	183 $L_{E, 24hr}$	206 $L_{p,pk}$	187 $L_{E, 24hr}$
Scenario 4: Offshore Substation Piled Jacket Foundation	2.8 m Pin Pile	3,000 b/	410	0	344	10,069	344	7,306
				6	197	5,959	197	4,000
				10	94	4,000	94	2,959

Source: Stadler and Woodbury 2009

dB = decibel; Lp,pk = peak sound pressure level; LE = sound exposure level; 24h = 24-hour

Notes:
Same information is presented in Appendix Z

a/ Small fish are fish less than 2 grams in weight. Large fish are 2 grams or larger.
b/ Corresponds to the maximum rated hammer energy; however, actual hammer energy transferred to the pile during installation will be less.

Table 4.1-59. Sea Turtle Behavioral and Acoustic Injury Criteria Threshold Distances (meters) for Impact Pile-Driving – Offshore Substation Location

Scenario	Pile Type	Hammer Energy (kilojoule)	Installation Duration (minutes)	Mitigation (dB)	Species				
					Sea Turtle Behavioral	Sea Turtle Temporary Threshold Shift		Sea Turtle Permanent Threshold Shift	
					175 L_p	226 $L_{p,pk}$	189 $L_{E,\ TUW,\ 24hr}$	232 $L_{p,pk}$	204 $L_{E,\ TUW,\ 24hr}$
Scenario 4: Offshore Substation Piled Jacket Foundation	2.8 m Pin Pile	3,000 a/	410	0	2,041	0	5,900	0	1,695
				6	1,134	0	3,197	0	914
				10	742	0	2,303	0	653

Source: NOAA Fisheries 2020

dB = decibel; Lp,pk = sound pressure level; Lp,pk = peak sound pressure level; LE = sound exposure level; TUW = sea turtles in water; 24h = 24-hour

Notes:

Same information is presented in COP Section 4.2.6 and Appendix Z.
a/ Corresponds to the maximum rated hammer energy; however, actual hammer energy transferred to the pile during installation will be less.

Table 4.1-60. Threshold Distances (meters) for Sound Pressure Levels (L_p) for Impact Pile Driving at the Offshore Substation Location

Scenario	Pile Type	Hammer Energy (kilojoules)	Installation Duration (minutes)	Mitigation (dB)	Sound Pressure Level Thresholds (dB)					
					200 L_p	190 L_p	180 L_p	175 L_p	160 L_p	150 L_p
Scenario 4: Offshore SubstationPiled Jacket Foundation	2.8 m Pin Pile	3,000 a/	410	0	148	489	1,238	2,041	5,530	13,641
				6	29	247	728	1,134	3,291	8,243
				10	0	148	489	742	2,172	5,530

dB = decibel; Lp = sound pressure level;

Notes:

Level B values presented here are the same as those presented in COP Section 4.2.5 and Appendix Z.
a/ Corresponds to the maximum rated hammer energy; however, actual hammer energy transferred to the pile during installation will be less.

Table 4.1-61. Marine Mammal PTS Onset Criteria Threshold Distances (meters) for Vibratory Hammer – Offshore Substation Location

Scenario	Pile Type	Installation Duration (minutes)	Mitigation (dB)	Hearing Group a/			
				LF Cetaceans	MF Cetaceans	HF Cetaceans	Phocid Pinnipeds
				199 $L_{E,\ 24hr}$	198 $L_{E,\ 24hr}$	173 $L_{E,\ 24hr}$	201 $L_{E,\ 24hr}$
Scenario 4: Offshore Substation Piled Jacket Foundation	2.8 m Pin Pile	120	0	218	0	190	63
			6	130	0	112	35
			10	75	0	68	0

Source: NOAA Fisheries 2018

dB = decibel; LE = sound exposure level; LF = low-frequency; MF = mid-frequency; HF = high frequency; 24h = 24-hour

Notes:

a/ Level A Injury

Table 4.1-62. Fish Acoustic Injury Threshold Distances (meters) for Vibratory Hammer – Offshore Substation Location

Scenario	Pile Type	Installation Duration (minutes)	Mitigation (dB)	Hearing Group	
				Small Fish a/	Large Fish a/
				183 $L_{E,\ 24hr}$	187 $L_{E,\ 24hr}$
Scenario 4: Offshore Substation Piled Jacket Foundation	2.8 m Pin Pile	120	0	1,664	1,088
			6	887	569
			10	569	427

Source: Stadler and Woodbury 2009

dB = decibel; LE = sound exposure level; 24h = 24-hour

Notes:

Same information is presented in Appendix Z

a/ Small fish are fish less than 2 grams in weight. Large fish are 2 grams or larger.

Table 4.1-63. Sea Turtle Behavioral and Acoustic Injury Criteria Threshold Distances (meters) for Vibratory Hammer – Offshore Substation Location

Scenario	Pile Type	Installation Duration (minutes)	Mitigation (dB)	Species		
				Sea Turtle Behavioral	Sea Turtle TTS	Sea Turtle PTS
				175 L_p	200 $L_{E,\ TUW,\ 24hr}$	220 $L_{E,\ TUW,\ 24hr}$
Scenario 4: Offshore Substation Piled Jacket Foundation	2.8 m Pin Pile	120	0	85	239	14
			6	38	142	0
			10	7	94	0

Source: NOAA Fisheries 2020

Scenario	Pile Type	Installation Duration (minutes)	Mitigation (dB)	Species		
				Sea Turtle Behavioral	Sea Turtle TTS	Sea Turtle PTS
				175 L_p	200 $L_{E, TUW, 24hr}$	220 $L_{E, TUW, 24hr}$

PTS = permanent threshold shift; TTS = temporary threshold shift; dB = decibel; Lp = sound pressure level; TUW = sea turtles in water; 24h = 24-hour

Note: Same information is presented in COP Section 4.2.6 and Appendix Z.

Table 4.1-64. Threshold Distances (meters) for Sound Pressure Levels (L_p) for Vibratory Pile Driving at the Offshore Substation Location

Scenario	Pile Type	Installation Duration (minutes)	Mitigation (dB)	Sound Pressure Level Thresholds (dB)					
				180 L_p	175 L_p	160 L_p	150 L_p	140 L_p	120 L_p
Scenario 4: OSS Piled Jacket Foundation	2.8 m Pin Pile	120	0	46	85	N/A	991	2,497	8,912
			6	0	38	N/A	540	1,404	5,272
			10	0	7	N/A	393	991	3,601

Source: NOAA Fisheries 2019

dB = decibel; Lp = sound pressure

Note: Level B values presented here are the same as those presented in COP Section 4.2.5 and Appendix Z.

The results for the modeled scenarios indicate that the unmitigated distances to the Lpk thresholds are generally below 5,317 ft (1,621 m) for the monopile scenarios and below 1,663 ft (508 m) for the jacket pin pile scenario. Distances to the PTS onset thresholds in terms of SEL are also provided. Similar results are given for fish and sea turtles, with ranges to applicable thresholds varying depending on the threshold value and sound level weighting. Expectedly, the largest ranges to thresholds are the ones for the marine mammal and fish behavioral response, which are 150 dB and 120 dB, respectively. Figure 4.1-17 through Figure 4.1-22 provide sound contour figures for the unmitigated SPL levels for the deep, shallow and Offshore Substation modeling locations.

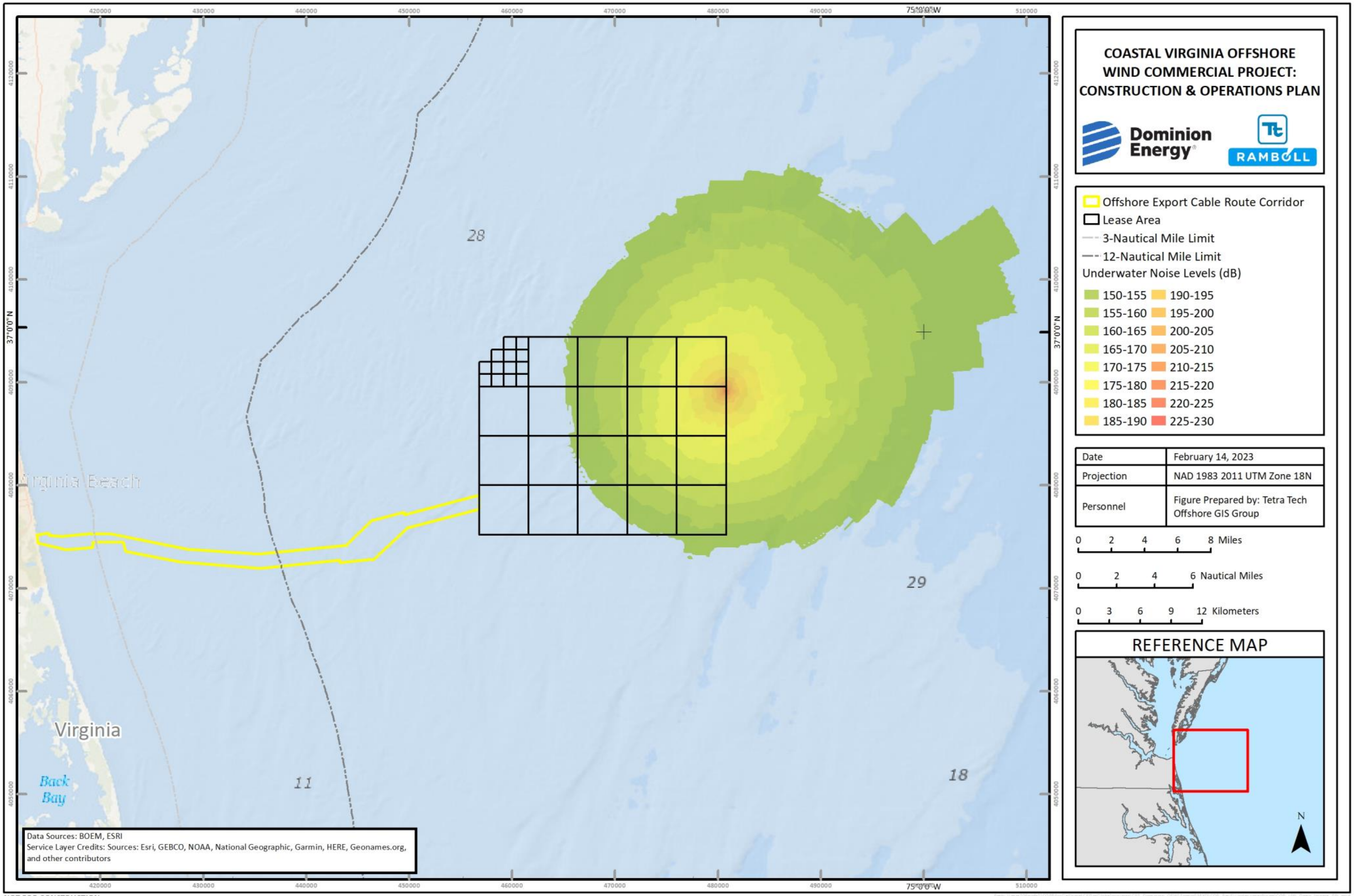


Figure 4.1-17. Underwater Received Sound Levels: Scenario 1 through 3, Impact Pile Driving, Unmitigated, Deep Location (SPL)

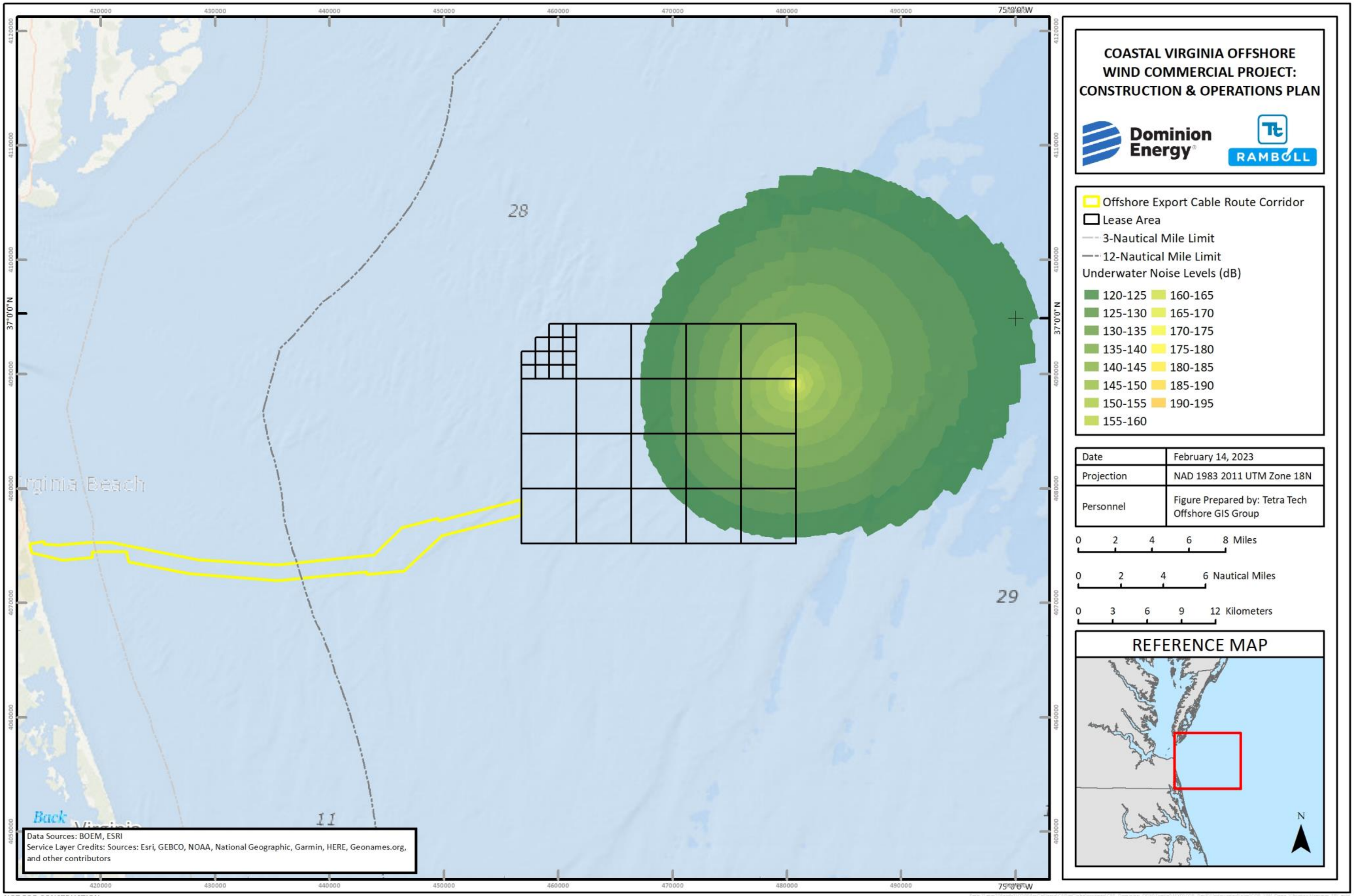


Figure 4.1-18. Underwater Received Sound Levels: Scenario 1 through 3, Vibratory Pile Driving, Unmitigated, Deep Location (SPL)

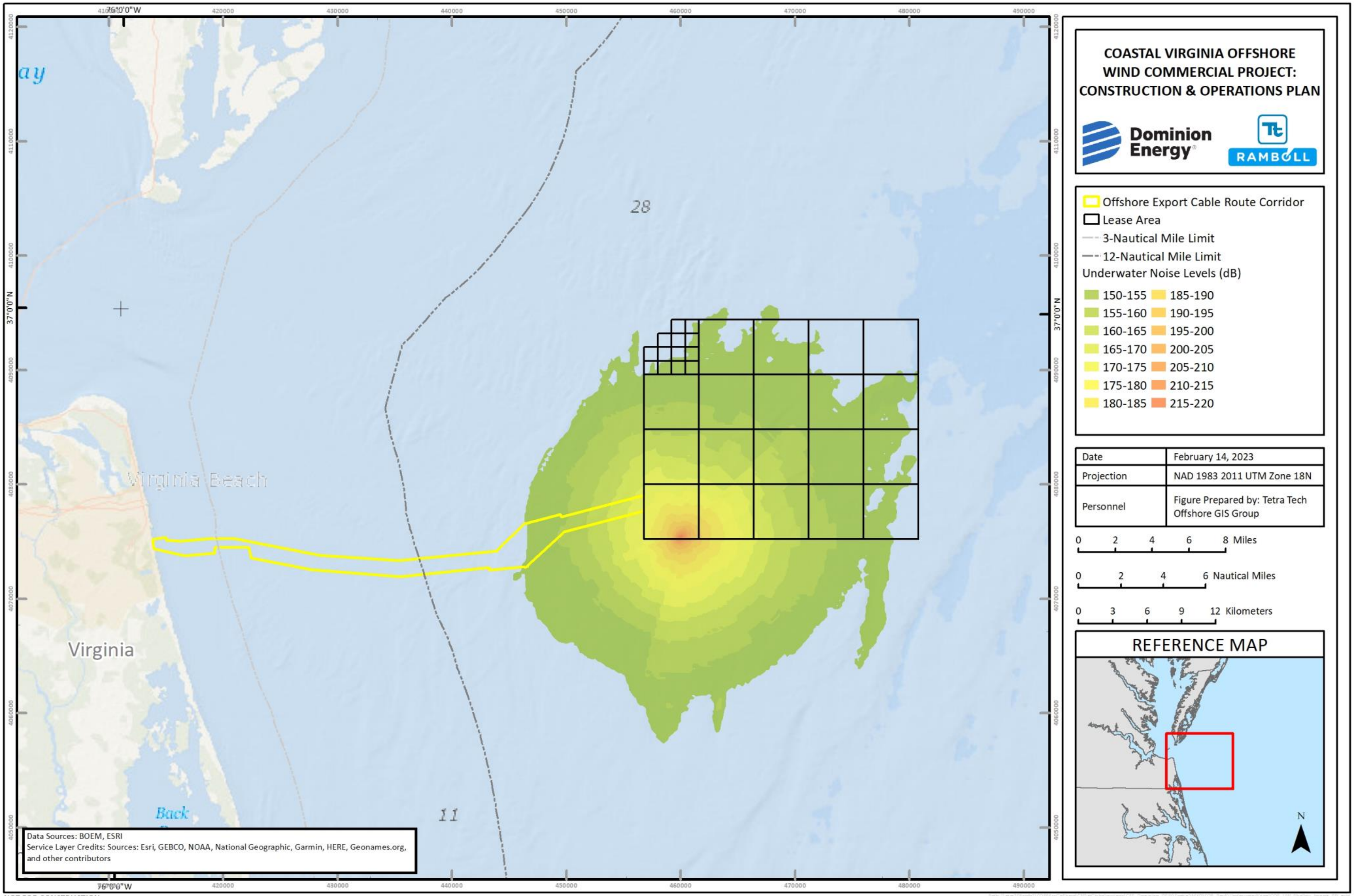


Figure 4.1-19. Underwater Received Sound Levels: Scenario 1 through 3, Impact Pile Driving, Unmitigated, Shallow Location (SPL)

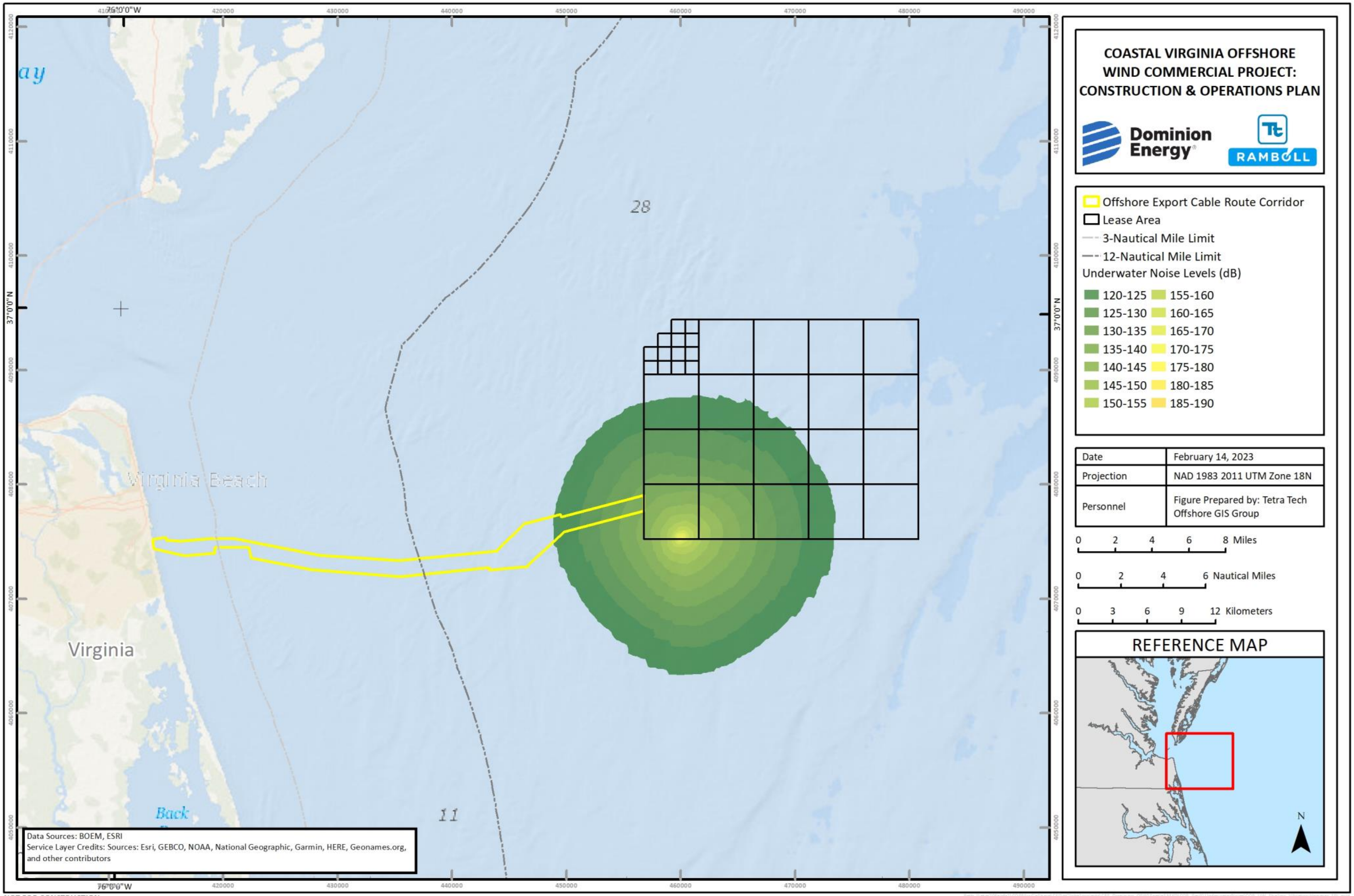


Figure 4.1-20. Underwater Received Sound Levels: Scenario 1 through 3, Vibratory Pile Driving, Unmitigated, Shallow Location (SPL)

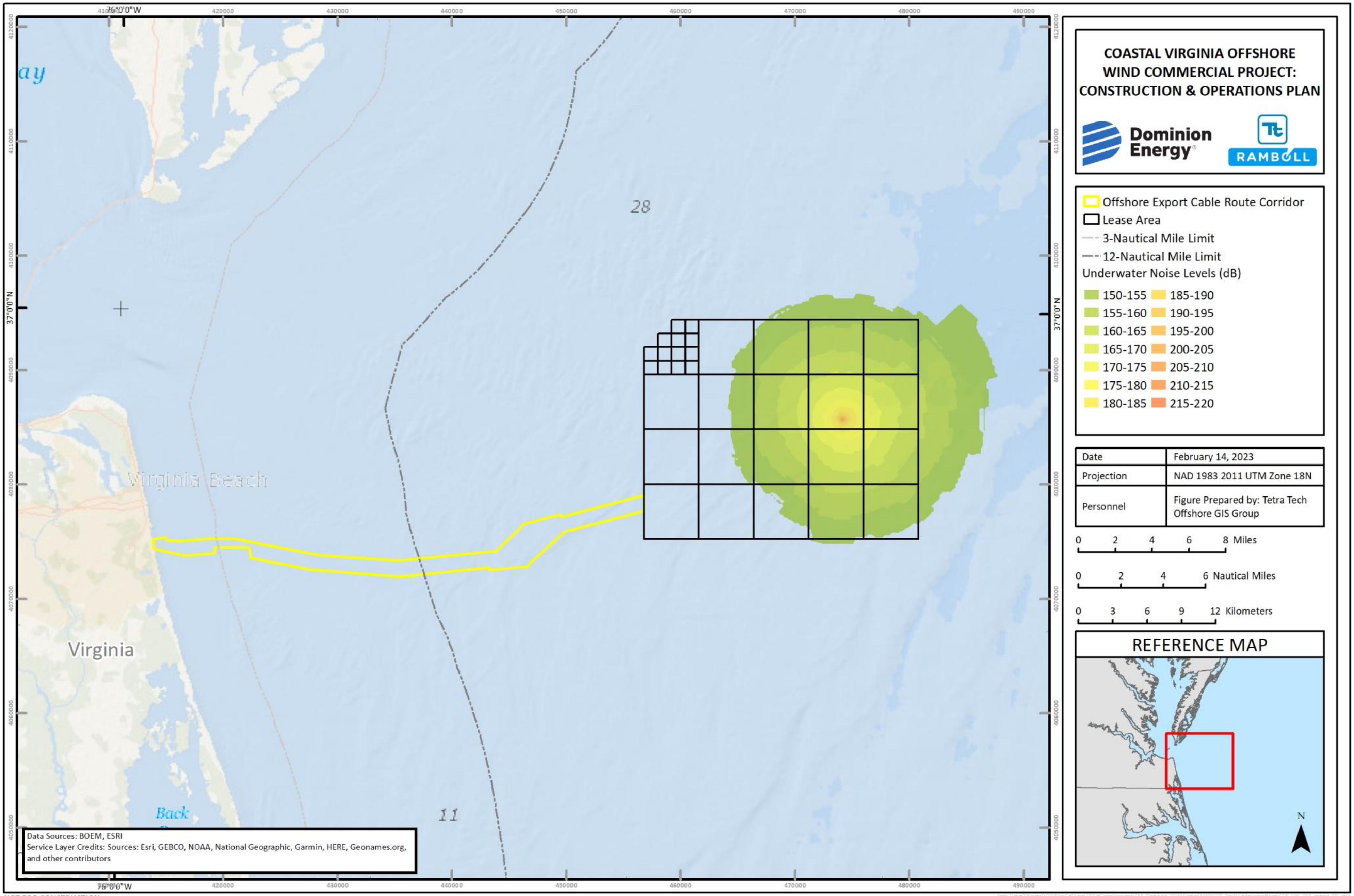


Figure 4.1-21. **Underwater Received Sound Levels: Scenario 4, Impact Pile Driving, Unmitigated, Offshore Substation Location (SPL)**

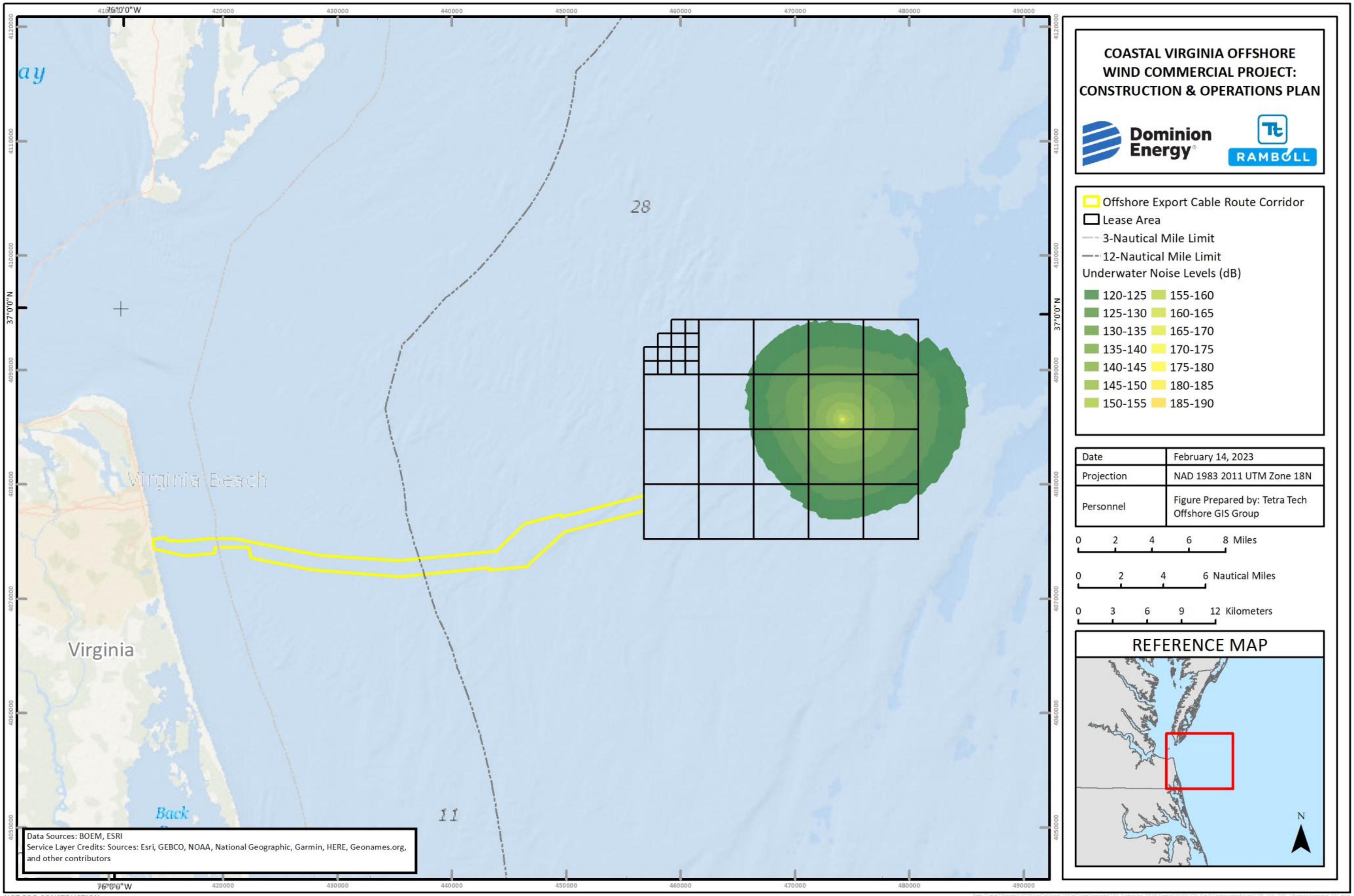


Figure 4.1-22. **Underwater Received Sound Levels: Scenario 4, Vibratory Pile Driving, Unmitigated, Offshore Substation Location (SPL)**

Short-term increase in underwater noise levels is associated with vibratory pile-driving for the cofferdam Installation. Vibratory pile-driving modeling scenarios resulted in distances to applicable acoustic thresholds of less than 82 ft (25 m) with the exception of marine mammal and fish behavioral response thresholds of 120 dB SPL RMS and 150 dB SPL RMS, respectively. Results for the representative vibratory pile-driving location associated with cofferdam installation are given in Table 4.1-65 through Table 4.1-68.

Table 4.1-65. Marine Mammal PTS Onset Criteria Threshold Distances (meters) for Vibratory Hammer – Cofferdam

Scenario	Pile Type	Installation Duration (minutes)	Mitigation (dB)	Hearing Group a/			
				LF Cetaceans	MF Cetaceans	HF Cetaceans	Phocid Pinnipeds
				199 $L_{E,\ 24hr}$	198 $L_{E,\ 24hr}$	173 $L_{E,\ 24hr}$	201 $L_{E,\ 24hr}$
Scenario 5: Cofferdam Installation	Sheet Pile	60	0 b/	108	0	0	0
			6	16	0	0	0
			10	0	0	0	0

Source: NOAA Fisheries 2018

dB = decibel; LE = sound exposure level; LF = low-frequency; MF = mid-frequency; HF = high frequency; 24h = 24-hour

Notes:

Same information is presented in COP Section 4.2.5 and Appendix Z

a/ Level A Injury

Table 4.1-66. Fish Acoustic Injury Threshold Distances (meters) for Vibratory Hammer – Cofferdam

Scenario	Pile Type	Installation Duration (minutes)	Mitigation (dB)	Hearing Group	
				Small Fish a/	Large Fish a/
				183 $L_{E,\ 24hr}$	187 $L_{E,\ 24hr}$
Scenario 5: Cofferdam Installation	Sheet Pile	60	0	567	506
			6	389	317
			10	317	206

Source: Stadler and Woodbury 2009

dB = decibel; LE = sound exposure level; 24h = 24-hour

Notes:

Same information is presented in Appendix Z

a/ Small fish are fish less than 2 grams in weight. Large fish are 2 grams or larger

Table 4.1-67. Sea Turtle Behavioral and Acoustic Injury Criteria Threshold Distances (meters) for Vibratory Hammer – Cofferdam

Scenario	Pile Type	Installation Duration (minutes)	Mitigation (dB)	Species		
				Sea Turtle Behavioral	Sea Turtle TTS	Sea Turtle PTS
				175 L_p	200 $L_{E,\ 24hr}$	220 $L_{E,\ 24hr}$
Scenario 5: Cofferdam Installation	Sheet Pile	60	0	0	5	0
			6	0	0	0
			10	0	0	0

Source: NOAA Fisheries 2020

Note: Same information is presented in COP Section 4.2.6 and Appendix Z

Table 4.1-68. Marine Mammals and Fish Behavioral Response Criteria Threshold Distances (meters) for Vibratory Hammer – Cofferdam

Scenario	Pile Type	Installation Duration (minutes)	Mitigation (dB)	Hearing Group		
				Fish	Marine Mammals	Marine Mammals
				150 L_p	160 L_p	120 L_p
Scenario 5: Cofferdam Installation	Sheet Pile	60	0	470	N/A	3,097
			6	349	N/A	2,228
			10	248	N/A	1,814

Note: Same information is presented in Appendix Z

Short-term increase in underwater noise levels associated with impact pile-driving for goal post installation. The goal posts would be installed with an impact hammer. Goal posts would be up to 1.07 m (42 in) steel pipe piles, with up to two installed per day for a total hammer duration of 130 minutes. The strike duration would be 0.5 to 2 seconds and there would be 260 strikes per pile. A maximum of 12 goal posts spaced 50 ft apart would be needed for each of the 9 Direct Pipe locations, for a total of 108 piles. All pile installation activities will occur only in daylight hours. Impact hammer activity will start no earlier than 60 minutes after civil sunrise and is anticipated to end no later than 60 minutes before civil sunset to allow for proper visual monitoring. Goal post installation was evaluated assuming impact pile driving and the results for that scenario are presented in Table 4.1-69 through Table 4.1-71.

Table 4.1-69. Marine Mammal PTS Onset Criteria Threshold Distances (meters) for Impact Pile-Driving – Goal Post Installation

Scenario	Pile Type	Maximum Hammer Energy (kilojoules)	Installation Duration (minutes)	Mitigation (dB)	Hearing Group a/							
					LF Cetaceans		MF Cetaceans		HF Cetaceans		Phocid Pinnipeds	
					219 $L_{p,pk}$	183 $L_{E,\ 24hr}$	230 $L_{p,pk}$	185 $L_{E,\ 24hr}$	202 $L_{p,pk}$	155 $L_{E,\ 24hr}$	218 $L_{p,pk}$	185 $L_{E,\ 24hr}$
Scenario 6: Goal Post Installation	Goal Post Piles	N/A	130	0	2	591	0	21	31	704	3	316
				6	0	235	0	8	12	280	1	126
				10	0	127	0	4.5	7	152	0	68

Source: NOAA Fisheries 2018

dB = decibel; LE = sound exposure level; Lp,pk = peak sound pressure level; LF = low-frequency; MF = mid-frequency; HF = high frequency; 24h = 24-hour; N/A = thresholds not applicable for source type

Notes:

SEL Unmitigated values are presented in COP Section 4.2.5 and Appendix Z
a/ Level A Injury

Table 4.1-70. Marine Mammal and Fish Behavioral Response Criteria Threshold Distances (meters) for Impact Pile-Driving – Goal Post Installation

Scenario	Pile Type	Installation Duration (minutes)	Mitigation (dB)	Hearing Group		
				Fish	Marine Mammals	Marine Mammals
				150 L_p	160 L_p	120 L_p
Scenario 6: Goal Post Installation	Goal Post Piles	130	0	6,750	1,450	41,000
			6	2,700	580	20,500
			10	1,450	314	12,900

dB = decibel; LE = sound exposure level; Lp = sound pressure level

Note: Level B Unmitigated values are presented in COP Section 4.2.5 and Appendix Z

Table 4.1-71. Sea Turtle Behavioral and Acoustic Injury Criteria Threshold Distances (meters) for Impact Pile-Driving – Goal Post Installation

Scenario	Pile Type	Hammer Energy (kilojoule)	Installation Duration (minutes)	Mitigation (dB)	Species				
					Sea Turtle Behavioral	Sea Turtle Temporary Threshold Shift		Sea Turtle Permanent Threshold Shift	
					175 L_p	226 $L_{p,pk}$	189 $L_{E,\ TUW,\ 24hr}$	232 $L_{p,pk}$	204 $L_{E,\ TUW,\ 24hr}$
Scenario 6: Goal Post Installation	Goal Post Piles	N/A	130	0	156	0	0	0	0
				6	63	0	0	0	0
				10	34	0	0	0	0

Source: NOAA Fisheries 2019

dB = decibel; LE = sound exposure level; Lp = sound pressure level; Lp,pk = peak sound pressure level; 24h = 24-hour; dB = decibel; Lp = sound pressure level; TUW = sea turtles in water; N/A = thresholds not applicable for source type

Note: Same information is presented in COP Section 4.2.6 and Appendix Z.

The results of the analysis would be used to inform development of evaluation and mitigation measures that would be applied during construction and operation of the Project, in consultation with BOEM and NOAA Fisheries (see Appendix FF, Construction Mitigation and Monitoring Plan). The Project would obtain necessary permits to address potential impacts to marine mammals, sea turtles and fisheries resources from underwater noise and would establish appropriate and practicable mitigation and monitoring measures through discussions with regulatory agencies. Dominion Energy understands that the measures required by the final NOAA Fisheries-approved LOA would be incorporated into COP approval, and BOEM and/or the Bureau of Safety and Environmental Enforcement will monitor compliance with these measures.

Short-term increase in underwater noise levels associated with Offshore Export Cables and Inter-Array Cable laying activities. During construction, vessels specifically designed for laying and burying cables on the seabed would be used to install the Offshore Export Cables and Inter-Array Cables, which are proposed to be completed through the use of jet trencher, plow, and/or other available technology. Other activities associated with installation of cables may include pre-lay grapnel run and installation of cable protection on top of the cables. In addition, there is the possibility that munitions and explosives of concern (MEC) may need to be mitigated. Based on the results of a desktop study which indicates that the likelihood of encountering MEC that would cause a notable safety risk is below the ALARP threshold, it is anticipated that mitigation could be achieved without high-order detonation.

Dominion Energy began MEC investigation surveys in August 2022, which are still ongoing. An IHA Application was submitted for this survey work to NOAA Fisheries on September 30, 2021. If, during investigation surveys, anomalies are identified and interpreted as potential MEC that cannot be avoided, MEC identification surveys using a remotely operated vehicle may be required. Following survey and identification activities, potential impacts will be evaluated for mitigation, if required. Throughout the cable lay process, a dynamic positioning-enabled cable lay vessel would maintain its position (fixed location or predetermined track) by means of its propellers and thrusters using a GPS, which controls the ship's position by sending positioning information to an onboard computer that controls the thrusters. The underwater noise produced by subsea trenching operations depends on the equipment used and the nature of the seabed sediments, but would be predominantly generated by vessel thruster use.

Thruster sound source levels may vary in part due to technologies employed and are not necessarily dependent on either vessel size, propulsion power, or the activity engaged. Dynamic positioning thruster noise is non-impulsive and continuous in nature, and is not expected to result in harassment. Recent guidance from NOAA Fisheries indicates that they do not expect the use of directional thrusters to impact marine species in any material way, and no longer require that those activities be included in requests for an IHA.

Short-term increase in underwater noise levels associated with Project-related vessels. While dynamic positioning enabled cable lay vessels are expected to generate the highest level of vessel-related noise, there are other vessels used during construction that may also contribute to increases in sound level relative to the ambient underwater acoustic environment. These other vessels include those that are anchored such as jack-up barges, those in transit such as medium service vessels, and smaller vessels like tugboats and crew transfer/workboats. Underwater noise emitted from other anchored and transiting vessels is expected to be relatively minimal, and comparable to other vessel traffic that routinely transits the Offshore Project Area. In addition, the increase in Project vessel activity would not be a combined increase occurring all at once, but rather would be sporadic throughout the construction period (both in the 24-hour work period, and the season). It is unlikely that the noise impact of anchored vessels and vessel traffic associated with Project construction would result in a significant increase to the underwater acoustic environment.

Operations and Maintenance

During operations, the potential impact-producing factors to the underwater noise environment may include the presence of vessels and generation of WTG noise and vibrations. Dominion Energy proposes to implement measures, as appropriate, to avoid, minimize, and mitigate impacts during Project O&M. The following impacts may occur related to the factors identified above:

- Increase in underwater noise levels associated with WTG operations; and
- Increase in intermittent underwater noise levels associated with Project O&M and Project-related vessels.

Increase in underwater noise levels associated with WTG operations. When the WTGs are operational, noise and vibration are transmitted into the sea by the structure of the tower itself, and manifests as low-frequency noise. Other sound transmission pathways are via the monopile and the seabed, or through the air and air/water interface, but those pathways are unlikely to be as important as the pathway directly through the monopile or jacket legs (Nedwell et al. 2004). Source levels from operating offshore WTGs that have monopile foundations show peak frequencies occurring predominantly below 500 Hz, and that the apparent source level ranges from 140 to 153 dB (Nedwell et al. 2004). Similar measurements by Nedwell indicate that the steady state background in an offshore oceanic environment also occurs within this frequency range, which implies masking effects of operational WTG noise. The available field data showed that although the absolute level of turbine noise increases with increasing wind speed, the noise level relative to ambient noise (i.e., from wave action, entrained bubbles) remained relatively constant.

Increase in intermittent underwater noise levels associated with Project O&M and Project-related vessels. During operations, underwater noise from Project-related operations and support vessel traffic is not anticipated to be greater than the ambient noise levels in the review area. Vessel traffic is expected to have an insignificant increase above the existing baseline conditions as a result of the Project. Vessel traffic would increase during operations mainly from transportation of supplies and maintenance crews (see Section 4.4.7, Marine Transportation and Navigation). Given the amount of existing vessel traffic in the Offshore Project Area, the noise associated with supply vessels transiting to the offshore facilities would have a negligible contribution to the total ambient underwater sound levels. Similarly, nearshore vessel activity would be generally concentrated in established shipping channels (where applicable) and near industrial port areas and would be consistent with the existing noise environment in those areas. Therefore, impacts from underwater sound due to Project-related vessel activity are not expected to be significantly greater than the existent ambient conditions.

As described in Section 3, Description of Proposed Activity, infrequent maintenance may be required of major Project Components. Impacts associated with these activities, and the associated vessels, is expected to similar or less than that described for construction impacts.

Decommissioning

Impacts resulting from decommissioning of the Project are expected to be similar to or less than those experienced during construction. Decommissioning techniques are further expected to advance during the useful life of the Project. A full decommissioning plan will be provided to the appropriate regulatory agencies for approval, and potential impacts would be re-evaluated at that time.

4.1.5.4 Summary of Avoidance, Minimization, and Mitigation Measures

Dominion Energy proposes to implement the following measures to avoid, minimize, and mitigate the potential impact-producing factors described (Table 4.1-72). In addition, Dominion Energy will implement all avoidance, minimization, and mitigation measures included in the NOAA Fisheries-approved Letter of Authorization and Construction Mitigation and Monitoring Plan (CMMP) for the Project. Dominion Energy submitted a draft Protected Species Mitigation and Monitoring Plan (now referred to as the CMMP) for the Project to NOAA Fisheries on December 8, 2022. Dominion Energy will continue discussions and engagement with the appropriate regulatory agencies and environmental non-governmental organizations throughout the life of the Project to develop an adaptive mitigation approach that provides the most flexible and protective mitigation measures.

Table 4.1-72. Summary of Avoidance, Minimization, and Mitigation Measures

Project Stage	Location	Impact	Avoidance, Minimization and Mitigation
Construction; Decommissioning	Offshore Project Area	Short-term increase in underwater noise levels associated with Wind Turbine Generator (WTG) Foundations and/or pin pile impact pile-driving activities required for the installation of WTG and Offshore Substation Jacket Foundations	• Noise mitigation requirements and methods have not been finalized at this stage of permitting; therefore, two levels of reduction were applied to potentially mimic the use of noise mitigation options such as bubble curtains; • The results of the analysis would be used to inform development of evaluation and mitigation measures that would be applied during construction and operations and maintenance (O&M) of the Project, in consultation with the Bureau of Ocean Energy Management (BOEM) and National Oceanic and Atmospheric Administration's National Marine Fisheries Service (NOAA Fisheries); • The Project would obtain necessary permits to address potential impacts to marine mammals, sea turtles and fisheries resources from underwater noise and would establish appropriate and practicable mitigation and monitoring measures through discussions with regulatory agencies; and • Dominion Energy understands that the measures required by the final NOAA Fisheries-approved Letter of Authorization and Construction Mitigation and Monitoring Plan would be incorporated into the COP approval, and BOEM and/or Bureau of Safety and Environmental Enforcement will monitor compliance with these measures.
		Short-term increase in underwater noise levels associated with pile-driving for cofferdam Installation	
		Short-term increase in underwater noise levels associated with impact pile -driving for goal post installation	
		Short-term increase in underwater noise levels associated with Offshore Export Cables and Inter-Array Cable laying activities	
		Short-term increase in underwater noise levels associated with Project-related vessels	
Operations and Maintenance	Offshore Project Area	Increase in underwater noise levels associated with WTG operations	

Project Stage	Location	Impact	Avoidance, Minimization and Mitigation
		Increase in intermittent underwater noise levels associated with Project O&M and Project-related vessels	• No mitigation measures are expected to be needed during Project O&M to minimize underwater noise levels.