VOWTAP

Virginia Offshore Wind Technology Advancement Project

Research Activities Plan

Submitted by:

Dominion®

Virginia Department of Mines Minerals and Energy

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RESEARCH ACTIVITIES PLAN

Virginia Offshore Wind Technology Advancement Project

(VOWTAP)

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EXECUTIVE SUMMARY

Virginia Electric and Power Company, a wholly-owned subsidiary of Dominion Resources, Inc. (Dominion), proposes to construct, own, and operate the Virginia Offshore Wind Technology Advancement Project (VOWTAP or Project), a 12 megawatt (MW) offshore wind technology testing facility located approximately 27 statute miles (mi) (24 nautical miles [nm], 43 kilometers [km]) east of the city of Virginia Beach, Virginia. While Dominion will construct, own, and operate the Project, the VOWTAP is a collaborative research and development effort comprised of the Virginia Department of Mines, Minerals, and Energy (DMME), as the offshore lease holder; Alstom, as the turbine manufacture; Keystone Engineering Inc. (Keystone), as the foundation design firm; Kellogg, Brown, & Root (KBR), as the marine engineering contractor; Tetra Tech, Inc. (Tetra Tech) as the environmental contractor; the National Renewable Energy Laboratory (NREL) and the Virginia Coastal Energy Research Consortium (VCERC), represented by Virginia Polytechnic Institute (Virginia Tech), as renewable energy research partners; and Newport News Shipbuilding, for their logistical knowledge of local ports and harbors. This group of partners, collectively referred to as the VOWTAP Team, exemplifies the essential roles necessary to deliver a state-of-the-art offshore wind technology advancement and demonstration project.

The VOWTAP will consist of two, 6 MW wind turbine generators (WTGs), a 34.5-kilovolt (kV) alternating current (AC) submarine cable interconnecting the WTGs (Inter-Array Cable), a 34.5 kV AC submarine transmission cable (Export Cable), and a 34.5 kV underground cable (Onshore Interconnection Cable) that will connect the Project with existing Dominion infrastructure located in the City of Virginia Beach. Interconnection with the existing Dominion infrastructure will also require an onshore Switch Cabinet, an underground Fiber Optic Cable, and a new Interconnection Station to be located entirely within the boundaries of the Camp Pendleton State Military Reservation (Camp Pendleton), in the City of Virginia Beach.

The offshore components of the VOWTAP, including the WTGs and Inter-Array Cable, will be located in federal waters, while the Export Cable will traverse both federal and state territorial waters. The onshore components, including the Onshore Interconnection Cable, Fiber Optic Cable, Switch Cabinet, and Interconnection Station will be located entirely within the boundary of Camp Pendleton. During construction, the Project will additionally be supported by construction laydown area(s) and a Construction Port. The operation phase of the Project will have an operations and maintenance (O&M) facility with an associated Base Port. Dominion will locate these support facilities at existing waterfront industrial or commercial sites located in the cities of Virginia Beach, Norfolk, and/or Newport News, Virginia.

The purpose of the VOWTAP is to respond to the expressed need for the advancement of offshore wind energy research and development in the United States and in Virginia. This need has been expressed by both the U.S. Department of Energy (DOE) and the Commonwealth of Virginia. In 2010, the DOE Energy Efficiency and Renewable Energy Wind and Water Power Program instituted the Offshore Wind Innovation and Demonstration Initiative (OSWInD) to consolidate and expand its efforts to promote and accelerate responsible commercial offshore wind development in the United States (DOE 2011). In 2012, VOWTAP was one of seven entities selected to receive grants from DOE to support the initial development of innovative offshore wind demonstration projects. In 2014, DOE selected the VOWTAP as one of three technology demonstration projects to receive additional funding to support the advancement of the Project towards construction.

Construction and operation of the VOWTAP will require an Outer Continental Shelf (OCS) Renewable Energy Research Lease. On March 23, 2015, Bureau of Ocean Energy Management (BOEM) formally issued the Research Lease to DMME with Dominion named as the designated operator. An Easement from BOEM will also be necessary for the portion of the Export Cable that traverses federal waters. Prior to issuance of an OCS Renewable Energy Research Lease or Easement, BOEM must review the environmental effects and benefits of the Project in accordance with the National Environmental Policy Act (NEPA) (42 United States Code [USC] 4321 et seq.), and other agency-specific statutes, regulations, and guidelines. The major federal actions that require review under NEPA are BOEM's issuance of the OCS Renewable Energy Research Lease, U.S. Army Corps of Engineer's issuance of an Individual Permit under the Clean Water Act, and the grant of federal funds by DOE for further development of the Project under the OSWInD Initiative.

The proposed Project represents over three years of consideration of alternative sites and design parameters, while being designed to satisfy the needs identified by the OSWinD Initiative and the Commonwealth of Virginia. Dominion and the VOWTAP Team have identified a Preferred Alternative for the Project based on the results of these alternative evaluations. The Preferred Alternative that is evaluated in this Research Activities Plan (RAP) comprises:

- The Research Lease Area (OCS Block 6111, Aliquots D, H, L and OCS Block 6061, Aliquots H, L, P);
- An Export Cable with a landfall location at Camp Pendleton Beach, in Virginia Beach, Virginia;
- An Onshore Interconnection Cable and Fiber Optic Cable, and Interconnection Station located entirely on state-owned lands;
- The Keystone Inward Battered Guide Structure (IBGS) as the innovative foundation structure; and
- The 6 MW Alstom Haliade 150 as the innovative WTG technology.

The VOWTAP will support one of the first U.S. offshore deployments of the 6 MW Haliade 150 WTG and the IBGS foundation. Proposed Project innovations will also deliver significant cost reductions that can be applied toward future commercial-scale wind energy deployment, will help remove market barriers, identify potential improvements in the BOEM permitting process, and advance environmental research and understanding of effects to the environment from offshore wind projects.

The location of the WTGs and onshore facilities reflects the substantial efforts undertaken by Dominion and the VOWTAP Team, and with the involvement of agencies and stakeholders, to choose a site that minimizes the potential impacts on natural resources (e.g., benthic ecology, marine mammals, avian and bat species, fish, and habitat) and existing human uses (e.g., military maritime uses, commercial and recreational fishing, cultural and historic sites, recreation and tourism, and marine transportation). In addition to the site selection process, Dominion has completed thorough site-specific analyses in order to further avoid and minimize potential environmental impacts. As a result of these measures, remaining impacts on the environment from the VOWTAP are expected to be minor.

Table ES-1 summarizes the environmental resources evaluated in this RAP, the potential impacts from the VOWTAP on each resource, as well as the avoidance, minimization, and mitigation measures undertaken and proposed by Dominion.

Table ES-1. Potential Impacts and Avoidance, Minimization, and Mitigation Measures

Resource	Potential Impacts	Avoidance, Minimization, and Mitigation Measures
Physical and Oceanographic Conditions	Meteorological or oceanographic conditions: no impact. Seafloor sediments: localized and short-term impacts during construction. Terrestrial soils: localized and short-term impacts during construction.	Design: • The VOWTAP has been designed to account for the meteorological conditions within the Project Area. • Dominion has selected a construction schedule and WTG technology that takes into consideration both weather and environmental conditions. • The WTGs have been designed to shut down in extreme weather conditions. • Jet plowing, remotely operated vehicle (ROV) jet trenching, horizontal directional drilling (HDD) techniques, and the use of a Dynamic Positioning (DP) vessel for cable installation will minimize sediment disturbance and alteration, and disturbance of soils during construction. • Man-made and natural hazards have been avoided to the maximum extent possible. • Dominion has sited Project facilities along previously disturbed lands and within existing rights-of-way. BMPs: • Dominion will implement a Stormwater Management Plan and Erosion and Sediment Control (ESC) Plan in support of construction. • Dominion has selected minimum target depths of burial of 3.3 ft (1 m) along the Inter-Array Cable route and 6.6 ft (2 m) along the Export Cable route to ensure protection from external egression. In areas where the minimal target depth of burial cannot be achieved, Dominion may also apply additional cable protection measures, such as concrete mattresses, sandbags, rocks, and articulated split pipe. • Where the Export Cable crosses the Dam Neck Ocean Disposal Site (DNODS), and within a 100-ft (30.5-m) perimeter upon entering and exiting the DNODS, Dominion will bury the cable not less than 6 ft (1.8 m) below the existing bottom. • Prior to installation, Dominion will complete route clearance and pre-lay grapnel activities to identify potential obstructions along the proposed cable routes and within the WTG and Offshore HDD Work Areas. • Dominion will conduct regular monitoring for scour along the offshore cable routes. • Dominion will conduct additional research, in coordination with Camp Pendleton, into abandoned communication lines along the Interconnection Cable and Fiber Optic Cable route and determine any measures required to avoid and/or remove those lines. In areas where existing utilities or other constraints are encountered, Dominion may elect to increase the burial depth of the cables to up to 20 ft (6 m).

Table ES-1. Potential Impacts and Avoidance, Minimization, and Mitigation Measures (continued)

Resource	Potential Impacts	Avoidance, Minimization, and Mitigation Measures
Avian and Bat Species	Habitat: • Onshore: short-term habitat disturbance from construction, no long-term impacts on habitat. • Offshore: no impact to avian or bat habitat. Mortality or injury through collision with onshore or offshore facilities: low risk. Potential displacement or barrier effects: low risk. Direct or indirect impacts to bats: low to no risk	Design: • Dominion located onshore facilities primarily along existing right-of-way and in currently disturbed areas that are not known to support breeding shorebirds or bats. • Dominion has oriented the WTGs in parallel with the prevailing avian flight direction in order to minimize potential barrier effects. • Dominion will install the Onshore Interconnection Cable underground using HDD to minimize potential impacts to sensitive shoreline habitats. BMPs • Construction vehicles will not be driven on the beach, dunes, or in other sensitive shoreline habitats. • The WTGs and Project onshore facilities will not create a barrier to bird migration or movement. • Tree clearing will be minimized to the maximum extent possible. Trees removed will be low-quality and/or diseased trees. • Dominion will use flashing aviation safety lights on the WTG nacelles and will investigate the possibility of using down shielded lights (aka hooded lights) where possible on construction vessels. • Dominion will install anti-perching devices on the IBGS foundations. • Dominion will implement a post-construction monitoring program during operation of the Project to evaluate actual impacts from the WTGs.
Threatened and Endangered Species and Species of Special Concern	Impacts could occur similar to those described for non-listed fish species, marine mammals, avian species, and terrestrial mammals. Fish: localized and short term disturbance during construction. Marine mammals: localized and short term noise impacts during construction. Sea turtles localized and short term noise impacts during construction. Invertebrates: no impacts Avian species: low likelihood of impacts. Terrestrial mammals: low likelihood of impacts. Terrestrial reptiles: low likelihood of impacts. Amphibians: no impacts. Vascular plants: no impact.	Design: • Jet plowing, ROV trenching, HDD techniques, and the use of a DP vessel for cable installation will minimize sediment disturbance and alteration, and reduce associated turbidity and TSS. BMPs. Avoidance, minimization, and mitigation measures are similar to those described for marine biological resources, terrestrial biological resources, and avian and bat species. • Dominion will use soft start and ramp-up procedures to minimize potential noise impacts from pile driving to marine mammals; these will also minimize potential impacts to fish and sea turtles. • Dominion will establish exclusion and monitoring zones to minimize potential noise impacts to marine mammals; these will also meet or exceed protection guidelines for sea turtles. • For threatened and endangered nesting sea turtles, Dominion will not conduct any construction activities at the cable landing site between the dates of May 1 through August 31. • Dominion has committed to landing the Export Cable onshore via HDD to avoid impacts to the beach and dune, and to ensure no potential sea turtle nesting habitat is disturbed.

Table ES-1 Potential Impacts and Avoidance, Minimization, and Mitigation Measures (continued)

Resource	Potential Impacts	Avoidance, Minimization, and Mitigation Measures
Water Quality	Ground and surface water: no impacts. Marine water quality: localized and short-term increases to total suspended solids (TSS) during construction and decommissioning. Accidental spills or releases (e.g., oil, lubricants or trash) during construction, operation, or decommissioning: low risk. Sedimentation from frac-out during HDD: • Offshore: low risk • Onshore: no impact (drilling mud will not be used).	Design: • Jet plowing, ROV jet trenching, HDD techniques, and the use of a DP vessel for cable installation will minimize sediment disturbance and alteration, and reduce associated turbidity and TSS. BMPs: • Dominion will employ spill containment measures at each WTG and the onshore Interconnection Station. • Dominion will develop an HDD Contingency Plan to address the inadvertent release of drilling fluid to further minimize the potential risks associated with a frac-out during Export Cable landfall construction. • All VOWTAP vessels will operate in accordance with the Oil Pollution Act of 1990 (OPA-90), the international treaty, MARPOL 73/78, and recent EPA Small Vessel General Permit best management practices for vessels less than 79 ft (24.1 m). • Dominion will develop and will submit an Oil Spill Response Plan to manage an inadvertent spill or release of oils or other hazardous materials during operations. • Dominion will implement a Stormwater Management Plan and ECS Plan in support of construction. • Dominion will return the drilling fluid to a mud pond located within the HDD Work Area where it will be collected for reuse after cleaning. • Dominion conducted an assessment of the depth of the water table along the onshore portion of the route. Final engineering design will determine if groundwater will need to be managed during construction at locations such as cable splice pits. • Dominion will consult with jurisdictional agencies regarding any addition of fill for cable protection in select locations. Dominion will ensure that fill used for cable protection is properly tested and is free of toxins.
Marine Biological Resources	Benthos and fish: • Localized and temporary disturbance from IBGS foundation, WTG and Offshore Export Cable installation. • Limited, localized loss or alteration of benthic habitat. • IBGS foundations, as well as protective measures along portions of the Export Cable that require additional cable protection, may produce a minor beneficial impact by creating artificial hard substrate that may attract some fish and/or benthic sessile encrusting species EMFs: no impacts due to cable design and burial depth.	Design: • The Project has been sited outside of any sensitive habitats. • Jet plowing, ROV jet trenching, HDD techniques, and the use of a DP vessel for cable installation will minimize sediment disturbance and alteration, and reduce associated turbidity and TSS. BMPs • Dominion will implement soft-start and ramp-up procedures during impact pile driving activities to minimize impacts on fish and other marine species from underwater noise. • Vessels will follow NOAA guidelines for marine mammal strike avoidance. • Dominion has selected an offshore construction window outside of the known peak migration period for the North Atlantic right whale. • Personnel onboard construction, operation, and/or decommissioning vessels will receive training on marine mammal sighting and reporting that will stress individual responsibility for marine mammal awareness and protection. Personnel will also undergo marine debris awareness training.

Table ES-1 Potential Impacts and Avoidance, Minimization, and Mitigation Measures (continued)

Resource	Potential Impacts	Avoidance, Minimization, and Mitigation Measures
Marine Biological Resources (cont.)	Underwater noise: • Localized and temporary impacts for marine mammals and sea turtles associated with pile driving, WTG installation and cable installation. • Construction noise will not create either Temporary or Permanent Threshold Shift in marine mammals. • For marine mammals: temporary harassment during impact pile-driving, and during the use of DP thrusters during Inter-Array Cable, Export Cable or WTG installation. Injury or mortality from entanglement or vessel collision: low risk Loss of habitat or prey availability: negligible impact. Impacts from spills of hazardous material or marine debris: low risk.	• Dominion will employ visual monitoring and mitigation measures as directed by NOAA Fisheries for pile driving during construction. Impact avoidance and minimization measures for underwater noise may include shut-down procedures, marine mammal monitoring protocols, and the use of sort-starts during pile driving. • Dominion will establish exclusion and monitoring zones sufficient to meet noise guidelines for marine mammals and sea turtles. • Dominion will monitor sound levels during construction and for a period during operation.
Terrestrial Biological Resources	Terrestrial wildlife: localized and short- term disturbance during construction.	Design: • Dominion located onshore facilities primarily in currently disturbed areas. • Dominion will install the Onshore Interconnection Cable underground using HDD to minimize potential impacts to sensitive shoreline habitats. BMPs • Dominion will return disturbed areas to pre-construction conditions following construction. • Dominion will implement a Stormwater Management Plan and ESC Plan in support of construction.
Visual Resources	Offshore facilities: no impact as the Project facilities would not be visible to casual observers at viewing locations on the shore Offshore facilities: minor impact as the onshore facilities would create limited change to existing visual conditions.	Design: • The WTGs are sited at a distance offshore that will result in limited visibility at key viewpoints. • The onshore cables will be placed underground. • Onshore facilities are located within previously developed areas. • Dominion has selected colors for onshore facilities that will reduce visual contrast by blending the structures into the surrounding environment. BMPs: • Dominion will further screen the Interconnection Station by planting vegetation, as needed. • Dominion will implement a Fugitive Dust Control Plan to minimize dust during onshore construction activities. • Dominion will maintain onshore construction areas to remove trash and debris.

Table ES-1 Potential Impacts and Avoidance, Minimization, and Mitigation Measures (continued)

Resource	Potential Impacts	Avoidance, Minimization, and Mitigation Measures
Socioeconomic Resources	Local and regional economy: potential benefits from job creation during construction and operation of the Project. Traffic: minor, short-term increases to traffic during construction. Offshore commercial shipping and fishing, and recreational boating and fishing: • Minor, short-term impacts during construction associated with temporary displacement of vessel traffic. • Minor long-term impacts on during Project operation in the vicinity of the WTGs. Environmental justice: no impacts.	Design: • Onshore facilities are located within previously developed areas that are not used for recreation. • The WTGs are sited at a distance offshore that will result in limited visibility at key viewpoints. BMPs: • Dominion will hire local workers where possible to meet labor needs for Project construction, operation, and decommissioning. • Dominion will establish a Project-specific website to share information about VOWTAP construction progress. • Dominion will issue specific local notices to mariners in coordination with the USCG throughout the construction period. • Dominion will temporarily restrict vessel access within temporary WTG Work Areas, an Offshore HDD Work Area, and along the Export and Inter-Array Cable right-of-way during construction. • During cable installation, Dominion may elect to deploy additional buoys with lights to indicate the location of the cable as it is being installed. • During operation, Dominion will light, individually mark, and maintain Private Aids to Navigation (PATON) per USCG ATON requirements. • Dominion will place a radar beacon (RACON) at the WTG site. • Dominion plans to complete onshore construction activities prior to the start of the summer tourist season (May 31).
Essential Fish Habitat	Habitats: • Localized and short term disturbance to habitat during WTG installation and cable laying activities. • Permanent habitat loss: negligible amounts of benthic habitat loss. • IBGS foundations, as well as protective measures along portions of the Export Cable that require additional cable protection, may produce a minor beneficial impact by creating artificial hard substrate that may attract some fish and/or benthic sessile encrusting species. TSS: localized and short-term increases in TSS near the WTG foundations and along the Inter-Array and Export Cable routes. Noise: localized and short-term impacts during construction. EMF: no impact due to cable design and burial depth.	To minimize and/or avoid impacts to Essential Fish Habitat (EFH) and associated EFH Species, Dominion will implement the same actions as described for marine biological resources.

Table ES-1 Potential Impacts and Avoidance, Minimization, and Mitigation Measures (continued)

Resource	Potential Impacts	Avoidance, Minimization, and Mitigation Measures
Wetlands and Other Jurisdictional Waterbodies	Direct removal or fill impacts to wetlands: no impacts. Sedimentation: low risk.	Design: • Onshore facilities will be located within previously developed areas outside of delineated wetlands. No removal or fill will occur within onshore surface waters. BMPs: • Dominion will implement a Stormwater Management Plan and ECS Plan in support of construction.
Cultural Resources	Disturbance of terrestrial archaeological resources: low risk given the location of onshore facilities in previously disturbed areas. Unanticipated archaeological discoveries: low risk given the location of onshore facilities in previously disturbed areas. Chesapeake Light: no impacts. Camp Pendleton Historic District: no impacts.	Design: • Dominion has sited the Project to avoid potential submerged cultural sites, terrestrial archaeological resources, and historic properties. BMPs • Dominion will implement an Onshore and Offshore Unanticipated Discoveries Plan, including archeological resource identification training, in consultation with the VDHR and BOEM. • Dominion will install the Onshore Interconnection Cable underground using HDD to minimize potential impacts to terrestrial archaeological resources.
	NRHP-listed properties located within the onshore APE: Cape Henry Lighthouse (NHL), Cape Henry Light Station (NRHP), deWitt Cottage (NRHP), and the Virginia Beach USCG Station (NRHP): no impact to the NRHP qualifying characteristics of these properties.	• Dominion will use colors for the Switch Cabinet and Interconnection Station that will reduce visual contrast.
Military Maritime Uses	Military testing and training activities: no impacts.	BMPs • Dominion will coordinate all Project construction, operation, and decommissioning activities closely with the Fleet Area Control and Surveillance Facility, VA Capes and the Fleet Forces Atlantic Exercise Coordination Center at Naval Air Station Oceana. • At Camp Pendleton, Dominion will stage work in a manner that will minimize impacts on training and daily activities.
Land Use	Consistency with local land use regulation: no impact. Alteration to existing land use patterns: no impact.	Design: • Dominion has sited the Interconnection Station to minimize the need for tree clearing to the maximum extent possible. BMPs • Dominion will comply with the P-1 and I-2 zoning requirements for Category I screening at public utility installations.

Table ES-1 Potential Impacts and Avoidance, Minimization, and Mitigation Measures (continued)

Resource	Potential Impacts	Avoidance, Minimization, and Mitigation Measures
Acoustic Environment	In-air noise: minor, short-term and localized impacts on in-air noise during construction and operation. Underwater noise: short-term and localized underwater noise impacts on marine species as described for fish, marine mammals, and sea turtles.	BMPs: • Dominion will not conduct onshore construction activities between 7:00 p.m. and 7:00 a.m. Monday through Saturday, or at any time on Sunday. • Dominion will establish and enforce construction site and access road speed limits during the construction period. • Dominion will utilize electrically-powered equipment where feasible. • Dominion will locate material stockpiles and mobile equipment staging, parking, and maintenance areas as far as practicable from NSRs at the onshore HDD Work Area.
Acoustic Environment (cont.)		• Dominion will only use noise-producing signals for safety warning purposes. • Dominion will not make Project-related public addresses or allow on-site music systems to be audible at any adjacent receptor. • Dominion will ensure all noise-producing construction equipment and vehicles with internal combustion engines are equipped with mufflers, air-inlet silencers where appropriate, and any other shrouds, shields, or other noise-reducing features. • Dominion will establish exclusion and monitoring zones sufficient to meet noise guidelines for marine mammals and sea turtles. • Dominion will monitor sound levels during construction and for a period during operation.
Air Quality	Emissions: minor, short-term air emissions associated with construction and decommissioning. Small to negligible levels of air emissions during operation.	BMPs: • Vessels providing construction or maintenance services for the Project will use low-sulfur fuel. • Vessels constructed on or after January 1, 2016 will meet Tier III NO_X requirements when operating within ECAs. • Dominion will require its equipment and fuel suppliers to provide equipment and fuels for the Project that have been certified to be in compliance with the applicable EPA or equivalent emission standards. • Marine engines with a model year of 2007 or later and non-road engines complying with the Tier 2 standards (in 40 CFR 89 or 1039) or better will be used to satisfy Best Available Control Technology (BACT). • Dominion will meet BACT standards for the SF_6 insulated circuit breakers by installing the circuit breakers with a low pressure alarm and a low pressure lockout.

Table ES-1 Potential Impacts and Avoidance, Minimization, and Mitigation Measures (continued)

Resource	Potential Impacts	Avoidance, Minimization, and Mitigation Measures
Transportation	Marine transportation and navigation: minor and short-term impacts during offshore construction. Onshore transportation: minor, short-term traffic increases during construction. Aviation: no impact.	BMPs: • Dominion will establish a Project-specific website to share information about VOWTAP construction progress. • Dominion will issue specific local notices to mariners in coordination with the USCG throughout the construction period. • Dominion will establish and temporarily restrict vessel access within temporary WTG Work Areas, an offshore HDD Work Area, and along the Export and Inter-Array Cable right-of-way during construction. • During cable installation, Dominion may elect to deploy additional buoys with lights to indicate the location of the cable as it is being installed. • During operation Dominion will light, individually mark, and maintain PATON per USCG ATON requirements. • Dominion has committed to place a RACON at the WTG site. • Construction activities will not block roadways to Camp Pendleton vehicular traffic for long periods. • Dominion will comply with agency and military requests for notification of the start of Project construction, in order to make necessary charting revisions. • Dominion will request that the FAA issue a Notice to Airmen (NOTAM) prior to the start of WTG construction. • WTGs will be marked and lit with both USCG and FAA approved navigational aids.
Public Health and Safety	Accidents during construction: low risk. Accidents during operation: low risk.	Design: • The IBGS foundation design will provide mooring for a vessel in distress, and the platforms on the foundations could serve as a refuge while waiting for rescue. • Onshore electrical facilities have been designed with fire protection systems. BMPs: • Dominion will manage the overall health and safety of the Project under a Project-specific Safety Management System. • Dominion will limit public access to work sites during construction and will ensure all equipment is stored within a fenced area. • During operation, the Interconnection Station will be surrounded by a fence and locked to prevent access. • Access to the interior of the WTGs will be restricted by a locked door at the base of the tower. • At the Construction Port, Base Port, and O&M facility, secondary containment equipment and spill response kits will be provided for oils and other hazardous materials. • Each WTG will be equipped with a lightning protection system. • Dominion will employ additional operational safety systems on each WTG including a back-up power generator, fire suppression, and first aid and survival equipment.

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ACRONYMS AND ABBREVIATIONS

Acronym	Definition
°C	degrees Celsius
°F	degrees Fahrenheit
AC	alternating current
A.D.	Anno Domini
AEP	annual energy production
amsl	above mean sea level
APE	Area of Potential Effects
ASMFC	Atlantic States Fishery Management Council
ATCT	Air Traffic Control Tower
BACT	best available control technology
BCC	birds of conservation concern
BCE	Before Common Era
BGEPA	Bald and Golden Eagle Protection Act
BIWF	Block Island Wind Farm
BITS	Block Island Transmission System
BMP	Best Management Practices
BOEM	Bureau of Ocean Energy Management
BOS	balance of station
BPOL	Business, Professional and Occupational License
CAA	Clean Air Act
Camp Pendleton	Camp Pendleton State Military Reservation
CBBT	Chesapeake Bay Bridge Tunnel
CEQ	Council for Environmental Quality
CFR	Code of Federal Regulations
CH_4	methane
cm	centimeter
CNEL	community noise equivalent level
CO	carbon monoxide
CO_2	carbon dioxide
COP	Construction and Operation Plan
cSEL	accumulated sound exposure level
CVA	certified verification agent
CWA	Clean Water Act
CZMA	Coastal Zone Management Act
CZMP	Coastal Zone Management Program
dB	decibel
dBA	A-weighted decibel
dBL	linear decibel

Acronym	Definition
DMME	Virginia Department of Mines, Minerals, and Energy
DNCI	Determination of No Competitive Interest
DNODS	Dam Neck Ocean Disposal Site
DoD	Department of Defense
DOE	Department of Energy
DOI	Department of the Interior
Dominion	Virginia Electric and Power Company, a wholly-owned subsidiary of Dominion Resources, Inc.
DP	dynamically positioned
EA	Environmental Assessment
ECA	Emission Control Area
EERE	Energy Efficiency and Renewable Energy
EEZ	Exclusive Economic Zone
EFH	Essential Fish Habitat
EMF	electric and magnetic field
EMS	Emergency medical services
EPA	U.S. Environmental Protection Agency
ESA	Endangered Species Act
ESC	Erosion Sediment Control
ESPreSSo	Experimental System for Predicting Shelf and Slope Optics
FAA	Federal Aviation Administration
FAD	fish aggregating device
FACSFAC	Fleet Area Control & Surveillance Facility
FPM	Flash per minute
FR	Federal Register
ft	foot
FUDS	Formerly Used Defense Site
FY	fiscal year
gal	gallon
GDP	gross domestic product
GHG	greenhouse gas
GMFMC	Gulf of Mexico Fishery Management Council
HAT	highest astronomical tide
HDD	horizontal directional drill
hp	horsepower
HUD	Department of Housing and Urban Development
Hz	hertz
IBGS	Inward Battered Guide Structure
in	inch
INRMP	Integrated Natural Resources Management Plan

Acronym	Definition
ISO	International Organization for Standardization
KBR	Kellogg, Brown, & Root
Keystone	Keystone Engineering Inc.
kHz	kilohertz
kJ	kilojoule
km	kilometer
KP	kilometer point
kV	kilovolt
L	liter
L_{dn}	day-night sound level
L_{eq}	24-hour equivalent sound level
µg/L	microgram per liter
µPa	micropascal
µPa2-s	micropascal-squared seconds
m	meter
m^3	cubic meter
m/s	meter per second
MAFMAC	Mid-Atlantic Fisheries Management Council
MARPOL	International Convention on the Prevention of Pollution from Ships
MBTA	Migratory Bird Treaty Act
MEC	munitions and explosives of concern
mG	milligauss
mg/L	milligram per liter
mi	statute miles
MHW	mean high water
mm	millimeter
MMPA	Marine Mammal Protection Act of 1972
mph	miles per hour
MPRSA	Marine Protection, Research and Sanctuaries Act
MSFCMA	Magnuson-Stevens Fishery Conservation and Management Act
MVA	Minimum vectoring altitude
MW	megawatt
N_2O	nitrous oxide
NAAQS	National Ambient Air Quality Standards
NARA	National Archives and Records Administration
NCOM	Navy Coastal Ocean Model
NEFSC	Northeast Fisheries Science Center
NEPA	National Environmental Policy Act
NHL	National Historic Landmarks
NHP	Natural Heritage Program

Acronym	Definition
NHPA	National Historic Preservation Act
nm	nautical miles
NMFS	National Marine Fisheries Service
NNS	Newport News Shipbuilding
NOAA	National Oceanic and Atmospheric Association
NOAA Fisheries	National Oceanic and Atmospheric Association National Marine Fisheries Service
NOEP	National Ocean Economics Program
NOTAM	Notice to Airmen
NO_x	nitrous oxides
NPDES	National Pollutant Discharge Elimination System
NRCS	Natural Resources Conservation Service
NRHP	National Register of Historic Places
NREL	National Renewable Energy Laboratory
NSR	noise sensitive receptor
NVIC	Navigation Vessel Inspection Circular
O&M	operations and maintenance
OCS	outer continental shelf
OCSLA	Outer Continental Shelf Lands Act
OPAREA	Operating Area
OSWInD	Offshore Wind Innovation and Demonstration
PATON	Private Aids to Navigation
PCPT	piezocone penetration test
P.L.	Public Law
$PM_{2.5}$	Particulate matter up to 2.5 micrometers in size
PMDD	permanent magnet direct drive
PPT	parts per thousand
Project	Virginia Offshore Wind Technology Advancement Project
PSO	Protected Species Observer
Psu	practical salinity unit
PTE	Potential to Emit
PTS	permanent threshold shift
RACON	radar beacon
RFI	Request for Information
RI Ocean SAMP	Rhode Island Ocean Special Area Management Plan
RAP	Research Activities Plan
RCRA	Resource Conservation and Recovery Act
RMS	root mean square
ROV	remotely operated vehicle
ROW	right-of-way

Acronym	Definition
SAFMC	South Atlantic Fishery Management Council
SAP	Site Assessment Plan
SESEF	Shipboard Electronic Systems Evaluation Facility
SFA	Sustainable Fisheries Act
SGCN	species of greatest conservation need
SHPO	State Historic Preservation Office
SMA	Seasonal Management Area
SOC	species of concern
SO_2	sulfur dioxide
SO_x	sulfur oxides
SCADA	Supervisory Control and Data Acquisition
SMS	Safety Management System
Tetra Tech	Tetra Tech, Inc.
TRACON	Terminal Radar Approach Control
TSS	total suspended solids
TTS	temporary threshold shift
USACE	U.S. Army Corps of Engineers
USC	United States Code
USCG	U.S. Coast Guard
USFWS	U.S. Fish and Wildlife Service
USGS	U.S. Geological Survey
UXO	unexploded military ordnance
VAC	Virginia Administrative Code
VACAPES	Virginia Capes
VCERC	Virginia Coastal Energy Research Consortium
VDACS	Virginia Department of Agriculture and Consumer Services
VDCR	Virginia Department of Conservation and Recreation
VDEQ	Virginia Department of Environmental Quality
VDGIF	Virginia Department of Game and Inland Fisheries
VDHR	Virginia Department of Historical Resources
VFR	visual flight rules
VIA	Visual Impact Assessment
Virginia Tech	Virginia Polytechnic Institute
VMRC	Virginia Marine Resources Commission
VOC	volatile organic compound
VOWDA	Virginia Offshore Wind Development Authority
VOWTAP	Virginia Offshore Wind Technology Advancement Project
VRP	Vessel Response Plan
VWP	Virginia Water Protection
WEA	Wind Energy Area

Acronym	Definition
WTG	wind turbine generator
yd^3	cubic yard
ZOI	zone of influence

1 INTRODUCTION

1.1 Project Overview

Virginia Electric and Power Company, a wholly-owned subsidiary of Dominion Resources, Inc. (Dominion), proposes to construct, own, and operate the Virginia Offshore Wind Technology Advancement Project (VOWTAP or Project), a 12 megawatt (MW) offshore wind technology testing facility located approximately 27 statute miles (mi) (24 nautical miles [nm], 43 kilometers [km])[1] east of the City of Virginia Beach, Virginia (Figure 1.1-1). While Dominion will construct, own, and operate the Project, VOWTAP is a collaborative research and development effort comprised of the Virginia Department of Mines, Minerals, and Energy (DMME), as the offshore lease holder; Alstom, as turbine manufacture; Keystone Engineering Inc. (Keystone), as the foundation design firm; Kellogg, Brown, & Root (KBR) as the marine engineering contractor; Tetra Tech, Inc. (Tetra Tech) as the environmental contractor; the National Renewable Energy Laboratory (NREL) and the Virginia Coastal Energy Research Consortium (VCERC), represented by Virginia Polytechnic Institute (Virginia Tech), as renewable energy research partners; and Newport News Shipbuilding, for their logistical knowledge of local ports and harbors. This group of partners, collectively referred to as the VOWTAP Team, exemplifies the essential roles necessary to deliver a state-of-the-art offshore wind technology advancement and demonstration project.

The VOWTAP will consist of two, 6 MW wind turbine generators (WTGs), a 34.5-kilovolt (kV) alternating current (AC) submarine cable interconnecting the WTGs (Inter-Array Cable), a 34.5 kV AC submarine transmission cable (Export Cable), and a 34.5 kV underground cable (Onshore Interconnection Cable) that will connect the Project with existing Dominion infrastructure located in Virginia Beach, Virginia (Figure 1.1-1). Interconnection with the existing Dominion infrastructure will also require an onshore Switch Cabinet, a Fiber Optic Cable, and new Interconnection Station to be located entirely within the boundaries of the Camp Pendleton State Military Reservation (Camp Pendleton).

In connection with VOWTAP, Dominion proposes to install three stand-alone metocean instrumentation platforms for the purpose of collecting oceanographic measurements in the Project area. This innovative data collection effort is evaluated in a separate Site Assessment Plan (SAP), and is therefore not further discussed in this document.

[1] Distances throughout the RAP are provided as statute miles (mi) or nautical miles (nm) as appropriate, with kilometers in parentheses. For reference, 1 mi equals approximately 0.87 nm.

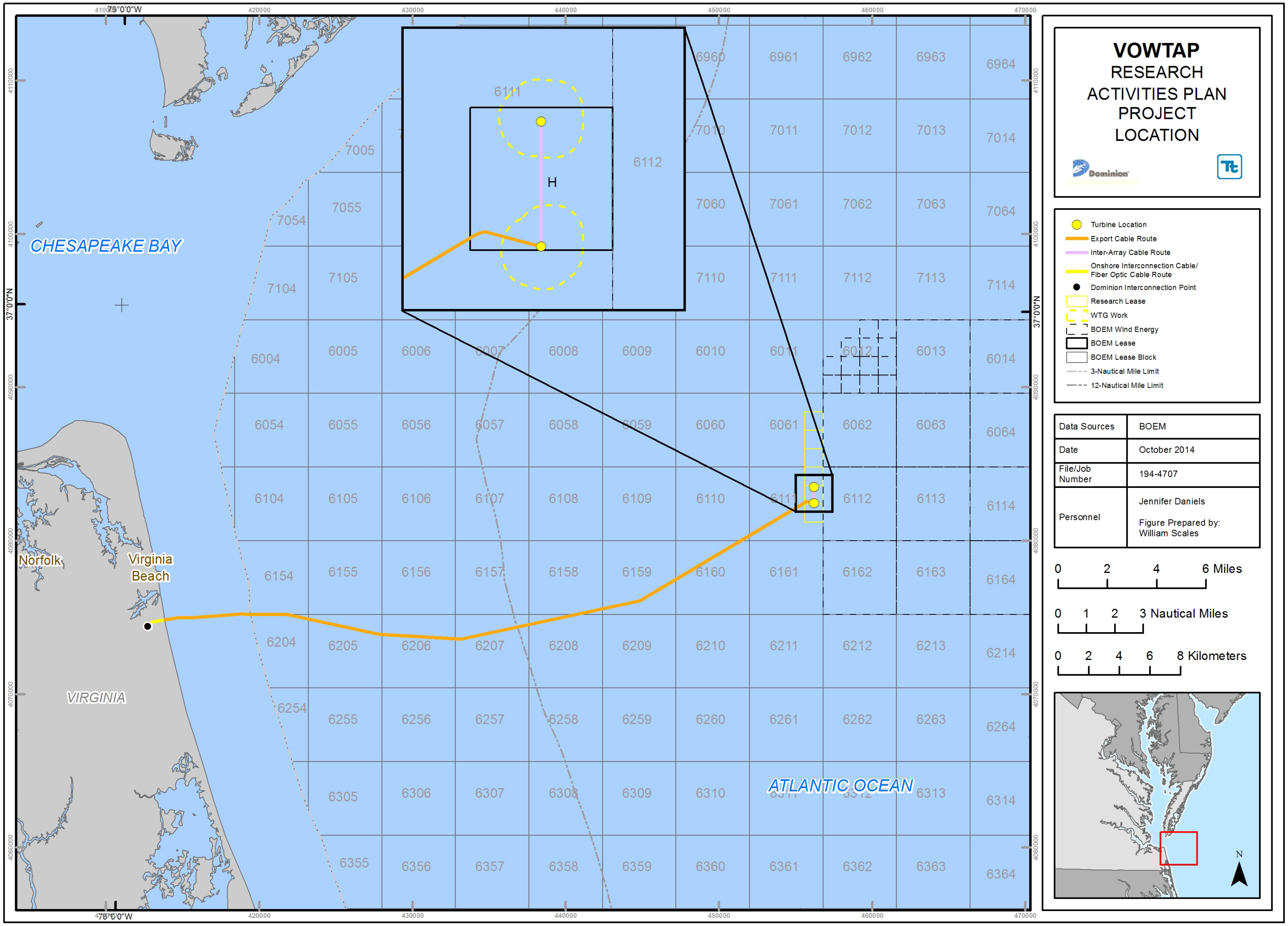


Figure 1.1-1 Project Location

Construction and operation of the VOWTAP will require federal, state, and local permits and environmental reviews. On February 8, 2013, DMME filed an Unsolicited Application for an Outer Continental Shelf (OCS) Renewable Energy Research Lease with the Bureau of Ocean Energy Management (BOEM), pursuant to 30 Code of Federal Regulations [CFR] §585.238. On December 6, 2013, BOEM issued DMME a Determination of No Competitive Interest (DNCI) for the proposed Research Lease. On March 23, 2015 BOEM formally issued the Research Lease to DMME with Dominion named as the designated operator. Per BOEM's direction, dated December 2, 2013, Dominion has prepared this Research Activities Plan (RAP) to demonstrate compliance with federal regulations for renewable energy projects proposed under an OCS research lease (30 CFR §585.626 and 585.627) (see Appendix A for a record of this communication). Specifically in accordance with 30 CFR §585.621 this RAP demonstrates how VOWTAP:

- Conforms to all applicable laws, implementing regulations, lease provisions, and stipulations (Section 1.3);
- Is safe (Section 4.17 and Appendix S);
- Does not unreasonably interfere with other uses of the OCS, including those involved with national security or defense (Sections 4.11, 4.12, and 4.14);
- Does not cause undue harm or damage to:
  - Natural resources;
  - Life (including human and wildlife);
  - Property;
  - The marine, coastal, or human environment; or
  - Sites, structures, or objects of historical or archaeological significance (Section 4.0);
- Uses best available and safest technology (Section 2.0);
- Uses Best Management Practices (BMPs) (Section 4.18); and
- Uses properly trained personnel (Section 4.14 and Appendix S).

1.2 Purpose and Need for the Project

The purpose of VOWTAP is to respond to the expressed need for the advancement of offshore wind energy research and development in the United States and in Virginia. This need has been expressed by both the U.S. Department of Energy (DOE) and the Commonwealth of Virginia.

In 2010, the DOE Energy Efficiency and Renewable Energy (EERE) Wind and Water Power Program instituted the Offshore Wind Innovation and Demonstration (OSWInD) Initiative to consolidate and expand its efforts to promote and accelerate responsible commercial offshore wind development in the United States (DOE 2011). This initiative is part of DOE's National Offshore Wind Strategy for creating an offshore wind energy industry in the United States. The primary objectives of OSWInD are to reduce deployment timelines and uncertainties, reduce the cost of energy through technology development, determine ways in which to remove market barriers, and demonstrate advanced technologies, including innovations in WTG and foundation design, marine systems engineering, computational tools and test data, resource planning, siting and permitting, complementary infrastructure, and the development of advanced technology demonstration projects (DOE 2011). In 2012, DOE selected seven technology demonstration projects to further the objectives of OSWInD; VOWTAP was selected as one of these proposed projects.

On May 8, 2014, DOE selected the VOWTAP once again as one of three technology demonstration projects to receive additional funding to support the advancement of the Project towards construction.

The Commonwealth of Virginia enacted legislation (Title 67, Chapter 12, Code of Virginia) in 2010 that created the Virginia Offshore Wind Development Authority (VOWDA). The expressed mission of the VOWDA is to facilitate, coordinate, and support the development of the offshore wind energy industry, offshore wind energy projects, and supply chain vendors within the state of Virginia by:

- Collecting metocean and environmental data;
- Identifying regulatory and administrative barriers;
- Working with local, state, and federal government agencies to upgrade port and logistic facilities and sites;
- Ensuring development is compatible with other ocean uses and avian/marine wildlife; and
- Recommending ways to encourage and expedite offshore wind industry development (VOWDA 2013).

In July 2010, the Commonwealth of Virginia also provided a response to DOE's Request for Information (RFI; DE-FOA-EE00038) supporting the OSWInD Initiative, and documenting the Commonwealth's interest in developing a new offshore wind power industry in Virginia.

The VOWTAP has been designed to satisfy the needs identified by the OSWinD initiative and the Commonwealth of Virginia, as follows:

- **Technical Innovation and Validation** – The VOWTAP will support one of the first United States offshore deployments of the Haliade 150 6MW WTG. The Haliade 150 is a three-bladed, upwind oriented WTG whose rotor nacelle and tower assembly establishes a new paradigm for the offshore wind market with a permanent magnet direct drive (PMDD) generator, optimum power density, and significantly reduced tower head mass compared to other offshore WTGs of the same class. This innovative WTG also incorporates a new state-of-the-art supervisory control and data acquisition system (SCADA) that can observe the operation of the WTG in real-time and detect changes before failure or damage can occur, thus reducing the potential for unscheduled outages and improving the planning of preventive maintenance. The VOWTAP will also be one of the first applications of the Keystone Inward Battered Guide Structure (IBGS) as a foundation for an offshore wind project. This foundation technology has been proven in the oil and gas sector as suitable under a wide range of seabed conditions. Application of this foundation at the VOWTAP site will support the demonstration of this known design concept to offshore WTGs in water depths and extreme weather conditions that are common to the mid- and south-Atlantic regions.
- **Cost Reduction** – The VOWTAP provides a necessary step towards future cost effective, commercial-scale wind energy deployment. The proposed Project innovations will deliver significant cost reductions that can be attributed to four major areas: increased annual energy production (AEP); decreased WTG capital costs; decreased balance of station (BOS) and foundation costs; and decreased operations and maintenance (O&M) costs. The Haliade 150 rotor, robust drive train, and high capacity factors contribute to the increase in AEP. The proposed use of the IBGS foundation also represents a cost savings, as this type of foundation system has a reduction in steel utilization leading to lower cost than current WTG foundation technologies.

Furthermore the application of the Haliade permanent magnet direct-drive and the enhanced SCADA system reduce the need for visits to the WTGs, thereby reducing O&M costs. In addition, by using two WTGs, the Project will allow research on wind turbine wake effects and wind farm control strategies to optimize the power output of the entire system. Overall, the innovations proposed for the VOWTAP are estimated to lower the levelized cost of energy for a commercial scale project by an estimated 25 percent from Dominion's baseline conditions.

- **Removal of Market Barriers** – The VOWTAP provides a platform for removing many of the first-of-a-kind risks that currently constitute barriers to development of a U.S. offshore wind industry. Some of these risks include navigating the permitting process for an offshore wind project in federal waters; installing larger WTGs that are new to the offshore wind market, and gaining a better understanding of domestic supply chain requirements.
- **Identify Potential Improvements to the Permitting Process** – Of the demonstration projects selected by DOE in 2013 and 2014, the VOWTAP is the only fixed-bottom project subject to BOEM's permitting process, and will be one of the first offshore wind projects to use BOEM's Smart-from-the-Start Initiative. The VOWTAP Team will document the permitting approval processes, and identify areas where the process can be improved in order to reduce deployment timelines and lower risks.
- **Progressing Environmental Research and Understanding** – The VOWTAP Team will provide data that will help to further the understanding of effects to the environment and from environmental conditions on future offshore wind projects, most notably the commercial development of the Virginia Wind Energy Area (WEA). This data will include the environmental baseline evaluations conducted in support of the siting and development of the VOWTAP and proposed post-construction and operational monitoring.

1.3 Regulatory Framework

Several federal, state, and local agencies have regulatory authority over the VOWTAP, based on the location of different Project components. The two WTGs, Inter-Array Cable, and the majority of the Export Cable (approximately 24.2 mi [39 km]) will be located on the OCS in federal waters of the United States. A segment of the Export Cable route (approximately 3 mi [4.8 km]) will also be in state territorial waters. The Onshore Interconnection Cable and associated interconnection facilities will be located in Virginia Beach, Virginia on state-owned property. Ancillary Project facilities, including the Construction Port, O&M facility, and Base Port for the VOWTAP, will be located in the cities of Virginia Beach, Norfolk, and/or Newport News, Virginia.

1.3.1 Permits, Approvals, and Consultations

Construction and operation of the VOWTAP will require an OCS Renewable Energy Research Lease and associated easement for the Export Cable from BOEM. The Outer Continental Shelf Lands Act (OCSLA) delegated authority to the Department of the Interior (DOI) to manage submerged lands on the OCS. The Energy Policy Act of 2005 further gave DOI authority (subsequently delegated to BOEM) for issuing submerged lands leases for alternative energy development on the OCS (i.e., activities that produce or support production, transportation, or transmission of energy from sources other than oil and gas). An Easement from BOEM will also be necessary for the portion of the Export Cable that traverses federal waters. Prior to issuance of an OCS Renewable Energy Research Lease or Easement, BOEM must review the environmental effects and benefits of the Project in accordance with the National Environmental Policy Act (NEPA) and other agency-specific statutes, regulations, and guidelines. On March 23, 2015, BOEM formally issued the Research Lease to DMME with Dominion named as the designated operator.

The VOWTAP will also require various other federal approvals, including an Individual Permit from the U.S. Army Corps of Engineers (USACE) under Section 10 of the Rivers and Harbors Act (33 United States Code [USC] 403) and Section 404 of the Clean Water Act (CWA) (33 USC 1344). The Individual Permit for the construction and operation of the VOWTAP was issued by USACE on December 4, 2014.

The Project will also require review under NEPA (42 USC 4321 et seq.). The major federal actions that require review under NEPA are BOEM's issuance of the OCS Wind Research Lease, USACE's issuance of an Individual Permit under the CWA, and the grant of federal funds by DOE. BOEM noticed the Draft Environmental Assessment (EA) in the Federal Register for 30-day public comment on December 1, 2014.

Federal permitting agencies are also required to comply with Section 7 of the Endangered Species Act (ESA), the Magnuson-Stevens Fishery Conservation and Management Act (MSFCMA), Section 106 of the National Historic Preservation Act (NHPA), and Section 307 of the Coastal Zone Management Act (CZMA) (see Section 1.3.2). Dominion received their Federal Consistency Certification from DEQ on August 7, 2014.

At the state level, the Virginia Marine Resources Commission (VMRC) will issue a Submerged Lands (VMRC) Permit for the portions of the VOWTAP located in state waters under the Virginia Code and regulations. The Permit was unanimously approved by VMRC at the public hearing held on March 24, 2015 (Attachment A). VMRC and the Virginia Department of Environmental Quality (VDEQ) will issue a Joint Tidal Wetland Permit and Virginia Water Protection (VWP) Individual Permit pursuant to the Virginia Code and the Section 401 Water Quality Certification requirements of the federal CWA. VDEQ also requires that the Project submit an air permit application under the Clean Air Act (CAA) for marine vessels or other equipment used to construct and/or operate the VOWTAP. Dominion's Notice of Intent (NOI) to submit an application for a preconstruction permit to EPA was filed on May 20, 2014. The OCS Permit Application was submitted to DEQ on October 8, 2014 and DEQ deemed the application complete on December 31, 2014. The Virginia Department of Historical Resources (VDHR) has consulted with the VOWTAP Team regarding Project compliance with Section 106 of NHPA for both state and federal approvals. BOEM issued a Finding of No Adverse Effect on April 6, 2015.

Table 1.3-1 provides a list of the required approvals and consultations, the anticipated timeline, and the status as of the filing of the RAP. Records of agency consultations are provided in Appendix A.

Table 1.3-1. Permits, Approvals, and Consultations

Permit, Approval, or Consultation	Regulatory Authority	Filing Date/Status	Approval/Anticipated Approval Date	Status
FEDERAL				
OCS Lands Lease pursuant to the OSCLA (43 USC §§1331 et seq.) and BOEM implementing regulations (30 CFR Part 585)	BOEM	12/6/2013	03/23/2015	BOEM published request for competitive interest in Federal Register on December 21, 2012. On December 6, 2013 BOEM issued DMME a DNCI for the proposed Research Lease. On March 23, 2015, BOEM issued the Research Lease. Per BOEM direction issued on December 3, 2013 this RAP is submitted to BOEM in accordance with 30 CFR § 585.626 and 627.
Individual Permit pursuant to Section 10 Rivers and Harbors Act (33 USC § 403) & Section 404 CWA (33 USC §1344)	USACE Norfolk District (VA)	07/02/2014	12/04/2014	Pre-application consultation was initiated in March 2013. Permit authorization was received on December 4, 2014. Information required to support the acquisition of this permit was provided in this RAP. A copy of the USACE permit has been included in Appendix A.
Review pursuant to NEPA (42 USC §§4321 *et seq.*) and BOEM regulations (30 CFR §§585.646,585. 648(b))	BOEM, USACE, and DOE	12/6/2013	Q2 2015	Scoping with primary federal permitting agencies has been ongoing since March 2013. Information required to support NEPA review has been provided in this RAP.BOEM Issued the draft EA in December 2014.
Consultation and Incidental Take Authorization (IHA) pursuant to the Marine Mammal Protection Act (MMPA) (16 USC §§1361 *et seq.*)	National Oceanic and Atmospheric Administration National Marine Fisheries Service (NOAA Fisheries)	Q4 2015	Q3 2016	Pre-application consultation has been ongoing since March 2013. Information to support consultation between federal permitting agencies and federal wildlife resource agencies has been provided in this RAP (Section 4.3), and Appendix M-2).
Consultation pursuant to Section 7 of the ESA (16 USC §§*1531 et seq.*)	NOAA Fisheries, USFWS	Ongoing	Q2 2015	Pre-application consultation has been ongoing since March 2013. Information to support consultation between federal permitting agencies and federal wildlife resource agencies has been provided in this RAP (Section 4.6, Appendix J, and Appendix L).
Essential Fish Habitat (EFH) Consultation pursuant to the MSFCMA (16 USC §§1801 *et seq.*)	NOAA Fisheries	Ongoing	Q2 2015	Pre-application consultation has been ongoing since March 2013. Information to support consultation between federal permitting agencies and federal wildlife resource agencies has been provided in this RAP (Section 4.7, and Appendix J).
Consultation pursuant to the Migratory Bird Treaty Act (MBTA) (16 USC §§703 *et seq.*)	USFWS	Ongoing	Q2 2015	Pre-application consultation has been ongoing since March 2013. Information to support consultation between federal permitting agencies and federal wildlife resource agencies has been provided in this RAP (Section 4.5, and Appendix J).

Table 1.3-1. Permits, Approvals, and Consultations (continued)

Permit, Approval, or Consultation	Regulatory Authority	Filing Date	Approval/Anticipated Approval Date	Status
Consultation pursuant to Section 106 of the NHPA (16 USC §§470 *et seq.*)	VDHR	Completed	04/06/2015	Pre-application consultation has been ongoing since March 2013. Information to support consultation between federal permitting agencies and VDHR has been provided in this RAP (Section 4.9, Appendix N, Appendix O, and Appendix P).
Approval for Private Aids to Navigation (33 CFR 66)	USCG	4 months prior to Construction	3 weeks prior to Construction	Proposed lighting and marking has been developed in consultation with the USCG and provided in this RAP (Section 4.14.1, Appendix R).
STATE				
Concurrence with Federal Consistency Certification pursuant to Section 307 of the CZMA (16 USC §1451 *et seq.*)	VDEQ , BOEM	05/14/2014	08/07/2014	Federal Consistency Certification was received on 08/07/2014. Information necessary to support this certification was provided in this RAP (Section 1.3.2). A copy of the Federal Consistency Certification has been included in Appendix A Dominion submitted the Federal Consistency Certification Conformance Statement on 10/24/2014.
Submerged Land (VMRC) Permit (Code of Virginia § 28.2-1200 thru 28.2-1213; 4 VAC 20)	VMRC	07/02/2014	Q2 2015	Pre-application consultation has been ongoing since March 2013. Approval will be obtained through the VMRC and VDEQ Joint Permit Application Process. Information to support the acquisition of the authorization has been provided in this RAP (Section 4.0). The Permit was unanimously approved by VMRC at the public hearing held on March 24, 2015.
Water Quality Certification under Section 401 of the CWA (33 USC §1341); 9 VAC 25-660 *et seq.*	VDEQ	07/02/2014	Q2 2015	Pre-application consultation has been ongoing since March 2013. Approval will be obtained through the Joint Permit Application Process. Information to support review of the Project under the CWA has been provided in this RAP (Section 4.2).
Conformity Determination Air pursuant to the Clean Air Act (CAA) (42 USC §§ 7401 *et seq.*; 9VAC5 CHAPTER 30; 40 CFR Parts 50 to 99)	VDEQ	Q4 2014	Q4 2015	Pre-application consultation has been ongoing since March 2013. Information to support consultation between the federal permitting agencies and VDEQ has been provided in this RAP (Section 4.16 and Appendix I).

Table 1.3-1. Permits, Approvals, and Consultations (continued)

Permit, Approval, or Consultation	Regulatory Authority	Filing Date	Approval/Anticipated Approval Date	Status
OCS Air Permit (40 CFR Part 55; VDEQ 9 VAC 5-80 *et seq.*)	VDEQ	10/08/2014	Q4 2015	Pre-application consultation has been ongoing since October 2013. Information to support the acquisition of the authorization has been provided in this RAP (Section 4.16 and Appendix I).
Construction Stormwater General Permit Authorization (VAR10; 9 VAC 25-880)	VDEQ	Q3 2016	Q1 2017	Information to support the acquisition of the authorization will be provided upon approval of the RAP.

1.3.2 Coastal Zone Management Act Consistency

The CZMA of 1972 requires that federal actions likely to affect any land or water use, or natural resource of a state's coastal zone, be conducted in a manner that is consistent with the state's federally-approved Coastal Zone Management Program (CZMP). The Virginia CZMP was established in 1986 and is administered by VDEQ, which serves as the lead agency for the network of Virginia state agencies and local governments that administer the CZMP. The enforceable policies that make up the CZMP include:

- Fisheries Management (Va. Code §28.2-200 through §28.2-713 an Va. Code §29.1-100 thru §29.1-570);
- Subaqueous Lands (Va. Code §28.2-1200 through §28.2-1213);
- Wetlands Management (Va. Code §28.2-1300 through §28.2-1320 and §62.1-44.15.5);
- Dunes Management (Va. Code §28.2-1400 through §28.2-1420);
- Point and Nonpoint Source Pollution Control (Va. Code §10.1-560 et seq. and §62.1-44.15);
- Shoreline Sanitation (Va. Code §32.1-164 through §32.1-165;
- Air Pollution Control (Va. Code §10-1.1300); and
- Coastal Lands Management (Chesapeake Bay Preservation Act, Va. Code §10.1-2117 through §10.1-2134 and regulations 4 VAC 50-90).

Table 1.3-2 has been prepared pursuant to 15 CFR §930.39, and provides the data and information necessary to certify that the construction and operation of the VOWTAP will be consistent with the CZMP, in accordance with CZMA §307(c)(3)(A) and 15 CFR Part 930, subpart D. Table 1.3-2 presents both a summary of each enforceable policy under the CZMP and how VOWTAP will be consistent with each policy, including a reference to specific sections of the RAP which address each policy. This information was provided to VDEQ on May 14, 2014, and a Federal Consistency Certification was received on August 7, 2014. A copy of the Federal Consistency Certification is provided in Appendix A.

Table 1.3-2. Coastal Zone Management Program Consistency Certification

Policy	Policy Summary	Compliance Summary	Section in the RAP
Enforceable Policies			
Fisheries Management *(Va.Code §28.2-200 to §28.2-713 and Va.Code §29.1-100 to §29.1-570)*	This policy stresses the conservation and enhancement of finfish and shellfish resources and the promotion of commercial and recreational fisheries to maximize food production and recreational opportunities. The State Tributyltin (TBT) Regulatory Program is part of the Fisheries Management program and monitors boating activities and boat painting activities to ensure compliance with TBT regulations The fisheries management program is administered by the VMRC.	The VOWTAP is not applicable to the promotion of commercial and recreational fisheries and will not result in long-term direct or indirect impacts to commercial and recreational fisheries during construction, operation or decommissioning of the Project. Vessels used for construction and operation of the VOWTAP will be in compliance with TBT regulations.	Section 4.3.1.1 Benthic and Epibenthic Resources; Section 4.3.1.2 Demersal and Pelagic Fish; Section 4.7, Essential Fish Habitat Section 4.11.1.4, Recreation and Tourism; Section 4.11.1.5, Commercial Shipping; and Appendix J, Benthic Survey Report
Subaqueous Lands *(Va.Code §28.2-1200 to §28.2-1213)*	This policy establishes conditions for granting or denying permits to use state-owned subaqueous land based on considerations of potential effects on marine and fisheries resources, wetlands, adjacent or nearby properties, anticipated public and private benefits, and water quality standards established by the Water Division of the VDEQ. The subaqueous lands program is administered by the VMRC.	Impacts from the construction, operation and decommissioning of the Project will not result in long-term direct or indirect impacts to marine fisheries resources. Project facilities have been sited to avoid wetlands and other jurisdictional waters, and will implement appropriate stormwater management and erosion control BMPs during construction and/or decommissioning, as such the Project will not result in direct or indirect impacts on these resources. The Project has also demonstrated compatibility with existing land uses and applicable land use plans and regulations. The Project will not result in long-term direct or indirect impacts on the local population and economy, housing conditions, public services, or commercial or recreational fishing and boating. Impacts to the local economy will likely be positive, through creation of employment and tax revenue.	Section 4.2, Water Quality Section 4.3.1., Benthic and Epibenthic Resources; Section 4.3.1.2, Demersal and Pelagic Fish; Section 4.7, Essential Fish Habitat; Section 4.8, Wetlands and Other Jurisdictional Waters; Section 4.11,.Socioeconomic Resources; Section 4.13, Land Use; Appendix J, Benthic Survey Report; and Appendix H, Jurisdictional Wetland Delineation Report

Table 1.3-2. Coastal Zone Management Program Consistency Certification (continued)

Policy	Policy Summary	Compliance Summary	Section in the RAP
Wetlands Management *(Va.Code §28.2-1300 to §28.2-1320 and §62.1-44.15.5)*	The purpose of the wetlands management policy is to preserve tidal wetlands and accommodate economic development in a manner consistent with wetlands preservation. The tidal wetlands program is administered by the VMRC. Section 401 of the federal CWA of 1972 (33 USC 1341) and the Virginia Code (§62.1-44.15.5) authorize the Virginia Water Protection Permit (VWPP) Program which includes the protection of tidal and non-tidal wetlands. The VWPP program is administered by the Virginia VDEQ.	Project facilities have been sited to avoid wetlands and other jurisdictional waters, and will implement appropriate stormwater management and erosion control BMPs during construction and/or decommission, as such the Project will not result in direct or indirect impacts on these resources.	Section 4.2, Water Quality; Section 4.8, Wetlands and Other Jurisdictional Waters; and Appendix H, Jurisdictional Wetland Delineation Report.
Dunes Management *(Va.Code §28.2-1400 to §28.2-1420)*	The Coastal Primary Sand Dune Protection Act and implementing regulations (4 VAC 20-440-10 et. seq.) prevent destruction or alteration of primary dunes. The dunes management program is administered by the VMRC.	Dominion has selected HDD for the Export Cable landfall to avoid impacts to sensitive dunes on Camp Pendleton Beach. In addition, construction vehicles will not be driven on the beach, or dunes.	Section 4.4.1.1, Vegetation
Non-point Source Pollution Control (Va.Code §10.1-560 et seq.)	Virginia's Erosion and Sediment Control Law requires soil-disturbing projects to be designed to reduce soil and erosion and to decrease inputs of chemical nutrients and sediments into the Chesapeake Bay, its tributaries, and other rivers and water of Virginia. The non-point source pollution control program is administered by the Department of Conservation and Recreation (VDCR).	Dominion will implement an Erosion Sediment Control (ESC) Plan and associated BMPs in accordance with 9VAC25-840. This plan will be provided to relevant agencies for review and approval prior to construction.	Section 4.2, Water Quality
Point Source Pollution Control (Va.Code §62.1-44.15)	Point source pollution control is accomplished through implementation of the National Pollutant Discharge Elimination System (NDPES) permit program established pursuant to Section 402 of the CWA and administered in Virginia as part of the VPDES permit program. The Water Quality Certification requirements of section 401 of the CWA are administered under the Virginia Water Protection Permit program. The point source pollution control program is administered by the State Water Control Board.	Dominion will implement a Stormwater Management Plan pursuant to VAR10 General Permit, 9 VAC25-880 and an Erosion Sediment Control (ESC) Plan and associated BMPs in accordance with 9VAC25-840. These plans will be provided to relevant agencies for review and approval prior to construction.	Section 4.2, Water Quality

Table 1.3-2. Coastal Zone Management Program Consistency Certification (continued)

Policy	Policy Summary	Compliance Summary	Section in the RAP
Shoreline Sanitation *(Va.Code §32.1-164 to §32.1-165)*	Regulates the installation of septic tanks, sets standards concerning soil types suitable for septic tanks, and specify minimum distances that tanks must be placed away from streams, rivers, and other waters of Virginia. Administered by the Department of Health	This policy is not applicable to the VOWTAP.	
Air Pollution Control *(Va.Code §10-1.1300)*	The CAA provides a legally enforceable State Implementation Plan for the attainment and maintenance of the National Ambient Air Quality Standards. Administered by the State Air Pollution Control Board.	Dominion will comply with these standards.	Section 4.16, Air Quality; and Appendix I, Air Emissions Calculations and Methodology
Coastal Lands Management (Chesapeake Bay Preservation Act; Va.Code §10.1-2117 to §10.1-2134 and regulations 4 VAC 50-90)	A state-local cooperative program that is administered by the DCR's Division of Stormwater Management and by 88 localities. The coastal lands management program was established pursuant to the Chesapeake Bay Preservation Act (Bay Act) and Chesapeake Bay Preservation Area Designation and Management Regulations.	VOWTAP activities are at least 1 mi (1.6 km) from the closest area designated as Chesapeake Bay Preservation Area.	Section 4.2, Water Quality
Advisory Policies			
Coastal Natural Resource Areas	Coastal natural resource areas are vital to estuarine and marine ecosystems and/or are of great importance to areas immediately inland of the shoreline. These areas have special conservation, recreational, ecological, and aesthetic values and include wetlands; aquatic spawning, nursery, and feeding grounds; coastal primary sand dunes; barrier islands; significant wildlife habitat areas; public recreation areas; sand and gravel resources; and underwater historic sites.	The VOWTAP will not impact coastal natural resource areas. Dominion has either sited the Project to avoid these areas or have selected construction techniques to such as jet plowing, HDD techniques, and use of Dynamic Positioning (DP) vessels minimize and/or avoid impacts to these resources	Section 4.2, Water Quality; Section 4.3, Marine Biological Resources; Section 4.4, Terrestrial Biological Resources; Section 4.6, Threatened and Endangered Species and Other Species of Special Concern; Section 4.7, Essential Fish Habitat; Section 4.8, Wetlands and Other Jurisdictional Waters; Section 4.9, Cultural Resources, 4.11.Socioeconomic Resources; Appendix J, Benthic Survey Report; Appendix H, Jurisdictional Wetland Delineation Report; and Appendix N, Marine Archaeological Resources Assessment

Table 1.3-2. Coastal Zone Management Program Consistency Certification (continued)

Policy	Policy Summary	Compliance Summary	Section in the RAP
Coastal Natural Hazard Areas	This policy covers areas vulnerable to continuing and severe erosion and areas susceptible to damage from wind, tidal, and storm-related events including flooding. New structures should be designed and sited to minimize the potential for property damage due to storms or shoreline erosion. Areas of concern include highly erodible areas and coastal high hazard areas such as flood plains.	Dominion has designed the Project to meet the physical and oceanographic conditions within the Project Area.	Section 4.1, Physical and Oceanographic Conditions; Appendix E, Met Ocean Report; and Appendix F, Marine Site Characterization Report
Waterfront Development Areas	There are a limited number of areas suitable for waterfront activities. Areas of concern include commercial ports, commercial fishing piers, and community waterfronts.	Dominion will not affect waterfront development areas. No construction or operational activities will affect commercial, ports fishing piers or community waterfronts. Dominion plans to complete all waterfront construction activities prior to the start of the summer tourist season (May 31). In addition, Dominion will be utilizing existing port facilities to support construction and operation that will not require upgrades to support Project activities.	Section 3.2.6, Construction and O&M Facilities; Section 4.11, Socioeconomic Resources; Section 4.13, Land Use; Section 4.14 Transportation; and Appendix R, Navigational Risk Assessment.
Virginia Public Beaches	The approximately 25 miles of public beaches that are located in cities, counties, and towns of Virginia, exclusive of public beaches on state and federal land, should be maintained to allow public access to recreational resources.	The VOWTAP will not prevent public access to any public beaches.	Section 4.13, Land Use
Virginia Outdoors Plan	The Virginia Outdoors Plan identifies recreational facilities in the Commonwealth that provide recreational access and identifies future needs in relation to the provision of recreational opportunities and shoreline access. Prior to initiating any project, consideration should be given to the proximity of the project site to recreational resources identified in this plan. Planning for coastal access is provided by the Department of Conservation and Recreation in cooperation with other state and local government agencies.	The VOWTAP will not interfere with public access to recreational facilities nor will it preclude the provision of recreational opportunities in the future.	Section 4.11.1.4, Recreation and Tourism

Table 1.3-2. Coastal Zone Management Program Consistency Certification (continued)

Policy	Policy Summary	Compliance Summary	Section in the RAP
Parks, Natural Areas, and Wildlife Management Areas	The recreational value of parks, natural areas, and wildlife management areas should be protected and maintained for the recreational pleasure of the citizens of Virginia.	The VOWTAP will not affect the recreational value of parks, natural areas, or wildlife management areas.	Section 4.7, Visual Resources; Section 4.11.1.4, Recreation and Tourism; and Appendix Q, Visual Impact Assessment
Waterfront Recreational Land Acquisition	Any areas, properties, lands, or estate of scenic beauty, recreational utility, historical interest, or unusual features may be acquired, preserved, and maintained for the citizens of Virginia.	This policy is not applicable to the VOWTAP because it does not involve or affect the acquisition, preservation, or maintenance of waterfront recreational land.	
Waterfront Recreational Facilities	Boat ramps, public landings, and bridges that provide water access to the citizens of Virginia shall be designed, constructed, and maintained to provide points of water access when and where practicable.	This policy is not applicable to the VOWTAP because it does not involve or affect the design, construction, or maintenance of waterfront recreational facilities.	
Waterfront Historic Properties	Buildings, structures, and sites of historical, architectural, and/or archeological interest are significant resources for the citizens of Virginia and should be protected from damage or destruction when practicable. Administered by the Department of Historic Resources.	The VOWTAP will not have a significant affect on buildings, structures, and sites of historical, architectural, and/or archeological interest.	Section 4.9.3, Historic Properties; and Appendix O, Historic Properties Assessment

1.4 Agency and Public Outreach

Starting in 2011, the VOWTAP Team began to meet with federal, state, and local officials to discuss the Project. At these meetings, the VOWTAP Team provided background information on the Project, including the scope, proposed environmental surveys and evaluations, and the anticipated timing of the permit applications. Table 1.4-1 summarizes the agency coordination and pre-application meetings conducted on behalf of the Project. Records of official agency correspondences have been included as Appendix A. Dominion also contacted Native American tribes to invite them to be a part of the VOWTAP process, to attend the inter-agency kick-off meeting, and to request information to be considered in the document. Dominion anticipates that this early consultation will lead to a more streamlined and effective permitting process for the Project.

Project information was also provided during this time period to stakeholders representing various interest groups, including maritime stakeholders such as the Virginia Maritime Association, the Virginia Pilot Association, the American Waterways Operators, VOWDA, Virginia Power commercial customers, Camp Pendleton, the U.S. Coast Guard (USCG), the U.S. Navy, and the City of Virginia Beach.

On August 14, 2013, the VOWTAP Team hosted an open house in Virginia Beach, Virginia, at the Virginia Aquarium and Marine Science Center. The local media was informed of the event and invitations were sent to key regulatory and industry stakeholders, as well as elected officials representing the region.

Table 1.4-1. Summary of Agency Consultations

Agency	Date	Consultation Summary
Department of Defense (DoD), USCG, and NOAA	January 11, 2013	Meeting to confirm location of proposed VOWTAP Research Lease
BOEM and DOE	January 16, 2013	Meeting to confirm location of proposed VOWTAP Research Lease
DoD, USACE, and NOAA	March 8, 2013	Pre-Application meeting to discuss proposed offshore cable routing options.
USCG, DoD USACE, NOAA, VHDR, VMRC, VDEQ, Virginia Department of Game and Inland Fisheries (VDGIF), and the Virginia Institute of Marine Sciences.	March 25, 2013	Pre-Application federal and state inter-agency kick-off meeting to introduce the VOWTAP.
DoD	March 25, 2013	Pre-survey and application meeting to discuss de-conflicting Project activities in the Navy live fire zones.
BOEM, DOE, NOAA, USCG, USFWS, USACE, DoD, DMME, VMRC, VDGIF, VDHR, VDEQ, Virginia Department of Conservation and Recreation (VDCR)	April 22 and 29, 2013	Technical working sessions to review the proposed marine geophysical, shallow geotechnical, marine archeological, and marine benthic surveys.
BOEM (via phone)	May 16, 2013	Pre-survey meeting for marine geophysical, shallow geotechnical, marine archeological, and marine benthic surveys.
USCG	September 4, 2013	Pre-Application meeting to discuss the scope of the VOWTAP navigational risk assessment
VDHR	September 4, 2013	Pre-Application meeting to discuss the scope of the VOWTAP terrestrial, archaeological resource, architectural resource and visual impact assessment survey plans
VDEQ	October 24, 2013	Pre-Application meeting to discuss air permitting requirements for the VOWTAP

Table 1.4-1. Summary of Agency Consultations (continued)

Agency	Date	Consultation Summary
USFWS	October 25, 2013	Meeting to discuss the preliminary findings of the VOWTAP avian and bat surveys
BOEM, NOAA	October 31, 2013	Conference Call to discuss plans for assessing impacts to marine mammals, sea Turtles, and fish for VOWTAP
BOEM	November 4, 2013	Meeting to discuss the preliminary findings of the VOWTAP avian and bat surveys
VDGIF	November 7, 2013	Meeting to discuss the preliminary findings of the VOWTAP avian and bat surveys
BOEM	November 21, 2013	Meeting with BOEM to confirm the filing of the VOWTAP as a RAP pursuant to 30 CFR § 585.626 and 627 (see also the record of correspondence in Appendix A).
DOE, USCG, BOEM, USACE, VDHR, NMFS, Navy VMRC	May 15, 2014	Technical working sessions to review the proposed supplemental marine geophysical and geotechnical surveys.
BOEM	May 19, 2014	Pre-survey meeting for supplemental marine geophysical and geotechnical surveys.
BOEM, VDGIF, USFWS	July 21, 2014	Meeting to review the Annual Avian Report with federal and state agencies.
BOEM, VDGIF, USFWS	October 2, 2014	Meeting to provide information to agencies and input on Dominion's proposed approach for Post-Construction Monitoring of avian and bat species.

Dominion and the VOWTAP Team are committed to continued stakeholder communications and effective public outreach. The public outreach program includes the following:

- Identifying and meeting with local associations, citizen groups, and other non-governmental organizations to inform them about the Project and address any issues that may be raised;
- Meeting with key federal, state, and local agencies, elected officials, and other potentially interested stakeholders to identify issues;
- Holding public open houses to provide information about the VOWTAP; and
- Maintaining a Project-specific web site with information on the status of the Project (https://www.dominion.com/vowtap). Details available on the web site include:
  - A description of the Project, including photos and visual simulations;
  - News briefs;
  - Contacts for additional information; and
  - Other appropriate Project-related information.

1.5 Authorized Representative and Designated Operator

Dominion is the operator of the VOWTAP. The contact information for the Authorized Representative for the VOWTAP is as follows:

Name of Authorized Representative	Mark D. Mitchell
Title	Vice President – Generation Construction
Phone Number	(804) 273-4543
Email	Mark.D.Mitchell@dom.com
Address	5000 Dominion Blvd, Glen Allen, VA 23060

1.6 Certified Verification Agent

Pursuant to 30 CFR § 585.705, a certified verification agent (CVA) must be used to certify to BOEM that the proposed facility is designed to withstand the environmental and functional load conditions for the intended life of a project at its proposed location. In accordance with 30 CFR § 585.706, Dominion has included with this RAP a CVA nomination for BOEM approval. This nomination has been included as Appendix B under confidential cover.

1.7 Financial Assurance

Prior to issuance of an OCS Lease, the prospective lessee must provide financial assurance to assure that lessee, operator, and/or grant holder obligations can be fulfilled. DMME intends to designate Dominion as the operator of the VOWTAP. Dominion and its affiliates have a long history of undertaking, and obtaining, the necessary financing for large, innovative projects in a responsible manner; offshore wind follows that tradition. Revenue provided by electric generation and distribution operations is based primarily on rates established by state regulatory authorities. A full listing of current generation projects and detailed financial statements can be found in the Annual Report on Form 10-K included as Appendix C.

2 ALTERNATIVES

During initial development, the VOWTAP Team considered several potential alternatives to support the selection of the Project (the Preferred Alternative), including the following:

- The No Action Alternative;
- Alternative locations for the VOWTAP Research Lease Area;
- Alternative locations for the VOWTAP transmission system, including:
  - Alternative Export Cable landing locations;
  - Alternative Onshore Interconnection Cable routes; and
- Alternative WTG foundation technologies.

Sections 2.1 through 2.4 describe the alternatives considered and provide the rationale for their inclusion or exclusion in the Project based on their environmental, technical, and financial consequences, and their ability to achieve the purpose and need for the Project. Section 2.5 summarizes the Preferred Alternative.

2.1 No Action Alternative

Under the No Action Alternative, the VOWTAP Team would not proceed with design, development, construction, operation, and decommissioning of the Project as described in Section 3, USACE would not issue an authorization for the Project under Sections 10 and 404, and DOE would not award additional funding to the VOWTAP Team to fund completion of the Project.

Under the No Action Alternative, the impact-producing factors associated with the construction, operation, maintenance, and decommissioning of the VOWTAP would be avoided (a discussion of environmental resources is provided in Section 4). However, the United States would not realize the benefits and objectives of the Project related to the demonstration of technology and process innovations, construction and installation techniques, and operations and maintenance strategies that could remove market barriers and reduce the levelized cost of commercial offshore wind energy.

The No Action Alternative applies specifically and exclusively to the Project and associated BOEM, USACE, and DOE actions. The No Action Alternative does not include or imply a lack of action on the part of other government or private entities related to development of offshore renewable energy resources. BOEM would presumably continue to implement its initiative to facilitate offshore wind energy development on the Atlantic OCS. DOE would continue to fund research and development efforts related to offshore wind energy, and would presumably award final engineering, design, and construction grants to entities other than the VOWTAP Team. The Commonwealth of Virginia would continue to implement its 10-Year Energy Plan, including VCERC's efforts to provide information related to coastal and offshore energy resources. As a result of such ongoing programs, assessments of offshore wind energy sites, technology advancement and testing, and commercial development activities would still occur on the Atlantic OCS in areas that have been identified as suitable for such purposes, including the offshore Virginia WEA.

2.2 Alternative Locations for the VOWTAP

The proposed VOWTAP location reflects consideration of potential locations for offshore wind energy facilities off the Virginia coast that began over three years ago. Starting in 2010, the Commonwealth of Virginia initiated the evaluation of potential sites that would be suitable to support offshore wind testing and demonstration (Miles et al. 2012). The Commonwealth presented these areas to the DOE in its response to the DOE Advanced Technology Demonstration Request for Information (RFI; DE-FOA-EE0000384) in July 2010. In its response, the Commonwealth proposed a staged approach to offshore wind testing facilities: Stage 1 (inshore) located in relatively shallow waters accessible from land via footbridge; Stage 2 (nearshore) also installed in relatively shallow waters, but in more oceanic conditions just east of the Chesapeake Bay Bridge Tunnel (CBBT); and Stage 3 (offshore) installed in federal waters in a Section 238 research lease near the Chesapeake Light Tower. In its response to the DOE's Advanced Technology Demonstration Funding Announcement (DE-FOA-000410) in May 2012, the VOWTAP Team decided to carry forward the Stage 2 and 3 concepts for further evaluation. Locations that had been identified near shore (identified as the Newport News Site and the Suffolk Site on Figure 2.2-1) were eliminated because these sites were less applicable to commercial scale development. In evaluating locations for the VOWTAP WTGs, the VOWTAP Team recognized the CBBT Site (Figure 2.2-1) as a potentially viable state-water location for the proposed Project because it offered more representative water depths (33 feet [ft] to 36 ft [10 m to 11 m]), suitable oceanic wind and wave conditions, and potential access via the CBBT for grid interconnection. In addition, the CBBT Fourth Island offered an excellent platform to accommodate remote sensing devices and field observers needed for monitoring the demonstration WTGs and wildlife interactions.

The VOWTAP Team applied the following siting criteria to support the identification of additional potential Project sites within state or federal waters off the coast of Virginia:

- Sites that avoided vessel traffic lanes, safety fairways, and separation zones;
- Sites that avoided military danger zones and precautionary areas;
- Sites that were outside a 10-nm (18.5 km) radius from commercial airports and military airfields
- Sites that would mimic the site conditions, permitting requirements, design parameters and O&M requirements of a commercial scale-project;
- In federal waters, sites within the geographic scope of the Virginia WEA EA, in order to support expedited BOEM review of lease issuance and site characterization activities.

Through this process, Dominion identified two additional candidate sites for the VOWTAP including:

- A state-water site located approximately 5 nm (9.3 km) northeast of Cape Henry and 5 nm (9.3 km) southeast of the CBBT Site (this area is identified as Cape Henry Site on Figure 2.2-1); and
- A federal-water site that included three aliquots (C, F, G) within BOEM OCS Lease Block 6160, located approximately 20 nm (37 km) offshore from Virginia Beach, 7 nm (13 km) southeast of the Chesapeake Light Tower, and 2.5 nm (4.6 km) west of the Virginia WEA (this area is identified as Federal Lease Alternative A on Figure 2.2-1).

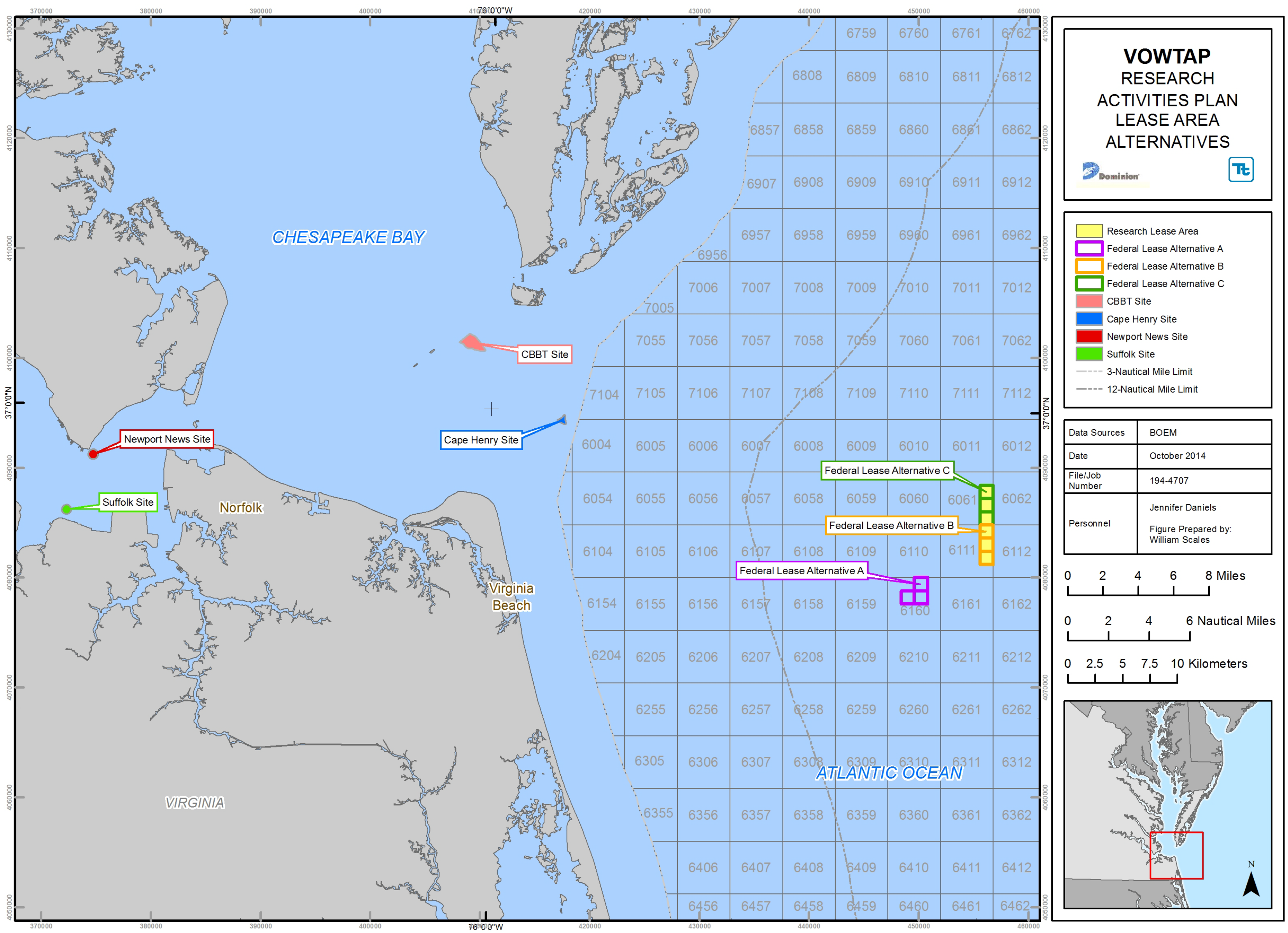


Figure 2.2-1. Project Sites Considered

Dominion then conducted a comparative analysis of the environmental, technical, and regulatory conditions associated with each of these three sites. Based on this analysis it was determined that the Cape Henry Site offered the site characteristics (e.g., water depth, and oceanic wind and wave conditions) necessary to support the development of a two turbine demonstration project, and provided for a relatively short submarine Export Cable route with multiple interconnection options in the vicinity of Fort Story, Virginia. However, several concerns were identified with the Cape Henry Site, as follows:

- The Federal Aviation Administration (FAA) considered a facility in this location to be an obstruction to air navigation;
- The DoD Renewable Energy Clearinghouse recommended not developing this site;
- The site is surrounded by heavily-trafficked waterways used by commercial, recreational, and military vessels; and
- Impacts to avian species were considered potentially significant at this site, which is located within a documented avian flyway.

Similar avian concerns also applied to the CBBT Site, as the nearby High Rise Bridge is a known nesting location for several avian species, including peregrine falcons (*Falco peregrinus*). Although avian biologists had indicated that a single turbine might be acceptable at this site, two WTGs (necessary for meeting DOE objectives of demonstrating turbine to turbine interactions) would represent an unacceptable risk. For these reasons, both the CBBT and Cape Henry sites were removed from further consideration by the VOWTAP Team.

Federal Lease Alternative A met all of the VOWTAP siting criteria and received preliminary stakeholder and agency approval. In July 2012, the DMME submitted a draft application to BOEM for a Section 238 Research Lease in support of an offshore wind turbine testing site at proposed Federal Lease Alternative A. This site was located on a shoal area between the natural deep-water channel that trends northeast-southwest between the open Atlantic Ocean and the terminus of the federally-maintained Southern Approach of the Chesapeake Entrance Vessel Traffic Separation Scheme. It had been considered an acceptable alternative by the maritime community provided that the demonstration WTGs would be decommissioned and removed prior to the build-out of the commercial Virginia WEA.

When it was realized that the VOWTAP WTGs would have a service life of at least 20 years, DMME initiated a series of update meetings with maritime interests, the military, and other federal agencies in January 2013. Although long-lived WTGs at the Alternative A site would not interfere with deep-draft vessel navigation, it would provide a bottleneck for tug and barge operators who use the area between the Alternative A site and the Virginia WEA during periods of severe or inclement weather. Based on consensus with the maritime community and federal regulatory agencies, the VOWTAP Team moved the proposed research lease to an area directly adjacent to the Virginia WEA. This site is referred to as Federal Lease Alternative B and is comprised of three BOEM OCS aliquots (D, H, L) within BOEM OCS Lease Block 6111 (Figure 2.2-1). Based on further input from federal and maritime stakeholders and the need for potential additional flexibility in siting the WTGs, the VOWTAP Team also considered three additional BOEM OCS aliquots (H, L, P) within BOEM OCS Lease Block 6061 (referred to as Federal Lease Alternative C; Figure 2.2-1). On February 8, 2013, DMME submitted its final *Unsolicited Application for an OCS Renewable Energy Research Lease*, for the six aliquots within OCS Lease Block 6111 and 6061. This site is collectively referred to as the proposed "Research Lease Area" and avoids the noted maritime stakeholder concerns with Federal Lease Alternative A (see Figure 2.2-1).

2.3 Alternative Locations for the VOWTAP Transmission System

A multi-phased approach was used in assessing potential locations for the VOWTAP terrestrial and marine transmission systems including the cable landfall location and associated on and offshore transmission cable routes. These assessments included detailed desktop analyses, site-specific studies, and consultations with a wide range of stakeholders. The following sections describe the VOWTAP transmission system evaluation process.

2.3.1 Export Cable Landfall Locations

In identifying potential landfall locations for the Export Cable, the VOWTAP Team considered the following:

- Availability and access to existing Dominion electrical infrastructure;
- Availability of a location with sufficient construction workspace;
- A landing location and terrestrial route for which Dominion could be reasonably sure of obtaining land rights;
- Avoidance or minimization of disturbance to sensitive coastal areas, habitat, and resources (e.g., eelgrass, beach dunes);
- Avoidance or minimization of impacts on the local community; and
- Avoidance of impacts to military operations.

Based on these landfall siting criteria, the VOWTAP Team identified the Camp Pendleton State Military Reservation and Dam Neck Naval Training Center as potential Export Cable landfall locations. Each of these sites would allow the Project to interconnect with Dominion's existing electrical infrastructure located along South Birdneck Road (Figure 2.3-1).

Starting in late 2012, the VOWTAP Team initiated consultations with military stakeholders regarding the proposed landfall sites, including communications with Dam Neck and Camp Pendleton personnel, the U.S. Naval Office of Seafloor Cable Protection, and Fleet Forces Atlantic Exercise Coordination Center at Naval Air Station Oceana. Based upon these communications, it was determined that landing the VOWTAP Export Cable on Dam Neck property would be very difficult due to potential interference with Dam Neck military operations. In addition, the routing of the Export Cable to the Dam Neck facility would put the route in close proximity (approximately 0.2 mi [300 m]) to a military exclusion zone established by the U.S. Naval Office of Seafloor Cable Protection (see Section 2.3.3 for additional information on the Export Cable alternatives assessment). For these reasons, the Dam Neck facility was excluded from further consideration.

Further consultation showed that a cable landfall at Camp Pendleton would meet the stated siting criteria. This site provides suitable access to existing Dominion infrastructure, has an ideal beach landing location, and as discussed further in Section 2.3.2, provides several viable Onshore Interconnection Cable routes to existing Dominion electrical infrastructure. The landowner, the Virginia Army National Guard, as well as the U.S. Navy tenant command, which has control over this landfall site, have not opposed the use of the facility.

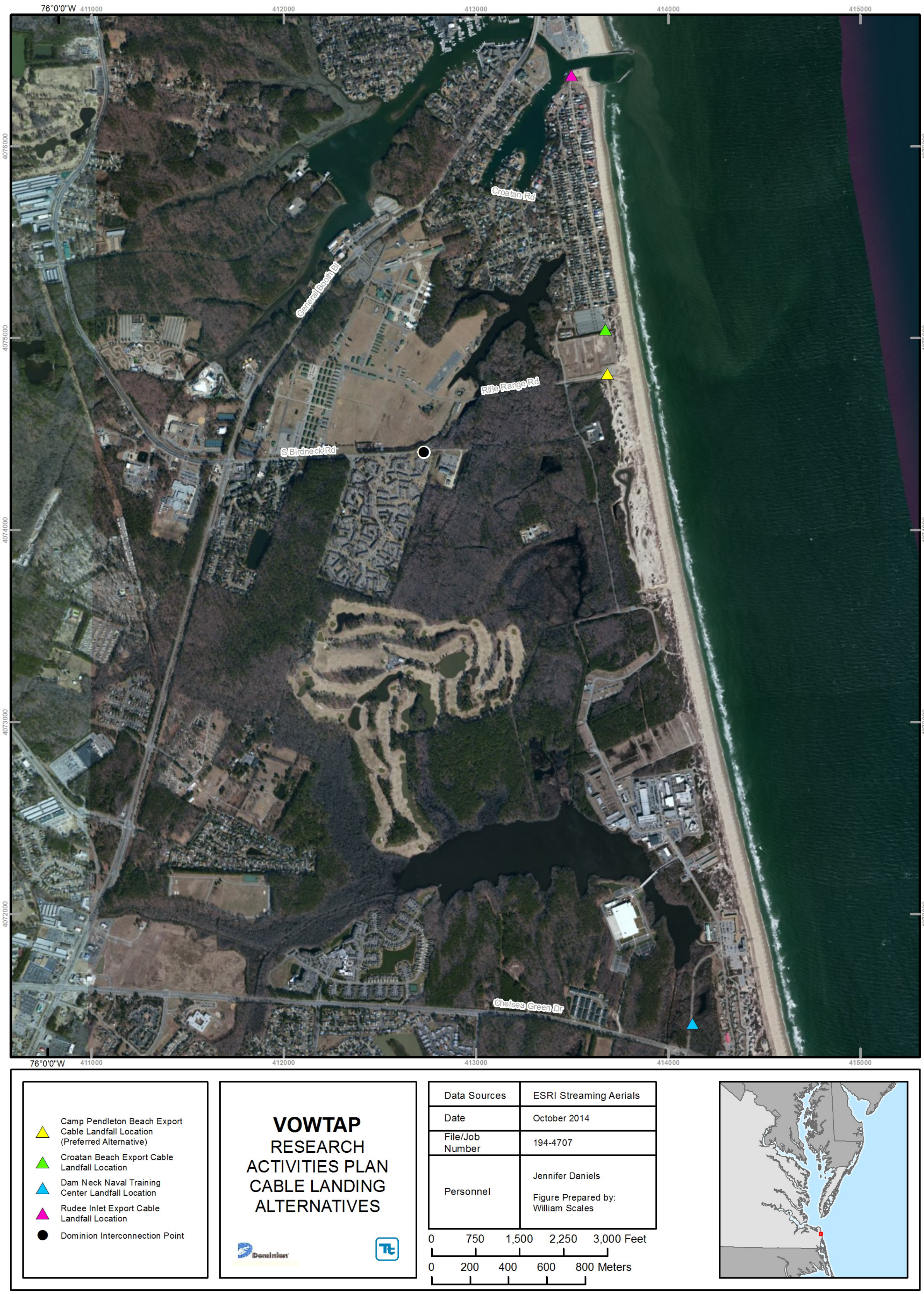


Figure 2.3-1. Export Cable Landfall Locations

Subsequent to the elimination of Dam Neck as a potential landfall site, the VOWTAP Team concluded that it would be advisable to identify other viable landfall locations near Camp Pendleton in the event that further study identified significant issues with the Camp Pendleton landfall site and/or the associated siting of the Onshore Interconnection Cable route on Camp Pendleton property. Consequently, the Team identified two alternative landfall locations along Croatan Beach, including the Croatan Beach public parking lot owned by the City of Virginia Beach, Virginia, and an established parking area located on the south side of Rudee Inlet (Figure 2.3-1). Each of these sites would allow the Project to interconnect with Dominion's existing 34.5kV electrical circuit at the intersection of General Booth Boulevard and Croatan Road (Figure 2.3-1). However, for reasons discussed further in Section 2.3.2, the Rudee Inlet Landfall and Croatan Beach Landfall locations were eliminated from further consideration due to both on- and offshore constraints.

2.3.2 Onshore Interconnection Cable Route Alternatives

Route alignments for the proposed Onshore Interconnection Cable were evaluated from the proposed landfall locations at Camp Pendleton, Croatan Beach, and Rudee Inlet to proposed interconnection points at Dominion infrastructure located on South Birdneck Road and at the intersection of General Booth Boulevard and Croatan Road (see Figure 2.3-2).

The following criteria were used in evaluating alternatives for the Onshore Interconnection Cable route:

- Minimize the distance between the landfall location and the interconnection location;
- Maximize the use of existing rights-of way to avoid and/or minimize potential impacts to existing utilities, infrastructure, and the local community;
- Avoid or minimize potential impacts to environmental and cultural resources; and
- Avoid impacts to military operations.

Based upon this criteria Dominion identified the following onshore cable route alternatives:

- Onshore Route Alternative 1 – Rifle Range Road, Camp Pendleton landfall;
- Onshore Route Alternative 2 – Regulus Avenue, Croatan Beach landfall;
- Onshore Route Alternative 3A and 3B – Lake Christine, Croatan Beach landfall;
- Onshore Route Alternative 4 – Vanderbilt Avenue, Croatan Beach landfall; and
- Onshore Route Alternative 5 – South Atlantic Avenue, Rudee Inlet landfall.

As depicted in Figure 2.3-2, Onshore Route Alternative 1 would begin at the proposed landfall location a parking lot at the end of Rifle Range Road on Camp Pendleton. Alternative 1 then extends west, parallel to Rifle Range Road on the north side (subgrade) for approximately 2,372 ft (723 m) to the intersection of Rifle Range Road and Jefferson Avenue. The cable route then extends from this intersection approximately 872 ft (266 m) down an access road to an entrance for Camp Pendleton at Gate No. 10 (Gate 10 Access Road) off of South Birdneck Road. From the Gate 10 Access Road the cable route continues 207 ft (63 m) to interconnect with Dominion's existing electrical infrastructure located on the south side of South Birdneck Road. The total length from the landfall to the interconnection point for this alternative is 0.7 mi (1 km).

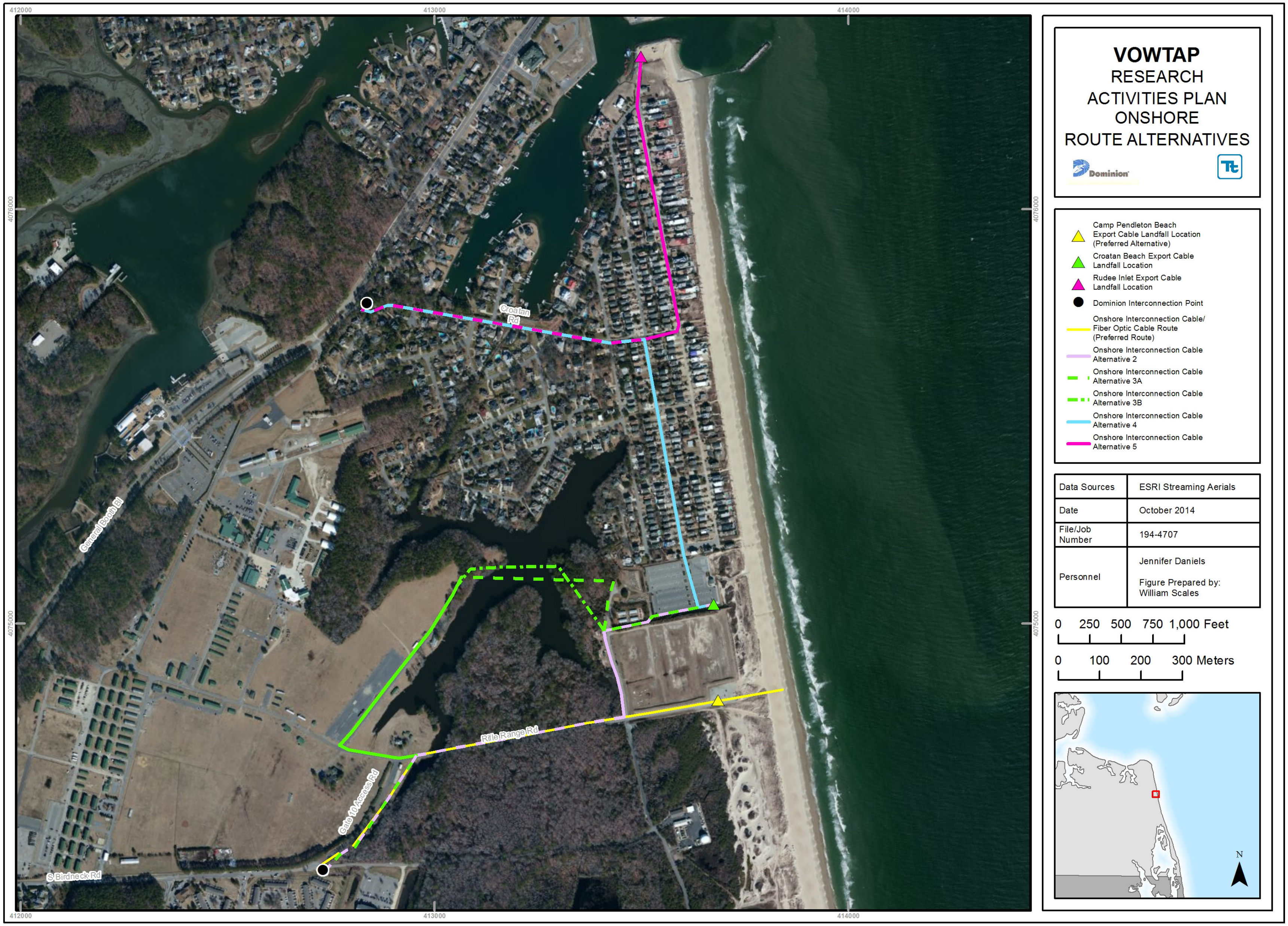


Figure 2.3-2. Export Cable Landing Sites Considered

Onshore Route Alternative 2 would begin at the proposed Croatan Beach landfall site (Figure 2.3-2). From the proposed landfall location, Alternative 2 extends west approximately 950 ft (290 m), parallel to the southern edge of the parking lot adjacent to an existing chain link fence (subgrade), until it intersects with Regulus Avenue. From this intersection, the route extends south along the western edge of Regulus Avenue for approximately 740 ft (225 m) to Rifle Range Road. From this intersection, Alternative 2 shares the same route as Alternative 1 to its interconnection with Dominion's existing electrical infrastructure on the southern side of South Birdneck Road. The total length of Alternative 2 from landfall to the interconnection point is 0.91 mi (1.46 km).

Onshore Route Alternative 3 shares the same Croatan Beach landfall and subgrade route segment to Regulus Avenue as Alternative 2. However, from the intersection with Regulus Avenue, Alternative 3 includes two options for crossing Lake Christine. One option (identified as Alternative 3A) extends north along Regulus Road for approximately 400 ft (122 m) and then would require a 1,200 ft (366 m) horizontal directional drill (HDD) under Lake Christine to Lake Road. The second option (Alternative 3B) angles to the northwest for approximately 620 ft (189 m) and then would require a 750 ft (229 m) HDD to Lake Road. Both Alternatives 3A and 3B include an approximately 0.5 acre (0.2 hectare) temporary workspace at each end of the Lake Christine crossing to accommodate HDD equipment. Past the Lake Christine crossing, Alternatives 3A and 3B both extend southwest along Lake Road for approximately 1,750 ft (530 m) to the intersection with Jefferson Avenue. The route then extends east to the same intersection of Rifle Range Road and Jefferson Avenue as Alternatives 1 and 2. From this point, Alternative 3 shares the same route proposed for Alternatives 1 and 2 to the existing Dominion infrastructure on South Birdneck Road. The total length of Alternative 3A from the proposed Croatan Beach landfall location to the interconnection at South Birdneck Road is 5,800 ft (1,770 m), and the total length of Alternative 3B is 1 mi (1.68 km) (see Figure 2.3-2).

Onshore Route Alternative 4 shares the same Croatan Beach landfall as Alternatives 2, 3A and 3B. From the Croatan Beach landfall location this Alternative would follow Vanderbilt Avenue for approximately 2295 ft (700 m), to its intersection Croatan Road. Alternative 4 would then follow Croatan Road for approximately 2336 ft (712 m) to its interconnection with an existing Dominion 34.5 kV circuit at the intersection with General Booth Boulevard. The total length of Alternative 4 from the proposed Croatan Beach landfall location to the interconnection at General Booth Boulevard is 0.88 mi (1.41 km) (see Figure 2.3-2).

As depicted in Figure 2.3-2, Onshore Route Alternative 5 would begin at the proposed landfall location on City of Virginia Beach property at the north end of South Atlantic Avenue adjacent to Rudee Inlet. From this landfall location, Alternative 5 would follow South Atlantic Avenue for approximately 2,212 ft (674 m) to its intersection Croatan Road. Alternative 5 would follow the same route proposed for Alternative 4 along Croatan Road to its interconnection with the existing Dominion 34.5 kV circuit at the intersection with General Booth Boulevard. The total length of Alternative 5 from the proposed Rudee Inlet landfall location to the interconnection at General Booth Boulevard is 0.91 mi (1.46 km) (see Figure 2.3-2).

During initial investigation of the six route alternatives, the VOWTAP Team identified several constraints associated with Onshore Route Alternatives 3A, 3B, 4 and 5. Constraints associated with Onshore Route Alternatives 3A and 3B include the potential for unexploded ordnance (UXO) to be present, both onshore and in Lake Christine, that could increase Project construction risk, the need to clear ecologically important maritime forest habitat and forested wetlands to support the HDD crossing of Lake Christine, and the identification of several cultural resource features that would require avoidance. In addition, Alternatives 3A and 3B are both substantially longer than Alternatives 1, 2, 4, and 5, and therefore would be more costly. For these reasons Alternatives 3A and 3B were eliminated from further consideration.

Constraints associated with Alternatives 4 and 5 included the routing of the cable through established residential neighborhoods, the need to obtain right-of-way and easement agreements from multiple property owners and significant increases in Project cost associated with the need to rebuild the existing local distribution infrastructure to accommodate the VOWTAP system onshore. In addition, further evaluation of the proposed landfall location associated with Alternative 4 revealed that frequent dredging activity in the Rudee Inlet could result in damage to the marine cable sited in this area and a breakwater located on the south side of the inlet would complicate Export Cable construction activities. For these reasons, Alternatives 4 and 5, and the Rudee Inlet landfall site, were eliminated from further consideration.

Both Onshore Route Alternatives 1 and 2 offered similar advantages including suitable cable landfall conditions, a suitable onshore workspace and a route that would not cause disruption to the local community during construction. However, after further consultations with U.S. Navy it was determined that there was a strong preference for a cable landfall at the Camp Pendleton parking lot over the Croatan Beach parking lot. Therefore Onshore Route Alternative 2 was dropped from further consideration.

2.3.3 Export Cable Alternative Routes

Routing criteria used in evaluating the alternative routes for the Export Cable included the following:

- Minimize the total length of the Export Cable, including:
  - Reducing the total length of the marine cable route to minimize impacts to the surrounding marine environment; and
  - Selecting a shore landing location that allows for minimal impact and minimal terrestrial distance to the point of interconnection;
- Avoid or minimize cable locations within areas of human-caused hazards or use conflicts (e.g., vessel traffic lanes, military live-fire zones, and dredge disposal areas);
- Avoid impacting sensitive biological habitat and cultural marine resource sites (pre- and post-contact); and
- Minimize impacts to other sensitive environmental receptors in the surrounding area.

In evaluating potential Export Cable routes from the proposed Research Lease Area to the Camp Pendleton site, the following constraints were identified (Figure 2.3-3):

- Two dredged material placement areas;
- A navigational fairway and Traffic Separation Scheme deep-water navigation route;
- Two live-fire danger zones including Warning Zone 50A (W-50A) and Restricted Airspace 6606 (R-6606) associated with the Dam Neck facility, and a live-fire area associated with Camp Pendleton; and
- Dam Neck Ocean Disposal Site, managed by USACE for dredge spoil disposal.

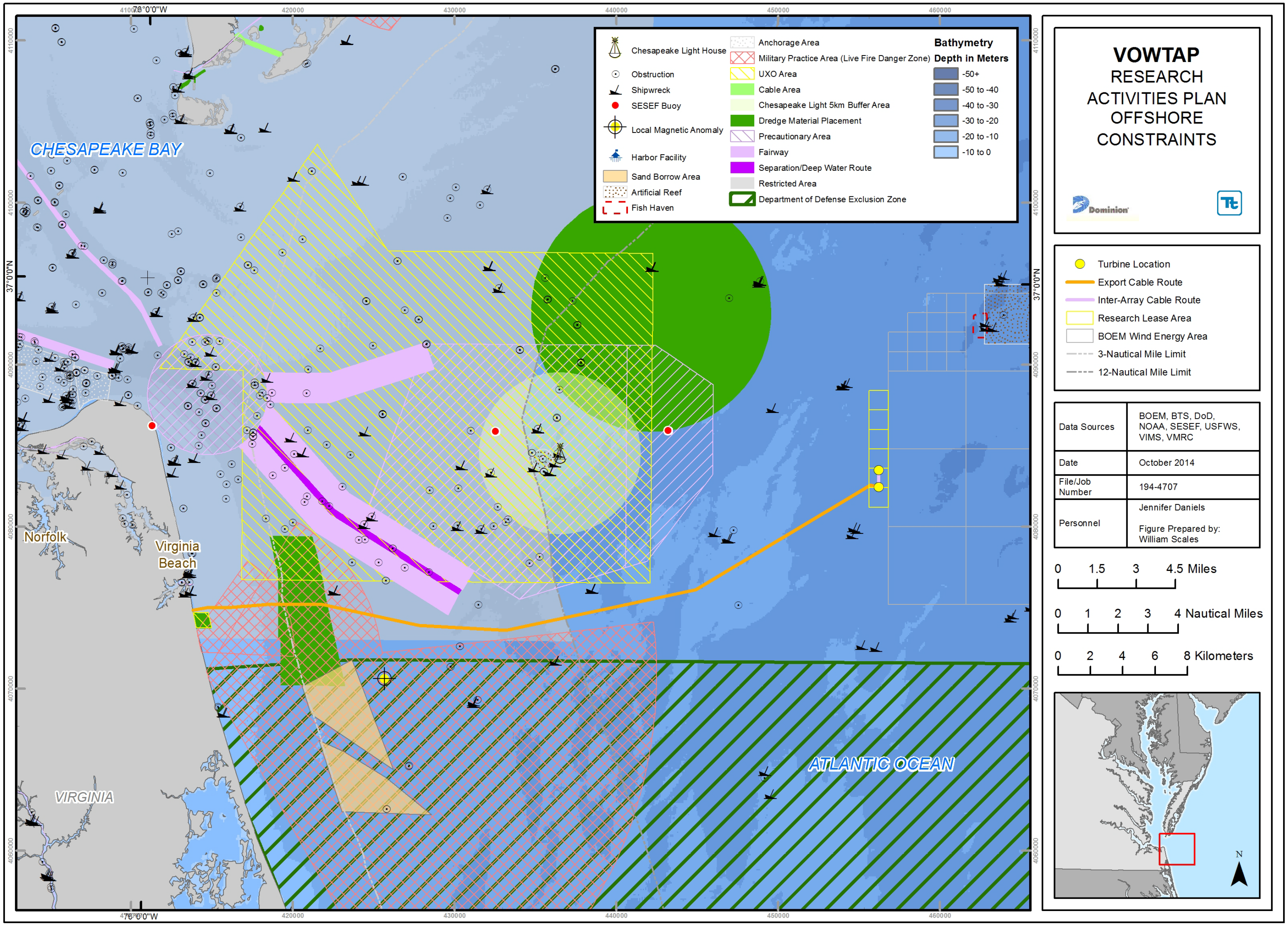


Figure 2.3-3. Constraints for the Export Cable Route

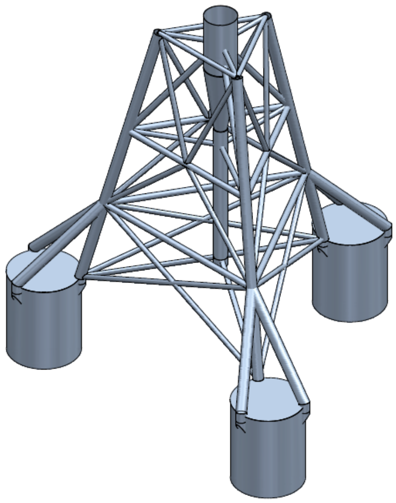
Given the geographic distribution of these constraints, and based on consultations with military stakeholders, including the USACE, the VOWTAP Team determined that the only viable Export Cable route for the VOWTAP would be an approximately 27 mi (43 km) route located between the W-50A area and the R-6606 area that avoided the navigational fairway and Traffic Separation Scheme deep-water navigation channel. The proposed Export Cable route is depicted on Figure 2.3-3. An alternate route from the Research Lease Area to the mainland that avoided the W-50A area and the overlapping dredge disposal area to the north would require the installation of a submarine cable of at least 42 nm (77.8 km) long, compared to approximately 28 nm (51.9 km) for the proposed Export Cable route, and it would still need to cross the Traffic Separation Scheme corridor north of Cape Henry. An alternate southerly route from the proposed Research Lease Area to the mainland, which avoided the R-6606 area, would be more than 60 nm (111.1 km) long. The significantly longer Export Cable routes were not considered feasible, as they would result in an overall increase in Project costs and longer installation times, as well as increased potential impacts on the surrounding marine environment.

2.4 Alternative WTG Foundation Technologies

The VOWTAP Team evaluated a total of 13 foundation concepts, employing a multi-phased process to select the Project turbine foundation design (KBR 2013). The goal of the foundation evaluation effort was to identify the most technically innovative and viable foundation concept for the Project.

The aim of the first phase was to carry out an initial screening exercise on a large number of concepts, identifying potential shortcomings prior to undertaking a detailed structural analysis. Information for this phase was gathered from vendors and other authoritative sources. The Phase 1 evaluation considered 11 innovative concepts and two reference concepts for comparison. The innovative concepts included the following (Figure 2.4-1):

- Concrete Gravity Base (proposed by Ramboll GBF);
- SPT Suction Bucket with Symmetrical 3 Leg Jacket (proposed by SPT Offshore);
- Inward Battered Guide Structure (IBGS) (proposed by Keystone);
- Monopile Suction Bucket (proposed by Universal Foundations A/S);
- Titan Jack-up System (proposed by Offshore Wind Power Systems of Texas);
- Float and Flip (proposed by IHC Merwede);
- Monolithic Tri-frame (proposed by KBR);
- Tri-frame with Planted Central Stem (proposed by KBR);
- Tri-frame on Suction Buckets (proposed by SPT Offshore / KBR);
- Self-installation Concrete Gravity Base (proposed by Gravitas); and
- Hexabase Jacket (proposed by Thyssen Krupp)

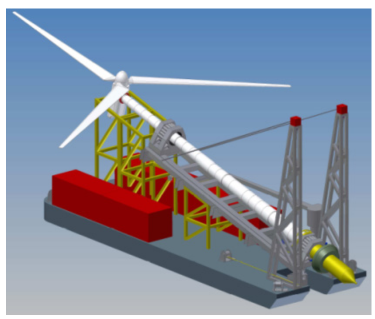


Suction Bucket with Symmetrical 3 Leg Jacket

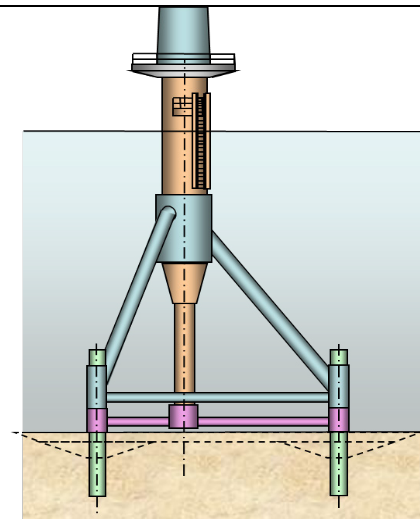
Inward Battered Guide Structure (IBGS)

Monopile Suction Bucket

Jack-up System (Titan)

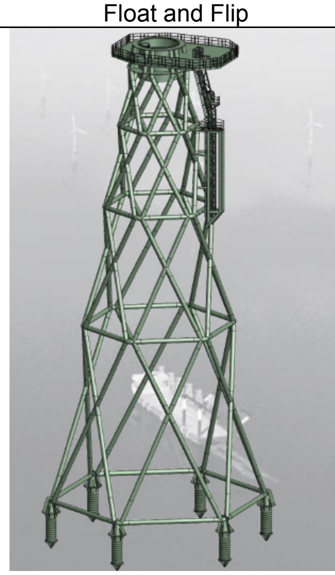


Float and Flip



Tri-frame with planted central stem

Self-installation concrete gravity base



Hexabase jacket

Other WTG foundation technologies (graphic not available):

- Concrete Gravity Base:
  An innovative design.
- Monolithic Tri-frame:
  Would be similar in concept to the Tri-frame with Planted Central Stem foundation.
- Tri-frame on Suction Buckets:
  Would be similar in concept to the Suction Bucket with Symmetrical 3 Leg Jacket foundation.

Figure 2.4-1. Alternative Foundation Concepts

Based upon the Phase 1 analysis, the Concrete Gravity Base, Monopile Suction Bucket, Float and Flip, Self-installation Concrete Gravity Base, and the Hexabase Jacket were removed from additional consideration for one or more of the following reasons:

- The foundation had been withdrawn by the promoter following initial design development (Foundations included the Concrete Gravity Base and the Float and Flip);
- The foundation required the support of a purpose built vessel which would be uneconomical for a two-turbine demonstration project (Foundation included the Concrete Gravity Base);
- The technology did not match the Project conditions (e.g., water depth, soil conditions, WTG specifications) (Foundation included the Monopile Suction Bucket); or
- The foundation lacked proof of concept such as an analysis or testing of a prototype (Foundation included the Self-installation concrete gravity).

The Phase 2 Evaluation involved a more detailed evaluation of the remaining six concepts. The process included providing the foundation suppliers with an initial Basis of Design and an invitation to provide a technical and commercial proposal for their respective concepts. The VOWTAP Team developed two sets of criteria to evaluate the proposals. Ten specific technical assessment criteria were defined to address the ability to successfully design, procure, and construct each foundation concept. The categories for these criteria included: level of innovation, technical maturity and viability, fabrication and installation requirements, environmental risks, and maturity of the supply chain. Similarly, ten specific commercial assessment criteria were defined to address the ability of the vendor to deliver the foundation concept; the categories for these criteria included factors such as financial stability, costs for the fabricated structures and installation, innovation, and various measures of risk. The VOWTAP Team assigned weights to each set of criteria and assigned scores to the concepts through a workshop process.

Following the initial technical and commercial rankings for the concepts, the VOWAP Team proceeded to develop a comparative cost estimate for the substructure and foundation concepts that achieved adequate ratings for both the technical and commercial assessment. This exercise focused on cost differentiation and did not account for items that were common to all concepts. The work resulted in a preliminary estimate for further development of the selected concepts within the overall estimate for the Project. The VOWTAP Team then performed a basic risk and opportunity assessment using the technical submissions and the data provided for the cost estimates. The objective for this step was to provide a method for assessing the maturity, completeness, and level of contingency within each concept.

Based upon the results of the technical, commercial, and financial ranking assessments, the following conclusions were made about each of the remaining six innovative foundations:

- **SPT Suction Bucket with Symmetrical 3 Leg Jacket** – This foundation concept is a proven technology for offshore oil and gas structures, requires no impact pile driving (which would reduce impacts to marine species from underwater noise), and can be assembled at dockside location in proximity to a given project location. This foundation technology scored high both technically and commercially. However, this foundation type has not yet been proven for wind turbine dynamic loading (e.g., cyclical loads) and is only suitable in specific soils. In addition, this foundations technology was also determined not to be as cost effective as other proposed innovations that were under consideration. For these reasons this foundation was not carried forward as an option for the VOWTAP at this time.

- **Titan Jack-up System –** This innovative foundation system is based on a jack-up concept. Jack-up systems are frequently used for jack-up barges and drilling rigs within the oil and gas industry. A similar design was also implemented in support of a moveable metmast in the Baltic Sea. This innovative concept has several advantages as it would allow the complete WTG and substructure to be towed to the site via tugs without the support of costly purpose built installation or transportation vessels. This foundation concept would also avoid the need for impact pile driving which will significantly reduce impacts to marine species from underwater noise. Despite these advantages, the technology was determined to be both technically and commercially immature for deployment at the VOWTAP site given the challenging physical and environmental conditions.
- **Tri-frame with Planted Central Stem –**This proposed innovative foundation structure is a cross between a tripod and a monopile and features a central stem supported by a tri-frame. Tripods have been used successfully within the oil and gas industry and in the offshore wind industry. Tripods offer higher lateral load and stiffness compared to monopiles but less fabrication than a traditional square jacket. Because the proposed tri-frame and stem are fabricated in sections, it allows stacking for transportation, thereby reducing transportation costs for a project. Despite these advantages, during Phase 2 evaluations it was determined that foundation was commercially inferior to other proposed innovations that were under consideration. It also posed a number of technical challenges regarding structural connections and flexibility within the design arrangement. Thus, it was dropped from further consideration for the VOWTAP.
- **Monolithic Tri-frame –** This foundation is similar to the tri-frame foundation with the planted central stem; however, the tri-frame would be fabricated as a single vs. a stackable unit. This solved some of the technical issues described for the tri-frame by including the planted central stem option, but leads to the creation of a very heavy system that is difficult to deploy. Similar to the previous tri-frame option this foundation was determined to be commercially inferior to the other proposed innovations.
- **Tri-frame on Suction Buckets –** This foundation is similar to the tri-frame foundation; however, this foundation would employ suction buckets vs. piles for stability. For the same reasons as applied to the previous suction bucket concept and again due to the heavy nature of the jack-up system which would be difficult to deploy this foundation was not considered as commercially viable as other proposed innovations that were under consideration. Thus it was dropped from further consideration for the VOWTAP.
- **IBGS** – This structure design has been used for two oil and gas platforms in the Gulf of Mexico, and also for one offshore meteorological mast off the east coast of the UK. While the proposed use of this foundation for a WTG is different than the current Gulf of Mexico and UK applications, both the fabrication and installation process have a good degree of proof. This foundation has also demonstrated it is capable of withstanding hurricane conditions similar to those anticipated at the VOWTAP site. The IBGS foundation would also require less steel than a standard jacket foundation, resulting in up to a 20 percent reduction in cost over a conventional 4-leg jacket foundation. With regard to environmental impacts, the IBGS would result in half the footprint area

of a conventional 4 leg jacket. For these technical, financial, and environmental reasons, the VOWTAP Team selected this innovative foundation technology for the Project.

In addition to the 11 innovative foundation technologies evaluated for the Project, the VOWTAP Team also evaluated the systems used previously for wind farm developments using smaller WTGs and/or less complex marine conditions. These systems included the monopile and the four leg jacket foundations currently being deployed in European offshore wind project sites. The monopile was dismissed as a viable option for the VOWTAP as the turbine size, seabed conditions and water depth in conjunction with both the wind and wave regime in the Atlantic Ocean would result in structural loading that is significantly outside of the current tried and tested scenarios typically adopted world-wide. While the four leg jacket would be a viable option for VOWTAP, the use of this proven foundation design does not meet the purpose and need of the Project to advance offshore wind technologies with the potential for reducing the levelized cost of commercial offshore wind energy. The four leg jacket is also heavier and more expensive to fabricate than the IBGS option.

2.5 Preferred Alternative

Dominion and the VOWTAP Team have identified a Preferred Alternative for the Project based on the results of the alternative evaluations discussed in Sections 2.2 through 2.4. The Preferred Alternative is comprised of:

- The Research Lease Area (OCS Block 6111, Aliquots D, H, L and OCS Block 6061, Aliquots H, L, P);
- An Export Cable with a landfall location at Camp Pendleton Beach, in Virginia Beach, Virginia;
- Onshore Route Alternative 1 (referred to herein as the Onshore Interconnection Cable Route); and
- The IBGS as the innovative foundation structure.

The VOWTAP Team's analysis indicates that the proposed location of the VOWTAP and associated facilities (Figure 1.1-1), as well as the proposed technologies, meet the established purpose and need for the Project as defined in Section 1.2.

Section 3 provides a detailed description of the Preferred Alternative, including specifics regarding the location, installation, operation, maintenance, and decommissioning of the facilities. Section 4 describes the potential impact-producing factors resulting from the construction, operation, and decommissioning of the Project, and the proposed mitigation measures for these impacts.

3 DESCRIPTION OF PROPOSED ACTIVITY

3.1 Project Location

This section describes the proposed location of the onshore and offshore components of the VOWTAP. The proposed facility locations have been selected based on the environmental and engineering site characterization studies that have been completed to date. The location of Project facilities will be further refined based on final engineering design.

The offshore components of the VOWTAP, including the WTGs and Inter-Array Cable, will be located in federal waters, while the Export Cable will traverse both federal and state territorial waters. The Onshore Interconnection Cable, Fiber Optic Cable, Switch Cabinet, and Interconnection Station will be located entirely within the boundary of Camp Pendleton in Virginia Beach, Virginia. During construction, the Project will additionally be supported by construction laydown area(s) and a Construction Port. The operation phase of the Project will have an O&M facility with an associated Base Port. Dominion will locate these support facilities at existing waterfront industrial or commercial sites located in the cities of Virginia Beach, Norfolk, and/or Newport News, Virginia.

For the purposes of this RAP, the Project Area refers to the footprint of the VOWTAP facilities discussed in Sections 3.1.1 through 3.1.3 below. Figure 1.1-1 provides an overview of the Project Area.

3.1.1 Offshore Facilities

The VOWTAP will include two 6 MW Alstom Haliade 150 WTGs located within the proposed VOWTAP Research Lease Area approximately 27 mi (43 km) off the coast of Virginia, in OCS Lease Block 6111, Aliquot H. Each of the WTGs will be installed atop Keystone IBGS foundations. The WTGs will be arranged in a north-south configuration spaced approximately 3,445 ft (1,050 m) apart, and will be connected by means of a 34.5 kV AC submarine Inter-Array Cable. Water depths at the WTG installation locations are approximately 80.4 ft (24.5 m) at the northern WTG, and 82 ft (25.0 m) at the southern WTG. The Inter-Array Cable will connect the two WTGs for a total length of approximately 0.62 mi (1.00 km). A separate bundled 34.5-kV AC submarine transmission and communications cable, referred to as the Export Cable, will connect the WTGs to the existing onshore electrical grid in Virginia Beach, Virginia. The Export Cable will originate at the southern WTG and travel approximately 27 nm (43 km) to a proposed Switch Cabinet at a landfall site located at Camp Pendleton Beach (Figure 3.1-1). The landfall site will serve as the transition point where the Export Cable will be spliced to the Onshore Interconnection Cable and separate Fiber Optic Cable.

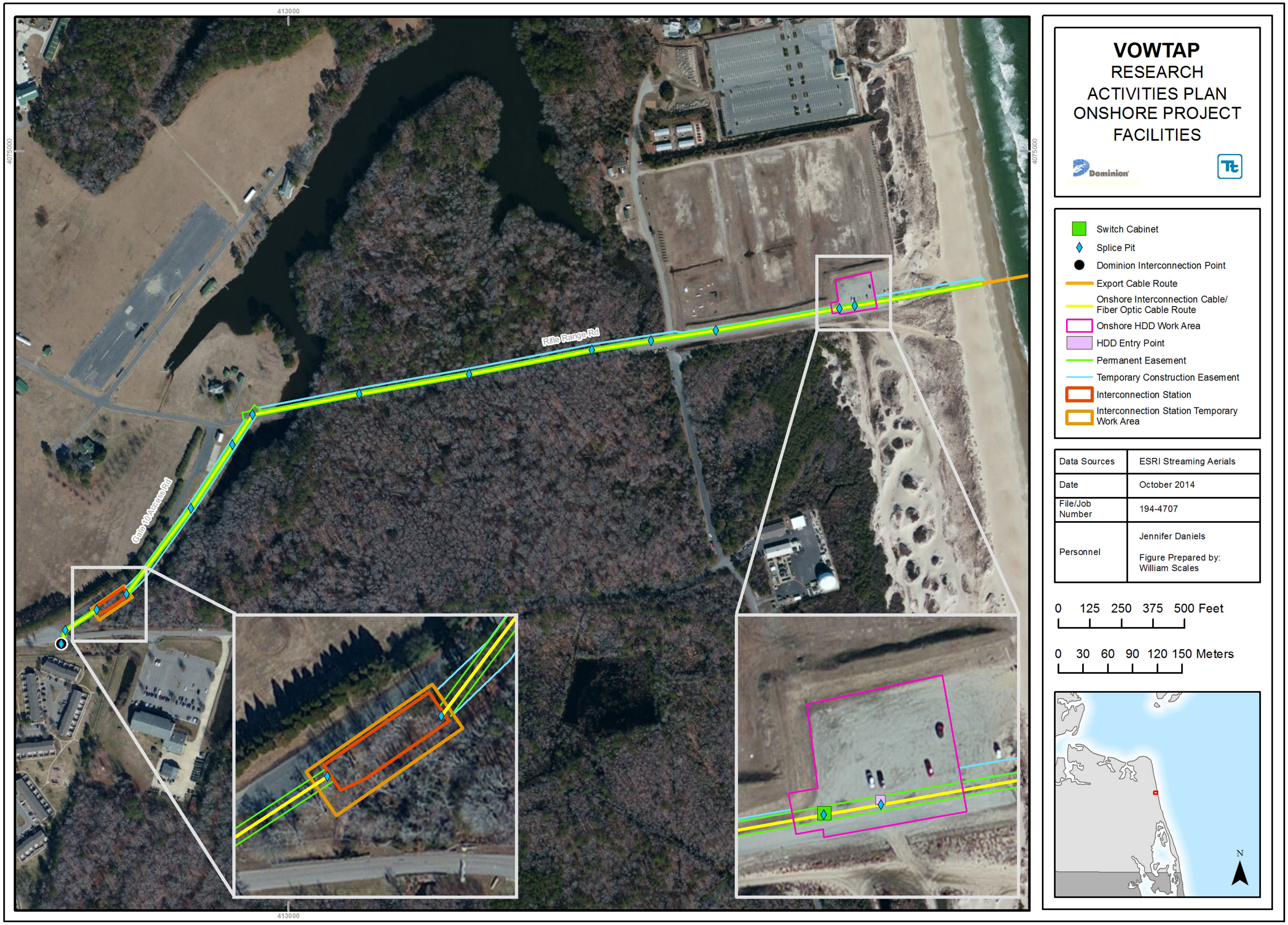


Figure 3.1-1. Onshore Project Facilities

3.1.2 Onshore Facilities

The VOWTAP's onshore equipment, including the Onshore Interconnection Cable, Fiber Optic Cable, Switch Cabinet, and Interconnection Station, will be located entirely within land owned by Camp Pendleton in Virginia Beach, Virginia. Both the Onshore Interconnection Cable and Fiber Optic Cable routes will originate at a proposed Switch Cabinet located within an existing parking lot at the end of Rifle Range Road and adjacent to Camp Pendleton Beach. From the Switch Cabinet the Onshore Interconnection Cable and Fiber Optic Cable routes will extend under Rifle Range Road and the Gate 10 Access Road to the proposed Interconnection Station. From the Interconnection Station, the Onshore Interconnection Cable and Fiber Optic Cable routes will connect to Dominion's existing infrastructure located on the southern side of South Birdneck Road (Figure 3.1-1). The total length of the Onshore Interconnection and Fiber Optic Cable route is approximately 0.7 mi (1 km).

Minor upgrades will also be required to Dominion's existing equipment on South Birdneck Road to support the interconnection with the VOWTAP. However, all upgrades will be conducted within Dominion existing right-of-way in accordance with the established requirements for work within this area and are therefore not discussed further in this RAP.

3.1.3 Construction and O&M Facilities

The VOWTAP Team is currently investigating existing facilities in the cities of Virginia Beach, Norfolk, and Newport News, Virginia, to serve as a potential Construction Port, O&M facility, and Base Port for the VOWTAP. Dominion will locate these Project support facilities at existing ports, marinas, waterfront industrial site(s), nearby commercial site(s), or existing Dominion facilities in the three-city area. Section 3.2.6 provides additional details for the Construction Port, O&M, and Base Port facilities.

In addition, an Onshore HDD Work Area will be established near the Export Cable landfall site at Camp Pendleton Beach. This temporary work area will support the offshore HDD drilling rig, associated pumping units, and mud ponds, as well as contain a site office and material storage area. Section 3.2.6 provides additional details regarding the requirements for this work area.

3.2 Description of Proposed Facilities

The VOWTAP will be comprised of the following offshore and onshore components:

Offshore:

- Two 6 MW Alstom Haliade 150 WTGs;
- Two IBGS foundations;
- Inter-Array Cable; and
- Export Cable.

Onshore:

- Onshore Interconnection Cable;
- Fiber Optic Cable
- Switch Cabinet;
- Interconnection Station; and

- Construction and O&M facilities.

Sections 3.2.1 through 3.2.6 provide a description of each of these Project components.

3.2.1 Wind Turbine Generators

The VOWTAP will employ two 6 MW Alstom Haliade 150 WTGs. The 6 MW Alstom Haliade 150 is a 3-bladed upwind WTG that operates at variable speeds. A conceptual rendering of the Haliade WTG is provided as Figure 3.2-1. Each of the WTGs will be comprised of a tower, nacelle, rotor, and blades that will be supported on an IBGS foundation. Table 3.2-1 provides a summary of the physical characteristics of the Haliade 150 WTGs. Figure 3.2-1 shows a conceptual rendering of the WTG.

Table 3.2-1. Alstom Haliade 150 6 MW Wind Turbine Generator Specifications

WTG Component	Specifications
Individual turbine power output rating	6 MW
VOWTAP nameplate electric generating capacity	12 MW
Position of rotor relative to tower	Upwind
Hub height (from MSL)	338 ft (103 m)
Turbine minimum height (from highest astronomical tide [HAT])	581 ft (177 m)
Turbine height (from mean sea level [MSL])	584 ft (178 m)
Turbine Maximum height (from mean lower low water [MLLW])	586 ft (179 m)
Air gap (MSL to the bottom of the blade tip)	89 Ft (27 m)
Base height (tower height)	267 ft (81m)
Base (tower) width (at the bottom)	20 ft (6 m)
Base (tower) width (at the top)	13 ft (4 m)
Nacelle dimensions	25.3 x 64.3 x 27 ft (7.7 x 19.8 x 8.9 m)
Nacelle radius	13.5 ft (4.1 m)
Blade length	241 ft (73.5 m)
Blade width	10.5 ft +/- 0.11 in (3.2 m +/- 2.7 mm)
Rotor diameter	495 ft (151 m)
Rotor Speed	4 to 11.5 rpm
Operational Cut-in Wind Speed/Cut-Out Wind Speed	6.7 mph (3 m/s) / 56 mph (25 m/s)

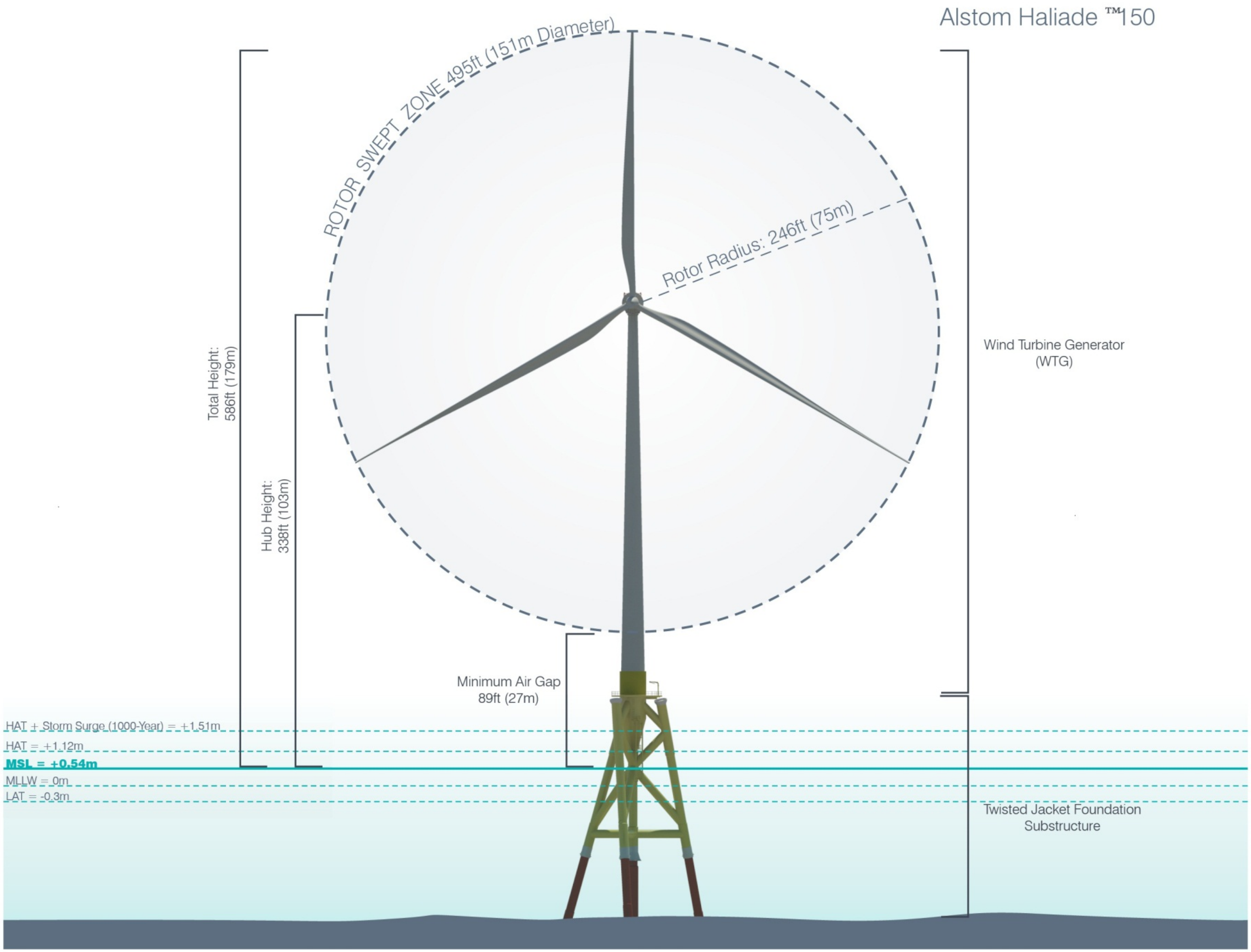


Figure 3.2-1. Conceptual Rendering of the WTG

Each of the WTGs will require various oils, fuels, and lubricants to support the operation of the WTG's hydraulic system, generator, transformers, and emergency back-up generator. Table 3.2-2 provides a summary of the physical characteristics of these oils and lubricants per WTG. The spill containment strategy for each WTG is comprised of preventive, detective and containment measures. These measures include 100 percent leakage free joints to prevent leaks at the connectors; high pressure and oil level sensors that can detect both water and oil leakage; and two retention tanks – one 132 gallon (gal) (500 liter [L]) at the bottom of each generator and one 528.3 gal (2000 L) at the bottom of each transformer – capable of containing 110 percent of the volume of potential leakages at each WTG.

Table 3.2-2. Alstom Haliade 150 Summary of Oils, Fuels and Lubricants

WTG System	Oil/Fuel Type	Oil/Fuel Capacity
Hydraulic System	Hydraulic fluid, ISO Viscosity Grade DIN 51519	10.6 gal / 40 L
Generator Cooling System (Primary and Secondary)	Water and Glycol	132 gal / 500 L
Primary Transformer Cooling System	Class 3k synthetic ester liquid	528 gal / 2000 L
Secondary Transformer Cooling System	Water and Glycol	53 gal / 200 L
Converter	Water and Glycol	53 gal / 200 L
Emergency Back-up Generator	Diesel fuel	1000 gal / 3785 L

The WTGs have been designed following Class I-B specifications of the standards IEC-61400-1/IEC-61400-3. The design is specifically suited for offshore wind sites with referenced wind speeds of 112 miles per hour (mph) (50 m/s over a 10-minute average) and 50-year extreme gusts of 157 mph (70 m/s over a 3-sec average) as well as air temperatures greater than -4°F (-20°C) and less than 122°F (50°C) However, standard environmental operating conditions for the proposed WTGs include wind speeds between 6.7 mph and 55.9 mph (3 m/s and 25 m/s), and air temperatures between 14ºF and 104ºF (-10ºC and +40ºC). The WTG will automatically shut down outside of these operational limits.

The WTGs will also be protected both externally and internally by a lightning protection system. The external lightning protection system is comprised of lightning receptors located within the both the nacelle and blade tips which are designed to handle direct lightning strikes and will conduct the lightning's peak current through a conductive cabling system that leads through the tower into the WTG grounding/earthing system. To avoid and/or minimize internal damage from the secondary effects of lightning (e.g., power surges), the WTG's internal electrical systems will be protected by equipotential bonding, overvoltage protection, and electromagnetic coordination.

Operation of the WTGs will be continuously monitored by the Haliade Control System which has the capability of being both locally and remotely operated over a local area network to ensure the WTGs are operating within their specified design limits. The Haliade Control System is comprised of several key components that include GALILEO, which serves as the main controller of WTGs, and a SCADA. The GALILEO is an automatic, self-diagnosing turbine management system that monitors and manages the operation of the WTGs based on real-time environmental conditions and turbine status. The SCADA provides remote control and monitoring of the WTGs from an operations center onshore, including real-time information on electrical and mechanical data, operation and fault status, meteorological data, and grid station data. No form of communication other than fiber optic is currently being considered. Depending on further analysis of design requirements, other forms of redundancy may be considered. The 24 optical fibers in the Inter-Array and Export Cables provide for multiple fiber optic cable connections to address concerns with potential failures, such as loss of port or electronic card.

Additional operational safety systems on each WTG include a back-up power generator, FAA and USCG-compliant aviation and navigation obstruction lighting, fire suppression, and first aid and survival equipment. WTG safety systems and equipment are described in detail in Section 4.14.

3.2.2 IBGS Foundations

Each WTG will be supported by an IBGS foundation. The IBGS foundation consists of one approximately 10.2-ft (3.1-m) diameter central caisson, the structural jacket, and three through-the-leg inward battered piles approximately 5.9-ft (1.8-m) in diameter spaced approximately 95 ft (29 m) apart. The total footprint of each IBGS foundation is approximately 0.09 acre (0.04 hectare) on the seafloor. At sea level, the IBGS foundation measures approximately 56 ft by 56 ft (17 m by 17 m). A transition deck, boat landing, ladders and stairs, guide tubes for the Export Cable, Inter-Array Cable and other appurtenances will be installed on the foundation. Appendix D-1, Figure 1 provides a plan and profile of the IBGS foundation.

Table 3.2-3 provides a summary of the construction and operation footprints for the two IBGS foundations.

Table 3.2-3. IBGS Foundation and WTG Construction and Operation Footprint

IBGS Foundation and WTG	Construction	Operation
IBGS Foundation [a/]	0.2 ac / 0.1 ha	0.2 ac / 0.1 ha
Heavy Lift Vessel [b/]	0.8 ac / 0.3 ha	0
High Lift Jack-up Vessel [c/]	0.001 ac / 0.0004 ha	0
WTG Temporary Work Area [d/]	190 ac / 76.9 ha	0
IBGS Foundation and WTG Total	**191 ac / 77.3 ha**	**0.2 ac / 0.1 ha (No Change)**

a/ IBGS foundation area immediately under foundation is based on piles being placed 95 ft (29 m) apart. Includes two foundation structures of 0.1 ac (0.04 ha) each. Impacts will all occur within 95 ac (38.5 ha) WTG Temporary Work Area at each foundation location.

b/ Assumes a single set of an 8-point anchored vessel per WTG. Impact area includes anchors (0.006 ac [0.002 ha] per anchor) and anchor chain sweep (0.09 ac [0.04 ha]) based on approximate 200 ft (61 m) of anchor chain resting on the bottom and a maximum of 20 ft (6.1 m) of lateral drag per chain.

c/ Assume 1 jack-up per WTG (approximately .0003 ac [0001 ha]). Impacts will all occur within the 95 ac (38.5 ha) WTG Temporary Work Area at each foundation location.

d/ Includes the two WTG Work Areas of 95 ac (38.5 ha) each.

3.2.3 Inter-Array Cable

The Inter-Array Cable will comprise a single, three-conductor 34.5 kV submarine cable. Because the Inter-Array Cable and grid connection voltage will be the same (34.5 kV) the VOWTAP does not require an offshore substation. The cable will consist of three bundled copper conductor cores surrounded by layers of cross-lined polyethylene insulation and various protective armoring and sheathing. Appendix D-1, Figure 2 provides an example of a typical three-conductor marine cable. A fiber optic cable will also be included in the interstitial space between the three conductors and will be used to transmit data from each of the VOWTAP WTGs to the SCADA system. The bundled cable will be approximately 4.3 in (110 millimeter [mm]) in diameter, depending on the manufacturer selected. Appendix D-2 shows the preliminary Inter-Array Cable plan and profile drawings.

Dominion is currently evaluating the use of a towed jet plow and/or self-propelled remotely operated vehicle (ROV) jet trencher supported by a dynamically positioned (DP) cable-lay vessel to support the installation of the Inter-Array Cable. The method selected will be based upon final engineering design and the space available between the two WTGs to support the installation equipment and vessels (see Section 3.3.4.3 for a description of cable installation).

Installation using the jet plow will create a narrow, temporary trench up to 3.3 ft (1 m) wide. The cable will be fed into this trench as the jet plow is towed along the ocean floor. The jet plow will rest on skids or wheels with a width of approximately 18.4 ft (5.6 m). Installation using the self-propelled ROV jet trencher will be similar to the process described for the jet plow; however, installation activities would result in a narrower trench than the jet plow (approximately 1.6 ft. [0.5 m]). Both the jet plow and ROV jet trencher will bury the Inter-Array Cable to a minimum depth of 3.3 ft (1 m); however, the exact depth will be dependent on the substrate encountered along the route.

Regardless of the technique selected for the installation of the Inter-Array Cable a ROV jet trencher will be required for the installation of the Inter-Array Cable within a distance of not less than 656.2 ft (200 m) from each foundation.

Table 3.2-4 provides a summary of the total construction and operation footprints for the Inter-Array Cable. To be conservative, impacts have been based upon the use of the jet plow.

Table 3.2-4. Inter-Array Cable Construction and Operation Footprint

Inter-Array Cable	Construction	Operation
Jet Plow / ROV Jet Trencher [a/]	1.5 ac / 0.6 ha	0
Inter-Array Cable Total	**1.5 ac/ 0.6 ha**	**0**
a/ Assume a temporary trench up to 3.3 ft (1 m) wide and jet plow skids or wheels with a width of approximately 18.4 ft (5.6 m) to the boundaries of the revised Temporary WTG Work Areas. The size of the impacts footprints associated with cable installation within the Temporary WTG Work Areas is included in Table 3.2-3.		

3.2.4 Export Cable

The Export Cable will transmit the energy produced by the VOWTAP WTGs to shore and will be located within a 200-ft (61-m) wide easement. The preliminary Export Cable plan and profile drawings inclusive of the proposed Easement are provided in Appendix D-2.

The Export Cable will use the same type of cable as described for the Inter-Array Cable (Section 3.2.3). Installation of the cable will be achieved using a jet plow. Due to water-depth constraints, installation via jet plow will be supported by a maximum 8-point anchored barge from the proposed HDD punch-out location, for a distance of approximately 4.5 mi (7.2 km) followed by the use of DP cable-lay vessel for the remainder of the route. At a distance of not less than 656.2 ft (200 m), a ROV jet trencher will be used to install the Export Cable at the foundation location. Installation via anchored barge will require a temporary 95 ac (39 ha) Nearshore Work Area (Figure 3.2-2).

The target depth of burial for the Export Cable is approximately 6.6 ft (2 m). Conditions along the proposed Export Cable route indicate that the target depth of burial is achievable; however, Dominion has identified five areas along the route where the presence of mobile sand waves may require additional

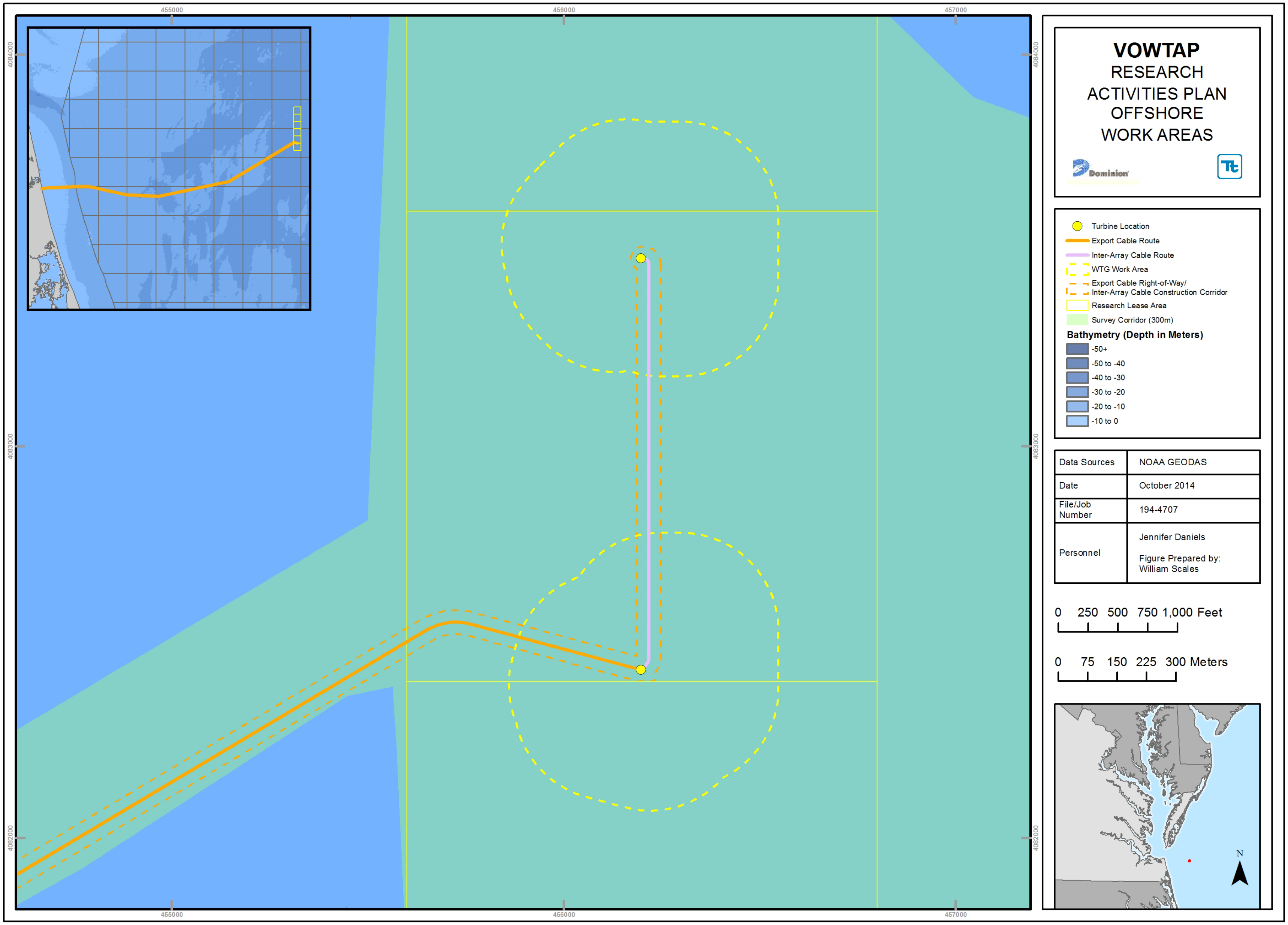


Figure 3.2-2. Offshore Work Areas

measures to ensure the protection of the cable (see Appendix D-2, Drawing Nos. 0011, 0012, 0013, 0014, 0018, 0019, and 0020). In addition, Dominion proposes to install additional cable protection at the HDD punch-out location (see Appendix D-2, Drawing No. 0010). At the five identified sand wave areas and the HDD punch-out location, Dominion is considering the placement of either a rock berm or concrete mattress for protection of the cable. Appendix D-1, Figure 3 provide representative schematics of the proposed rock berm and concrete mattress, respectively.

At the HDD punch-out location, the use of a rock berm would require the placement of a maximum of 880 cubic yards (yd^3) (672 cubic meters [m^3]) of rock fill over a distance of approximately 98.4 ft (30 m). Use of the concrete mattresses would require the placement of a maximum of 117.7 yd^3 (90 m^3) of fill across the same distance. In the sand wave areas, the placement of a rock berm would require a maximum of 132,616 yd^3 (101,388 m^3) of fill over a total distance of 4.5 mi (7.2 km). Use of the concrete mattresses would require the placement of a maximum of 28,417 yd^3 (21,726 m^3) of fill across the same distance. In addition, at finite areas along the Export Cable route where sand waves are present, Dominion may also elect to level the seafloor prior to cable installation. Dominion will consult with jurisdictional agencies regarding the preferred protection approach at each location and will provide detailed site plans where cable protection is desired prior to construction.

Table 3.2-5 provides a summary of the total construction and operation footprints for the Export Cable. To be conservative, impacts associated with the placement of additional cable protection have been based upon the use of the rock berm.

Table 3.2-5. Export Cable Construction and Operation Footprint

Export Cable	Construction	Operation
Jet Plow [a/]	61.5 ac / 25 ha	0
Offshore HDD and Nearshore Work Area [b/]	20 ac / 8 ha	0
HDD Punch-out Rock Berm	0.1 ac / 0.04 ha	0.1 ac / 0.04 ha
Export Cable Rock Berm	23.3 ac / 9.4 ha	23.3 ac / 9.4 ha
Export Cable Total	**104.9 ac / 42.4 ha**	**23.4 ac / 9.4 ha**

a/ Assume a temporary trench up to 3.3 ft (1 m) wide and jet plow skids or wheels with a width of approximately 18.4 ft (5.6 m) from the HDD punch-out location to the boundaries of the revised Temporary WTG Work Areas. Impacts associated with cable installation within the Temporary WTG Work Areas are included in Table 3.2-3.

b/ Assumes 200 individual anchor sets and from a maximum 8-point anchored vessel. Impact area includes anchors (0.006 ac [0.002 ha] per anchor) and anchor chain sweep (0.09 ac [0.04 ha]) based on approximate 200 ft (61 m) of anchor chain resting on the bottom and a maximum of 20 ft (6.1 m) of lateral drag per chain.

As detailed in Section 3.1.3, the landfall site for the Export Cable will be at an existing parking area located adjacent to Camp Pendleton Beach (Figure 3.1-1). The Export Cable will come ashore via HDD. The HDD will extend from the designated temporary Onshore HDD Work Area to the Offshore HDD punch-out location, located between 2,789 ft to 3,281 ft (850 m to 1,000 m) from shore in approximately 20-ft (6-m) water depths (Figure 3.2-3). Offshore activities at the HDD punch-out location will require vessel anchorage for a diver support vessel and an anchored barge or jack-up vessel to act as a winch vessel to pull the cable conduit into the drilled HDD bore. All such activities will occur within the proposed Nearshore Work Area.

See Section 3.3.3 for additional information on Export Cable landfall construction.

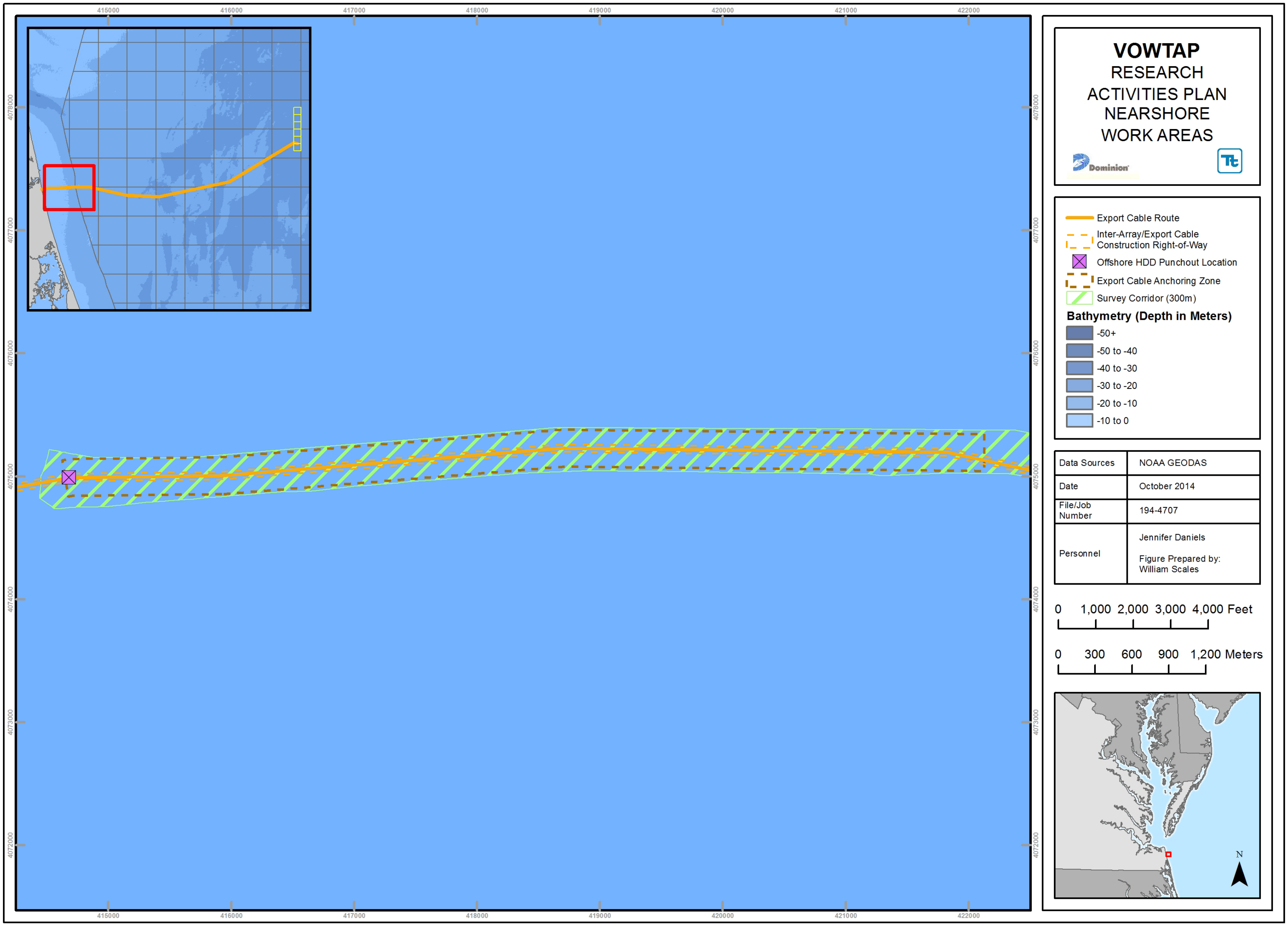


Figure 3.2-3. Nearshore Work Areas

3.2.5 Onshore Facilities

The VOWTAP onshore facilities include the Onshore Interconnection Cable, Fiber Optic Cable, Switch Cabinet, and Interconnection Station. Table 3.2-6 summarizes the construction and operation footprint associated with the onshore facilities.

Table 3.2-6. Onshore Construction and Operation Footprint

Onshore Construction and Operation	Construction	Operation
Onshore HDD Work Area [a/]	0.5 ac / 0.2 ha	0
Switch Cabinet	NA [b/]	0.001 ac / 0.0003 ha
Rifle Range Road Right-of-Way [c/]	1.5 ac / 0.6 ha	0
Gate 10 Access Road Right-of-Way [d/]	0.7 ac / 0.3 ha	0
Splice Pits [e/]	NA	0
Interconnection Station	0.2 ac / 0.09 ha	0.1 ac / 0.04 ha
Onshore Construction and Operation Total	**2.9 ac / 1.2 ha**	**0.1 ac/ .04 ha**

a/ Onshore HDD work area will support the onshore HDD drilling rig, associated pumping units and mud ponds, as well as contain a site office and material storage area.
b/ Construction impacts will be within the Onshore HDD Work Area.
c/ Assumes 30-ft (9-m) wide temporary work space inclusive of a 15-ft (4.6-m) wide permanent easement from the HDD Work Area west down Rifle Range Road to the intersection with Gate 10 Access Road within existing road shoulders.
d/ Assumes a 30 ft (9 m) wide temporary work space inclusive of a 15-ft (4.6-m) wide permanent easement from the intersection of Rifle Range Road and Gate 10 Access Road south to the Interconnection Station. Work space will be within existing road shoulders.
e/ Splice pits will be located within the Rifle Range Road and Gate 10 Access Road temporary work areas.

The Onshore Interconnection Cable will comprise a single, three-conductor 34.5 kV cable. The Onshore Interconnection Cable will be approximately 5 in (12.7 centimeters [cm]) in diameter, depending on the manufacturer selected. Appendix D-1, Figure 4 provides a cross section of the Proposed Onshore Interconnection Cable. To support the VOWTAP SCADA system a separate 1-in (2.5-cm) diameter Fiber Optic Cable will also be installed.

Both the Onshore Interconnection Cable and Fiber Optic Cable will originate at the proposed Switch Cabinet located at the landfall site within the parking lot adjacent to Camp Pendleton Beach (Figure 3.1-1). The Switch Cabinet will serve as the transition point where the bundled Export Cable will be spliced to the Onshore Interconnection Cable and separate Fiber Optic Cable. The Switch Cabinet will measure approximately 6 ft long by 6 ft wide by 6 ft tall (2 m long by 2 m wide by 2 m tall), and will be constructed within the footprint of the proposed Onshore HDD Work Area (Figure 3.1-1).

From the Switch Cabinet, the Onshore Interconnection Cable and Fiber Optic Cable will be buried below ground via HDD to the proposed Interconnection Station. Where the Onshore Interconnection Cable and Fiber Optic Cable crosses under a road, they will be installed in a steel or high density polyethylene conduit. The HDD will occur in up to 12 segments ranging from approximately 60 ft (18 m) to 500 ft (152 m) in length to the proposed Interconnection Station. From the proposed Interconnection Station the two cables will be installed using HDD an additional 207 ft (63 m) to interconnect with Dominion's existing infrastructure located on the southern side of South Birdneck Road (Figure 3.1-1). The total distance of the Onshore Interconnection Cable and Fiber Optic Cable from the Switch Cabinet at Camp Pendleton Beach to Dominion's existing infrastructure is approximately 0.7 mi (1 km).

To support the construction and operation of the Onshore Interconnection Cable and Fiber Optic Cable, Dominion proposes a 30 ft (9.1 m) temporary construction right-of-way along Rifle Range Road and the Gate 10 Access Road for installation of the cable. Upon completion of construction 15 ft (4.6 m) will be retained as a permanent easement for access during operation. The Onshore Interconnection Cable and Fiber Optic Cable will be installed approximately 3 ft (0.9 m) apart and buried to a minimum depth of 3.3 ft (1 m) to be consistent with local utility standards. Appendix D-2 shows preliminary design plans for the Onshore Interconnection Cable.

The Interconnection Station will be located on the east side of the Gate 10 Access Road in proximity to its interconnection with South Birdneck Road within Camp Pendleton (Figure 3.1-1). The Interconnection Station will consist of an approximately 132.9 ft by 36.1 ft (40.5 m by 11 m) area that will contain the following anticipated equipment:

- A switch disconnector, a 34.5kV recloser;
- A 12 MVA transformer;
- A 4.3 MVAR shunt reactor;
- A cable sectionaliser cabinet;
- A vacuum interrupter with isolator;
- A metering cabinet; and
- A communications cabinet.

All sensitive equipment will be encased in metal cabinets. The area will be graveled and surrounded by an 8 ft (2.4 m) high fence. Vegetative screening will also be applied as needed. Access to the Interconnection Station will be supported by removable fence panels located adjacent to the Gate 10 Access Road. Appendix D-2 shows the preliminary design plans for the Interconnection Station.

The shunt reactor and transformer will contain approximately 2,245.5 gallons (8,500 liters) of mineral insulating transformer oil. Each will be mounted on a concrete foundation with a concrete oil containment pit. Each of the containment pits will be designed in accordance with local utility standards.

3.2.6 Construction and O&M Facilities

Construction of the VOWTAP will require both a Construction Port and associated land-based laydown areas. Activities at the Construction Port will consist of the staging and storage of equipment and tools in support of marine construction. All other large components such as the foundations, WTGs, and Export Cable will be delivered directly from offsite fabrication and manufacturing facilities in either the Gulf of Mexico or Europe to the VOWTAP site. In order to support these activities, the Construction Port facility will require approximately 0.5 acres to 1.5 acres (0.2 hectares to 0.6 hectares) of space, a vessel berthing area of at least 165 ft (50.3 m), and deep water access of at least 16.4 ft (5 m). Dominion is currently in the process of identifying suitable existing port facilities in the cities of Norfolk and/or Newport News, Virginia. Based upon preliminary investigations of local facilities, Dominion does not anticipate that improvements or land-disturbing activities will be necessary to support Project construction and staging.

In support of onshore construction, Dominion will utilize the proposed temporary Onshore HDD Work Area located at the Export Cable landfall location adjacent to Camp Pendleton Beach (Figure 3.1-1). This 0.5 ac (0.2 ha) temporary work area will support the offshore HDD drilling rig, associated pumping units, and mud ponds, as well as a site office and material storage area. The site will be secured by means of a chain link fence. Dominion may also use portions of the 30-ft (9.1-m) temporary construction right-of-way along Rifle Range Road and the Gate 10 Access Road for additional equipment laydown and storage.

Operation of the VOWTAP will require a permanent O&M facility and supporting Base Port. The O&M facility will require 1,800 to 2,500 square ft (0.016 hectares to 0.023 hectares) of space that will house an office, storage space, a control room, and storage for consumables and spare parts. Dominion is currently considering locating the O&M facility at either an existing Dominion facility in the cities of Norfolk or Virginia Beach, or at other existing industrial/commercial waterfront parcels located within the these cities.

The Base Port will serve as the logistics hub for the movement of personnel and equipment to and from the VOWTAP during operation. There are several marinas, primarily located in the area of Virginia Beach that could serve as the Project's Base Port. However, minimizing distance and travel time to the WTGs is a major consideration in the final selection of the Base Port location. Base Port requirements include work boat access to piers for personnel, tools and material transports as well as office space with storage for personnel protective gear and hand-carried tool sets, small replacement parts and small material containers. Base Port office spaces will accommodate up to six personnel and include male and female toilet and shower facilities, plus a small kitchenette and crew meeting area. Due to the minimal length of time projected to support standard WTG maintenance (see Section 3.6) it is not necessary to homeport work boats and the Base Port itself. Based on preliminary evaluations, no major marina improvements or land-disturbing activities will be necessary to support either the O&M facility or Base Port.

3.3 Deployment and Construction

The deployment and construction of the VOWTAP will involve the following sequence of activities:

- Contracting, mobilization, fabrication of WTG and foundation components, transportation to the offshore construction site, and verification;
- Onshore construction including:
  - Interconnection Station construction;
  - Onshore Interconnection Cable installation;
- Export Cable landfall construction;
- Offshore deployment and construction including:
  - Transportation and installation of foundations and WTGs;
  - Export Cable and Inter-Array Cable installation; and
- Commissioning and post-construction activities.

The following sections provide additional details regarding each of the activities associated with the deployment and construction of the VOWTAP both on and offshore.

3.3.1 Contracting, Mobilization, Material Fabrication, Transportation, and Verification

Upon receipt of requisite permits and approvals, Dominion will finalize contracts with vendors, fabrication contractors, and installation contractors. Pursuant to 30 CFR 585.705 to 713, Dominion will also engage an independent CVA to review the Project design, fabrication, and installation plans (see Section 1.6). Upon CVA and BOEM approval, Dominion will initiate the necessary offsite facilities fabrication activities, mobilize the necessary vessels, and finalize arrangements with the selected Construction Port that will serve as the base of operations during construction. In addition, prior to construction, Dominion will also prepare a detailed Safety Management System (SMS) in accordance with 30 CFR 585.810 § 585.627 (d), 614 (b) and 651, including an environmental management system which will describe all of the health and safety, environmental, and permitting commitments to be carried out in support of Project activities. Section 4.14 provides additional detail regarding human health and safety, and Appendix S contains a draft of the proposed VOWTAP SMS. Section 4.18 provides a summary of the environmental avoidance, mitigation, minimization, and BMPs Dominion has committed to support the construction, operation, and/or decommissioning of the Project.

3.3.2 Onshore Construction

Onshore construction activities will include the construction of the Interconnection Station and the installation of the Onshore Interconnection Cable and Fiber Optic Cable via HDD. Onshore construction will require a total of 3 months and is anticipated to take place during the months of March through June (see Section 3.4 for the Project schedule).

Throughout onshore construction activities, Dominion will employ the appropriate measures to avoid, minimize, and mitigate impacts. Environmental protection measures are detailed in Section 4.0 and summarized in Section 4.18. Work will also be staged in a manner that will minimize impacts on training and daily activities at Camp Pendleton. No trenches or holes will be left open or unsecured overnight, and roadways will not be blocked to base vehicular traffic for long periods.

3.3.2.1 Interconnection Station Construction

Construction of the Interconnection Station will occur within a 0.2 ac (0.08 ha) temporary workspace. Access to the Interconnection Station will be via the existing Gate 10 Access Road during all phases of Project development in order to minimize disturbances to the existing area.

Excavation at the site will be conducted to support the installation of the concrete pad foundations for the proposed equipment as well as for the necessary ducting for the Interconnection Cable and Fiber Optic Cable. During the excavation activities the site will be cleared, top-soil removed and stored, and target trees felled and disposed of. The number of trees felled will be kept to a minimum and will be comprised of primarily low-quality and/or diseased trees. Surplus excavated spoils will be tested and disposed of offsite at an approved location in accordance with applicable laws and standards. The concrete pad foundations will either be pre-cast offsite or poured onsite.

The incoming Interconnection and Fiber Optic cables will be accomplished via HDD as described further in Section 3.3.2.2 at the north side of the Interconnection Station. Cable troughs will be incorporated into the foundations of the equipment within the Interconnection Station to allow for bottom entry of the cables.

Dominion has conducted a utility survey and soil testing to support the final engineering design of the Interconnection Station (Appendix U).

3.3.2.2 Onshore Interconnection Cable and Fiber Optic Cable Installation

The Onshore Interconnection Cable and Fiber Optic Cable will each be installed below grade via HDD along the entirety of the proposed route using guided drilling equipment in a point-to-point fashion in up to 12 segments starting at the HDD Work Area and terminating at the interconnection point with Dominion's existing infrastructure on the southern side of South Birdneck Road. Each segment will range from approximately 60 ft (18 m) to 500 ft (152 m) in length between splice points. Dominion is proposing a 30-ft (9.1-m) temporary construction right-of-way along the north side of Rifle Range Road and along the east side of the Gate 10 Access Road to support this activity. Upon completion of construction 15 ft (4.6 m) will be retained as a permanent easement for access during operation. All activities will occur along the paved roadway and within the existing cleared road shoulders along the route. The Onshore Interconnection Cable and the Fiber Optic Cable will be installed in separate bore holes located approximately 3 ft (0.9 m) apart and buried to a minimum depth of 3.3 ft (1 m) below final ground level. Where the cable crosses underneath a road it will be placed within a conduit for protection. Dominion has conducted a formal land survey of the Interconnection Cable and Fiber Optic Cable route to ensure the proposed location of the route and burial depth avoid existing utilities and/or other constraints. Dominion has also completed soil testing along the route to support the final engineering design (Appendix U).

Each splice point will require the excavation of a 4.0 ft by 6.0 ft by 2.0 ft (1.2 m by 1.8 m by 0.6 m) splice pit. The splice pit will serve as the location where the cable drilling will either be initiated and/or received. No drilling muds will be required to complete the installation of the Onshore Interconnection Cable or Fiber Optic Cable. The route will require the use of up to 13 splice pits. The splice pits and associated excavated soils will be located within the proposed construction right-of-way and will not require expanded workspaces. Upon completion of cable splicing activities, the excavated material will be returned to the splice pits, compacted, and returned to pre-construction conditions.

Onshore Interconnection Cable and Fiber Optic Cable installation and splicing activities is estimated to take a total of approximately 8 weeks, using a Dominion qualified construction crew working during typical daylight hours using the following equipment:

- Guide drill machine;
- Cable trailer;
- Two line trucks;
- Equipment trailer; and
- Two pickup trucks.

3.3.3 Export Cable Landfall Construction

To ensure the protection of sensitive beach and dune habitat, the Export Cable will be brought to shore through a 12-in (300-mm) diameter conduit installed via HDD. The HDD will extend from the designated temporary Onshore HDD Work Area located in the existing parking lot adjacent to Camp Pendleton Beach, to the HDD punch-out located between 2,683 ft to 2,835 ft (818 m to 864 m) from shore (Figure 3.2-3). Water depth at this location will be approximately 20 ft (6 m). The final location of the proposed Offshore HDD punch-out location will be determined upon final engineering design. Export Cable landfall construction will require the support of a HDD rig located onshore and a winching system located offshore. The offshore winching equipment will be located on a tug boat, a jack-up barge, or a maximum 8-point anchored barge sited within the Nearshore Work Area. Offshore activities will also be supported by divers.

HDD will initiate from shore with the drilling of a pilot hole that will then be reamed back to a diameter of approximately 18 in (450 mm) to support the installation of the conduit. A non-toxic drilling mud will be used to support the HDD activities. During the HDD activities drilling fluids will be pumped back to shore for recycling and cleaning.

To minimize the potential for frac-out of drilling fluid, the conduit will be drilled on a single arc. The burial depth beneath the beach will be a minimum of approximately 20 ft (6 m) to ensure the conduit will be protected from breaking wave induced scour during operation. The maximum burial depth offshore will be approximately 44 ft (13.5 m) under the seabed. The final depths of burial of the conduit will be determined upon final engineering design.

To further minimize the potential for the release of drilling fluid offshore, the bore will be stopped approximately 100 ft (30 m) short of the punch-out location. The actual position will be dictated by an analysis of the seabed conditions and depth. This leaves a soil plug to control the drilling fluid from leaking out into the surrounding marine environment. Dominion will also develop an HDD Contingency Plan prior to construction to support the management of HDD activities in the event a frac-out of drilling fluid should occur.

The total duration of the HDD work activities is anticipated to be approximately 11 weeks, including set up, drilling, installation of the conduit, and demobilization. HDD activities will comprise approximately 4 weeks of this period. All HDD activity will occur during daytime hours in conformance with local noise requirements.

3.3.4 Offshore Deployment and Construction

Offshore deployment and construction will consist of the following sequence of activities:

- Vessel mobilization;
- Transportation of foundations, WTG components, and other materials;
- Installation of foundations and WTGs at the VOWTAP site; and
- Export Cable installation between Camp Pendleton and the VOWTAP site and Inter-Array Cable installation between the WTGs.

Offshore construction will require a total of 12 weeks and is anticipated to take place during the months of May through July (see Section 3.4 for a Project schedule). Cable laying will occur 24 hours a day, while pile driving will only occur during daylight hours.

The following sections describe the deployment and construction of the offshore components of the VOWTAP based on representative methods, vessels, and equipment. The proposed construction methods, vessels, and equipment as outlined in the following sections are based on industry knowledge, site conditions, and BMPs. Final construction plans will be developed and vendors and vessels will be procured during the contracting phase following receipt of Project permits.

Throughout offshore construction activities, Dominion will employ the appropriate measures to avoid, minimize, and/or mitigate impacts on natural resources and existing marine uses to the extent possible. Offshore activities will also be closely coordinated with the Fleet Area Control and Surveillance Facility, VA Capes (FACSFAC VA Capes) in Virginia Beach to avoid potential conflicts with military training activities. Environmental protection measures associated with offshore construction activities are provided in Section 4.0. To ensure the safety of the local mariners, Dominion will establish a 95-acre (38.5-hectare) temporary work area around each WTG location and a 200-ft (61-m) wide Easement along the routes of the Export Cable and Inter-Array Cable (Figure 3.3-1). As appropriate, these areas will be marked and lit

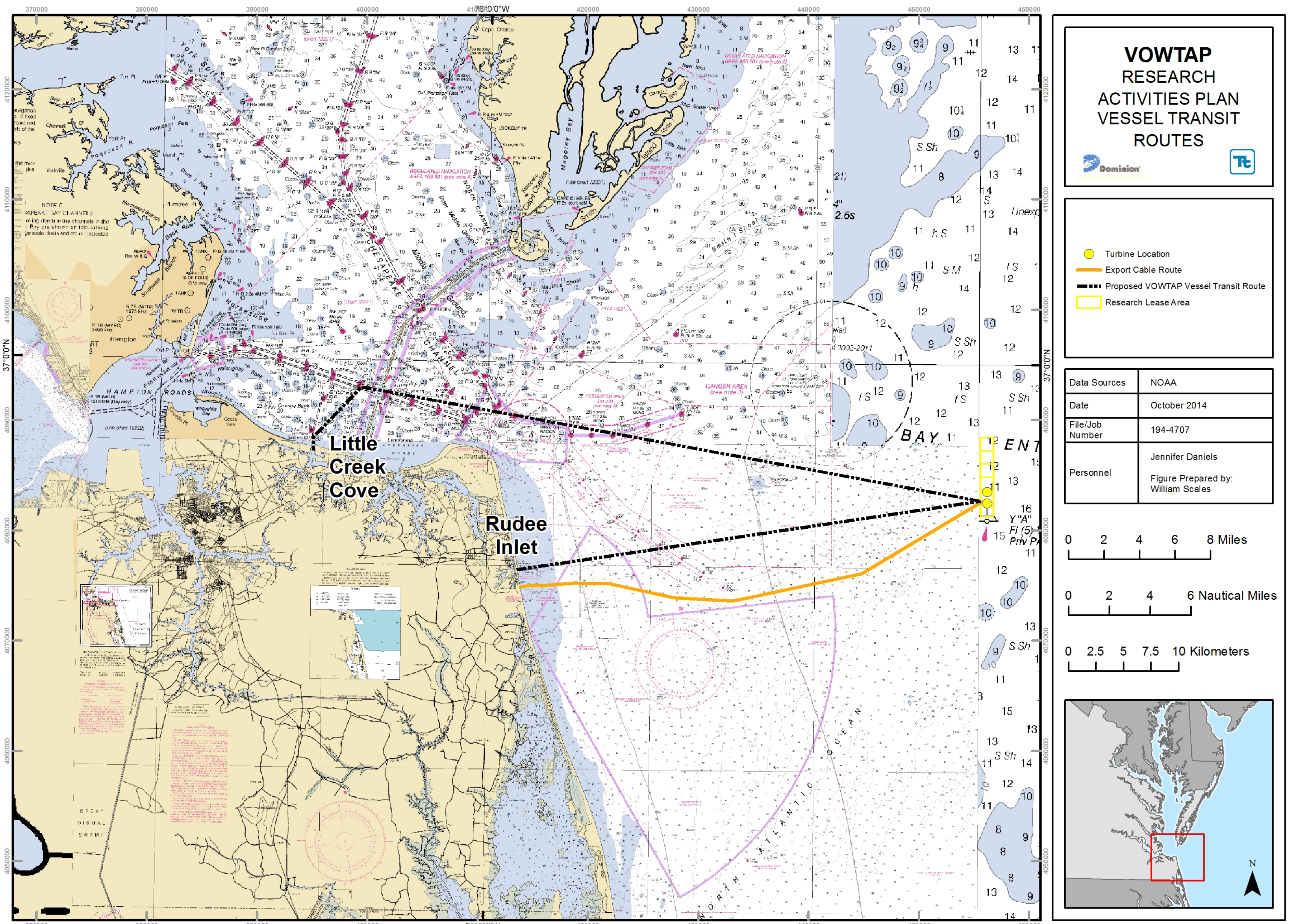


Figure 3.3-1. Proposed Vessel Routes during Construction

in accordance with USCG requirements and monitored by a security boat that will be available to assist local mariners. In addition, prior to construction, a project-specific website will be established to share information about VOWTAP construction progress with the community and also to give guidance on the daily construction activities and how they may affect the area. Dominion will also issue specific local notices to mariners in coordination with the USCG throughout the construction period.

3.3.4.1 Vessel Mobilization and Material Transportation

All large Project components, including the WTGs, the IBGS foundations, Inter-Array and Export Cable, will be delivered directly to the Project Area from the offsite fabrication and manufacturing facilities located in either the Gulf of Mexico or Europe. Secondary equipment, supplies and crew will be transported to and from the offshore Project Area from the local Construction Port. Table 3.3-1 lists the types of vessels used during construction depending on contract agreements and vessel availability. Figure 3.3-1 shows the proposed vessel routes for offshore construction. Sections 3.3.4.2 and 3.3.4.3 provide more detail on the construction methods, vessels, and equipment that will be utilized to install the offshore components of the VOWTAP.

As stated previously, Dominion will implement a communication plan during construction to inform commercial mariners, of construction activities and vessel movements. Communication will be facilitated through maintaining a Project website, submitting local notices to mariners, and vessel float plans, as appropriate, to the USCG.

Table 3.3-1. Vessel Types

Vessel	Approximate Size (ft) Length x Width x Depth (Draft)	Description/Equipment
Self-Propelled Jack Up Vessel	530 x 160 x 30 (18)	1,322-ton lifting capacity Dynamic Positioning System, 4x3400kW thrusters Used to install substructure and WTGs.
Heavy Lift Vessel	355 x 160 x 26 (16)	4409-ton lifting capacity Dynamic Positioning System, 4x1700kW Thrusters
Cable Installation Vessel	390 x 105 x 26 (20)	Cable tank / carousel for 45km cable Cable laying spread including: Jet Plow and/or ROV jet trencher, ROV, 2x400kW generators, 2xCable Engine, Cable Gantry, Coiling arm, Overboard Chute, 1500kW Dynamic Positioning system Used to transport cable to VOWTAP location from the Construction Port and install cable to correct burial depth.
Jet Plow	32 x 18	28-ton plough capable of burial depths up to 17.7 ft (5.4 m) 500kW of jetting power Used by cable installation vessel to install cable into the seabed.
ROV Jet Trencher	18 X 15	17-ton trencher capable of burial depths up to 10 ft (3.0 m) 600 kW of jetting power Used by cable installation vessel to install cable into the seabed.
Foundation Transportation Barge	250 x 72 x 20 (16)	Flat top barge Requires supporting tug boat. Used to transport substructure from fabrication yard to the construction area.

Table 3.3-1. Vessel Types (continued)

Vessel	Approximate Size (ft) Length x Width x Depth (Draft)	Description/Equipment
WTG Transportation Vessel	180 x 45 x 40 (20)	Self-propelled vessel Used to transport frames, deck grillage, and sea fastening chains to support WTGs.
Temporary Offshore Work Barge	400 x 120 x 25 (12)	Flat top barge. Requires supporting tug boat. Used to support installation activities as required.
Tug Boats	180 x 45 x 40 (20)	Ocean class tug with large horsepower (hp) and high bollard pull. Assists barge and other vessel repositioning as required.
Supply Vessel	160 x 40 x 35 (18)	Crew Transfer to demonstrator site, 10,000-lb cargo capacity Transports small equipment and other supplies to and from the construction area.
Crew Transportation Vessel	55 x 16.5 x 6.5 (4.5)	Specialized Crew transfer vessel, capable in extreme weather. Transports crew to and from construction area.
Security Vessel	160 x 40 x 35 (18)	Security for site work zone. Provides security for cable-laying operations and WTG construction. Maintains communications with other vessels, including non-Project vessels, to avoid collisions and warn of Project construction activities.
Marine Mammal Observation Vessel	160 x 40 x 25 (18)	Performs observations of the protected species monitoring and exclusions zones,
Supporting Work Vessel	300 x 80 x25 (10)	Performs grapnel run to remove obstacles from seabed prior to cable install.
Survey Vessel	120 x 40 x 20 (16)	Performs geotechnical survey for site characterization.

3.3.4.2 Foundation and WTG Installation

Offshore installation of the IBGS foundations will be carried out by a heavy-lift vessel supported by an 8-point anchoring system. The setting of the anchor system will be performed with the assistance of both a survey tug and an anchor handling tug. The IBGS foundations and associated piles will be transported to the site on a transportation/material barge supported by tugs and will be moored alongside the heavy-lift installation vessel.

The IBGS has multiple components to be installed including the central caisson, structural jacket and pile sections. Prior to commencing the installation of these components, the seabed will be checked for debris, and debris will be removed as necessary. Once the site has been made ready and the heavy-lift vessel is securely and correctly positioned, the self-standing central caisson will be lifted into place from the transportation/material barge. The initial penetration of the caisson into the seafloor will be achieved under the weight of the caisson itself. The caisson will then be driven into the seafloor to its design penetration depth of approximately 98.4 ft to 131.2 (30 m to 40 m) using a 1000 kilojoule (kJ) rated hydraulic hammer located on the heavy-lift vessel and grouted. The final design depth of each caisson is pending the results of the final geotechnical studies at the WTG locations.

After the central caisson is installed, the IBGS jacket will be lifted from the transportation/material barge and lowered onto the caisson and held approximately 30 ft (9 m) above the seabed. The initial pile sections that will be used to secure the IBGS jacket to the seafloor will be inserted into the battered legs of the jacket and secured using pile grippers. Once the IBGS jacket is positioned and levelled, pile grips located within the sleeves will be released and the piles will be allowed to complete their initial penetration under their own weight. These will then each be driven until the top of the initial pile section reaches the top of the jacket let. Additional pile sections will then be connected and driving will continue. There are a total of three pile sections per battered leg. Design penetration depth is estimated to be approximately 164 ft to 246 ft (50 m to 75 m) and will require the use of a 600-kJ rated hydraulic hammer. The final design depth of each pile is pending the results of the final geotechnical studies at the WTG locations. Once piling is complete, the IBGS jacket will be checked for levelness and adjusted as necessary using jacks and pile grippers. Once level the three piles will be grouted within the legs of the jacket.

The anticipated total duration to install the two IBGS foundation is 3 weeks assuming no delays due to weather or other circumstances. The total duration of pile driving is anticipated to be 7 days per IBGS. Pile driving activities will occur during daylight hours starting approximately 30 minutes after dawn and ending 30 minutes prior to dusk unless a situation arises where ceasing the pile driving activity would compromise safety (both human health and environmental) and/or the integrity of the Project.

WTG installation will commence after the Inter-Array Cable and Export Cable have been installed into the central caisson. The WTG components, including the three tower pieces, nacelle, and blades, will be transported to the VOWTAP site from their fabrication location in France or Central Europe aboard an ocean-going transport vessel. Once onsite, the WTGs will be installed using a jack-up high-lift vessel.

The three tower sections will be the first components to be installed atop the foundations, followed by the nacelle and blades. Each lift requires special lifting equipment and guides to hold and support the placement of the tower pieces, nacelle, and blades without causing damage. Once the components are bolted sufficiently by the internal bolting crew, the lifting equipment will be disengaged and final bolting and equipment hook-up will be conducted.

The total anticipated duration for installing the two WTGs installation is 3 weeks, assuming a 24-hour work window and no delays due to weather or other circumstances.

3.3.4.3 Offshore Cable Installation

Dominion has selected the use of the jet plow, ROV jet trencher, and a DP vessel as the primary cable installation vessel to minimize seafloor disturbance. As stated in Sections 3.2.3 and 3.2.4, the following methods will be used to install the Inter-Array and Export Cables, respectively:

- **Inter-Array Cable**:
  - Towed jet plow and/or self-propelled ROV jet trencher supported by a DP cable-lay vessel. Regardless of the technique selected for the installation of the Inter-Array Cable, a ROV jet trencher will be required to support the installation of the Inter-Array Cable within a distance of not less than 656.2 ft (200 m) from each foundation.
- **Export Cable:**
  - Towed jet plow supported by a maximum 8-point anchored barge from the proposed HDD punch-out location, for a distance of approximately 4.5 mi (7.2 km]) followed by the use of DP cable-lay vessel for the remainder of the route.
  - ROV jet trencher supported from the DP cable-lay vessel to install the Export Cable at the foundation location within a distance of not less than 656.2 ft (200 m) from the foundation.

To achieve the required minimum burial depth of 3.3 ft (1 m) along the Inter-Array Cable and 6.6 ft (2 m) along the Export Cable, both the jet plow and ROV jet trencher use high pressure water from vessel-mounted pumps that is injected into the sediments through nozzles distributed along the front of the plow/trencher. As the plow and ROV jet trencher are maneuvered along the cable route, the seafloor sediments are temporarily fluidized creating a narrow trench (approximately 3.3 ft [1 m] wide for the jet plow and 1.6 ft [0.5 m] for the ROV jet trencher) as the cable is simultaneously guided into the trench by the plow/trencher. The trench will be backfilled by the water current and the natural settlement of the suspended material. Umbilical cords will connect the submerged jet plow and/or ROV jet trencher to the vessel to control the equipment to allow the operators to monitor and control the installation process and to make adjustments, such as speed and alignment as the installation of the cable proceeds across the seafloor.

Prior to the installation of the Export Cable or Inter-Array Cable, Dominion will complete route clearance and pre-lay grapnel activities to identify and remove as appropriate any obstructions within the proposed 200-ft (61-m) wide cable construction corridors. Along the portion of the Export Cable route that crosses the military live fire zone, Dominion will also conduct a detailed pre-construction unexploded ordnance survey.

Installation of both the Export Cable and Inter-Array Cable will occur in one continuous run to avoid the need for offshore splicing of the cable. Export Cable installation will initiate at the proposed cable landfall location at Camp Pendleton Beach and proceed toward the southern WTG. At the Export Cable landfall site, the cable installation vessel will approach the pre-installed offshore conduit as close as navigable during high tide. The cable will then be reeled off the vessel using cable floats and a supporting work boat. The cable will then be pulled through the conduit by the use of a pull in/guide wire and brought onshore to its interconnection point at the Switch Cabinet. The installation of the Inter-Array Cable will initiate upon completion of the Export Cable and will initiate at the southern WTG.

Dominion anticipates installation of the marine cables will occur between the months of May and June. The Inter-Array Cable will require 2 weeks to install inclusive of the electrical interconnections necessary at each WTG. The Export Cable will require approximately 4 weeks to install. This installation period assumes 24-hour operations and no delays due to weather or other circumstances. See Section 3.4 for the Project schedule.

Upon completion of the cable laying activities, Dominion will conduct post-lay surveys to verify both cable buried depth and location. Post-lay surveys will be conducted from the cable installation vessel using a ROV or Burial Assessment Sled. Results of this analysis will determine the need for additional cable protection along the Inter-Array Cable or Export Cable routes.

3.4 Project Construction Schedule

Table 3.4-1 represents the proposed Project construction schedule based on both weather and environmental work windows. The final construction schedule for the VOWTAP is dependent on receipt of permits, completion of final engineering, and the procurement of vessels and equipment. Target installation date is 2017.

Table 3.4-1. Project Construction Schedule

Activity	Anticipated Timeframe [a]	Duration [b] (Weeks)
Interconnection Station Installation [c]	April through June	8
Onshore Interconnection Cable and Switch Cabinet installation [d]	February through April	8
Export Cable Landfall Construction (including Offshore HDD) [e]	March through April	11
IBGS Foundation Installation and Pile Driving [f]	May	3
Export Cable Installation	May through June	4
Inter-Array Cable Installation [g]	June	2
WTG installation	June through July	3 [h]
Commissioning	August through September	5

a/ Schedule does not account for weather delays.
b/ Onshore construction activities assume a 5-day work week; offshore construction activities assume a 7-day work week.
c/ Includes site preparation, equipment installation, and commissioning.
d/ Includes site preparation of onshore HDD Work Area, HDD of Rifle Range Road, HDD of Gate 10 access road, and Switch Cabinet installation.
e/ Includes HDD and offshore conduit installation, assumes 4 weeks for drilling and reaming.
f/ Includes 14 days of pile driving.
g/ Includes 3 days for cable installation and 8 days for internal electrical connections.
h/ Includes 15 days with the high-lift vessel and 5 days for final bolting and hook-up using a crew boat only.

3.5 Commissioning

Upon completion of construction activities, Dominion will require approximately 5 weeks of commissioning activities. This will entail the testing of the two WTGs as well as the offshore and onshore transmission system capabilities to meet standards for safety and grid interconnection reliability. This testing will require technicians traveling to the WTGs weekly during the commissioning period. Technicians will be transported to and from the WTGs via a dedicated crew workboat.

3.6 Operation and Maintenance

The VOWTAP has been designed to be operated remotely with minimal day-to-day supervisory input throughout its 20-year life. However, standard operation monitoring and preventative maintenance will be required for each of the Project's onshore and offshore facilities.

As with construction, the operation of the VOWTAP will be conducted in accordance with a detailed SMS, including an environmental management system which will describe all of the health and safety and environmental and permitting commitments to be carried out in support of the Project's ongoing operational activities. The following sections summarize the anticipated operation and maintenance of the VOWTAP facilities.

3.6.1 IBGS Foundations

Inspections of the foundations will occur on an annual basis (unless accidental damage has occurred) and will initiate no later than 12 months after the Project's commissioning. Inspections will typically be carried out during periods of low tide from the Project's dedicated service vessel, and will include an assessment of the following:

- **Foundation.** Visual inspections will include the assessment of the general condition of the foundation coating, including the presence of any rust-staining and/or color variations and any dents, abrasions and/or scars to steelwork; and the type and thickness of marine growth. The visual coating inspection will be carried out at 6 month intervals for the first year of Project operation and at 12 month intervals thereafter. A visual inspection of the sub-structure below the water level will also be carried out by a diver or ROV. ROV surveys will be carried out after the first 6 month of operation and then every 2 years thereafter.

- **Cathodic Protection System.** The purpose of the cathodic protection system is to prevent corrosion. Verification of the functionality of this system will be carried out within 6 months of the foundations installation. Subsequent scheduled surveys will be carried out every 2 years.
- **Scour.** Each foundation has been designed to meet the local scour conditions. However, monitoring will be conducted to ensure that design scour depth is not exceeded at the seabed. An initial local scour survey will therefore be carried out within 6 months of commissioning. Subsequent scheduled surveys will be carried out at intervals of 1 year, 2 years, 5 years and 10 years after commissioning or after a major storm event. Monitoring will be carried out by multibeam sonar soundings. Should scour holes develop within 10 percent of the local scour design values, additional monitoring and/or mitigation will be carried out. Mitigation measures may include the infilling of the scour hole with an appropriate crushed rock fill, or the use of frond mats or other proven systems to minimize/reverse future scour. The need, type, and method for installing scour protection will be determined in consultation and coordination with relevant jurisdictional agencies prior to deployment.
- **Bolted Connections.** Inspection and maintenance of major bolted connections such as fenders and platforms will be carried out at intervals of 1 year, 2 years, 5 years, and 10 years after commissioning.
- **Other Equipment**. All ladders, fall arrest and safety systems, fenders, platforms, handrails, and lifting and other equipment will be inspected and maintained on a 6- to 12-month interval.

3.6.2 WTGs

The WTGs will be maintained in accordance with a dedicated maintenance plan. It is anticipated that each WTG will require approximately 240 man hours of planned preventative maintenance per WTG per year which equates to a team of four to six people over an average period of one week per WTG. Standard maintenance activities will include inspection of safety systems and equipment, high voltage and low voltage elements, lubrication of WTG components, sensor operation, torque of the structural bolts as well as the replacement of filters and consumables.

Preventative maintenance activities will be planned for periods of low wind and good weather (typically corresponding to the spring and summer seasons) during daylight hours. The WTGs will remain operational at night between work periods of the maintenance crews. These activities will not require large vessels and only standard crew transfer will be used.

3.6.3 Inter-Array and Export Cables

The Inter-Array Cable and Export Cable have no maintenance needs unless a fault or failure occurs. Cable failures are only anticipated as a result of damage from outside influences, such as boat anchors. However, Dominion will conduct a sonar survey along the entirety of the cable routes at intervals of 6 months and 1 year after installation. Survey frequency thereafter will be reduced to every 2 years or after a major storm event. Surveys of the cables will be conducted in coordination with the scour surveys at the foundations.

3.6.4 Onshore Facilities

The Onshore Interconnection Cable and Fiber Optic Cable will have no maintenance needs unless a fault or failure occurs. Should an Onshore Interconnection fault occur, protective relays will de-energize the circuit until the fault can be located and repaired. Repairing the cable will require digging within the operational easement to expose the cable fault, removing the faulted section of the cable and splicing a new segment of cable. Should a failure of the Fiber Optic Cable occur, a similar process would be completed.

Maintenance of the Interconnection Station will consist primarily of periodic visual inspections of equipment installed within the pad-mounted cabinets. Normal VOWTAP operations will not require personnel to be located inside, or have access to, the Interconnection Station. However, should a failure occur at the Interconnection Station, the entire station will be de-energized until the failed equipment can be removed and replaced.

3.7 Decommissioning

At the end of the VOWTAP's operational life, the Project will be decommissioned in accordance with a detailed Project decommissioning plan that will be developed in compliance with applicable laws, regulations, and BMPs at that time. Decommissioning will consist of the following general sequence of activities.

In preparation for decommissioning activities, Dominion will conduct a bathymetric survey to define the datum to which the foundations will be removed below the sea bed. In addition, all cables and connections will be uncoupled or cut. Oil and other fluids will be secured and loose items will be either removed or secured to prevent spillages and to increase the safety of the operation. Once these activities are complete the WTGs will be deconstructed using a heavy-lift vessel following the same relative sequence as construction, but in reverse (blades, nacelle, then tower). The foundation will then be cut to a minimum depth of approximately 3.3 ft (1 m) below the surveyed seabed level using either an internal or external cutting system. Once cut, each foundation will be removed and transported to shore where the steel will be re-used or recycled. The Inter-Array and Export Cables will either be removed using a similar jet plow and/or ROV jet trencher technique used for installation and re-used or cut below the seabed and left in place. The Onshore Interconnection Cable, Fiber Optic Cable, and other equipment will be disconnected, dismantled, and recycled in accordance with applicable permits and regulations.

4 SITE CHARACTERIZATION AND ASSESSMENT OF IMPACT PRODUCING FACTORS

This section describes the affected environment for the VOWTAP, assesses potential impact producing factors related to the applicable physical, biological, and social resources, and identifies protective measures and BMPs that could avoid or reduce potential effects of the Project. The resources discussed in this section were identified through consultation and coordination with the VOWTAP Team, state and federal agencies, and public outreach. The assessment is organized by resource area as follows:

- Physical and Oceanographic Conditions
- Water Quality
- Marine Biological Resources
- Terrestrial Biological Resources
- Avian and Bat Species
- Threatened and Endangered Species
- Essential Fish Habitat
- Wetlands and Waterbodies
- Cultural Resources
- Visual Resources
- Socioeconomic Resources
- Military Maritime Uses
- Land Use
- Transportation and Navigation
- Acoustics
- Air Quality
- Public Health and Safety

As used in this section, the Project Area refers to the footprint of the VOWTAP offshore and onshore facilities, including areas of potential direct and indirect impact during construction, operation, and decommissioning of the Project. These areas are described in Sections 3.1.1 through 3.1.3. Figure 1.1-1 provides an overview of the Project Area.

The environmental setting for each resource is described based on available literature, site-specific environmental survey data, ongoing state and federal agency consultations, and public outreach. Important sources of available literature included the following:

- *The Final Programmatic Environmental Impact Statement for Alternative Energy Development and Production and Alternate Use of Facilities on the Outer Continental Shelf, Final Environmental Impact Statement (MMS 2007);*
- *The Final Environmental Assessment for Commercial Wind Lease Issuance and Site Assessment Activities on the Atlantic Outer Continental Shelf Offshore New Jersey, Delaware, Maryland, and Virginia (BOEM 2012);* and
- Resource-specific scientific literature.

To further define existing environmental conditions, Dominion carried out site-specific environmental surveys and investigations, documentation for which are attached to this RAP as appendices. They include:

- Metocean Report (Appendix E)
- Marine Site Characterization Survey Reports (Appendices F-1 through F-4)
- Sediment Transport Analysis (Appendix G)
- Jurisdictional Wetland Delineation Report (Appendix H)
- Air Emissions Calculations and Methodology (Appendix I)
- Benthic Survey Report (Appendix J)
- Magnetic Fields from Submarine Cables (Appendix K)
- Interim Avian Survey Report (Appendix L)
- In-Air and Underwater Acoustic Assessments (Appendix M-1 and M-2)
- Marine Archeological Resources Assessment (Appendix N – not for public distribution)
- Terrestrial Archaeological Survey (Appendix O – not for public distribution)
- Historic Properties Assessment (Appendix P)
- Visual Impact Assessment (Appendix Q)
- Navigational Risk Assessment (Appendix R)
- Safety Management System Requirements (Appendix S)
- Aviation Risk Assessment (Appendix T)
- Onshore Geotechnical Field Data Report (Appendix U)

All Project-specific investigations followed protocols and methods that were reviewed, commented upon and, as appropriate, approved by the agencies with jurisdiction for the respective resources. Consultation with the VOWTAP Team, federal and state agencies and the public has been ongoing, and is documented in Appendix A.

Within each resource section, the affected environment is discussed first followed by a presentation of potential impact producing factors, proposed environmental protection measures, and BMPs. The discussions of impact producing factors address the potential direct and indirect impacts associated with construction and operation of the VOWTAP. Effects are further identified as short-term or long-term.

- **Direct Effects** – caused by the action and occur at the same time and place (40 CFR 1508.8).
- **Indirect Effects** – defined as effects which are "caused by an action and are later in time or farther removed in distance but are still reasonably likely. Indirect impacts may include growth inducing effects and other effects related to induced changes in the pattern of land use, population density or growth rate, and related effects on air and water and other natural systems, including ecosystems" (40 CFR 1508.8). Indirect impacts are caused by the Project but do not occur at the same time or place as the direct impacts.
- **Short-term or Long-term Impacts** – Short- or long-term impacts do not refer to any defined time period. In general, short-term impacts are those that would be intermittent, infrequent, or last for the duration of a discrete activity, such as construction. Long-term impacts would be frequent, or extent from several years up to the life of the Project.

Available means to avoid, reduce, or otherwise mitigate potential Project effects are addressed. These discussions include measures that are incorporated in Project plans, BMPs that are typically employed or that are required under terms of applicable permits, and other measures that Dominion has agreed to implement.

4.1 Physical and Oceanographic Conditions

This section describes the physical and oceanographic conditions in the Project Area, including physical oceanography, meteorology, and marine and terrestrial geologic conditions, as well as natural and manmade hazards. These site conditions influenced preliminary Project design and the requirements for construction, operation, and decommissioning of the Project.

4.1.1 Physical Oceanography and Meteorology

This section describes the oceanographic and meteorological environment in the Project Area, including a discussion of circulation and current patterns, temperature, and winds. Based on a metocean study conducted for the VOWTAP (Appendix E), the major oceanographic and meteorological processes that are expected to influence the Project Area are hurricanes, strong Nor'easter winds and associated waves and currents, tides, and tidal currents. This section also identifies how the Project facilities, construction, operation, and decommissioning may affect or be affected by the oceanographic and meteorological conditions in the Project Area.

4.1.1.1 Affected Environment

The Project is located in the Mid-Atlantic Bight, the area of the OCS situated between Cape Hatteras, North Carolina and Cape Cod, Massachusetts. It includes five major estuarine systems, and a wide continental shelf cut by a deep cross-shelf valley and multiple shelf-break canyons. The Mid-Atlantic Bight is a dynamic transition area between cooler arctic waters from the north and warmer tropical waters from the south, with seasonal, complex physical dynamics.

Currents

The Gulf Stream is the principal ocean current system in the waters off the southeastern United States. In general, the current is characterized by a deep blue color, high salinity, high temperature, high clarity, and high speed. From the Straits of Florida, the Gulf Stream flows north to northeastward, paralleling the general trend of the 600-ft (180-m) contour up to Cape Hatteras. Average speed of the Gulf Stream along the coast is approximately 2.8 mph (2.5 knots), with a maximum of up to just over 5 mph (4.5 knots). Beyond Cape Hatteras, the Gulf Stream flows eastward, away from the coast into much deeper water. Currents on the shelf in the Project Area generally have a velocity of less than 1.2 mph (1 knot) and change direction seasonally, generally flowing southerly in the winter and transitioning to northerly in the spring and summer. The U.S. Navy Operational Global Ocean Model, developed by the Naval Research Laboratory (Barron et al. 2004; Barron et al. 2006), provides boundaries for regional models produced by NOAA with a resolution of 1/36 degree (3 km). An excerpt from a three-day model for October 2013, presented in Figure 4.1-1, clearly shows the fast-flowing Gulf Stream and slower shelf and slope current systems in the Project Area (NOAA 2013a).

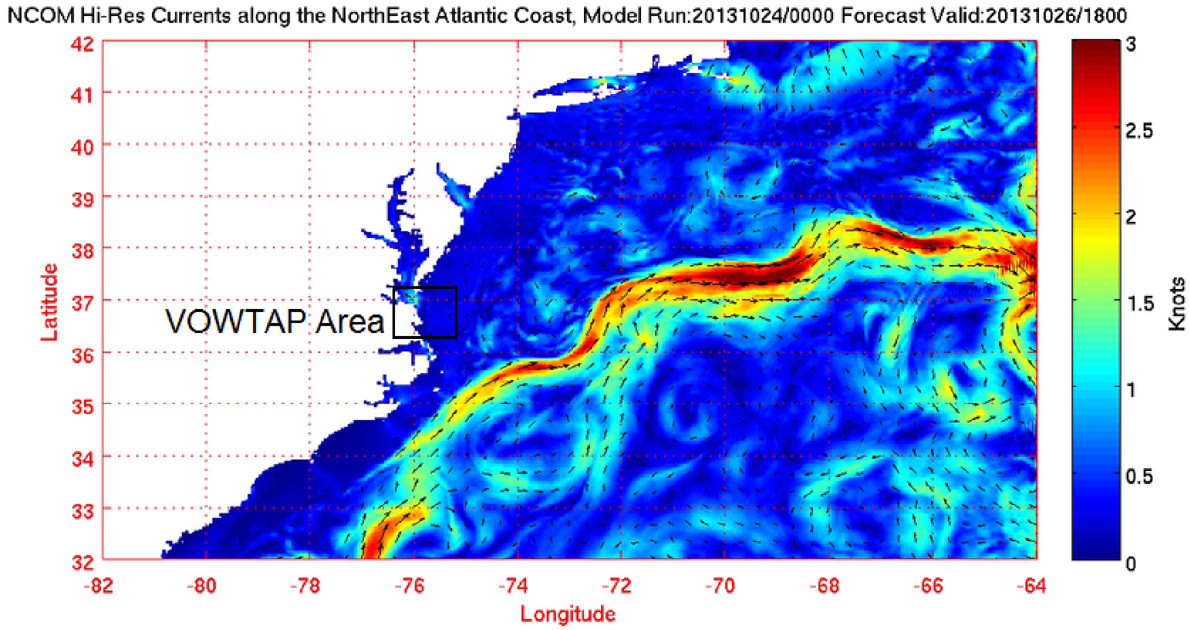


Figure 4.1-1. Navy Coastal Ocean Model (NCOM) Ocean Current Forecast Data for the U.S. East Coast

The metocean study (Appendix E) used the Regional Ocean Modeling System Experimental System for Predicting Shelf and Slope Optics (ESPreSSO), developed by the Ocean Modeling Group at Rutgers University (Rutgers 2013), to model regional currents. ESPreSSO has also been used by scientists at USGS who are studying the movement of seafloor sediments by tidal and wind-driven currents, as well as the orbital motion of surface waves (Dalyander and Butman 2012a; Dalyander and Butman 2012b). The ESPreSSO model, along with wave data provided by a Simulating Waves Nearshore model and sediment texture data from the USGS East Coast Sediment Texture Database (Poppe et al. 2005), were used to estimate bottom shear stress and sediment mobility across the continental shelf, which is important for understanding scour potential on offshore infrastructure such as WTG foundations and undersea cables. The left panel of Figure 4.1-2 shows the modeled bottom stress in the Mid-Atlantic Bight. Regions of high stress, shown in reds and yellows, are generally found in coastal areas, owing to the stronger influence of waves at shallower depths. The right panel shows the percentage of time the critical stress is exceeded for winter (December 2010 – February 2011). Sediments move more than 20 percent of the time in a band along the coast. Sediments are less mobile over the outer shelf. The model predicts that sediments in the Project Area will be mobile 10 to 20 percent of the time during the winter months.

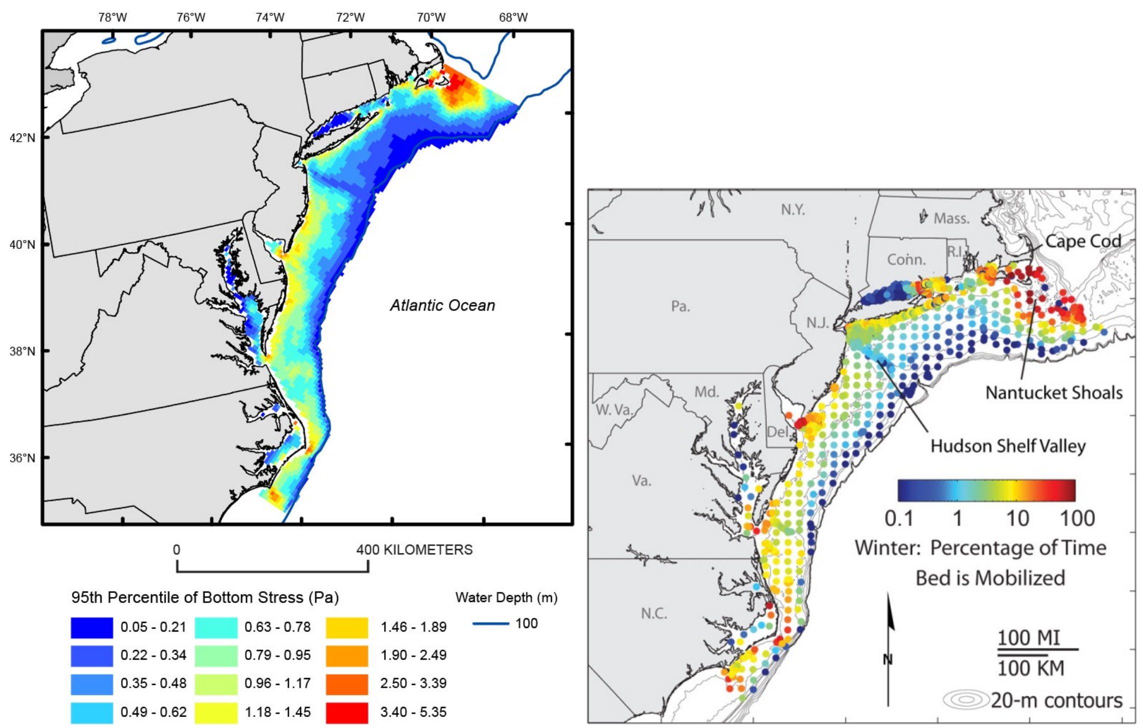


Figure 4.1-2. Sediment Mobility Modeling in the Mid-Atlantic Bight (Dalyander and Butman, 2012a [left] and 2012b [right])

Water Temperature, Salinity, and Density

Sea surface temperatures in the Project Area range from the high 30s °F to low 60s °F (4°C to 15°C) in the winter and spring months, and into the low 70s °F and 80s °F (20°C to 30°C) in the late summer (Table 4.1-1; see Appendix E for details on methodology). During the first six months of 2012, sea surface temperatures in the region were the highest ever recorded. Above-average temperatures were found across the Mid-Atlantic Bight from the ocean bottom to the sea surface, and seaward from the shoreline to beyond the shelf break. Ocean bottom temperatures measured near Chesapeake Bay as part of the eMOLT project, a cooperative research program between the Northeast Fisheries Science Center and lobstermen who deploy temperature probes attached to lobster traps, reported temperatures more than 11°F (6°C) above historical average at the surface and more than 9 °F (5 °C) above average at the bottom (NFSC 2012).

Table 4.1-1. Seawater Temperature, Salinity, and Density at Near Surface

Combined Period (2006-2012)	Seawater Temperature (°C)			Seawater Salinity (PSU)			Seawater Density (km/m³)		
	Min	Max	Std Dev	Min	Max	Std Dev	Min	Max	Std Dev
January	4.66	13.46	1.82	27.43	33.68	1.15	1020.72	1025.97	0.96
February	3.75	9.75	1.36	26.08	33.90	0.97	1020.24	1026.33	0.73
March	4.26	15.39	1.63	27.63	33.55	1.14	1021.21	1026.23	0.99
April	7.17	15.83	1.78	24.04	33.14	1.37	1018.04	1025.58	1.26
May	9.56	22.24	2.34	24.81	33.42	1.75	1017.59	1025.43	1.63
June	18.12	26.92	1.72	24.67	32.89	1.68	1015.95	1023.07	1.46
July	20.14	28.32	1.21	24.19	34.42	1.97	1014.92	1022.57	1.60
August	22.57	29.87	1.17	26.61	34.47	1.68	1016.32	1022.17	1.41
September	19.37	26.97	1.26	28.07	32.48	0.83	1017.91	1022.80	0.83
October	15.96	24.70	1.75	28.58	32.77	0.88	1019.20	1023.57	0.86
November	10.86	20.47	1.67	27.26	32.98	0.90	1020.55	1024.52	0.71
December	7.03	15.83	1.55	26.32	33.04	0.88	1019.53	1025.27	0.79
All Year	3.75	20.87	6.84	24.04	34.47	1.55	1014.92	1026.33	2.32
Source: Fugro 2013 (Appendix E)									

Tides

The tidal levels relative to lowest astronomical tide for the Project Area are presented in Table 4.1-2.

Table 4.1-2. Tidal Levels Relative to Lowest Astronomical Tide

Tidal Levels	Lowest Astronomical Tide (m)
Highest Still Water Level	2.98
Highest Astronomical Tide	1.46
Mean Higher High Water	1.22
Mean Sea Level	0.67
Mean Lower Low Water	0.16
Mean Low Water Spring	0.06
Lowest Astronomical Tide	0
Lowest Still Water Level	-1.06
Source: Fugro 2013 (Appendix E)	

Meteorology

The coastal region of the Mid-Atlantic Bight is subject to potential weather hazards year-round, including tropical cyclones and Nor'easters. Nor'easters are macro-scale storm systems along the upper east coast of the United States. They are one of the more frequent weather features encountered in the winter months, though they can develop at any time of the year. These systems vary in size from insignificant to a large circulation that covers most of the western North Atlantic. Winds can reach hurricane force, and seas of 40 feet (12 m) and more have been encountered. While these storms are usually forecasted, they can develop rapidly, particularly off Cape Hatteras over the Gulf Stream. These storms are most frequent and intense between the months of November through March. Between December and February, an average of four to six storms per month develop in the area (NOAA 2013b). Persistent northeasterly winds and long wind distances over water can raise spring tides to record levels, generating high seas in the open ocean.

A tropical cyclone is a warm core, low pressure system that develops over tropical areas that exhibits a rotary, counterclockwise circulation in the Northern Hemisphere around the center, or "eye". In the North Atlantic region, including the United States east coast, the following terminology is used in tropical cyclone warnings issued by the National Hurricane Center (National Weather Service):

1. Tropical Depression – A tropical cyclone in which the maximum sustained surface wind (1-minute mean) is 38 mph (33 knots) or less.
2. Tropical Storm – A tropical cyclone in which the maximum sustained surface wind (1-minute mean) ranges from 39 mph to 73 mph (34 knots to 63 knots).
3. Hurricane – A tropical cyclone in which the maximum sustained surface wind (1-minute mean) ranges from 74 mph (64 knots) or more.
4. Major Hurricane – A tropical cyclone with maximum sustained winds of 111 mph (96 knots) or higher.

Hurricane season in the Atlantic begins June 1 and ends November 30 (NOAA 2013c). Figure 4.1-3 identifies the significant storm events that have occurred in the Project Area in the last 68 years.

Storm Surge

Along the coast, prolonged winds blowing toward shore can increase water levels from 3 ft to 10 ft (1 m to 3 m) above normal. Additionally, the low pressure in the storm's center can create a mound or ridge of water, known as a surge that will move in the direction of the storm. The height of the mound is directly related to the drop in barometric pressure; roughly a 10 mm (1 cm) increase in sea level for every millibar drop in atmospheric pressure (DMME 2012). Storm surge is enhanced by wind-driven waves that build on top of the mound and potentially further enhanced by the tidal stage.

Storm surge can push tides to 20 ft (6 m) or more above normal (NOAA 2013b) and, combined with the high rainfall produced by the storm, can result in coastal flooding. The effect of storm surge can be disastrous to onshore infrastructure, similar to that of a tsunami caused by an earthquake. Storm wave activity can also lead to amplified shoreline erosion and undermining of buildings, roadways, and utility lines.

Wind Speeds

Based on a 25-year period, excluding hurricanes, the winds in the Project Area are primarily south-southwesterly in the summer, with a mean wind speed of about 8.9 mph (4 m/s). Mean wind speed rises in the winter months to nearly 17.9 mph (8 m/s) and winds come primarily from the north-northwest. The monthly average and maximum wind speeds are presented in Table 4.1-3. With the addition of hurricanes into the calculations, the monthly average wind speed increases to 5.6 mph (2.5 m/s) during hurricane season (Table 4.1-4). Wind models and measurements are discussed further in Appendix E.

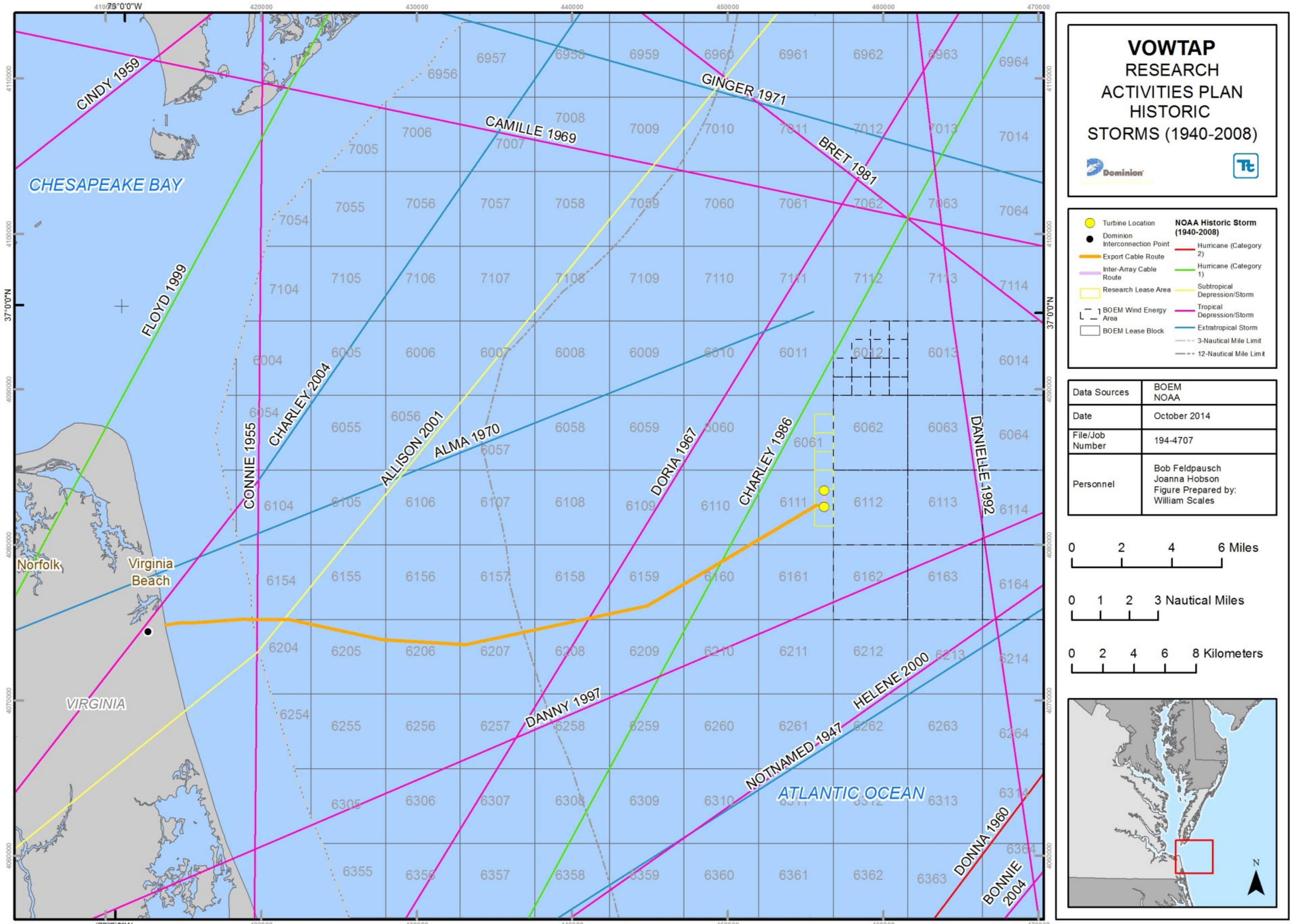


Figure 4.1-3. Significant Storm Events in the Project Area (1940 to 2008)

Table 4.1-3. Monthly Average and Maximum Wind Speed, Excluding Hurricanes

Combined Period (1980-2005)	1hr Wind Speed at 10m (m/s)		Main Direction(s)
	Mean	Max	
January	7.81	19.33	NW
February	7.33	20.06	N NW
March	6.97	23.02	N NW
April	5.98	19.64	S
May	4.93	17.06	S SW
June	4.46	15.09	S SW
July	4.49	18.72	S
August	4.67	25.63	S SW
September	5.35	24.51	NE
October	6.31	23.21	N NE
November	6.96	19.18	N NW
December	7.73	21.13	N NW
All Year	6.09	25.63	N S SW NW
Source: Fugro 2013 (Appendix E)			

Table 4.1-4. Monthly Average and Maximum Wind Speed, Including Hurricanes

Combined Period (1980-2005)	1hr Wind Speed at 10m (m/s)		Main Direction(s)
	Mean	Max	
January	7.81	19.33	NW
February	7.33	20.06	N NW
March	6.97	23.02	N NW
April	5.98	19.64	S
May	4.93	17.06	S SW
June	4.46	15.09	S SW
July	4.52	21.82	SW
August	4.80	25.63	S SW
September	5.60	30.27	NE
October	6.34	23.21	N NE
November	6.96	19.18	N NW
December	7.73	21.13	N NW
All Year	6.11	30.27	N S SW NW
Source: Fugro 2013 (Appendix E)			

Air Temperature and Density

Air temperature and density were derived from 29 years of buoy data (1984 to 2012) measured by the National Data Buoy Center. Monthly statistics are provided in Table 4.1-5. Additional discussion of air temperature data is found in Appendix E.

Table 4.1-5. Air Temperature and Density

Combined Period (1984-2012)	Air Temperature (°C)			Air Density (kg/m³)		
	Min	Max	Std Dev	Min	Max	Std Dev
January	-16.70	21.20	4.91	1.18	1.36	0.03
February	-9.50	21.10	4.27	1.18	1.34	0.03
March	-6.50	24.90	4.23	1.17	1.34	0.03
April	0.00	29.10	3.86	1.16	1.28	0.02
May	8.00	31.30	3.54	1.16	1.26	0.02
June	12.10	32.20	2.85	1.14	1.22	0.01
July	17.20	33.10	1.99	1.14	1.21	0.01
August	16.50	32.30	1.89	1.12	1.20	0.01
September	12.60	30.80	2.39	1.14	1.23	0.01
October	5.90	29.30	3.44	1.15	1.28	0.02
November	-0.20	24.40	3.95	1.18	1.31	0.02
December	-8.80	23.00	4.59	1.18	1.33	0.03
All Year	-16.70	33.10	7.91	1.12	1.36	0.04
Source: Fugro 2013 (Appendix E)						

4.1.1.2 Potential Impact Producing Factors, Proposed Environmental Protection Measures, and BMPs

The principle impact producing factor related to meteorological conditions is whether storms or temperatures in the Project Area have the potential to disrupt the construction process or damage any of the Project components once installed. To minimize risk and ensure an efficient and effective construction process, Dominion has selected a construction schedule that takes into consideration both weather and environmental conditions in the Project Area (see Table 3.4-1). Weather will be monitored carefully throughout construction, and will ultimately dictate the sequence and duration of onshore and offshore construction activities to ensure the safety of construction personnel and the integrity of the VOWTAP facilities and equipment.

Dominion has designed the VOWTAP to account for the meteorological conditions within the Project Area. The Alstom Haliade 150 WTG was chosen for the Project based on its suitability for offshore wind sites, with referenced wind speeds of 112 mph (50 m/s over a 10-minute average) and 50-year extreme gusts of 157 mph (70 m/s over a 3-sec average) (see Section 3.2.1). These wind speeds are considerably higher than the maximum wind speeds expected for the Project Area, as shown in Table 4.1-4. Confirmation of the VOWTAP WTG's ability to withstand extreme weather conditions is a goal of this demonstration Project (see Section 1.2)

Standard environmental operating conditions for the WTGs include wind speeds between 6.7 mph and 56 mph (3 m/s and 25 m/s), and air temperatures between 14°F and 104°F (-10°C and +40°C). The WTGs will not operate in extreme weather conditions. If wind speeds exceed 56 mph (25 m/s) over a 10-minute average, or the air temperature reaches less than -4°F (-20°C) or greater than 122°F (50°C), the WTGs will automatically shut down. In addition, the Haliade 150 WTG is equipped with an ice sensor on the top of the nacelle. If the sensor detects the presence of snow, freezing rain, or similar, a warning is issued in the SCADA which can then be used to shut down the WTG if needed. Overall, there is little likelihood that meteorological conditions will impact the Project. However, the need for additional measures/sensors to evaluate and respond to ice or other meteorological conditions at VOWTAP will be further evaluated during final engineering design.

Waves and currents associated with seasonal storm events, particularly hurricanes and strong Nor'easters, have the potential to cause seabed mobility in the Project Area. The interaction between the storm or wave currents can cause erosion, transport, and re-deposition of seafloor sediments. Seabed mobility in the Project Area varies both spatially and temporally, with smaller-scale changes in the seafloor being caused by minor storms and more significant and large-scale changes caused by large storms.

Sediment mobility can cause risks to the Inter-Array and Export Cables in one of the following ways:

- Removing overlying sediment, thereby reducing burial depths and resulting protection;
- Increasing sediment deposits, thereby affecting the ability of the cables to dissipate heat; or
- Increasing scour around exposed cable areas that could lead to strumming and increased risk of cable damage.

The Inter-Array and Export Cables will be buried to a minimum depth of 3.3 ft (1 m) and 6.6 ft (2 m), respectively, below the seabed, and up to 15 ft (4.5 m) along certain areas of the route where the Export Cable crosses active military practice areas. Additional cable protection measures, such as rock berms and/or concrete mattresses may also be used in areas where the cable route encounters sand waves on the seabed. As discussed in Section 3.6.3, Dominion will conduct regular surveys along the Inter-Array and Export Cable routes to monitor for cable burial depth and potential exposure from bedform migration.

Scour may impact the IBGS foundations in a similar manner. As discussed in Section 3.6.1, Dominion will also monitor the IBGS foundation to ensure that design scour depth is not exceeded. Should scour mitigation be required, the type and method for installing scour protection will be determined in consultation and coordination with relevant jurisdictional agencies prior to deployment.

Onshore, the entirety of the Onshore Interconnection Cable and Fiber Optic Cable will be buried underground and, therefore, shielded from meteorological events. As described in Section 3.2.5, the sensitive equipment associated with the Switch Cabinet and Interconnection Station will be encased in metal cabinets for protection, and is unlikely to be affected by the surrounding elements.

Overall, the design of the Project components, in combination with regular surveys and appropriate protective measures, should successfully reduce the likelihood of damage. At the end of the Project's useful life, decommissioning activities will take into account meteorological and oceanographic conditions.

4.1.2 Geologic Conditions

This section describes the regional geologic setting, marine sediments, and onshore soil types identified in the Project Area, along with potential Project impact producing factors related to sediments and soils. This discussion is based on published data and the following site-specific surveys:

- **Geophysical and Shallow Geotechnical Surveys** (Appendix F-1) conducted in 2013 across a 984.3-ft (300-m) survey corridor associated with the proposed Export Cable route, Research Lease Block 6111, aliquots D, H & L, and a supplemental survey area (OCS Lease Block 6112, aliquots E & I). The survey campaign was comprised of the acquisition and interpretation of bathymetry, sidescan sonar imagery, marine magnetic data, shallow- and medium-penetration sub-bottom profiling, and a shallow geotechnical investigation that included the collection, processing, and laboratory testing of seabed grab and core samples. Data were collected and reported in accordance with BOEM *Guidelines for Providing Geological and Geophysical, Hazards, and Archaeological*

Information Pursuant to 30 CFR Part 585 and 30 CFR 585.626(a)(1),(2),(4) and (6). Survey protocols for the geophysical and shallow geotechnical surveys were submitted for agency review and comment prior to deployment.

- **Geotechnical Surveys** (Field Data Report [Appendix F-2] and Final Report [Appendix F-3]) conducted in 2014 along the 984.3-ft (300-m) survey corridor and Research Lease Block 6111, aliquot H at the location of the proposed WTGs. Data collection was comprised of marine drilling and in-situ piezocone penetration test (PCPT) soundings to complement the 2013 geophysical and shallow geotechnical survey data and to further investigate the subsurface sediment structure to support the engineering design of the VOWTAP. Data were collected and reported in accordance with BOEM *Guidelines for Providing Geological and Geophysical, Hazards, and Archaeological Information Pursuant to 30 CFR Part 585 and* 30 CFR 585.626(a)(1),(2),(4) and (6). Survey protocols were submitted for agency review and comment prior to deployment.
- **Munitions and Explosive of Concern (MEC) Desktop Study** (Appendix F-4) conducted in 2015 to identify historical and current sources and, to the extent possible, estimate the distribution of MEC that could present a potential explosive hazard to Project offshore construction activities. Data used to support the study was comprised of both historical and current information from publically available online sources and through research conducted at the National Archives and Records Administration (NARA). Geophysical data previously collected in the 984.3-ft (300-m) wide Survey Corridor for the VOWTAP (Appendices F-1 through F-3) were also reviewed and used in combination with the historical information to support the understanding of potential MEC in the Project Area.
- **Onshore Geotechnical Surveys** (Appendix U) conducted in 2014 along the proposed location of the Export Cable landfall site, the Onshore Interconnection and Fiber Optic Cable route, and Interconnection Station. Data collection was comprised of a utility survey to locate buried utilities and communications lines, one deep borehole near the Export Cable HDD entry point, two shallow boreholes, and six test pits.

4.1.2.1 Affected Environment

Regional Geologic Setting

The Project Area is located on the shallow shelf of the Atlantic continental margin. The shelf represents the seaward portion of Virginia's coastal plain geological province that is currently covered by the sea. Thick, gently seaward-dipping units of sediments have been deposited on the Atlantic Margin over the past 175 million years. Variations in global sea level and the localized subsidence and uplift of the Earth's crust have created a complex series of transgressions and regressions. These changes have caused the coastline of Virginia to migrate, varying from low stands where the shoreline was at the continental shelf break, approximately 75 mi (120 km) farther offshore than the modern coastline, to extreme highs where the coastline pushed inland and is believed to have covered nearly the entire Commonwealth of Virginia (Oertel and Foyle 1995; Hobbs 2004).

Local Geology – Marine

The geologic features observed in the geophysical survey data collected for the VOWTAP in 2013 can be directly attributed to either modern features created by the action of waves and currents, or to relic features deposited or eroded during previous stages of sea-level over the last 500,000 years (Hobbs, 2004). Results of the site-specific surveys indicate that the seafloor in the Project Area is composed of unconsolidated sediments, with crystalline bedrock deeply buried below. In areas where older geological units outcrop at or near the seafloor, these units may be stiffer clays or more hardened sands and muds. Erosional channels and other incised features have mostly been filled in by more recent Holocene sediments and have little to no seafloor expression (Hobbs 2004). Localized bathymetric highs experience erosion and winnowing of sediments, leaving coarser sands and gravels on the shoals and allowing deposition of finer material in the lows (Snedden and Dalrymple 1999).

Historic data indicate that the Project Area was subaerially exposed within the last 10,000 years (Fleming et al. 1998), which resulted in erosion and channeling of the seabed and older geological features. Nearshore and shoreline features previously deposited in what are now areas of deeper water have also been reworked by the landward transgression of the shoreline, or "drowned" and preserved as localized highs (Nordfjord 2009). Where erosional features such as channels have not been completely filled in and overlain by flat-lying sediments, they are observed in the Project survey data as localized basins, lows, and rugged areas of bathymetry. Sand ridges, the remnants of offshore bars (Snedden and Dalrymple 1999), or the roots of barrier islands, now represent the majority of the localized bathymetric highs observed in the geophysical survey data.

Anthropogenic features are also visible in the survey results on both a small scale, such as debris identified in the sidescan records and magnetic anomalies, and at large scale, such as dredging operations to deepen and maintain critical navigational channels and the dumping of the same dredged materials in other areas. As recently as the spring of 2013, sands have been "borrowed" from offshore areas approximately 2.5 mi (4.0 km) south of the Project Area to replenish eroding beaches, modifying the offshore bathymetry (City of Virginia Beach 2013).

Site-specific marine geophysical surveys conducted for the Project show that the seabed is generally smooth, with minor undulations of low relief, and deepens gently to the east along the Export Cable survey corridor. Low-relief sand ridges, oriented primarily northwest to southeast, are the dominant features in the Project Area, with slopes not exceeding 4 degrees, except on the faces of the steeper sand ridges where slopes are up to 10 degrees. Bathymetric elevations in the vicinity of WTG locations range from around 78 ft to 85 ft (24 to 26 m) deep. Shallow subsurface conditions along the Export Cable survey corridor are comprised predominantly of sands and inter-bedded sands and silts, and are conducive to cable burial. Conditions within the Lease Area also show low relief. Shallow subsurface conditions in the Lease Area are comprised of sands and inter-bedded sands, silts, and clays, with deeper units consisting of sands, clays, and interbedded sands, silts, and clays. The findings are indicative of conditions suitable for installation of WTGs and the Inter-Array Cable.

As part of the site-specific geophysical and geotechnical investigations, sediment samples were collected to evaluate the near surface conditions at the WTG sites and along the Export Cable survey corridor. In 2013 sediment grab samples were collected for grain size testing and benthic analyses, and sediment cores were collected to investigate the upper 10 ft to 16.4 ft (3 m to 5 m) of the subsurface for stratigraphic definition and geotechnical laboratory testing. Nearly all (68 of 69) of the grab samples collected were comprised of sand and/or silty sand. One grab sample was classified as gray, sandy lean clay. A total of 31 cores (4 piston cores and 27 vibracores) were collected and processed. Five of the eight WTG core holes (VC-T1A-1A, VC-T1A-2A, VC-T2A-1, VC-T2B-1, and VC-T2B-2) contained some clay; of those, VC-

T2B-1 was mostly clay. Seven of the eight cores contained mostly sandy soils. Four of the cores (VC-007, VC-013, VC-016 and VC-017) from the 19 survey corridor core holes contained some clay, one of which (VC-017) was mostly clay. Eighteen of the cores contained mostly sandy soils (i.e., all cores except VC-017). Grab and core sample geotechnical laboratory test results are in the Marine Site Characterization Survey Report (Appendix F-1).

In accordance with BOEM regulations (30 CFR Part 585), additional geotechnical investigations were conducted in 2014. Borings were collected to 361 ft (110 m) deep at three locations (one at each proposed WTG location and one at an alternate WTG site). The shallow subsurface sediment structure and composition was found to be in agreement with the findings of the 2013 surveys in terms of thickness and engineering properties (Appendices F-2 and F-3). The borings identified intervals of predominantly fine to medium sand with interbedded shell layers and clay lenses in the upper part of the seabed across the three WTG boring sites. These findings correlate well to the interpretation of the 2013 geophysical data, which concluded that shallow sediment conditions were generally uniform across the Lease Area in the vicinity of the proposed WTG locations. Deeper sedimentary units comprised primarily of sandy clay and sand are typical of the layered marine and fluvial sediments associated with transgressive deposits. Gas blistering found in the borings at the turbine locations in Units III and VII are typical for soils with this depositional history.

An additional six boring locations were investigated near the cable landing site along the proposed HDD portion of the Export Cable route; the borings terminated between 80.4 ft and 99.7 ft (24.5 m and 30.4 m) below the seabed. In-situ PCPT soundings were conducted at the 2013 sediment core locations for verification of the geotechnical data measured from the vibracore samples. Vibracore and PCPT results were found to provide good correlation between sediment properties identified in the vibracore sample and the engineering properties recorded in the PCPT results. Two PCPT soundings collected along the proposed Inter-Array Cable route identified dense sands in the upper 6.6 ft to 9.8 ft (2 m to 3 m) of the seabed, which is consistent with the vibracore logs. The results of the geotechnical program are provided in Appendices F-2 and F-3.

Local Geology – Terrestrial

There are 14 soil types on the Camp Pendleton installation (USDA, NRCS 2013a). These soil types are shown on Figure 4.1-4 and the following:

- Acredale silt loam is poorly drained with slow permeability;
- Dragston fine sandy loam is somewhat poorly drained with moderately rapid permeability;
- Duckston fine sand is poorly drained in shallow depressions between dunes and marshes;
- Nawney silt loam is poorly drained with moderate permeability;
- Tomotley loam is poorly drained with moderate to moderately slow permeability;
- Augusta loam is somewhat poorly drained with moderate permeability;
- Bojac fine sandy loam is well drained with moderately rapid permeability;
- Munden fine sandy loam is moderately well drained, with moderate to moderately rapid permeability;

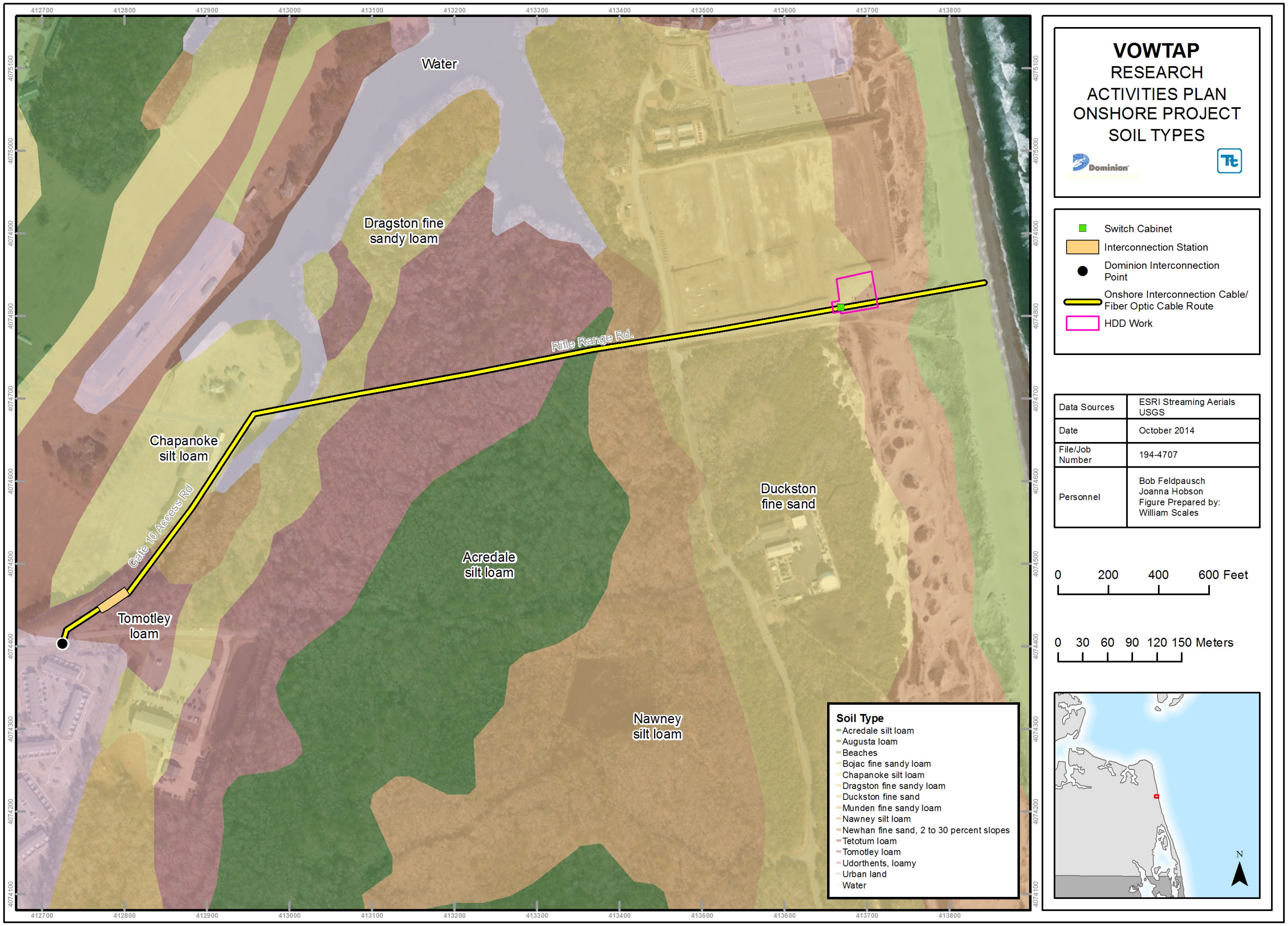


Figure 4.1-4. Onshore Project Soil Types

- Newhan fine sand, 2 to 30 percent slopes is excessively drained with very rapid permeability;
- Newhan-Corolla fine sands, 0 to 15 percent slopes are on flats and gentle slopes between Newhan soils, are excessively drained with very rapid permeability;
- Tetotum loam is moderately well drained with moderate to moderately rapid permeability;
- Udorthents, loamy soils are poorly described by NRCS; identified characteristics include more than 80 inches to a restrictive layer and no tendency for ponding or flooding, which indicate a well-drained soil with moderate to rapid permeability;
- Urban land is a landform classification rather than a soil type; it is characterized by artificial impermeable surface;
- Beaches are a landform classification rather than a soil type; it is characterized by sandy marine deposits.

Of these soil types, the onshore portion of the Project Area is predominantly comprised of Tomotley loam and Duckston fine sand. The description of these soils by the Natural Resources Conservation Service (NRCS) method above, generally match the descriptions of the soils from the test pit/boring logs found in the Onshore Geotechnical Field Data Report (Appendix U). These test pits and borings were performed to establish initial geotechnical characteristics for installation of the Onshore Interconnection and Fiber Optic Cables. The test pits and borings generally indicate poorly drained alternating clay silty sand or fine sand using the Unified Soil Classification System, which are equivalent to the loams to fine sands described above. None of these soil types are rated as especially susceptible to erosion, or are otherwise vulnerable.

Per the recommendation made by the VDEQ in the VOWTAP Federal Consistency Certification (Appendix A), Dominion conducted detailed background research to determine if any potential Resource Conservation and Recovery Act (RCRA) hazardous waste, Formerly Used Defense (FUDs), and/or petroleum release sites occur in or within proximity the onshore portions of the Project Area. Analysis revealed three documented incidents. However, each of the incidents was successfully remediated and/or addressed and closed. As such, Dominion does not anticipate encountering contaminated soils along the route. However, should any soil encountered during construction be suspected of contamination, Dominion will test, and as necessary, dispose of the soil in accordance with applicable federal, state, and local laws and regulations.

4.1.2.2 Potential Impact Producing Factors, Proposed Environmental Protection Measures, and BMPs

Potential impact producing factors related to marine sediments or terrestrial soils include:

- Disturbance to marine sediments and terrestrial soils during construction or decommissioning;
- Impacts to water quality resulting from erosion or sedimentation; and
- Impacts to Project facilities due to soil and sediment conditions.

Construction disturbance to marine sediments will result principally from the installation of the Inter-Array Cable and Export Cable using a jet plow and/or ROV jet trencher. However, Dominion has selected the use of the jet plow, ROV jet trencher, and a DP vessel as the primary cable installation vessel to minimize seafloor disturbance. As discussed in Appendix G, cable installation would result in suspension and re-deposition of fine sediment up to 160 m from the cable trench. The maximum thickness of the deposited material would be from 0.9 in to 0.13 in (1.2 mm to 3.3 mm), with most areas of deposition under 0.04 in (1 mm). These areas of disturbance are considered minor and are anticipated to recover quickly through natural tidal and current movement upon completion of cable installation activities.

Because jet plowing and/or ROV jet trenching will temporarily dislodge some seabed sediment into the water column, it could temporarily diminish water quality in the Project Area during installation. However, site-specific modeling of worst-case jet-plow operations showed impacts on the surrounding marine environment and water quality will be minor, with little to no effect (see Section 4.2.2 and Appendix G).

Temporary disturbances to marine sediments will also occur during IBGS foundations and WTG installation from the placement of vessel spuds and anchors used during the installation. As depicted in Table 3.2-3, these construction activities will result in a maximum area of temporary disturbance of only 191 ac (77.3 ha). These areas are also anticipated to recover quickly upon completion of construction activities (see Section 4.3.2). Furthermore, as discussed in Section 4.3.1.1, the sea bottom in the Project Area is highly dynamic, with suspension and re-deposition of sediment occurring continuously. Storms, for instance, can create sand ripples between 19.7 in and 39.4 in (50 cm and 100 cm) in height in a matter of hours. These processes are much larger than any potential project effects.

Impacts to terrestrial soils are also expected to be minor and limited to the period of construction. Onshore construction areas are generally flat and the soil types not especially susceptible to erosion. As discussed in Section 4.2.2, Dominion will implement stormwater pollution prevention BMPs and erosion control measures in support of all onshore construction activities to avoid or minimize any potential erosion impacts to surrounding surface waters and wetlands.

Because the Project has been designed to meet the existing sediment and soil conditions, impacts on the VOWTAP structures resulting from sediment erosion, deposition, and seabed mobility (see Section 4.1.1.2) during operations are not anticipated to be significant.

As stated in Section 3.7, decommissioning of the VOWTAP will follow a similar sequence as construction, except in reverse, and will, therefore, result in similar temporary impacts on marine sediments and terrestrial soils.

4.1.3 Natural and Anthropogenic Hazards

This section describes potential natural and anthropogenic hazards, based on published data and the site-specific marine geophysical survey and shallow geotechnical survey conducted in 2013 and the geotechnical investigation conducted in 2014. This section also discusses potential impacts of these hazards to the Project.

4.1.3.1 Affected Environment

There are no known active volcanoes, seamounts, volcanic vents, rifts, or mud diapirs in the region. Gas hydrates have been found beneath the continental rise between Georgia and New Jersey at depths around 6,000 ft (1,800 m). Gas hydrates are not expected to be present within the upper 300 ft (90 m) of the ocean in the Project Area (Fugro 2013).

Tsunamis

A tsunami is a series of sea waves generated by rapid displacement of a large volume of sea water. In general, the rapid displacement of water may result from vertical deformation of the seabed, large scale submarine or coastal landslides, or volcanic eruptions in or near ocean basins. Typically, tsunami waves are produced by displacement of the seafloor during an earthquake.

Tsunamis are usually described as local- or distant-sourced. The potential for significant, local-sourced tsunamis in the Project Area is small, but distant-sourced tsunamis may have a higher potential (Fugro 2013). However, based on desktop review, the potential for distant-sourced tsunamis is not well-defined.

Site-Specific Natural Seafloor Hazards

As stated in Section 4.2.1, site-specific geophysical and geotechnical surveys were conducted within the Project Area in 2013 and 2014, respectively, to support the identification of natural seafloor and shallow hazards. Results of the surveys are provided in Appendices F-1 through F-3. Table 4.1-6 summarizes the primary types of natural seafloor hazards identified during the 2013 and 2014 surveys and provides details, as necessary, on those hazards observed in the Project Area. Features identified in Table 4.1-6 are referenced to kilometer point (KP) along the centerline of the Export Cable survey corridor to KP0 at the cable landing location.

Table 4.1-6. Project Area Seafloor and Shallow Hazards

Hazard	Definition	Potential Presence in the Project Area
Steep seabed slopes	Steep seafloor gradients that pose a risk of unstable seabed and complications during installation	Not present
Sediment failure / mass movement	Large-scale movement of the seabed due to gravity, such as slumps and slides	Not present
Bedforms (e.g., sand waves)	Current controlled deposition of sediment, causing variable or wavy seabed. Large-scale sediment waves pose an issue for cable burial and subsea installations	Present throughout the surveyed area. A variety of bedforms are observed including sand ridges and sediment ripples. Movement/migration of sand ridge features is under further investigation at five areas along the Export Cable route for further engineering of the cable burial and protection solution. Sediment ripples observed are sub-meter scale and do not pose a hazard to the subsea assets or cable burial
Hard grounds	Rock or lithified sediments	Not present
Diapiric structures	Structures caused by the movement and flow of ductile sediments due to pressure	Not present
Faulting	A feature caused by relative movement of adjacent portions of seafloor, due to deeper movements of the Earth's crust or by shallower differential compaction of soft sediments	Not present
Fluid or gas expulsion	Movement of gas or fluid through the seabed and into the water column	Present. Gas blisters were identified in geotechnical borings taken in the proposed WTG locations. The quantities of gas observed are considered typical for the soils with the type of depositional history in the Project Area. The quantities encountered are considered insignificant and do not pose a hazard to the project facilities or activities.
Water scour	Erosion of seabed due to tidal, storm-induced, or other currents along the seabed	Present throughout the surveyed area. Areas of scour were observed near the base of sand ridges and other bathymetric features, where the current is concentrated. Scour appears to be minimal to moderate. The texture of the seabed at a water depth of approximately 25 meters appears to be slightly indurated and eroded.
Channels	Pathway taken by water and sediment flowing due to gravity	Present. Channel-like features observed in the seabed at approximately KP 10 to 16 along the Export Cable survey corridor are likely relic and no longer contain any substantial flow.

Site-Specific Natural Subsurface Hazards

Sub-bottom profiler data collected during the marine geophysical survey in 2013 were reviewed to identify possible hazards below the seabed. Table 4.1-7 lists common sub-surface hazards, and identifies those found during the site-specific Project surveys.

Table 4.1-7. Project Area Shallow Sub-Surface Hazards

Hazard	Definition	Identification and Description
Shallow faults	A feature caused by relative movement of adjacent portions of seafloor, due to deeper movements of the Earth's crust or by shallower differential compaction of soft sediments	Not present
Sediment failure / mass movement	Large-scale movement of the seabed due to gravity, such as slumps and slides	Not present
Shallow biogenic gas	Buildup of gas due to biological or chemical processes and trapped by less permeable layers in the seabed	Present. While biogenic gas deposits can form in areas with this depositional history, no significant buried shorelines or back-bays were encountered in the Project Area and no significant areas of gas-charged sediments were observed in the Project Area. Gas blisters were identified in geotechnical borings taken in the proposed WTG locations. The quantities of gas observed are considered typical for the soils with the type of depositional history in the Project Area. The quantities encountered are considered insignificant and do not pose a hazard to the project facilities or activities.
Shallow rock	Rock or lithified sediments sub-cropping the seafloor	Not present
Diapiric structures	Structures caused by the movement and flow of ductile sediments due to pressure	Not present
Fluid or gas expulsion	Movement of gas or fluid through the seabed and into the water column	Not present. No pockmarks or depressions indicating gas or fluid flow through the sediments were observed in the Project Area.
Channels	Former pathways of the transport of water and sediment due to gravity, partially or fully filled in by sedimentation	Present between KP10 and KP15.5 along the Export Cable survey corridor. In-filled channel-like features observed in the subsurface profile ranged in size from 10s to 100s of meters wide. Most are below the likely depth of cable burial

Anthropogenic Hazards

Anthropogenic hazards (e.g., manmade objects or debris) can be present on the seafloor or in the shallow subsurface. Table 4.1-8 lists potential anthropogenic hazards, and identifies those found during the marine geophysical survey.

Table 4.1-8. Project Area Anthropogenic Hazards

Hazard	Definition	Identification and Description
Shipwrecks	Wreckage and debris from lost vessels	Three potential cultural targets were identified during marine archeological review of the survey data. All identified potential targets fall outside of the proposed Project construction and operational footprints (See Section 4.9.1).
Debris	Discarded or lost objects on or below the seafloor	Present throughout the Export Cable survey corridor and Lease Area. Areas of concentration of sonar targets should be avoidable during cable route engineering.
Cables	Power or telecommunications cables, typically buried in the seabed in shallow water depths.	Not present
Pipelines	Linear conduit for transporting liquid or gas	Not present
Ordnance	Detonated or undetonated ammunitions	Possible along the Export Cable survey corridor, in particular between KP0 and KP 11.4 where the survey corridor is adjacent to a charted Dumping Area labeled "Unexploded rockets May 1954" and passes through two charted military ranges (Danger Zones 33 CFR 334.380 and 33 CFR 334.390) associated with historical and modern military live fire exercises (Appendix F-4). Some mapped sidescan and magnetometer targets could potentially be MEC. Additional MEC may be encountered further offshore to approximately KP 29 where the survey corridor runs outside of but adjacent to the larger range (334.490). A MEC-focused geophysical survey will be performed prior to construction.
Cultural resources	Historically significant objects or sites	Identified sites fall outside of the proposed Project construction and operational footprints (See Section 4.9.1)

In addition to the aforementioned hazards, the Export Cable will cross the Dam Neck Ocean Disposal Site (DNODS), which is a designated dredge material disposal site managed by USACE (Figure 2.3-3). Within the DNODS, the Export Cable specifically crosses Zones 2 and 5. These zones are designated for the disposal of fine material (e.g., silts and clays) (EPA and USACE 2009). The siting of the Export Cable route through these two zones was based upon recommendations made by the USACE (personal communications March 29, 2013, and April 15, 2013). Review of the DNODS Site Management and Monitoring Plan (EPA and USACE 2009) indicates that sediments placed within the DNODS must be approved for disposal under Section 103 of the Marine Protection, Research, and Sanctuaries Act (MPRSA). Section 103 of the MPRSA prohibits the dumping of material into the ocean that would unreasonably degrade or endanger human health or the marine environment.

4.1.3.2 Potential Impact Producing Factors, Proposed Environmental Protection Measures, and BMPs

Potential regional geologic hazards include sediment mobility, earthquakes, volcanic activity, and tsunamis. Of the natural seafloor hazards identified and examined within the Project Area, bedforms (sand ridges), water scour, and channels are present. Inspection of the site-specific Project survey data for natural subsurface hazards identified buried channels, but no items of major significance were identified within the area of the proposed WTGs, Inter-Array Cable, or Export Cable. Five areas along the Export Cable Route have been highlighted for further investigation for the possible use of additional cable protection solutions to mitigate the risk of cable exposure from bedform migration. In addition, the likelihood of a significant geologic event in this area, such as an earthquake or tsunami as described in Section 4.1.3.1, is low.

Dominion has avoided man-made hazards to the extent possible; however, as indicated in Section 4.1.3.1, the Export Cable will cross one dredge disposal site and two active military practice areas. Consultations with the USACE have indicated that Dominion will be required to bury the Export Cable no less than 6.6 ft (2 m) below the existing sea floor starting at distance of 100 ft (30.5 m) prior to entering the DNODS, across the entirety of the DNODS, and a distance of 100 ft (30.5 m) from exiting the DNODS. At the two military practice areas, Dominion may increase the cable burial depth to 15 ft (4.5 m) across these areas to ensure protection of the cable throughout operations. Final burial depth will, however, be determined in consultations with both BOEM and the USACE. Additional surveys specifically designed for munitions MEC detection and evaluation will also be conducted within the military practice areas prior to cable installation. These surveys will be performed in close coordination with applicable military stakeholders to ensure the safe installation of the Export Cable in this area. Prior to installation, Dominion will also complete route clearance and pre-lay grapnel activities to clear other obstructions along the proposed cable routes and within the WTG Work Areas.

Because Dominion has taken or will take the necessary steps to avoid known hazards, consequently there should be no impacts during operation of the project. During future decommissioning of the Project, Dominion will take the necessary steps to identify and avoid hazards.

4.2 Water Quality

This section discusses existing water quality of the waters off Virginia, along with groundwater and surface water resources in Camp Pendleton and the City of Virginia Beach, and the potential impact producing factors applicable to these resources. This section is based on data collected from the publicly available sources referenced below.

4.2.1 Affected Environment

4.2.1.1 Marine Waters

The Project Area is located within coastal waters (up to 3 nm [4.8 km] from shore), the territorial sea (3 to 12 nm [4.8 to 19.3 km] from shore), and the United States Exclusive Economic Zone (EEZ) (up to 200 nm [322 km] from shore) in the Mid-Atlantic Bight off the coast of Virginia. In this area, water quality generally increases with distance from shore as oceanic circulation and the volume of water disperse, dilute, and biodegrade contaminants. Water contaminants originating in the territorial sea and EEZ are limited to discharges from ships, including bilge and ballast water and sanitary waste. The primary location where pollutants, dissolved nutrients, groundwater discharge, and surface runoff outflow into the Project Area is from Chesapeake Bay.

The U.S. Environmental Protection Agency (EPA) classifies the conditions of the nation's coastal and ocean waters as poor, fair, or good (EPA 2013). In 2012, EPA rated the water quality along the coast of

Virginia as fair, because its estuaries are poorly flushed, highly settled, and susceptible to eutrophication. EPA classified sediment quality along the coast of Virginia as good based on the level of sediment toxicity, sediment contaminants, and sediment total organic carbon (EPA 2012).

The EPA assigns a water quality index value for ocean waters based on the levels of chlorophyll *a*, water clarity, nutrients, and dissolved oxygen. Chlorophyll *a* concentrations in ocean surface waters in the Mid-Atlantic Bight averaged 0.23 micrograms per liter (µg/L), which is below the National Coastal Assessment threshold for good water quality. Total suspended solids (TSS) in ocean surface waters of the Mid-Atlantic Bight averaged 5.6 milligrams per liter (mg/L), and near-bottom TSS concentrations averaged 6.9 mg/L. Suspended particle levels in benthic waters are higher than surface waters due to the resuspension of silt and fine-grained sands from bottom currents. Storm events, particularly frequent, intense wintertime storms, may also cause a temporary increase in TSS concentrations. Within the Mid-Atlantic Bight off the coast of Virginia, the dissolved inorganic nitrogen levels are classified as good, at less than 0.1 mg/L, and the dissolved oxygen levels are also classified as good, at less than 5 mg/L. Additionally, the EPA rated sediment quality as good based on concentrations of toxicity (EPA 2012).

For the portion of the Project (Export Cable) that will cross the DNODS, sediments within this area have been approved for disposal under Section 103 of the MPRSA.

4.2.1.2 Groundwater

Population growth in the Virginia Beach area has exceeded the fresh groundwater supply and much of the groundwater supply has suffered from saltwater intrusion. Seawater has an average salinity of about 35 parts per thousand. Magnesium, calcium, and sodium are indicators of the presence of saltwater. In Virginia Beach, the magnesium levels range from 1.5 to 50.5 mg/L, the calcium levels range from 26.1 to 70.2 mg/L, and sodium levels range from 7.13 to 148 mg/L (Wicklein et al. 2006).

The U.S. Geological Survey (USGS) and the VDEQ have measured groundwater levels in various locations in Virginia Beach since 1972. From 1972 to 2005, the water table in the City of Virginia Beach has ranged from 0.51 ft (0.2m) above land surface to 35.38 ft (10.9 m) below land surface in separate sampling locations within the city (Wicklein et al. 2006).

Public drinking water at Camp Pendleton is supplied by the City of Virginia Beach Department of Utilities and is not obtained through local groundwater withdrawal. The source of the drinking water is Lake Gaston, located on the border of Virginia and North Carolina, approximately 100 mi (161 km) west of Camp Pendleton (Virginia Beach 2013a). Private wells are not anticipated to exist in the area surrounding the proposed Onshore Interconnection Cable and Fiber Optic Cable route.

4.2.1.3 Surface Waters

Freshwater wetlands, tidal wetlands, and other water bodies (most notably Lake Christine) occur on Camp Pendleton near the proposed Export Cable landfall site, and in the vicinity of the Onshore Interconnection Cable and Fiber Optic Cable route. See Section 4.8 for more information on wetlands. However, the proposed route for the Onshore Interconnection Cable and Fiber Optic Cable will not cross any surface waters.

Section 303(d) of the CWA (33 USC 1341) requires identification of surface waters for which effluent limitations and thermal discharge controls are not stringent enough to meet the applicable water quality standards. No surface waters on Camp Pendleton have a 303(d) designation. However, Owl Creek, Lake Rudee, and Lake Wesley, which are located just north of Camp Pendleton, are designated as Section 303(d) surface waters (VCZMP 2013). The Project will not impact these surface waters.

The Virginia Beach Chesapeake Bay Preservation Area Board regulates activities within the Chesapeake Bay Watershed in accordance with the Chesapeake Bay Preservation Act (Virginia Code § 62.1-44.15 *et seq.*). However, all onshore Project activities are located at least 1 mi (1.6 km) from the closest area designated as a Chesapeake Bay Preservation Area or Research Management Area (Virginia Beach, 2013b).

4.2.2 Potential Impact Producing Factors, Proposed Environmental Protection Measures, and BMPs

Specific aspects of Project construction, operation, and decommissioning have the potential to impact water quality. This section addresses the following types of potential impact producing factors associated with the Project:

- Direct effects to marine water quality through construction-related sediment disturbance;
- Direct effects to marine water quality through the potential addition of fill material for cable protection;
- Direct effects to water quality through accidental spills and releases; and
- Indirect effects to surface water quality from erosion and run-off during construction.

4.2.2.1 Marine Waters

The primary change to marine water quality resulting from the construction of the Project will be temporary increases to TSS caused by sediment disturbance from pile driving, cable laying, and the positioning of construction vessels and vessel anchors. The EPA rated sediments along the coast and in the Mid-Atlantic Bight off Virginia as good based on sediment toxicity, sediment contaminants, and sediment total organic carbon (see Section 4.2.1.1). In addition, sediments within the portion of the Project (Export Cable) that will cross the DNODS are approved for disposal under Section 103 of the MPRSA. Accordingly, sediments disturbed along the Inter-Array and Export Cable routes are not expected to contain contaminants that would have an additional effect on water quality or result in the unreasonable degradation or endangerment of human health or the marine environment.

As described in Section 3.3.4.3, installation of the Inter-Array and Export Cables using a jet plow and a ROV jet trencher would result in temporary and localized suspension of sediments in the water column. The magnitude of this effect depends on the source sediment characterization (i.e., grain size), the volume of affected sediment, the rate of resuspension during the activity, and the currents transporting the sediment. Sediments in the Project Area are characterized as predominantly sandy, with some relatively small, localized areas of sand-shell and sand-gravel, which would quickly resettle to the sea floor after disturbance (see Section 4.1.2 and Appendix E for a description of sediment conditions within the Project Area).

Construction and decommissioning activities associated with WTG and Inter-Array and Export Cable installations will disturb soft sediments on the ocean floor. The disturbed sediments will mobilize and mix within the water column, resulting in increased turbidity and TSS in the immediate area of construction. The jet plowing and ROV jet trenching for the Inter-Array and Export Cables will be the primary source of increased TSS in the water column during construction. Dominion conducted a sediment transport modeling analysis of cable-laying activities based on the jet plow and a 6.6-ft (2-m) cable burial depth via jet plow to determine the extent of sediment disturbance from this activity (Appendix G). Modeling using the jet plow is considered the most conservative case because the jet plow creates a wider trench (3.3 ft [1 m]) than the ROV jet trencher (1.6 ft [0.5 m]) , therefore resulting in a greater potential volume of sediment that could be released into the water column.

Results of this conservative analysis indicate that TSS concentrations would be elevated up to approximately 6.6 ft (2 m) above the trench, and extending at increasingly shallow depths out to 100 to 160 m. Suspension would last for 6 to 7 minutes. Maximum TSS concentration would be from 6,700 to 400,000 mg/L directly over the trench, depending on the amount of fine sediment present, and decreasing to zero between 100 m to 160 m (Appendix G, Section 4). Project operation and maintenance activities will have limited potential for such sediment effects, primarily limited to intermittent anchoring of maintenance vessels. As described in Section 3.7, at the end of the Project's operational life both the Inter-Array and Export Cable may be removed using similar jet plowing and/or trenching techniques as for installation but in reverse. As such, increases in TSS from cable decommissioning are anticipated to be consistent with those estimated for construction.

As stated in Section 3.2.4, additional cable protection, including rock berms and/or concrete mattresses, may be required at the HDD punch-out location and at five sand-wave areas identified along the Export Cable route. The use of the rock berm or concrete mattresses would result in the addition of a maximum volume of 133,496 yd^3 (102,060 m^3) and 28,534.7 yd^3 (21,816 m^3) of fill into marine waters, respectively. Prior to finalizing engineering designs, Dominion will consult with jurisdictional agencies regarding the preferred protection approach at each location and will provide detailed site plans at sites where cable protection is desired. Pursuant to federal and state regulations, the fill will be free of toxins. Dominion will amend the VOWTAP JPA with USACE, VMRC, and VDEQ to request authorization for placement of the proposed fill.

As described in Section 3.3.3, Export Cable landfall will be installed using HDD. The use of HDD requires HDD drilling fluid, which typically consists of a water and bentonite mixture. The bentonite mixture is made up of mainly inert, non-toxic clays, and rock particles consisting predominantly of clay with quartz, feldspars, and accessory material such as calcite and gypsum. While the mixture is not anticipated to significantly affect water quality if released, Dominion will implement BMPs during cable landfall construction to minimize potential release of the fluid. These measures include returning the drilling fluid to a mud pond that will be located within the HDD Work Area, located in the public parking lot of Camp Pendleton Beach, where the drilling fluid will be collected for reuse after cleaning.

The use of HDD also creates a potential for frac-out during drilling activities. A frac-out occurs when the drilling fluids migrate unpredictably to the surface through fractures, fissures, or other conduits in the underlying rock or unconsolidated sediments. A frac-out under the water surface could potentially increase turbidity, and possibly affect aquatic habitats as the suspended material settles out of the water column and partially or entirely covers any sessile benthic organisms. Because Dominion has avoided sensitive habitat in selection of the Export Cable landfall site, and has proposed a minimum burial depth of 10 ft (3 m) under the beach area and a maximum burial depth of 65.6 ft to 98.4 ft (20 m to 30 m) offshore, the likelihood of a frac-out is low. Should a frac-out occur, it would result in only minor and localized impacts to water quality in the shallow marine environment associated with the Export Cable route, particularly when compared to the ongoing movement of bottom substrates due to normal current and storm activity, as discussed in Section 4.1.2. Dominion will develop an HDD Contingency Plan for the inadvertent release of drilling fluid prior to construction to further minimize the potential risks associated with a frac-out.

As standard practice, vessels operate in compliance with oil spill prevention and response plans that meet USCG requirements. Additionally, all vessels less than 79 ft (24.1 m) will comply with the Small Vessel General Permit issued by EPA on September 10, 2014 for compliance with National Pollutant Discharge Elimination System (NPDES) permitting. Dominion has prepared an Oil Spill Response Plan to address the specific use of lubricating oils and other hazardous materials at the WTGs, as described in Section 3.2.1.

4.2.2.2 Groundwater

The depth of the water table along the Onshore Interconnection Cable and Fiber Optic Cable route was evaluated during onshore investigations (see Appendix U) and found at a depth of approximately 2 ft to 6.6 ft (0.6 m to 2 m) from the surface. Final engineering design will determine if groundwater will need to be managed during construction at locations such as the cable splice pits. However, based on the low permeability soil types encountered within the Project Area, this effort should be minimal and, if necessary, could be managed by employing a simple bailing technique at the splice pits. Even with the high water table in the area of the Onshore Interconnection Cable and Fiber Optic Cable route, HDD does not require dewatering (Dimitroff 2008).

All proposed construction activities will occur within designated work areas located along existing roads or within previously disturbed areas. Dominion will implement stormwater pollution prevention BMPs and erosion control measures in support of all onshore construction activities to avoid and/or minimize any potential impacts to groundwater. If it is determined during final design that dewatering is needed, the dewatering plan will be incorporated into the Stormwater Management Plan. Final plans will be prepared during final engineering design and will be submitted to the relevant jurisdictional agencies for review and approval prior to construction.

4.2.2.3 Surface Waters

The Onshore Interconnection Cable and Fiber Optic Cable route will not impact surface waters. Dominion will avoid direct impacts to all nearby surface waters, and no removal or fill within onshore surface waters will take place. The Switch Cabinet and Interconnection Station will be constructed at previously disturbed sites. The greatest potential for impacts to surface water quality from the Project would result from the indirect effects of erosion and run-off during construction. As stated previously, Dominion will implement a Stormwater Management Plan pursuant to VAR10 General Permit, 9 VAC25-880 and ESC Plan, along with appropriate BMPs in accordance with 9VAC25-840, during construction to avoid and minimize any potential impacts. Given the implementation of these measures, construction activities are not expected to have an impact on surface water quality.

During operation, the cable will be buried to a minimum depth of 3.3 ft (1 m), and, therefore, will not affect water quality. The shunt reactors and transformer associated with the Interconnection Station contain approximately 2,245 gallons (8,500 liters) of mineral insulating transformer oil. However, because each of these systems will be mounted on a concrete foundation with associated oil containment pits, an inadvertent release of oil at the Interconnection Station is not expected to impact the water quality of the surrounding surface water resources.

4.3 Marine Biological Resources

This section describes the marine biological resources found in the Project Area; discusses impact producing factors associated with the Project relative to those resources; and identifies means to protect the resources during Project construction, operation, and decommissioning. Specific types of resources addressed in this section include benthic and epibenthic species, marine vegetation, demersal and pelagic fish species, and marine mammals. Species listed under the ESA, including several species of marine mammals and sea turtles, are addressed separately in Section 4.6. Essential Fish Habitat (EFH) is discussed in Section 4.7.

4.3.1 Affected Environment

The discussion of current resource conditions (Section 4.3.1) is based on available literature, in particular the Mid-Atlantic Wind Energy Area (WEA) EA (BOEM 2012) and the results of site-specific studies performed by Dominion in the Project Area. Survey results as they relate to the characterization of the existing environment for benthic resources are summarized below. The site-specific surveys and evaluations implemented in support of VOWTAP's benthic resources evaluation include:

- **Geophysical Surveys (June and July 2013)** to characterize and evaluate seafloor conditions (Appendix F-1).
- **Benthic Habitat Survey (June 2013)** to characterize benthic habitats using remote sensing and evaluate benthic infauna using grab samples (Appendix J).
- **Electromagnetic Fields (EMF) Analysis** to evaluate the potential EMF impacts from the Project's submarine cables on the overlying substrate, water column, and species during operation (Appendix K).

The discussions of marine vegetation (Section 4.3.1.2), demersel and pelagic fish species (Section 4.3.1.3), and marine mammals (Section 4.3.1.4) are based on reviews of available literature, NOAA Stock Assessment Reports, and the Mid-Atlantic WEA EA (BOEM 2012).

4.3.1.1 Benthic and Epibenthic Resources

The marine benthic environment consists of the materials (substrates) lying on the seafloor. Benthic species are the organisms living within those substrates, including infaunal (species that burrow into seafloor deposits) organisms and sessile invertebrates. Epibenthic species live on the surface of the benthic substrates. The benthic environment includes certain components of EFH, which are discussed separately in Section 4.7.

Benthic Habitat

The VOWTAP is adjacent to the Virginia WEA, in the Mid-Atlantic Bight of the Northeast Continental Shelf Large Marine Ecosystem. Similar to the rest of the Mid-Atlantic Bight, the VOWTAP is in an area of relatively flat topography, with a seafloor composed primarily of soft sediments (Steimel and Zetlin 2000). Benthic habitats in this region may be divided into seven bathymetric/morphologic subdivisions (Johnson 2002): the inner shelf, central shelf, central and inner shelf swales, outer shelf, outer shelf swales, shelf break, and continental slope. These subdivisions are identified based on several factors, including depth, faunal zone, and characteristic macrofauna (BOEM 2012).

Several data sources provide information on benthic habitat within the Project Area, on both a regional and a site-specific basis. Johnson (2002) characterized marine benthic ecosystems of the Northeast U.S. Shelf Large Marine Ecosystem. The Nature Conservancy has compiled several decades of NOAA Fisheries benthic grab sample data into an informative geodatabase, as part of their Northwest Atlantic Marine Ecoregional Assessment (Greene et al. 2010). BOEM prepared an EA that characterized benthic habitats of the Mid-Atlantic WEAs, including the VOWTAP Lease Area (BOEM 2012). On a more localized scale, Cutter and Diaz (1998) conducted a benthic habitat investigation that included the use of grab samples and sediment profile imaging to characterize benthic resources in areas between 3 and 10 nm (5.6 and 18.5 km) offshore from Virginia Beach; their study area includes a portion of the VOWTAP Export Cable route, but does not include the proposed Lease Area. The USACE, Norfolk District (2009) conducted an EA of the potential impacts to benthic resources of the Sandbridge Erosion Control and Hurricane Protection Project, which included a borrow area located just south of the VOWTAP Export Cable route. The geophysical and benthic surveys conducted in support of the Project (Appendices F and J) provide the site-specific habitat characterization necessary to establish the existing baseline conditions within the Project Area.

The overall review of data associated with the Project Area indicates that the benthic habitat is dominated by fine sand and coarse sand, with very little clay or silt (Cutter and Diaz 1998; Greene et al. 2010). Based on the combined results from the geophysical survey data and underwater imagery analysis, all benthic habitats within the Lease Area and Export Cable route were soft-bottom, with no hard-bottom habitats observed. The lack of natural hard substrate within the Project Area is further supported by the results of previous hydrographic surveys in this region (USGS 2000).

The slope of the continental shelf in the Project Area is gentle from the shoreline out to 54 to 108 nm (100 to 200 km) offshore, where it transitions into the continental slope at the shelf break (BOEM 2012). Because the VOWTAP lies entirely within the shelf habitat, this discussion is focused on this area. The primary morphological features of the shelf include shoal massifs, scarps, sand ridges and swales. The sediment type covering most of the shelf in the Mid-Atlantic Bight, including the Project Area, is sand, with some relatively small, localized areas of sand-shell and sand-gravel. Sand ridges are often covered with smaller similar forms, such as sand waves, megaripples, and ripples. Such features have been identified within the Lease Area (Appendix F-1). Sand waves are primarily found on the inner shelf and are often observed on the sides of sand ridges, including within the Project Area. Ripples and megaripples are perhaps the most dynamic of these sand formations, occurring on sand waves or separately on the inner or central shelf. Megaripples tend to survive for less than a season. They can also form during a storm and reshape the upper 19.6 in to 39.4 in (50 cm to 100 cm) of the sediments within a few hours. Ripples are also found everywhere on the shelf and appear or disappear within hours or days, depending upon storms and currents. Ripples usually have lengths of about 0.4 in to 59 in (1 cm to 150 cm) and heights of a few centimeters (BOEM 2012). Such ripples are abundant within the Lease Area and along the Export Cable route.

Hard-bottom and reef areas occur in limited areas within the Mid-Atlantic Bight; however, their presence is rare within most of the Mid-Atlantic Bight shelf area. The Mid-Atlantic WEA EA acknowledged that "hard-bottom and reef areas are not well mapped in the Mid-Atlantic WEAs, and it is uncertain whether they exist within the WEAs" (BOEM 2012). The VOWTAP site characterization geophysical survey data shows that hard-bottom or reef areas are entirely absent from the VOWTAP Lease Area and Export Cable route.

Benthic and Epibenthic Macroinvertebrates

In general, the Lease Area and Export Cable route occur at water depths between 89.2 ft (27.2 m) at the WTGs down to 26.9 ft (8.2 m) at the HDD punch-out location. The sandy sediments within the Project Area and reference sites support a diverse fauna dominated by polychaete species and, to a lesser extent, mollusks and arthropods (BOEM 2012). Marine benthic organism distribution in the Virginia WEA is influenced by benthic habitat and by physical and chemical characteristics of the water (e.g., depth, temperature, salinity, nutrient concentrations, and ocean currents) (Levinton 2009). The species diversity and abundance of marine invertebrates in coastal water habitats relative to the open ocean are a result of the food and protection provided by coastal water habitats (Levinton 2009). The diversity and abundance of arthropods (epibenthic species, such as crabs, lobsters, and barnacles) and mollusks (e.g., snails and clams) are typically greatest on the seafloor over the continental shelf (compared with the abyssal plain), due to high productivity and complex habitats relative to typical soft-bottom habitat of the deep ocean (Karleskint et al. 2006). These invertebrates are important in the marine food web as prey for many higher organisms (e.g., fish and whales), as scavengers and recyclers of nutrients, and as habitat-forming organisms. Table 4.3-1 identifies the invertebrate organism groups commonly found in sand-bottom habitat in the Mid-Atlantic Bight.

Table 4.3-1. Benthic and Epibenthic Invertebrate Groups

Common Name (Taxonomic Group)	Description
Flatworms (phylum Platyhelminthes)	Mostly bottom-dwelling; simplest form of marine worm with a flattened body.
Hydroids and corals (phylum Cnidaraia)	Bottom-dwelling animals either habitat-forming or attached to other substrates.
Ribbon worms (phylum Nemertea)	Bottom-dwelling marine worms with a long extension from the mouth (proboscis) that helps capture food.
Segmented worms (phylum Annelida)	Mostly bottom-dwelling, highly mobile marine worms; many tube-dwelling species. Includes polychaetes and oligochaetes.
Peanut worms (phylum Sipuncula)	Named for their similarity in shape to shelled peanuts. Primarily occur in shallow waters. Some burrow into sand and mud, others live in crevices in rocks or in empty shells.
Squid, bivalves, clams, quahog, sea snails, chitons, conchs (phylum Mollusca)	A diverse group of soft-bodied invertebrates with a specialized layer of tissue called a mantle. Mollusks such as squid are active swimmers and predators, while others such as sea snails are predators or grazers; clams may be filter feeders or deposit feeders.
Shrimp, crab, lobster, barnacles, copepods (phylum Arthropoda)	Bottom-dwelling or pelagic; some are immobile; with an external skeleton; all feeding modes from predator to filter feeder
Sea stars, sea urchins, sea cucumbers (phylum Echinodermata)	Bottom-dwelling predators and filter feeders with tube feet.
Horseshoe worms, lamp shells, moss animals (phylum Lophophorata)	Sessile suspension feeders enclosed in secreted exoskeleton, shell, or tube. Have a common ring of ciliated, hollow tentacles called a lophophore, used for feeding, defense, and respiration.
Chordates (phylum Chordata)	Both vertebrates and invertebrates, all have a number of structures in common, including: a notochord; a dorsal, hollow, ectodermal nerve cord; pharangeal slits; and a post-anal tail. Only non-vertebrate chordates are discussed in this assessment.
Acorn worms (phylum Hemichordata)	Generally live in burrows and are deposit feeders, but some species are pharyngeal filter feeders.

Benthic and epibenthic resources within the Project Area were evaluated through marine site characterization surveys conducted in 2013. Results for the sites within the Lease Area and along the Export Cable route are summarized in Table 4.3-2, and further discussed in Appendix J. Overall, the composition of sediment types as measured by grain size and the organic content analysis was consistent with the expected site conditions, and similar between the Project and reference sites. The sediments in most locations were dominated by fine sand with very low organic content.

Table 4.3-2. Summary Results and Comparisons between Project and Reference Sites within the Research Lease Area and Export Cable Route

Parameter	Research Lease Area		Export Cable Route	
	Project Sites	Reference Sites	Project Sites	Reference Sites
Number of Samples	15	3	45	6
Sample Numbers	GS-001 through GS-015	GS-REF-007 through GS-REF-009	GS-016 through GS-060	GS-REF-001 through GS-REF-006
Average Grain Size Categories	60% fine sand, 29% medium sand, 7% silt/clay, 2% coarse sand, 2% gravel	94% fine sand, 5% silt/clay, 1% medium sand, < 1% coarse sand and gravel	70% fine sand, 19% medium sand, 6% silt/clay, 3% coarse sand, 2% gravel	74% fine sand, 17% medium sand, 8% silt/clay, 1% coarse sand, < 1% gravel
Organic Content (percent)	0.3 – 2.3	0.5 - 0.8	0.2 - 1.4	0.2 - 0.8
Number of Species per Sample	14 – 32	25 – 35	14 – 37	19 – 31
Species Richness	101	57	166	81
Species Diversity (H')	1.05 – 3.04	1.46 – 2.87	1.02 – 3.11	1.96 – 2.75
Dominant Phyla	Annelida, Mollusca, Arthropoda	Annelida, Mollusca, Arthropoda	Annelida, Mollusca, Arthropoda	Annelida, Mollusca, Arthropoda
Dominant Species and Approximate % Abundance	Spiophanes bombyx (33%), Oligochaetae spp. (8%), Exogone hebes (4%)	Spiophanes bombyx (50%), Abra longicallus (10%), Nassarius trivittatus (5%)	Spiophanes bombyx (17%), Amastigos caperatus (9%), Ensis sp. (8%)	Prionospio pygmaeus (18%), Branchiostoma sp. (11%), Amastigos caperatus (7%)

Substrate and species composition in the Project Area are consistent with the description of benthic habitats in the Virginia WEA (BOEM 2012), as well as the other studies discussed in Appendix J. The coarse-grained sand of the Project Area provides a uniform and rather simple (non-complex) habitat for benthic infaunal organisms typical of this region (Cutter and Diaz 1998).

The dominant benthic infauna across all Project and reference sites within the Project Area was Annelida and Mollusca, followed by Arthropoda (Tables 4.3-3 and 4.3-4). The polychaete worm *Spiophanes bombyx* was the dominant species in the Lease Area. Polychaete worms also dominated the species composition along the Export Cable route, although the percent composition for the most abundant species was lower than in the Lease Area sites and was split between two different species, *Spiophanes bombyx* and *Prionospio pygmaeus*. *Spiophanes bombyx* was more abundant within Project sites along the Export Cable route, while *Prionospio pygmaeus* was more abundant within the reference sites. Other benthic infaunal species occurring in this VOWTAP benthic survey were mainly polychaete worms (*Prionospio pygmaeus*, *Amastigos caperatus*, *Aricidea (Acmira) catherinae*, *Streblospio benedicti*, and *Scalibregma inflatum*). Polychaetes were numerically dominant across all sampling areas, followed by mollusks, then crustaceans. Mollusks had the highest overall biomass, representing approximately 66 percent of the total. Annelids

Table 4.3-3. Abundance of Species by Phylum for the VOWTAP Project Sites and Reference Sites within the Research Lease Area

Phylum	Project Sites		Reference Sites	
	Total in Research Lease Area	% of Identified Species	Total in Research Lease Area	% of Identified Species
Annelida	9,036	72.50	609	69.68
Mollusca	1,681	13.49	197	22.54
Arthropoda	1,481	11.88	59	6.75
Chordata	124	0.99	0	0.00
Nemertea	86	0.69	8	0.92
Turbellaria	25	0.20	0	0.00
Echinodermata	12	0.10	0	0.00
Lophophorata	8	0.06	1	0.11
Cnidaria	5	0.04	0	0.00
Hemichordata	3	0.02	0	0.00
Sipuncula	2	0.02	0	0.00

Table 4.3-4. Abundance of Species by Phylum for the VOWTAP Project Sites and Reference Sites within the Cable Corridor

Phylum	Project Sites		Reference Sites	
	Total in Research Lease Area	% of Identified Species	Total in Research Lease Area	% of Identified Species
Annelida	1,235	66.29	626	63.30
Mollusca	330	17.71	133	13.45
Arthropoda	165	8.86	106	10.72
Chordata	112	6.01	112	11.32
Nemertea	18	0.97	10	1.01
Echinodermata	1	0.05	1	0.10
Lophophorata	1	0.05	0	0.00
Turbellaria	1	0.05	1	0.10
Cnidaria	0	0.00	0	0.00
Hemichordata	0	0.00	0	0.00
Sipuncula	0	0.00	0	0.00

were second in total biomass of the combined dataset (17 percent), and crustaceans represented approximately 11 percent of the combined total biomass. These findings are consistent with the conclusions of previously published reports on benthic infauna in coastal and offshore Virginia waters (Cutter and Diaz 1998; Diaz et al. 2004; USACE 2009). Species richness was highest in the sites containing the greatest number of samples, as expected, based on fundamental species-area relationships for marine ecosystems (Valiela 1995; Neigel 2003). However, the number of species per sample and overall species diversity (*H'*) was bound by similar ranges between the sampled sites.

The type of sandy substrate within the Project Area does not support any seagrasses, hard-bottom, live-bottom, or any other unique habitat features. Low levels of occurrence of both echinoderms and cnidarians can be attributed to the soft sand substrates within the Lease Area and Export Cable route survey sites. Such species are largely associated with hard-bottom communities, as they are unable to form "live-bottom" communities without a hard substrate to support attachment. No such hard-bottom substrate was observed in the VOWTAP Lease Area or along the Export Cable route.

4.3.1.2 Demersal and Pelagic Fish

The demersal zone refers to the bottom substrate within the continental shelf areas. Demersal fish occupy waters adjacent to bottom areas and feed on benthic organisms. The pelagic zone refers to the surface or mid-water depths within the continental shelf areas. Pelagic fish feed on organisms within the water column or on the water surface.

The demersal fish community has a strong relationship with benthic habitat complexity (e.g., hard-bottom, reef), as complex habitats contain greater fish diversity (Malek et al. 2010). The demersal species are widely distributed throughout coastal Virginia waters. Many demersal species occur year-round in these waters, although abundances vary with both season and life stage.

A wide variety of demersal finfish are associated with the coastal and offshore waters of Virginia, most of which can be grouped at the order level as shown in Table 4.3-5.

Table 4.3-5. Demersal Finfish Groups

Common Name (Taxonomic Group) [a/, b/]	Description
Sharks, Skates, Rays, and Chimaeras (Class Chondrichthyes)	Cartilaginous (nonbony) fish, many of which are open-ocean predators.
Greeneyes, Lizardfish, Lancetfish, and Telescopefish (Order Aulopiformes)	Have both primitive and advanced features of marine fish; includes both coastal and estuarine species, as well as deepsea fish that occur in midwaters and along the bottom.
Cods and Cusk-Eels (Orders Gadiformes and Ophidiiformes)	Important commercial fish; associated with bottom habitats; includes some deepwater groups. Most have a distinctive barbel (a slender tactile organ) below the mouth.
Toadfish and Anglerfish (Orders Batrachoidiformes and Lophiiformes)	Includes the sound-producing toadfish and the anglerfish, classic lie-in-wait predators.
Scorpionfish (Order Scorpaeniformes)	Bottom dwelling with modified pectoral fins to rest on the bottom. Many are venomous.
Drums, Snappers, Snooks, Temperate Basses, and Reef Fish (Order Perciformes[3/], with Representative Families Sciaenidae, Lutjanidae, Centropomidae, Moronidae, Apogonidae, Chaetodontidae, Pomacanthidae, Labridae, and Mullidae)	Important gamefish and common predators in all marine waters; sciaenids produce sounds with their swim bladders.
Sea Basses (Order Perciformes[3/], with Representative Families; Serranidae)	Important gamefish with vulnerable conservation status; in some species, individuals change from female to male as they mature.
Gobies and Blennies (Order Perciformes [c/], with Representative Suborders: Gobioidei and Blennioidei)	The largest and most diverse family of marine fish, mostly found in bottom habitats of coastal areas.
Flounders (Order Pleuronectiformes)	Flatfish lack swim bladders, are well camouflaged, and occur in bottom habitats throughout the world.

a/ Groups are not strictly taxonomic, but are based on the organization applied by Helfman et al. (2009); Moyle and Cech (1996); Nelson (2006).
b/ Presence in the Project Area includes open ocean areas (portions of the North Atlantic Subtropical Gyre, Labrador Current, and Gulf Stream Current) and coastal waters of several large marine ecosystems: West Greenland Shelf, Newfoundland-Labrador Shelf, Scotian Shelf, Northeast U.S. Continental Shelf, Southeast U.S. Continental Shelf, Gulf of Mexico, and Caribbean Sea. Representative species from all taxonomic groups occur in each open ocean area and large marine ecosystem; therefore, those areas are not identified in this table, but their vertical distribution within these areas is identified.
c/ Order Perciformes includes approximately 40 percent of all bony fish and includes highly diverse fish. Representative families are included here to reflect this diversity.

Many habitat and spatial factors affect the distribution of fish within the waters of the Mid-Atlantic Bight (Helfman et al. 2009), including temperature, salinity, pH, currents, and physical habitat. The diversity of Mid-Atlantic Bight fish is partly attributed to the numerous species that migrate seasonally through this region to spawn. The overall fish population includes both northern (temperate) and southern (subtropical/tropical) fish populations that undergo extensive migrations as they follow temperature isotherms (Olney and Bilkovic 1998). At least 250 fish species may occur in the Mid-Atlantic Bight, with over 75 percent having southern (warm water) affinities (Briggs 1974). According to Able and Fahay (1998), the ichthyofauna of the central part of the Mid-Atlantic Bight is composed of 336 marine and estuarine species.

Many of the fish species found in Mid-Atlantic WEAs are of importance due to their value to commercial and/or recreational fisheries, and some of the species are of special concern due to their depleted population status. Many finfish play an important role in food web dynamics as higher-order predators within the ecosystem. Finfish utilize the abundant stocks of lower trophic levels that then become available as food to larger fish and higher-order predators such as tuna and sharks. Other finfish species (e.g., menhaden, herring, etc.) feed on plankton or detritus, but are equally important to the ecosystem by providing a food source for higher trophic-level fish. Table 4.3-6 summarizes the demersal Mid-Atlantic Bight finfish species that have been identified as having EFH in the proposed Project Area, or are considered commercially or recreationally important. Eight of the 17 demersal species identified in this table have identified EFH in the Project Area. EFH for these species is further discussed in Section 4.7.

Table 4.3-6. Demersal Finfish Species Potentially Occurring in the Project Area

Representative Demersal Mid-Atlantic Bight Finfish Species	EFH	Species of Ecological Importance in the Project Area	Commercially or Recreationally Important in the Project Area [a/]	Seasonality
Atlantic croaker *Micropogonias undulatus*		X		Fall
Black sea bass *Centropristis striata*	X		X	Spring-Fall
Atlantic butterfish *Peprilus triacanthus*	X			Year-round
Clearnose skate *Raja eglanteria*		X		Year-round
Monkfish *Lophius americanus*	X		X	Year-round
Northern searobin *Prionotus carolinus*		X		Spring-Fall
Red hake *Urophycis chuss*	X		X	Winter-Spring
Scup *Stenotomus chrysops*	X	X	X	Fall
Silver hake (whiting) *Merluccius bilinearis*	X		X	Winter-Spring
Summer flounder (fluke) *Paralichthys dentatus*	X		X	Year-round
Spot *Leiostomus xanthurus*		X		Fall
Spotted hake *Urophycis regia*		X		Year-round

Table 4.3-6. Demersal Finfish Species Potentially Occurring in the Project Area (continued)

Representative Demersal Mid-Atlantic Bight Finfish Species	EFH	Species of Ecological Importance in the Project Area	Commercially or Recreationally Important in the Project Area [a/]	Seasonality
Smooth dogfish *Mustelus canis*				Year-round
Spiny dogfish *Squalus acanthias*	X		X	Year-round
Snappers-Groupers		X	X	Year-round
Weakfish *Cynoscion regalis*		X		Fall
White hake *Urophycis tenuis*			X	Spring

a/ NOAA Fisheries statistics website total value > $100k annually.
Sources: Colvocoresses and Musick (1984), Greene et al. (2010).

The pelagic finfish associated with the coastal and offshore Virginia waters also consist of a wide variety of fish species, most of which can be grouped at the order-level as shown in Table 4.3-7; three of these groups are also listed as demersal groups in Table 4.3-5.

Table 4.3-7. Pelagic Finfish Groups

Common Name (Taxonomic Group) [a/, b/]	Description
Sharks, Skates, Rays, and Chimaeras (Class Chondrichthyes)	Cartilaginous (nonbony) fish, many of which are open-ocean predators.
Eels (Order Anguilliformes)	Undergo a unique willow leaf-shaped larval stage, with a small head and often an elongated body.
Herrings (Order Clupeiformes)	Commercially valuable schooling plankton eaters, such as herrings, sardines, menhaden, and anchovies. Some herrings migrate between marine and estuarine and freshwater habitats.
Greeneyes, Lizardfish, Lancetfish, and Telescopefish (Order Aulopiformes)	Have both primitive and advanced features of marine fish; includes both coastal and estuarine species, as well as deepsea fish that occur in midwaters and along the bottom.
Mullets, Silversides, Needlefish, and Killifish (Orders Mugiliformes, Atheriniformes, Beloniformes, and Cyprinodontiformes)	Small nearshore (within 3 nm of shoreline) fish that primarily feed on organic debris; also includes the surface-oriented flyingfish.
Pipefish and Seahorses (Order Gasterosteiformes)	Small mouth, with tubular snout and armor-like scales; males care for young in nests or pouches.
Drums, Snappers, Snooks, Temperate Basses, and Reef Fish (Order Perciformes [c/], with Representative Families; Sciaenidae, Lutjanidae, Centropomidae, Moronidae, Apogonidae, Chaetodontidae, Pomacanthidae, Labridae, and Mullidae)	Important gamefish and common predators in all marine waters; sciaenids produce sounds with their swim bladders.
Sea Basses (Order Perciformes[3/], with Representative Families; Serranidae)	Important gamefish with vulnerable conservation status; in some species, individuals change from female to male as they mature.
Jacks, Tunas, Mackerels, and Billfish (Order Perciformes[3/], with Representative Families: Carangidae, Scombridae, Xiphiidae, and Istiophoridae)	Highly migratory predators found near the surface; commercially valuable fisheries.

Table 4.3-7. Pelagic Finfish Groups (continued)

Common Name (Taxonomic Group) [a/, b/]	Description
Triggerfish, Puffers, and Molas (Order Tetraodontiformes)	Unique body shapes and characteristics to deter predators (e.g., spines); includes ocean sunfish, the largest bony fish.

a/ Groups are not strictly taxonomic, but are based on the organization applied by Helfman et al. (2009); Moyle and Cech (1996); Nelson (2006).
b/ Presence in the Project Area includes open ocean areas (portions of the North Atlantic Subtropical Gyre, Labrador Current, and Gulf Stream Current) and coastal waters of several large marine ecosystems: West Greenland Shelf, Newfoundland-Labrador Shelf, Scotian Shelf, Northeast U.S. Continental Shelf, Southeast U.S. Continental Shelf, Gulf of Mexico, and Caribbean Sea. Representative species from all taxonomic groups occur in each open ocean area and large marine ecosystem; therefore, those areas are not identified in this table, but their vertical distribution within these areas is identified.
c/ Order Perciformes includes approximately 40 percent of all bony fish and includes highly diverse fish. Representative families are included here to reflect this diversity.

Pelagic fish can be broadly categorized into horizontal and vertical distributions within the water column. The primary ecological groups of fish that occur in the Project Area include the unstructured seafloor community (covered previously under demersal finfish), the water column community, and the surface community (Schwartz 1989). The highest number and diversity of pelagic fish typically occur where the habitat is most diverse, reflecting structural complexity (habitat structure/relief, seamounts, Sargassum patches, etc.) and/or a variety of physical and chemical conditions (currents, upwelling, nutrients, dissolved oxygen, and temperature) (Helfman et al. 2009; Moyle and Cech 1996; Parin 1984).

The pelagic fish of the Project Area are part of the Mid-Atlantic Bight and can be classified primarily as temperate species, but also include subtropical-tropical and highly migratory species (Helfman et al. 2009). The common coastal pelagic fish in the vicinity of the VOWTAP include striped bass (*Morone saxatilis*), bluefish (*Pomatomus saltatrix*), cobia (*Rachycentron canadum*), king mackerel (*Scomberomorus cavalla*), smooth puffer (*Lagocephalus laevigatus*), northern kingfish (*Menticirrhus saxatilis*), weakfish (*Cynoscion regalis*), clearnose skates (*Raja eglanteria*), spiny dogfish (*Squalus acanthias*), red drum (*Sciaenops ocellatus*), porgies (Sparidae), and Spanish mackerel (*Scomberomorus maculates*), and other temperate and subtropical-tropical transients (VMRC 2013a). Highly migratory pelagic fish, such as billfish (marlins and sailfish), swordfish, members of the mackerel (Scombridae) family (tuna), and many shark species are distributed from coastal waters seaward into the open ocean. These species are capable of migrating great distances seasonally (north to south or inshore to offshore), as well as vertically in the water column on shorter timescales (Packer et al. 2003). Many of the pelagic fish move through the Project Area seasonally to offshore and southern regions as the temperature falls within more northerly coastal waters (Schwartz 1989; VMRC 2006).

Pelagic fish can be further grouped into estuarine, marine, anadromous, and catadromous fish. Estuarine fish (e.g., striped bass, bluefish.) typically inhabit nearshore waters with salinities ranging from 0–30 parts per thousand (or practical salinity units), whereas marine species (e.g., tunas and sharks) are found in coastal or offshore waters with salinities averaging near 30 practical salinity units. Anadromous/catadromous forms—represented primarily by shad/herring (Clupeidae), migrate from ocean waters to freshwater or lower-salinity estuarine waters to spawn (Nelson 2006).

Artificial reefs often provide important habitat structure for pelagic fish that occupy an otherwise featureless portion of the Mid-Atlantic Bight. Two such artificial reefs, Tower Reef and Triangle Reef, are located 0.6 nm (1.1 km) southwest and 16.5 nm (30.6 km) northeast of the Chesapeake Light Tower, respectively. These artificial reefs were created by VMRC to enhance fish habitat (VMRC 2013a). Tower Reef is made up of hundreds of intentionally sunken vessels, a concrete tetrahedron, and "igloo" materials; it includes more than 100 pontoon sections, 50 subway cars, several barges, numerous amphibious landing craft and other vessels (VMRC 2013a).

Other fish distribution factors, including predator/prey relationships, water quality, and refuge (e.g., physical structure or vegetation cover) operate on more regional or local spatial scales (Helfman et al. 2009). Also, fish may move among habitats throughout their lives based on changing needs during different life stages (Schwartz 1989).

Management entities and stock status for pelagic species are as described previously for demersal finfish, with the exception of finfish classified as "highly migratory species" (e.g., tunas and sharks). Highly migratory species are managed in U.S. waters by NOAA Fisheries.

Table 4.3-8 lists pelagic species with the potential to occur in the Project Area. Eighteen of the 56 pelagic species identified in Table 4.3-8, have identified EFH in the Project Area; detailed information regarding these species is provided in Section 4.7.

Table 4.3-8. Pelagic Finfish Species Potentially Occurring in the Project Area

Pelagic Finfish Species	EFH	Species of Ecological Importance in the Project Area	Commercially or Recreationally Important in the Project Area [a/]	Seasonality
Atlantic bluefin tuna *Thunnus thynnus*	X	X	X	June to October
Atlantic herring *Clupea harengus*	X		X	Year-round
Atlantic mackerel *Scomber scombrus*			X	May to September
Atlantic menhaden *Brevoortia tyranus*		X	X	Year-round
Albacore tuna *Thunnus alalunga*		X		Winter
Atlantic angel shark *Squatina dumeril*		X		Fall-Winter
Atlantic bigeye tuna *Thunnus obesus*		X		Summer
Atlantic sharpnose shark *Rhizoprionodon terraenovae*	X			Year-round
Atlantic skipjack *Katsuwonus pelamis*	X	X		Year-round
Atlantic swordfish *Xiphias gladius*	X			Summer-Fall
Atlantic yellowfin tuna *Thunnus albacares*		X		Year-round
Basking shark *Cetorhinus maximus*		X		Spring-Fall
Bigeye tuna *Thunnus obesus*		X	X	Summer-Fall
Blacktip shark *Carcharhinus limbatus*		X		Summer

Table 4.3-8. Pelagic Finfish Species Potentially Occurring in the Project Area (continued)

Pelagic Finfish Species	EFH	Species of Ecological Importance in the Project Area	Commercially or Recreationally Important in the Project Area [a/]	Seasonality
Bluefish *Pomatomus saltatrix*	X		X	May to November
Blue marlin *Makaira nigricans*		X	X	June to October
Blue shark *Prionace glauca*			X	June to November
Atlantic butterfish *Peprilus triacanthus*	X		X	May to October
Cobia *Rachycentron canadum*	X	X	X	Spring-Summer
Dolphinfish *Coryphaena hippurus*			X	Summer
Dusky shark *Carcharhinus obscurus*	X	X	X	June to November
False albacore *Euthynnus alletteratus*		X	X	June to October
King mackerel *Scomberomorus cavalla*	X		X	Summer-Fall
Longbill spearfish *Tetrapturus pfluegeri*		X		Summer
Porbeagle shark *Lamna nasus*		X	X	Winter
Porgies Sparidae		X	X	Year-round
Red drum *Sciaenops ocellatus*	X	X	X	Year-round
Sailfish *Istiophorus platypterus*			X	summer
Sand tiger shark *Carcharias taurus*	X	X	X	summer
Sandbar shark *Carcharhinus plumbeus*	X	X	X	summer
Scalloped hammerhead *Sphyrna lewini*	X	X		summer
Scup *Stenotomus chrysops*	X	X		Year-round
Shortfin mako Shark *Isurus oxyrinchus*	X	X	X	June to December
Silky shark *Carcharhinus falciformis*			X	Year-round
Smooth dogfish *Mustelus canis*			X	Year-round
Snappers-Groupers		X	X	Year-round
Striped bass *Morone saxatilis*		X	X	April to November

Table 4.3-8. Pelagic Finfish Species Potentially Occurring in the Project Area (continued)

Pelagic Finfish Species	EFH	Species of Ecological Importance in the Project Area	Commercially or Recreationally Important in the Project Area a/	Seasonality
Thresher shark *Alopias vulpinus*			X	June to December
Spanish mackerel *Scomberomorus masculatus*	X	X	X	May-October
Wahoo *Acanthocybium solandri*		X	X	Summer
White shark *Carcharodon carcharias*		X		Summer
White marlin *Kajikia albida*			X	June to October
Yellowfin tuna *Thunnus albacares*		X	X	June to October

a/ NMFS fisheries statistics website total value > $100k annually.
Sources: Colvocoresses and Musick 1984; Greene et al. 2010; MAFMC 1998, 2005; NEFMC 1998, 2003, 2004; NMFS 1999, 2009a, 2009b; SAFMC 1998, 2003, 2009

4.3.1.3 Marine Vegetation

The types of plant organisms that can be present within the Mid-Atlantic Bight marine environment include seagrasses and various types of algae that exist in the water column (pelagic algae) or attached to substrates (macrophytic algae). Seagrasses grow predominantly in shallow, subtidal, or intertidal sediments sheltered from wave action, such as in estuaries, lagoons, and bays. In some locations vegetation can extend over large areas to form seagrass beds (Phillips and Meñez 1988). The occurrence of seagrass is limited by light penetration through the water column, which is dependent upon water clarity.

Existing mapping of seagrass distribution in the Project Area (Orth et al. 2012) was reviewed to determine the distribution of known seagrass beds. These data indicate that seagrass beds are unknown within the proposed Lease Area or Export Cable route. Generally, distribution of seagrasses in the Mid-Atlantic tends to be restricted to embayments rather than along the open coast (Orth et al. 2012). The type of sandy substrate within the Project Area does not support seagrasses, because it does not provide a suitable surface for attachment, and no seagrasses were observed during the benthic habitat mapping (Appendix J). Therefore, the Project Area should not impact seagrass or seagrass habitat.

4.3.1.4 Marine Mammals

Marine mammals include whales, dolphins, porpoise, and seals. This section discusses only those marine mammals known to traverse or occasionally visit the waters within or surrounding the Project Area, and that are not listed as threatened or endangered under the ESA. These species are protected under the Marine Mammal Protection Act of 1972, as amended in 1994 (MMPA). This section describes the species' biology, habitat use, abundance, and distribution, as well as the existing threats to these populations. Marine mammals listed as threatened or endangered under the ESA are discussed separately in Section 4.6.

Marine mammals inhabit all of the world's oceans and are found in coastal, estuarine, and pelagic habitats. All marine mammal species are protected by the MMPA (50 CFR 216). Under the 1994 amendments to the MMPA, the MMPA prohibits the "take" of marine mammals, which is defined as the harassment, hunting, or capturing of marine mammals, or the attempt thereof. "Harassment" is further defined as any act of pursuit, annoyance, or torment, and is classified as Level A (potentially injurious to a marine mammal or marine mammal stock in the wild) and Level B (potentially disturbing a marine mammal or marine mammal stock in the wild by causing disruption to behavioral patterns). Activities, such as pile driving or the use of vessels with dynamic positioning thrusters, have the potential to cause harassment as defined by the MMPA.

Table 4.3-9 lists the 35 marine mammal species that may occur off the Virginia coast. Certain marine mammal species, such as the bottlenose dolphin, spotted dolphin, striped dolphin, Risso's dolphin, long- and short-finned pilot whales, fin whale, and sei whale are resident to the Mid-Atlantic region. The remaining species tend to be more common during spring, summer, and fall, when prey is abundant, and otherwise are infrequent visitors. In addition, while the striped dolphin is resident to the Mid-Atlantic region, the habitat preference for this species is the deep, pelagic waters outside the continental shelf along the continental slope (Waring et al. 2012). Because of their preference for oceanic waters, striped dolphin presence within the Project Area is unlikely.

NOAA uses Operating Area Density Estimates developed by the U.S. Navy (2007), supplemented by data from other sources, to update species Stock Assessment Reports. These reports suggest that marine mammal density in the Mid-Atlantic region is patchy and seasonally variable. Table 4.3-9 provides a summary of key information for marine mammal species and their potential to occur in or near the Project Area.

Table 4.3-9. Marine Mammal Occurrence in Coastal and Offshore Virginia

English Name	Species Name	Seasonality	Status	Estimated Auditory Bandwidth [a]	Likelihood in Project Area
Odontocetes (Toothed Whales)					
Phocoenidae					
Harbor Porpoise	*Phocoena phocoena*	Winter	MMPA	200 Hz to 180 kHz	Most likely Winter
Delphinidae					
White-Sided Dolphin	*Lagenorhynchus acutus*	Winter/Spring	MMPA	150 Hz to 160 kHz	Most likely Winter and Spring
Short-beaked Common Dolphin	*Delphinus delphis*	Summer/Fall	MMPA	150 Hz to 160 kHz	Most likely Summer and Fall
Bottlenose Dolphin	*Tursiops truncates*	Year-round	MMPA	150 Hz to 160 kHz	Year-round
Clymene Dolphin	*Stenella clymene*	Infrequent Summer	MMPA	150 Hz to 160 kHz	Unlikely
Pan-Tropical Spotted Dolphin	*Stenella attenuata*	Infrequent Summer	MMPA	150 Hz to 160 kHz	Unlikely
Atlantic Spotted Dolphin	*Stenella frontalis*	Year-round	MMPA	150 Hz to 160 kHz	Year-round
Striped Dolphin	*Stenella coeruleoalba*	Year-round	MMPA	150 Hz to 160 kHz	Unlikely
Risso's Dolphin	*Grampus griseus*	Year-round	MMPA	150 Hz to 160 kHz	Year-round
Spinner Dolphin	*Stenella longirostris*	Occasional	MMPA	150 Hz to 160 kHz	Unlikely
Killer Whale	*Orcinus orca*	Infrequent/sporadic	Endangered-certain populations	150 Hz to 160 kHz	Unlikely

Table 4.3-9. Marine Mammal Occurrence in Coastal and Offshore Virginia (continued)

English Name	Species Name	Seasonality	Status	Estimated Auditory Bandwidth [a/]	Likelihood in Project Area
False Killer Whale	*Pseudorca crassidens*	Infrequent/sporadic	MMPA	150 Hz to 160 kHz	Unlikely
Melon-headed whale	*Peponocephala electra*	Infrequent/sporadic	MMPA	150 Hz to 160 kHz	Unlikely
Sperm Whale	*Physeter macrocephalus*	Infrequent/sporadic	Endangered	150 Hz to 160 kHz	Unlikely
Dwarf Sperm Whale	*Kogia sima*	Infrequent/sporadic	MMPA	150 Hz to 160 kHz	Unlikely
Pygmy Sperm Whale	*Kogia breviceps*	Infrequent/sporadic	MMPA	200 Hz to 180 kHz	Unlikely
Long-finned Pilot Whale	*Globicephala melas*	Year-round	MMPA	150 Hz to 160 kHz	Year-round
Short-finned pilot whale	*Globicephala macrorhynchus*	Year-round	MMPA	150 Hz to 160 kHz	Year-round
Ziphiidae					
Blainville's Beaked Whale	*Mesoplodon densirostris*	Infrequent Spring/Summer	MMPA	150 Hz to 160 kHz	Unlikely
True's Beaked Whale	*Mesoplodon mirus*	Infrequent Spring/Summer	MMPA	150 Hz to 160 kHz	Unlikely
Gervais' Beaked Whale	*Mesoplodon europaeus*	Infrequent Spring/Summer	MMPA	150 Hz to 160 kHz	Unlikely
Cuvier's Beaked Whale	*Ziphius cavirostris*	Infrequent/sporadic	MMPA	150 Hz to 160 kHz	Unlikely
Sowerby's Beaked Whale	*Mesoplodon bidens*	Infrequent Spring/Summer	MMPA	150 Hz to 160 kHz	Unlikely
Mysticetes (Baleen Whales)					
Balaenopteridae					
Humpback Whale	*Megaptera novaeangliae*	Fall/Winter/Spring	Endangered	7 Hz to 22 kHz	Most likely Fall, Winter and Spring
Fin Whale	*Balaenoptera physalus*	Year- round	Endangered	7 Hz to 22 kHz	Unlikely
Sei Whale	*Balaenoptera borealis*	Year- round	Endangered	7 Hz to 22 kHz	Unlikely
Minke Whale	*Balaenoptera acutorostrata*	Winter	MMPA	7 Hz to 22 kHz	Most likely Winter
Blue Whale	*Balaenoptera musculus*	Rare Summer/Fall	Endangered	7 Hz to 22 kHz	Unlikely
Bryde's Whale	*Balaenoptera edeni*	Infrequent Summer/Fall	MMPA	7 Hz to 22 kHz	Unlikely
Balaenidae					
North Atlantic Right Whale	*Eubalaena glacialis*	Winter/Spring	Endangered	50 to 600 Hz [b/]	Most likely Winter and Spring
Sirenia					
Trichechidae					
West Indian Manatee	*Trichechus manatus*	Infrequent/sporadic	Endangered	10 to 60 kHz	Unlikely
Pinnipeds					
Phocidae					
Harbor Seal	*Phoca vitulina*	Infrequent Fall/Winter/Spring	MMPA	75 Hz to 75 kHz	Unlikely
Gray Seal	*Halichoerus grypus*	Infrequent Fall/Winter/Spring	MMPA	75 Hz to 75 kHz	Unlikely
Harp Seal	*Pagophilus groenlandicus*	Rare January-May	MMPA	75 Hz to 75 kHz	Unlikely
Hooded Seal	*Cystophora cristata*	Rare Summer/Fall	MMPA	75 Hz to 75 kHz	Unlikely

a/ Southall et al. 2007
b/ Vanderlaan et al. 2003; Parks et al. 2010

The following discussion provides additional information on the biology, habitat use, abundance, distribution, and the existing threats to the non-endangered or threatened marine mammals that are both common in Virginia waters and have the likelihood of occurring, at least seasonally, in the Project Area. These species include the harbor porpoise (*Phocoena phocoena*), Atlantic white-sided dolphin (*Lagenorhynchus acutus*), short-beaked common dolphin (*Delphinus delphis*), bottlenose dolphin (*Tursiops truncates*), Atlantic spotted dolphin (*Stenella frontalis*), Risso's dolphin (*Grampus griseus*), long-finned pilot whale (Globicephala melas), short-finned pilot whale (*G. macrorhynchus*), and minke whale (*Balaenoptera acutorostrata*). In general, the remaining non-ESA whale species listed in Table 4.3-9 range is outside the VOWTAP Area; they are usually found in more pelagic shelf-break waters, have a preference for northern latitudes, or are so rarely sighted that their presence in the Project Area is unlikely. Because the potential presence of these species in the Project Area is considered low, they are not addressed in this analysis.

Harbor Porpoise

The harbor porpoise is likely to occur in the waters of the Mid-Atlantic during winter months, as this species prefers cold temperate and subarctic waters (Waring et al. 2012; Waring et al. 2011). Porpoise generally move out of the Mid-Atlantic during spring, migrating to the Gulf of Maine. Harbor porpoise are the smallest North Atlantic cetacean, measuring at only 4.6 ft to 6.2 ft (1.4 m to 1.9 m), and feed primarily on pelagic schooling fish, bottom fish, squid and crustaceans (Bjorge and Tolley 2009; Reeves and Read 2003). Most strandings of harbor porpoise from 2005 to 2009 occurred in Massachusetts. During this time, a total of 450 harbor porpoise have stranded along the U.S. Atlantic coast (Waring et al. 2012). An unusual mortality event in 2005 involved the stranding of 38 animals along the North Carolina coast from January 1 to March 28 (Waring et al. 2012). The current population estimate for harbor porpoise is from 2006 in the Gulf of Maine/Bay of Fundy area, estimating the population to be 89,054 individuals (Waring et al. 2012; Waring et al. 2011).

The most common threat to the harbor porpoise is incidental mortality from fishing activities, especially from bottom-set gillnets. It has been demonstrated that the porpoise echolocation system is capable of detecting net fibers, but they must not have the "system activated" or else they fail to recognize the nets (Reeves et al. 2002). Roughly 365 harbor porpoise are killed by human-related activities in U.S. and Canadian waters each year. In 1999, a Take Reduction Plan to reduce harbor porpoise bycatch in U.S. Atlantic gillnets was implemented. The ruling implements time and area closures, with some areas closed completely while others are closed to gillnet fishing unless the gear meets certain restrictions. In 2001, the harbor porpoise was removed from the candidate species list for the ESA; a review of the biological status of the stock indicated that a classification of "Threatened" was not warranted (Waring et al. 2011). However, this species has been listed as "strategic" because average annual human-related mortality and injury exceeds the potential biological removal (Waring et al. 2011).

White-Sided Dolphin

The Atlantic white-sided dolphin can be found in cold temperate to subpolar waters in the North Atlantic within deep OCS and slope waters (Jefferson et al. 2008). In the western North Atlantic, this species occurs from Labrador and southern Greenland to the coast of Virginia (Jefferson et al. 2008). During winter and spring, concentrations of Atlantic white-sided dolphins can be found in the Mid-Atlantic region, particularly in deeper waters along the continental slope (Waring et al. 2012). Atlantic white-sided dolphins range between 8.2 ft to 9.2 ft (2.5 and 2.8 m) in length, with females being approximately 20 cm shorter than males (Cipriano 2002). This species is highly social and is commonly seen feeding with fin whales. White-sided dolphins feed on a variety of small species, such as herring, hake, smelt, capelin, cod, and squid, with regional and seasonal changes in the species consumed (Cipriano 2002). Other prey species include mackerel, silver hake, and several other varieties of gadoids (Waring et al. 2012). A recent estimate placed the population of Atlantic white-sided dolphins off the U.S. east coast at approximately 23,390 individuals (Waring et al. 2012; Waring et al. 2011).

The biggest human-induced threat to the Atlantic white-sided dolphin is bycatch, because they are occasionally caught in fishing gillnets and trawling equipment. Fishery-related activities killed an estimated average of 266 dolphins each year in U.S. waters from 2004 to 2008 (Waring et al. 2010). Average annual fishery-related mortality and serious injury does not exceed the potential biological removal for this species; therefore, NOAA Fisheries considers this species as "non-strategic" (Waring et al. 2011).

Short-Beaked Common Dolphin

The short-beaked dolphin is one of the most widely distributed cetaceans and occurs in temperate, tropical, and subtropical regions (Jefferson et al. 2008). Common dolphins feed on nutrient rich squids and small fish, including species that school in proximity to surface waters, and on mesopelagic species found near the surface at night (Waring et al. 2012; IUCN 2013). This species is found between Cape Hatteras and Georges Bank from mid-January to May. Between mid-summer and fall they migrate onto Georges Bank and the Scotian Shelf, and large aggregations occur on Georges Bank in fall (Waring et al. 2011). While this dolphin species can occupy a variety of habitats, short-beaked common dolphins occur in greatest abundance within a broad band off the northeast edge of Georges Bank in the fall (Selzer and Payne 1988). Although this species is widely distributed, sightings in the vicinity of Hudson Canyon and points south have occurred at low densities (Waring et al. 2006). The species is less common south of Cape Hatteras, although schools have been reported as far south as the Georgia/South Carolina border (Jefferson et al. 2009). According to the species stock report, the best population estimate for the western North Atlantic common dolphin is approximately 120,743 individuals (Waring et al. 2011).

The short-beaked common dolphin is also subject to bycatch. It has been caught in gillnets, pelagic trawls, and longline fishery activities. From 2005 to 2009, the average estimated mortality per year was approximately 2 dolphins killed for the Mid-Atlantic gillnet fishery and 110 dolphins killed for the Mid-Atlantic bottom trawl fishery (Waring et al. 2011). Average annual fishery-related mortality and serious injury does not exceed the potential biological removal for this species; therefore, NOAA Fisheries considers this species as "non-strategic" (Waring et al. 2011).

Bottlenose Dolphin

The bottlenose dolphin occupies a variety of habitats and has been considered the most adaptable species of cetacean (Reeves et al. 2002). This species typically occurs in both tropical and temperate regions. In North America, bottlenose dolphins are found in surface waters with temperatures ranging from 10 to 32°C (50 to 90°F). Bottlenose dolphins range between 8 to 12 feet (2.4 to 3.7 meters) in length and are a light- to slate-gray color. The population of bottlenose dolphins in the North Atlantic consists of a complex mosaic of dolphin stocks (Waring et al. 2010). Evidence suggests that five coastal stocks of bottlenose dolphins exist: the Northern Migratory and Southern Migratory stocks, a South Carolina/Georgia Coastal stock, a

Northern Florida Coastal stock and a Central Florida Coastal stock (Waring et al. 2010). The Northern Migratory Coastal stock is best understood, based on survey data, and individuals occur along the North Carolina coast and as far north as New York during the summer (CETAP 1982; Kenney 1990; Garrison et al. 2003). During winter, bottlenose dolphins are rarely observed north of the North Carolina/Virginia border (Waring et al. 2010). The Southern Migratory Coastal stock is the most poorly understood due to overlap with the Northern Migratory Coastal and both the Northern and Southern North Carolina Estuarine System stocks; however, this stock generally ranges from North Carolina and Virginia during summer down to northern Florida during winter (Waring et al. 2010). The best population estimate for bottlenose dolphins is for the offshore stock, estimated at 81,588 individuals (Waring et al. 2011). Based on data collected in 2002, the population estimate for the Northern Migratory Coastal stock is 9,604 individuals, while the Southern Migratory Coastal stock is estimated at 12,482 individuals (Waring et al. 2011).

Bottlenose dolphins feed on a large variety of organisms, depending on their habitat. The coastal, shallow population tends to feed on benthic fish and invertebrates, while deepwater populations consume pelagic or mesopelagic fish such as croakers, sea trout, mackerel, mullet, and squid (Reeves et al. 2002). Bottlenose dolphins appear to be active both during the day and night. Their activities are influenced by the seasons, time of day, tidal state, and physiological factors such as reproductive seasonality (Wells and Scott, 2002).

The biggest threat to the bottlenose dolphin population is bycatch and the species has the potential to interact with mid-Atlantic gillnet, Virginia pound net, mid-Atlantic menhaden, Atlantic blue crab trap/pot, mid-Atlantic beach/haul seine, Southeastern U.S. Atlantic shark gillnet, and Southeast Atlantic gillnet fisheries (Waring et al. 2010). They have also been adversely impacted by pollution, habitat alteration, boat collisions, and human disturbance, and are subject to bioaccumulation of toxins. Scientists have found a strong correlation between dolphins with elevated levels of polychlorinated biphenyls and illness, indicating certain pollutants may weaken their immune system (Waring et al. 2012). Average annual fishery-related mortality and serious injury exceeds the potential biological removal for this species in the Coastal stocks; therefore, NOAA Fisheries considers this species as “strategic” but has not listed it as threatened or endangered under the ESA. The management units are “strategic” stocks due to the depleted listing under the MMPA (Waring et al. 2010).

Atlantic Spotted Dolphin

There are two species of spotted dolphin in the Atlantic Ocean, the Atlantic spotted dolphin (*Stenella frontalis*) and the pantropical spotted dolphin (*S. attenuata*) (Perrin 1987). Where they co-occur, the two species can be difficult to differentiate (Waring et al. 2006). The larger form is associated with continental shelf habitat while the smaller form is more pelagic, preferring offshore waters and waters around oceanic islands (Perrin, 2009; 1994). In addition, two forms of the Atlantic spotted dolphin exist, one that is large and heavily spotted and the other is smaller in size with less spots (Waring et al. 2012). The Atlantic spotted dolphin prefers tropical to warm temperate waters along the continental shelf 10 to 200 meters (33 to 650 feet) deep to slope waters greater than 500 meters (1640 feet) deep. Their diet consists of a wide variety of fish and squid, as well as benthic invertebrates (Herzing 1997).

No fishing-related mortality of spotted dolphin was reported for 1998 through 2003 (Yeung, 1999; Yeung 2001; Garrison 2003; Garrison and Richards 2004). The estimated abundance of Atlantic spotted dolphins has been reported at 50,978 individuals (Waring et al. 2011). Average annual fishery-related mortality and serious injury does not exceed the potential biological removal for this species; therefore, NOAA Fisheries considers this species as “non-strategic” (Waring et al. 2006).

Risso’s Dolphin

Risso's dolphin is typically an offshore dolphin whose inshore appearance is uncommon (Reeves et al. 2002). Risso’s dolphin prefers temperate to tropical waters along the continental shelf edge and can range from Cape Hatteras to Georges Bank from spring through fall, and throughout the Mid-Atlantic Bight out to oceanic waters during winter (Payne et al. 1984). Risso’s dolphins are usually seen in groups of 12 to 40 individuals. Loose aggregations of 100 to 200, or even several thousand, are seen occasionally (Reeves et al. 2002). Sightings of this species from surveys were mostly in the continental shelf edge and continental slope areas (Waring et al. 2011). The best estimate of Risso’s dolphins is 20,479 individuals, based on a surveys conducted in 2004 (Waring et al. 2011). The diet for this species is comprised mostly of squid (Baird, 2009).

Risso’s dolphin has been subject to bycatch. It has been caught in gillnets and pelagic longline fishery activities. From 2005 through 2009, the mean annual fishery-related mortality or serious injury was 18 dolphins (Waring et al. 2011). The current status of this stock is listed as unknown; however, NOAA Fisheries considers this species to not be strategic (Waring et al. 2011).

Long-Finned and Short-Finned Pilot Whale

The two species of pilot whales in the western Atlantic, the long-finned pilot whales and short-finned pilot whales, are difficult to differentiate. Therefore, both species are presented together, since much of the data is generalized for *Globicephala* species. Both species of pilot whale are more generally found along the edge of the continental shelf (a depth of 330 to 3,300 feet [100 to 1,000 meters]), choosing areas of high relief or submerged banks. In the western North Atlantic, long-finned pilot whales are pelagic, occurring in especially high densities in winter and spring over the continental slope, then moving inshore and onto the shelf in summer and autumn following squid and mackerel populations (Reeves et al. 2002). They frequently travel into the central and northern Georges Bank, Great South Channel, and Gulf of Maine areas during the summer and early fall (May to October) (NOAA 1993). Short-finned pilot whales prefer tropical, subtropical and warm temperate waters (Olson 2009). The short-finned pilot whale ranges from New Jersey south through Florida, the northern Gulf of Mexico, and the Caribbean (Waring et al. 2011). Populations for both of these species overlap between North Carolina and New Jersey (Waring et al. 2012; Waring et al. 2011). The best population estimate for long-finned pilot whales is 12,619 individuals, and for short-finned pilot whales it is 24,674 (Waring et al. 2011).

Pilot whales feed preferentially on squid but will eat fish (e.g., herring) and invertebrates (e.g., octopus, cuttlefish) if squid are not available. They also ingest shrimp (particularly younger whales) and various other fish species occasionally. These whales probably take most of their prey at depths of 600 to 1,650 feet (200 to 500 meters), although they can forage deeper if necessary (Reeves et al. 2002). Pilot whales are subject to bycatch in gillnet fishing, pelagic trawling, longline fishing, and purse seine fishing. Approximately 215 pilot whales were killed or seriously injured each year by human activities from 1997 to 2001. Strandings involving hundreds of individuals are not unusual and demonstrate that these large schools have a high degree of social cohesion (Reeves et al. 2002). Although the level of human-related mortality suggests that pilot whale stocks would likely be considered strategic by NOAA Fisheries, the inability to partition mortality estimates between the two species limits the ability to assess stock status (Waring et al. 2011).

Minke Whale

Minke whales are the smallest and are among the most widely distributed of all the baleen whales. They occur in the North Atlantic and North Pacific, from tropical to polar waters. Scientists currently recognize two subspecies of the so-called "common" minke whale: the North Atlantic minke and the North Pacific minke. Generally, they inhabit warmer waters during winter and travel north to colder regions in summer, with some animals migrating as far as the ice edge. They are frequently observed in coastal or shelf waters. Minke whales off the eastern coast of the United States are considered to be part of the Canadian East Coast stock. The best population estimate for the Canadian East Coast stock of the Western North Atlantic is 8,978 individuals (Waring et al. 2011).

As is typical of the baleen whales, minke whales are usually seen either alone or in small groups, although large aggregations sometimes occur in feeding areas (Reeves et al. 2002). Minke populations are often segregated by sex, age, or reproductive condition. Known for their curiosity, minkes often approach boats. They feed on schooling fish (e.g., herring, sand eel, capelin, cod, pollock, and mackerel), invertebrates (squid and copepods), and euphausiids. Minke whales basically feed below the surface of the water, and calves are usually not seen in adult feeding areas.

Minke whales are affected by ship strikes and bycatch from gillnet and purse seine fisheries. The estimated United States total annual average human-caused mortality was 5.9 minke whales per year from 2005 through 2009 (Waring et al. 2011). In addition, hunting for Minke whales continues today, by Norway in the northeastern North Atlantic and by Japan in the North Pacific and Antarctic (Reeves et al. 2002). International trade in the species is currently banned. Average annual fishery-related mortality and serious injury does not exceed the potential biological removal for this species; therefore, NOAA Fisheries considers this species as "non-strategic" (Waring et al. 2011).

4.3.2 Potential Impact Producing Factors, Proposed Environmental Protection Measures, and BMPs

Specific aspects of Project construction, operation, and decommissioning have the potential to affect marine biological resources. This section addresses the following types of potential impact producing factors associated with the Project:

1. Direct mortality or injury to marine species;
2. Disturbance or displacement of habitat for marine resources;
3. Direct or indirect effects on marine species through potential changes in water quality;
4. Disturbance or injury of marine species through Project-related noise;
5. Indirect effects on marine species through changes in prey availability;
6. Direct or indirect effects on marine species through Project-related EMFs; and
7. Direct or indirect effects on marine species through Project-related lighting.

For each marine biological resource that could be affected, the specific potential impact mechanism(s) and characteristics of the dimensions (e.g., timing, duration, extent, intensity) of the potential effects are considered. Some of the potential impact factors apply exclusively or primarily to one type of marine resource (such as benthic species or marine mammals), while others apply to multiple resources. Therefore, out of these potential impacts, only the factors that are relevant to each particular resource will be presented. As discussed in Section 4.3.1.3, the substrate within the Project Area does not support marine vegetation. Consequently, the Project will not have impacts to marine vegetation, and this resource is not discussed further.

4.3.2.1 Benthic and Epibenthic Resources

Direct Mortality or Injury

The Project construction phase has the greatest potential for physical disturbance of the seafloor environment. Permanent physical disturbance will occur in the footprints of the Inter-Array Cable and Export Cable, the WTG foundations and at the locations proposed for additional cable protection. Temporary disturbance will result from the use of jack-up barges and anchored vessels for installation of the WTGs and foundations. Temporary physical disturbance will also result from the suspension and redeposition of sediments mobilized by the jet plow and ROV jet trenching techniques used for cable-laying activities, and by anchor-cable sweeping along the seafloor.

The Project construction activities that will disturb the seafloor will create risk of direct and indirect mortality or injury primarily for benthic resources. Benthic species are immobile, in practical terms, and unable to avoid physical disturbance of their environment. Some epibenthic and demersal species have limited mobility, and those organisms in the immediate footprint of the WTG foundations and vessel anchors or spuds would be subject to some level of mortality. Most demersal species are highly mobile and would likely avoid, or disperse away from, these areas following initial disturbances at the onset of construction.

Benthic fauna and selected epibenthic and demersal species directly within the footprint (spatial area and penetration depth) of the WTG foundations, anchors, jack-up barge spuds, and locations of additional cable protection will be crushed when these objects contact the seafloor. Pile driving will also push any organisms within the footprint more deeply into the substrate, removing them from the benthic ecosystem even as a contribution to the detrital or nutrient cycles. Anchoring will occur in soft sediments within the VOWTAP Project Area. In the areas of anchor chain sweep, tube-dwelling amphipods and polychaetes, solitary anemones, and other larger infauna are probably the most susceptible to harm. These species are adapted to life in the highly dynamic environment of the Mid-Atlantic Bight, however, and are expected to be able to quickly repopulate disturbed areas that are not otherwise occupied by the installed structures.

Disturbance or Displacement of Habitat

The only direct loss of marine habitat expected with the VOWTAP will be associated with the 0.2 ac (0.1 ha) footprint of the WTG foundations and the maximum 23.4 ac (9.5 ha) footprint associated with the additional cable protection. The amount of marine habitat that would be lost as a result of the WTG foundation represents a negligible proportion of the subsea habitat available in similar water depths within the Mid-Atlantic Bight.

Given the dynamic nature of sediment processes in the Project Area, the jet plowing and ROV jet trenching of the cables and impacts from construction vessel anchoring and anchor chain sweep are expected to create only temporary and localized alterations to the seafloor habitat. The benthic community associated with the fine- and coarse-sand seafloor is expected to rapidly recover following construction (Brooks et al. 2006).

Typically, following this type of disturbance, a diverse benthic infaunal community would be recolonized from adjacent organisms within a matter of 1 to 3 years (Byrnes et al. 2004; Lundquist et al. 2010). This longer recovery period allows organic matter to accumulate, and for aerobic conditions to return to normal levels, thus providing invertebrates the ability to re-establish their populations (Greene 2002). However, studies conducted on offshore sand borrow areas off the outer New Jersey coast indicate that benthic communities were re-established on an even shorter timeframe (within 8 to 9 months), i.e., within one annual recruitment period after disturbance (USACE 1999). Larvae of re-colonizing invertebrate species would be dispersed from populations that inhabit the undisturbed habitat on either side of the trench. The overall rate of benthic recovery and degree of diversity following construction activities will largely be dependent upon several factors including, but not limited to: the duration and timing of the activity, the type of equipment used, the sediment composition at the time of disturbance and the amount removed, fauna present at the site prior to disturbance, water quality at the site, hydrodynamics, and the degree of sedimentation that occurs following the disturbance (Greene 2002).

According to the Sediment Transport Analysis conducted in support of the VOWTAP along the proposed Export Cable route (Appendix G), suspension and redeposition of sediment suspended will occur along the route during installation activities. Sediment accumulation depth of less than 0.04 in (1 mm) is expected to be confined to an area within 429 ft (150 m) on either side of the trench centerline. There is substantial evidence from both the Project-specific geophysical and shallow geotechnical survey (Appendix F-1) and the Sediment Transport Analysis (Appendix G) that the physical environment in the vicinity of the Project is dynamic. The presence of sand waves throughout much of the area is a strong indicator that bottom currents routinely move surface sediments, and this action is likely enhanced during storm events. The dominant benthic fauna in the Project Area contains species that are adapted to these types of dynamic physical conditions (see Appendix J), and are likely to withstand the small amounts of sedimentation that is estimated to occur within the Project Area during construction. In addition, studies by Maurer et al. (1986) found that several species of marine benthic infauna (the clam *Mercenaria mercenaria*, the amphipod *Parahaustorius longimerus*, and the polychaetes *Scoloplos fragilis* and *Nereis succinea*) exhibited little to no mortality when buried under up to 3 in (8 cm) of various types of sediment (from predominantly silt-clay to pure sand). These data suggest that burial up to 0.4 in (10 mm) of sediment resulting from jet plow construction activities will have no effect on typical benthic species near the trench (Wilber and Clarke 2001). Given the minimal area of potential disturbance and the short-duration of cable-laying activities, it is anticipated that once the disturbed area has stabilized physically, benthic recolonization will occur and the areas of disturbance will return to pre-construction physical conditions.

Direct or Indirect Effects from Changes in Water Quality

The primary water quality component with potential for indirect impacts on benthic resources during construction, operation, or decommissioning is turbidity. Isolated and temporary increases in turbidity and suspended sediment will result from jet plowing and ROV trenching of the Export Cable and Inter-Array Cable, as well as during installation of the WTGs and placement of the additional cable protection. Immediately following disturbance, this turbidity would begin to be re-deposited on surrounding habitat, as described above, with minimal impact to benthic resources. Fine sediment particles such as silt and clay will remain in suspension for approximately 6 to 7 minutes after initial release, while sand and gravel settle more quickly (Marszalek 1981) (Appendix G). Since the Project site is dominated by sand-size particles, an increase in turbidity is not expected to be long-lasting.

Direct or Indirect Effects from EMF

The EMF emitted from the operating Export Cable may have potential effects on benthic resources in the Project Area. Little is known about whether benthic invertebrates are affected by EMF and, if they are, what their responses would be (Normandeau et al. 2011). Susceptibility experiments have focused on arthropods, but several mollusks and echinoderms could also be susceptible to EMF. However, because susceptibility is variable within taxonomic groups, it is not possible to make generalized predictions for groups of marine invertebrates. Sensitivity thresholds, which vary by species, range from 0.3 to 30 millitesla, and responses include non-lethal physiological and behavioral changes (Normandeau et al. 2011).

Detailed modeling of the EMF field is included in Appendix K. EMF modeling of the Inter-Array Cable and Export Cable indicates that for the Inter-Array Cable the average magnetic field would be 3.1 milligauss (mG) and the maximum field would be 9.1 mG at the target burial depth of 3.3 ft (1 m). For the Offshore Export Cable, the average magnetic field would be 1.6 mG and the maximum field would be 4.8 mG at the targe burial depth of 6.6 ft (2 m). Magnetic fields will attenuate with distance both vertically and horizontally. Given that benthic infauna are typically most abundant in the uppermost 0.5 ft (0.15 m) of the seafloor, and Dominion plans to bury the Inter-Array Cable below at least 3.3 ft (1 m) of sediment and the Export Cable below at least 6.6 ft (2 m) of sediment, most infauna would have minimal exposure to EMF from the Export Cable. EMF levels from the Inter-Array Cable are expected to be lower than those from the Export Cable due to the lower levels of electrical current. It is, therefore, unlikely that EMF from either the Inter-Array or Export Cable will impact the benthic community.

4.3.2.2 Demersal and Pelagic Fish

Disturbance or Displacement of Habitat

The impacts to seafloor habitat were described in Section 4.3.2.1. Unlike most benthic fauna, many fishes are highly mobile and would be able to avoid direct mortality or injury associated with Project construction, operation, or decommissioning. There will, however, be certain habitat disturbances that will result in the displacement of demersal and pelagic fish from a portion of the available habitat within the Project Area. If a fish approaches the areas affected by construction activities (e.g., jet plowing/ROV jet trenching, pile driving, vessel anchoring and jacking), it would likely move away from the activity. Any fish that are displaced during construction are expected to return quickly following construction.

As previously stated, the benthic habitat within the Project Area is composed almost entirely of sand, so the habitat disturbed will not be unique within the Project Area. Once installed, the WTGs would provide hard substrates for the colonization by benthic organisms, which could serve as an additional food resource for finfish and provide a structure for finfish to congregate around. The permanent conversion of 0.2 ac (0.1 ha) of soft substrate to hard substrate associated with the footprint of the IBFS foundations and the maximum 23.4-ac (9.5-ha) footprint associated with the additional cable protection will also represent a very small amount of lost sand substrate habitat to demersal species. Both the WTG foundations and the rock berms/concrete mattresses are likely to provide additional habitat that would be suitable for structure-oriented species like the black sea bass, and colonization by sessile benthic species. For example, the

Chesapeake Light Tower, located at the mouth of the Chesapeake Bay, has been recognized as an exceptional source of habitat for aquatic life, especially structure-oriented species including black sea bass, flounder, king mackerel, Spanish mackerel and cobia. Impacts on demersal species from the disturbance of habitat during WTG installation is expected to be minor, given the relatively small affected area and short-term duration of activities. Demersal fish are expected to return to the area once construction activities are complete.

Operation of the VOWTAP and the associated Inter-Array and Export Cables will not have a significant effect on demersal or pelagic finfish species. It is possible, however, that as the WTGs become an established part of the marine environment and are covered by algae and sessile invertebrates, these areas could attract finfish and other mobile species to the Project Area.

Direct or Indirect Effects from Changes in Water Quality

The primary water quality component with potential for impact on fish during construction or decommissioning is turbidity (operation of the Project will not result in turbidity). Isolated and temporary increases in turbidity will result from jet plowing and ROV jet trenching of the Inter-Array Cable and Export Cable, as well as during installation of the WTGs. Activities that resuspend sediments have the potential to negatively impact early life stages of fish species (EPA 1976; Colby and Hoss 2004). Turbidity-related impacts may include reductions in growth and feeding rates, and the clogging of respiratory structures.

Installation of VOWTAP submarine cables using a jet plow and ROV jet trencher, in particular the Export Cable (which had the deepest target range of burial depth of at least 6.6 ft [2 m]) will be the greatest potential source of increased turbidity in the Project Area. Results of the VOWTAP Sediment Transport Analysis (Appendix G) indicate that under worst-case assumptions initial suspended sediment concentrations directly above (within 6.6 ft [2 m] above the seafloor) the immediate centerline of the route may be quite high, ranging between 6,700 mg/L to 400,000 mg/L, but would decrease to ambient levels within 6 to 7 minutes. Higher concentrations of suspended sediments may also occur along the portion of the cable route closer to shore, due to the presence of stronger currents, however, concentrations would diminish rapidly by several orders of magnitude within 16 ft to 33 ft (5 m to 10 m) of the centerline. The maximum zone of the lowest concentrations of suspended sediments will be confined to an area within 328 ft to 492 ft (100 m to 150 m) of the jet plow trench (see Figure 4.3-1). Since the modeled plume would extend only about 6.6 ft (2 m) above the seafloor, pelagic species will not encounter the turbidity resulting from the jet plow activities.

Impacts on demersal fish species from excess suspended sediments from the proposed construction cable installation activities have the potential to result in varying degrees of effects ranging from no effect to lethal effects (Newcombe and Jensen 1996). The severity of impacts is typically associated with both the concentration of suspended sediments and the duration of exposure. According to Wilber and Clarke

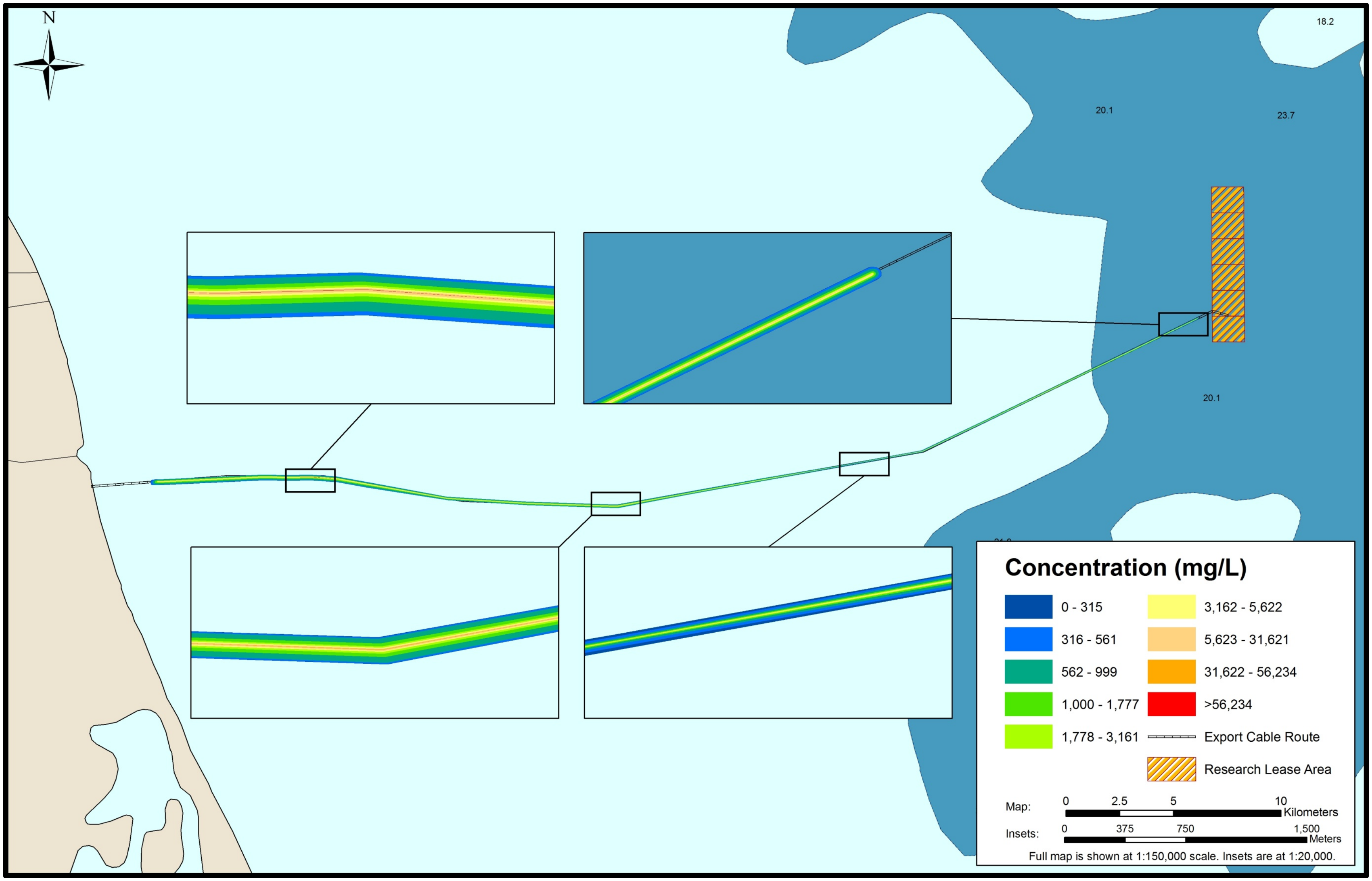


Figure 4.3-1. Jet Plow Fine Sediment Plume Along Proposed Cable Route (from Woods Hole Group 2013)

(2001), the estimated levels of TSS that are anticipated to occur outside of the immediate vicinity (beyond 16.4 ft to 32.8 ft [5 m to 10 m] from the center) of the jet plow/ROV jet trencher path are unlikely, in terms of both concentration and duration, to cause either lethal or sub-lethal effects to fish. The demersal fish located along the immediate centerline would likely leave the area as the jet-plow/ROV jet trencher approaches, thus avoiding the turbidity plume. In the unlikely event individuals remain within the immediate path of the trench, effects ranging from temporary physiological stress to mortality could occur (Wilber and Clarke 2001). Upon completion of jet-plowing/ROV jet trenching activities and re-deposition of the suspended sediments, demersal species are expected to return to the Project Area.

Disturbance or Injury from Project-Related Noise

Sources of underwater construction noise include impact pile driving of the IBGS foundation and use of DP thrusters during cable installation. Of these, pile driving is likely the most disruptive and, therefore, considered most extensively in this section. A discussion of underwater noise resulting from each of these construction activities is provided in Section 4.15.

The sensitivity of marine fish species to sound is highly variable, and largely unknown – hearing sensitivity is known for less than 0.004% of extant species of fish (NRC 2003). Noise impacts on marine fish resources depend on loudness, the specific acoustic frequency pattern at a given location, the distance from the sound source, and a fish's particular hearing sensitivity (MMS 2000). Current data suggest that most species of fish detect sounds from 50 to 1,000 Hertz (Hz), with few fish hearing sounds above 400 Hz (Popper 2008). It is believed that most fish have their best hearing sensitivity from 100 – 400 Hz (Popper 2003). Additionally, some clupeid herring possess ultrasonic hearing (i.e., able to detect sounds above 100,000 Hz) (Astrup 1999).

All fish have two sensory systems to detect sound in the water: the inner ear, which functions very much like the inner ear in other vertebrates, and the lateral line, which consists of a series of receptors along the fish's body (Popper 2008). The inner ear generally detects relatively higher-frequency sounds, while the lateral line detects water motion at low frequencies (below a few hundred Hz) (Hastings and Popper 2005). Furthermore, a fish's gas-filled swim bladder can enhance sound detection by converting acoustic pressure into localized particle motion, which may then be detected by the inner ear. Fish with swim bladders generally have better sensitivity and better high-frequency hearing than fish without swim bladders (Popper and Fay 2010).

Noise generated from pile driving and DP thruster use during VOWTAP construction could potentially affect some fish species if present during construction activities, particularly those with swim bladders. However, because the effects of pile driving noise on fish are poorly studied and there appears to be substantial variation in a species' response to sound, interpretations regarding the acoustic effects of the Project must be made cautiously. Exposure to sound from pile-driving activities may elicit behavioral responses, or cause fish to become temporarily stunned, making them more susceptible to predators. In addition, if pile driving were to occur during fish migrations, species avoidance behavior could result in a temporary barrier to fish migrations. Under certain conditions, intense sound pressure waves can change fish behavior or injure/kill fish by rupturing swim bladders or causing internal hemorrhaging (Hastings and Popper 2005). While impact pile driving activity has been linked to fish mortality, there are insufficient data to indicate the percentage mortality, whether some species are more susceptible to sound than others, and the distance at which fish could be killed (Hastings and Popper 2005). It is possible that fish outside a designated zone of influence are damaged and that ultimately this damage would indirectly lead to mortality.

An interagency work group, including the U.S. Fish and Wildlife Service (USFWS) and NOAA Fisheries, has reviewed the best available scientific information and developed criteria for assessing the potential of pile driving activities to cause injury to fish (FHWG 2008). The workgroup established dual sound criteria for injury, measured 33 feet away from the pile, of 206 decibels (dB) re 1 micropascal (µPa) Peak and 187 dB accumulated sound exposure level (dB cSEL; re: 1µPa2-sec) (183 dB accumulated SEL for fish less than 2 grams). Using a worst-case distance and assuming continuous exposure, the real-time received noise levels associated with VOWTAP pile driving that would potentially result in cumulative exceedances of the 187 dB cSEL are approximately equivalent to a 1-second SEL of 148 to 149 dB_{RMS}, below the threshold level to cause a physiological or even potential behavioral response for fish.

Some demersal fish, such as flounders, do not have swim bladders or strong hearing capacities, thus are not affected by underwater noise in the same manner as a pelagic fish (Popper and Fay 2010). Regardless of hearing sensitivity, it is probable that the noise and other disturbances will be sufficient to motivate most fish to temporarily leave the construction area, increasing the distance between the fish and the noise source. Upon completion of construction activities, finfish species are expected to return to the Project Area.

Further, the avoidance and minimization measures for marine mammals discussed in Section 4.3.2.3, especially the soft start and ramp-up procedures, will further reduce impacts to demersal and pelagic fish. During operations, it is likely that the WTGs will produce low-level, continuous underwater sound. There is currently no data on impact thresholds for fish exposed to continuous noise. It is likely, however, that noise levels of the operating wind farm will be too low (outside of the hearing range of most fish) to cause injury to finfish species.

Indirect Effects from Changes in Prey Availability

Benthic fauna serve as direct and indirect food sources for demersal fish. Therefore, the loss of benthic communities from construction activities in the isolated area around the IBGS foundations and Inter-Array and Export Cable routes could cause individual fish to avoid feeding in these areas for a short period. However, since the habitat type affected in the Project Area (sand) is highly abundant throughout the entire Mid-Atlantic Bight, these individuals could move to adjacent, unaffected locations where they would find similar prey resources, and thus quickly return to normal feeding and behavior patterns.

Direct or Indirect Effects from EMF

The EMF emitted from the operating Inter-Array Cable and Export Cable may potentially affect a variety of fish in the Project Area. Elasmobranch and other fish species, including migratory and demersal species, that encounter EMFs from operating transmission cables may experience behavioral changes, altered feeding patterns, altered migratory patterns, or reproductive effects, with impacts potentially ranging from temporary and isolated to long-term (Gill and Kimber 2005; Normandeau et al. 2011). Some fish groups that occur in coastal Virginia waters have an acute sensitivity to electrical fields (Bullock et al. 1983; Helfman et al. 2009), with elasmobranchs (e.g., sharks, skates, rays) being the most sensitive (Rigg et al. 2009). This electromagnetic response in elasmobranchs is due to the presence of a specialized electroreceptive apparatus (the Ampullae of Lorenzini), used to detect prey (Akoev et al. 1976; Kalmijn et al. 2002; Gill and Kimber 2005). Their sensitivity to electromagnetic fields may result in confusion of

EMF signals from a transmission cable with prey fields during foraging (Gill and Kimber 2005). Although pelagic species occur at a greater spatial separation (away from the bottom) from potential EMF sources, they may still be sensitive to the presence of magnetic fields. Many migratory pelagic species (salmonids, eels, etc.) have been found to contain ferromagnetic material (magnetite) which may be used for spatial orientation with geomagnetic fields. The EMF from transmission cables may disrupt that orientation during migration (Kirschvink et al. 1985; Mann et al. 1988; Öhman et al. 2007) as a fish moves over a subsea cable during its seasonal movements along the coastline or to offshore habitats. This disruption may lead to temporary changes in direction and the speed of travel (Gill and Kimber 2005; Öhman et al. 2007; Normandeau et al 2011). However, not all interactions may be adverse, as the cables may provide future recognizable landmarks to those individuals (Normandeau et al. 2011). Resident, non-migratory species, especially demersal species in contact with the seafloor, may also exhibit similar responses, but may be able to habituate to the magnetic fields emitted (Gill and Kimber 2005; Normandeau et al. 2011). Responses to EMFs vary between individual and species' sensitivities, though stronger fields closer to cables often result in repulsion.

The burial of the VOWTAP Inter-Array and Export Cable at target burial depths of at least 3.3 ft to 6.6 ft (1 m to 2 m), respectively, below the seafloor in soft sediments (e.g., sand) will likely minimize the potential for interactions of elasmobranchs, or other demersal and pelagic fishes, with the EMF associated with the Project marine cables. EMF modeling of both the Inter-Array Cable and Export Cable (included in Appendix K) indicates that for the Inter-Array Cable the average magnetic field would be 3.1 mG and the maximum field would be 9.1 mG at the target burial depth of 3.3 ft (1 m). For the Offshore Export Cable, the average magnetic field would be 1.6 mG and the maximum field would be 4.8 mG at the targe burial depth of 6.6 ft (2 m). Magnetic fields will attenuate with distance both vertically and horizontally. These predicted EMF levels at the seafloor are well below the theoretical detection level of 5 nanovolts/cm for electrosensitive fish with magnetite-based sensory systems that are known to occur in the Project Area (Normandeau et al. 2011). Therefore, it is unlikely that EMF from either the Inter-Array or Export Cable during average or peak loads will affect or alter the fish community or their behavior in the Project Area (Normandeau et al. 2011).

Direct or Indirect Effects from Project-related Lighting

The use of lighting during construction, operation, and decommissioning is described in Sections 3.2 through 3.6. Some fish species may be attracted to or avoid artificial light. The WTGs and vessels used during construction, operation, and decommissioning will be required to use navigational lights, deck lighting, or other types of lighting to ensure safety during nighttime operations. The Project lighting best management practices described in Section 4.3.2.2 will minimize the potential impacts associated with artificial lighting on fish to the extent possible. Demersal species are bottom-oriented and are not likely to encounter Project lighting. The lighting used on the Project support vessels may result in temporary and isolated fish attraction at the surface, but would not result in adverse impacts to the fish resources in the Project Area.

4.3.2.3 Marine Mammals

Direct Mortality or Injury

The primary risks to marine mammals that could result in either direct injury or mortality include collision with vessels and entanglement. Research indicates that most vessel collisions that result in serious injury or death for whales occur when a ship is traveling at speeds of over 16.1 mph (14 knots) (Laist et al. 2001). In addition, impacts from vessel collisions tend to be greater for baleen wales than for any other marine species (Wiley et al. 1995). As described in Section 3.3.4, the VOWTAP will require the support of a variety of vessels throughout various stages of construction (see Table 3.3-1). Project decommissioning will involve similar types and numbers of vessels, and Project operation will require a relatively low level of vessel activity over the operational life of the Project.

Vessels supporting the VOWTAP have the potential to interact with marine mammals traversing the Project Area. However, the vessel traffic associated with the construction, operation and decommissioning of the VOWTAP does not represent a significant increase to the existing levels of marine traffic in the Project Area. Further, most of the proposed Project support vessels will travel at speeds slower than 16.1 mph (14 knots), with the exception of the smaller crew/supply boats and the operational support vessel, which can travel at faster speeds, if necessary. Because ship speed is the greatest factor in vessel collisions, and most ships involved with Project construction, operation, and decommissioning activities will typically travel at slow speeds, collisions between whales and Project-related vessels are unlikely, and whales should be easily able to maneuver around Project-related vessels. In addition, studies have indicated that during periods of concentrated vessel activity, whales may temporarily avoid an area entirely due to both the increased presence of the ships themselves and/or from the ambient noise generated by the associated vessel activities (Erbe 2002; Jelinski et al. 2002; Nowacek 2004); this behavior trait further reduces the potential for impact.

To reduce risks to marine mammals from vessel collisions to the maximum extent possible. Dominion has scheduled construction to take place outside of the peak migratory period for the North Atlantic right whales. Dominion will also comply with the NOAA speed restrictions within the Mid-Atlantic U.S. Seasonal Management Area (SMA) of 10 knots for vessels 65 ft (19.8 m) or greater during the period of November 1 through April 30. Figure 4.14-1 depicts the location of the SMA in relation to the VOWTAP. In addition, personnel onboard construction, operation, and/or decommissioning vessels will receive training on marine mammal sighting and reporting that will stress individual responsibility for marine mammal awareness and protection. Dominion is also committed to following NOAA's Operational Guidelines When in Sight of Whales (NOAA Fisheries & NOS 2013), unless doing so would compromise human or environmental health and safety and/or the integrity of the Project.

The risk of injury or mortality from Project-related entanglement is unlikely. The only lines that will be deployed in support of the Project will be associated with the construction barge anchor cables, the jet plow towing cable, and ROV jet trencher umbilical. Steel anchor cables used on the construction barges are typically several inches in diameter and are typically under significant tension while deployed, eliminating the potential for entanglement. Similarly, the jet plow cable will be under constant tension, and in this taut condition will not represent an entanglement risk. The ROV jet trencher umbilical will be dynamic and also not present a risk of entanglement.

Disturbance or Displacement of Habitat and Associated Changes in Prey Availability

As discussed in Sections 4.3.2.1 and 4.3.2.2, potential impacts on benthic and finfish resources from substrate disturbance and increased turbidity will be localized and short-term, resulting in limited effects on marine species that would be targeted for consumption by whales. Impacts from loss of habitat will also be negligible, and will only be associated with the presence of the two WTG foundations (a combined area of 0.2 ac [0.1 ha]) and the additional cable protection (a combined maximum area of 23.4 ac [9.5 ha]).

Direct or Indirect Effects from Changes in Water Quality

Impacts to water quality from accidental fuel spills or releases of marine trash or debris during Project construction, operation, or decommissioning can result in risks to both marine mammals and other marine species from habitat destruction, entanglement and/or ingestion. In accordance with the Oil Pollution Act of 1990 (OPA-90) and the MARPOL 73/78 international treaty, owners and operators of certain vessels are required to prepare Vessel Response Plans (VRP) approved by the U.S. Coast Guard (USCG). In additional, the USCG regulates the at-sea discharges of vessel-generated waste under the authority of the Act to Prevent Pollution from Ships. All VOWTAP Project vessels will be required to comply with the applicable USCG pollution prevention requirements. Additionally, all vessels less than 79 ft (24.1 m) will comply with the Small Vessel General Permit issued by EPA on September 10, 2014 for compliance with NPDES permitting. Dominion will also ensure that all crew supporting the construction, operation, and/or decommissioning of the Project will undergo marine debris awareness training. Such training will include use of the data and educational resources available through NOAA's Marine Debris Program.

Disturbance or Injury from Project-related Noise

Sound is important to marine mammals for communication, individual recognition, predator avoidance, prey capture, orientation, navigation, mate selection, and mother-offspring bonding. Most marine animals can perceive underwater sounds over a broad range of frequencies, from about 10 hertz (Hz) to more than 10,000 Hz (10 kilohertz [kHz]). Many dolphins and porpoises use even higher-frequency sound for echolocation and perceive these sounds with high acuity. Marine mammals respond to low-frequency sounds with broadband intensities of more than about 120 dB re 1 μPa, or about 10 dB to 20 dB above natural ambient noise at the same frequencies (Richardson et al. 1991).

Potential effects of anthropogenic noise to marine mammals can include physical injury (e.g., temporary or permanent loss of hearing sensitivity), behavioral modification (e.g., changes in foraging or habitat-use patterns), and masking (the prevention of marine mammals from hearing important sounds).

The MMPA defines any act of pursuit, torment, or annoyance that has the potential to injure a marine mammal or marine mammal stock in the wild as Level A harassment (NOAA 2005; GPO 2005). Any act that has the potential to disturb marine mammals or their stock in the wild by causing disruption of behavioral patterns including, but not limited to, migration, breathing, nursing, breeding, feeding, or sheltering is referred to as Level B harassment (NOAA 2005; GPO 2005). For underwater noise, NOAA defines the zone of injury as the range of received levels from 180 linear decibels (dBL) referenced to 1 μPa root mean square (RMS) (180 dBL re 1μPa) for all marine mammals. For Level B harassment, the threshold is defined as 160 dBL re 1μPa for impulsive sound and 120 dBL re 1μPa for continuous sound for all marine mammals. Actual perceptibility of underwater sound is dependent on the hearing thresholds of the species under consideration and the inherent masking effects of ambient sound levels. The criteria established by NOAA do not consider species-specific hearing capabilities and are, therefore, very conservative.

NOAA has further established regulatory criteria to protect marine mammals from both temporary and/or permanent hearing loss. A temporary or reversible elevation in hearing threshold is termed a temporary threshold shift (TTS), while a permanent or unrecoverable reduction in hearing sensitivity is termed a permanent threshold shift (PTS) (NOAA 2006). NOAA (2006) has established a TTS of 195 dB re 1 micropascal-squared seconds (µPa2-s) and a PTS of 215 dB 1 µPa2-s for all marine mammals, based on the additional noise (dB) above TTS required to induce PTS in experiments with terrestrial mammals.

Project activities will not result in TTS or PTS. Project activities that have the potential to cause Level A or Level B harassment include impact pile-driving of the IBGS foundations and the noise associated with the intermittent use of DP vessel thrusters during installation of the Inter-Array Cable, Export Cable, and WTGs. Dominion conducted a detailed underwater acoustic modeling assessment to better understand both the level and extent of underwater noise generated by Project activities and their potential to impact marine species (Appendix M-2). Results of this analysis are summarized in Section 4.15.2. Table 4.15-7 presents the minimum and maximum distances to the NOAA threshold criteria associated with the construction and operation of the Project.

Dominion will obtain all necessary permits to address potential impacts on marine mammals from underwater noise, and will establish appropriate mitigation measures. Dominion will also commit to the following measures, which have been successfully implemented during similar offshore construction activities, to minimize impacts on marine mammals to the maximum extent possible. These measures are also applicable to ESA listed marine mammals and sea turtles, which are further discussed in Sections 4.6.2.2 and 4.6.2.3:

- **Establishment of Exclusion and Monitoring Zones** – Exclusion zones (defined as the Level A harassment ZOI out to the 180 dB isopleth) and monitoring zones (defined as the Level B harassment ZOI out to the 120 dB and 160 dB isopleths for continuous and impulse noise, respectively) will be established to minimize potential impacts to marine mammals.
- **Field Verification of Exclusion and Monitoring Zones** – Field verification of the proposed exclusion and monitoring zones for pile driving and DP vessel thruster use will be conducted during the first full day of both foundation and cable installation activities. During each activity, acoustic measurements will include measurements from two reference locations at two water depths (a depth at mid-water and a depth at approximately 3.3 ft [1 m] above the seafloor). If the field measurements determine that the actual Level A and Level B harassment ZOIs are less than or extend beyond the proposed exclusion zone and/or monitoring zone radii, a new zone(s) will be established accordingly in coordination with jurisdictional agencies.
- **Protected Species Observers (PSOs)** – PSOs will perform visual monitoring of the exclusion and monitoring zones established for pile driving and DP vessel thruster use. PSOs will be qualified and approved by NOAA Fisheries. Observer qualifications will include direct field experience on a marine mammal (and sea turtle) observation vessel or aerial surveys in the Atlantic Ocean/Gulf of Mexico. A minimum of three PSOs will be stationed aboard each noise-producing construction support vessel (e.g., jack-up barge and cable lay vessel). Each PSO will monitor 360 degrees of the field of vision and will have the authority, in coordination with Dominion's onsite Construction

Manager (or other authorized individual), to implement the necessary marine mammal (and sea turtle) protection measures (e.g., shut-down, ramp-down, and/or ramp-up procedures) during construction activities if marine mammals (or sea turtles) are seen approaching the established exclusion and monitoring zones and/or the zones cannot be adequately monitored (i.e., obscured by fog, inclement weather, poor lighting conditions).

- **Ramp-up/Soft-Start Procedures** – A ramp-up (also known as a soft-start) will be used for construction equipment capable of adjusting energy levels. The DP vessel thrusters will be engaged from the time the vessel leaves the dock; therefore, there is no opportunity to engage in a ramp up procedure for this noise source. For impact pile driving, ramp-up requires an initial set of three strikes from the impact hammer at 40 percent energy with a 1-minute waiting period between subsequent three-strike sets. The procedure will be repeated two additional times. A ramp-up will be used at the beginning of each pile segment during impact pile driving in order to provide additional protection to marine mammals near the VOWTAP Area by allowing them to vacate the area prior to the commencement of pile-driving activities. The ramp-up procedure for the pile driving will not be initiated if the monitoring zone cannot be adequately monitored (i.e., obscured by fog, inclement weather, poor lighting conditions) for a 60-minute period. If a ramp-up has been initiated before the onset of inclement weather, activities may continue through these periods if deemed necessary to ensure the safety and integrity of the Project. If marine mammals are sighted within the impact pile driving monitoring zone prior to or during ramp-up procedures, activities will be delayed until the animal(s) moves outside the monitoring zone and no marine mammals (or sea turtles) are sighted for a period of 60 minutes.
- **Shut-down Procedures** – PSOs will work in coordination with Dominion's onsite Construction Manager (or other authorized individual) to stop or delay any construction activity, if deemed necessary and/or safe to do so. It is important to note, however, that any significant stoppage of impact pile driving progress or stoppage in vessel maneuverability during jet plow activities has the potential to result in significant damage to both the foundations and the cable. Therefore, if marine mammals (or sea turtles) are sighted approaching the monitoring and/or exclusion zone during either of these operations and the stoppage of the construction activities would compromise safety (human health and/or environmental) and/or the integrity of the Project Dominion proposes that the hammer energy be reduced to the 40 percent "ramp-up" level and DP thrusters be powered down to the minimum output possible. This reduction in hammer and thruster energy will effectively reduce the potential for exposure of marine mammals (and sea turtles) to sound energy, proportional to the reduction in force. By maintaining impact pile driving and cable laying operations at the reduced energy levels, the momentum of piling penetration and jet plowing can be maintained, minimizing risk to both Project integrity and marine life.
- **Time of Day Restrictions** – Pile driving for wind turbine foundation installation will occur during daylight hours, starting approximately 30 minutes after dawn and ending 30 minutes prior to dusk, unless a situation arises where ceasing the pile driving activity would compromise safety (human health and/or environmental) and/or the integrity of the Project. If a soft-start has been initiated prior to the onset of inclement weather (e.g., fog, severe rain events), the pile driving of that segment may be completed. No new pile driving activities will be initiated until 30 minutes after

dawn or after the inclement weather has passed. Cable installation will be conducted 24 hours per day. Night vision equipment will be used by PSOs to monitor the DP thruster monitoring zone.

- **Reporting** – Dominion will provide, as required, to jurisdictional/interested agencies, including the USACE, NOAA Fisheries, and BOEM, notification of both commencement and completion of construction activities, re-establishment of safety and/or exclusion zones, observed significant behavioral reactions by marine mammals (or sea turtles) (e.g., fleeing the area), and injury or mortality to any marine mammals (or sea turtles). Dominion will also provide a final technical report after Project construction has been completed.

Operation and decommissioning of the VOWTAP are unlikely to cause potential acoustic impacts on marine mammals or sea turtles unless DP vessels are employed. Operational noise from turbine structures may occur, but is likely to be only measureable above ambient levels at frequencies below 500 Hertz (Tougaard et al. 2009) and likely be confined to the immediate vicinity around the WTGs. As such, underwater noise from the operating VOWTAP WTGs are not expected to have a great influence on these highly mobile species. As part of its future technology testing plan for the VOWTAP, Dominion is committed, to better understand the noise associated with the operating WTGs and will, therefore, monitor and observe underwater noise during a 2-week real-time monitoring period to collect data on the full range of wind turbine operational conditions. Should DP vessels be used during either operation or decommissioning, Dominion will follow, as appropriate, the marine mammal avoidance and mitigation procedures employed during construction.

4.4 Terrestrial Biological Resources

This section discusses the biological resources within and surrounding the onshore portions of the Project Area. These resources include plant species and vegetation communities, the wildlife habitats they provide, and the wildlife species present. Section 4.5 discusses avian and bat species, and Section 4.6 discusses state and federal threatened and endangered species known to occur within the terrestrial portion of the Project Area. Wetlands and terrestrial habitats are addressed separately in Section 4.8.

The resource discussions are based on reviews of available literature and information gathered during Project site visits conducted in 2013.

4.4.1 Affected Environment

4.4.1.1 Vegetation

The onshore portion of the Project Area is located within the City of Virginia Beach, Virginia. Habitats in the City and the region generally have been altered by human development and are highly fragmented. The largest patches of natural habitat in the vicinity of the onshore Project Area occur on conservation lands, protected areas, and military reservations. No conserved lands occur within or immediately adjacent to the proposed cable landfall or Onshore Interconnection Cable and Fiber Optic Cable route.

The terrestrial portion of the Project Area occurs in two ecoregions. The Export Cable landfall site is located in the Middle Atlantic Coastal Plain-Virginia Barrier Islands and Coastal Marshes ecoregion (EPA Level IV, Bailey et al. 1994). Beaches, dunes, and salt marshes are the dominant topography in the region (Woods et al. 1999). Further inland of these beach areas, the habitat transitions to the Middle Atlantic Coastal Plain-

Chesapeake-Pamlico Lowlands and Tidal Marshes ecoregion (Woods et al. 1999). Topography in the Chesapeake-Pamlico Lowlands is uniformly low in elevation and nearly flat, with tidal ponds, marshes, and streams. Tidal marshes and some freshwater ponds occur in areas of poorly drained, silty soils. Brackish and freshwater wetlands provide habitat for marine and estuarine fish, shellfish, and waterfowl.

An Oak-Hickory-Pine Forest extends from the Virginia Barrier Island and Coastal Marshes ecoregion into the Chesapeake-Pamlico Lowlands ecoregion, and is the dominant vegetation community on well-drained soils. This community type supports upland forest wildlife species, including canebrake rattlesnake (*Crotalus horridus*). Agriculture, urban development, and industrial development are common land uses, and have impacted drainage in the region. Areas of natural habitat have been isolated and fragmented by development.

The Virginia Natural Heritage Program employs a system of ranking the range-wide conservation status of vegetation types, similar to the global conservation ranking system. Maritime Dune Grassland and Upper Beach communities occur at the proposed Export Cable landfall site (Fleming and Patterson 2012). Maritime Dune Grassland habitat is ranked as S2 (imperiled community type), and Upper Beach is ranked as S3 (vulnerable community type) in Virginia (Fleming and Patterson 2012). The Maritime Dune Grassland community at the Export Cable landfall site is restricted to a small dune strip and fore-dune area above the upper beach and inter-tidal zone. The Maritime Dune Grassland community is heavily influenced by wind and the maritime environment, and is dominated by beachgrass (*Ammophila* spp.). These habitats may be used by shorebirds and seabirds, as well as terrestrial and marine invertebrates (Fleming and Patterson 2012).

There are remnants of Maritime Upland Forest along the Onshore Interconnection Cable and Fiber Optic Cable route. These isolated stands are dominated by hardwoods, including oak (Quercus spp.), maple (Acer spp.) and sweet gum (Liquidambar stryaciflua); loblolly pine (Pinus taeda) also occurs, and there is greenbrier (Smilax spp.) in the understory. Other habitats along these routes include early successional loblolly pine stands and mowed grass areas.

4.4.1.2 Wildlife Habitats and Species

The vegetation communities of the onshore Project Area support a diverse animal population, including 27 species of amphibians, 40 reptile species, and 35 mammal species. Table 4.4-1 lists terrestrial wildlife species potentially occurring in or near the Project Area, which are not federally or state listed or have special conservation status. Species with special status are discussed in Section 4.6.

Shorebirds, raccoons, and other terrestrial mammals may occur at the proposed Export Cable landfall location. Forest nesting birds, terrestrial mammals, amphibians, and reptiles common to southeastern Virginia may occur along forested uplands adjacent to, but not within, the Onshore Interconnection Cable and Fiber Optic Cable route.

At the Export Cable landfall site, sand dunes are located approximately 50 ft to 90 ft (15 m to 27 m) from the proposed onshore HDD Work Area adjacent to a state-owned beach. As stated previously, sand dune habitats may be used by shore birds and seabirds, as well as terrestrial and marine invertebrates (Fleming and Patterson 2012). At the Export Cable landfall site, the dunes are a known nesting habitat for sea turtles.

These dunes are protected by the VMRC. Construction or other activities that may damage coastal sand dunes or state-owned beaches are not permitted unless expressly authorized by the VMRC.

Table 4.4-1. Terrestrial Wildlife Species Potentially Occurring near the Project Area

Common Name	Species Name	Habitat Association [a/]	Likely to Occur [b/]
Amphibians			
Greater siren	*Siren lacertina*	WB	Moderate
Eastern newt	*Notphthalmus virdescens*	WB, WL, UF	High
Two-toed amphiuma	*Ampiuma means*	WB	Moderate
Marbled salamander	*Amystoma opacum*	WB, WL, UF	Moderate
Northern dusky salamander	*Desmognathus fuscus*	WB, WL, UF	Low
Two-lined salamander	*Eurycea bislineata*	WB, WL, UF	Moderate
Three-lined salamander	*Eurycea guttolineata*	WB, WL, UF	Moderate
Four-toed salamander	*Hemidactylium scutatum*	WB, WL, UF	High
Eastern red-backed salamander	*Plethodon cinereus*	WL, UF	Moderate
Slimy salamander	*Plethodon glutinosus*	WL, UF	Moderate
Many-lined salamander	*Stereochilus marginatus*	WB	Moderate
Southern toad	*Bufo terrestris*	UO, UF	Moderate
Fowler's toad	*Bufo fowleri*	WL, MI	High
Southern cricket frog	*Acris gryllus*	WB, WL	High
Cope's gray treefrog	*Hyla chrysoscelis*	UF, WL	Moderate
Green treefrog	*Hyla cinerea*	UF, WL, WB	High
Pine woods treefrog	*Hyla femoralis*	UF, WL	Moderate
Squirrel treefrog	*Hyla squirella*	UF, UO	High
Spring peeper	*Pseudoacris crucifer*	UF, WL	High
Little grass frog	*Pseudoacris ocularis*	WL	High
Brimley's chorus frog	*Pseudoacris brimleyi*	WL	High
American bullfrog	*Rana catesbeiana*	WL	High
Green frog	*Rana clamitans*	WL	High
Pickerel frog	*Rana palustris*	WL, UF, UO	High
Southern leopard frog	*Rana sphenocephala*	WL, UF, UO	High
Carpenter frog	*Rana virgatipes*	WB, WL	Moderate
Eastern narrow-mouthed toad	*Gastrophryne carolinensis*	UF, UO, WL	Moderate
Reptiles			
Snapping turtle	*Chelydra serpentine*	WB, WL	High
Eastern mud turtle	*Kinosternon subrubrum*	WB, WL, UF, UO	Moderate
Striped mud turtle	*Kinosternon baurii*	WB, WL, UF, UO	Moderate
Musk turtle	*Sternotherus odoratus*	WB, WL	Moderate
Florida cooter	*Pseudemys floridana*	WB, WL	Moderate
Northern red-bellied cooter	*Psuedemys rubriventris*	WB, WL	Moderate
Painted turtle	*Chrysemys picta*	WB, WL	Moderate
Pond slider turtle	*Trachemys scripta*	WB, WL	Moderate
Spotted turtle	*Clemmys guttata*	WB, WL	Moderate
Diamond backed terrapin	*Malaclemys terrapin*	WB, MI	Moderate
Eastern box turtle	*Terrapene Carolina*	WB, WL, UF, UO	High

Table 4.4-1. Terrestrial Wildlife Species Potentially Occurring near the Project Area

Common Name	Species Name	Habitat Association [a/]	Likely to Occur [b/]
Eastern fence lizard	*Sceloporus undulates*	UF, UO	High
Common five-lined skink	*Eumeces fasciatus*	UF	Moderate
Southeastern five-lined skink	*Eumeces inexpectatus*	UF, UO, MI	High
Broad-headed skink	*Eumeces laticeps*	UF, UO	Moderate
Little brown skink	*Scincella lateralis*	UF, UO	Moderate
Six-lined racerunner	*Cnemidophorus sexlineatus*	UF, UO, MI	High
Slender glass lizard	*Ophisaurus attenuates*	UF, UO	High
Eastern worm snake	*Carphophis amoenus*	UF	High
Scarletsnake	*Cemophora coccinea*	UF	Moderate
Eastern racer	*Coluber constrictor*	UO, UF	Moderate
Ring-necked snake	*Diadophis punctatus*	UO, UF, WL	Moderate
Eastern ratsnake	*Elaphe obsolete*	UO, UF	Moderate
Rainbow snake	*Farancia erytrogramma*	WB, WL, UO	Moderate
Eastern hog-nosed snake	*Heterdon platirhinos*	UF, UO, WL	Moderate
Milksnake	*Lampropeltis triangulum*	UF, UO	Moderate
Plain-bellied watersnake	*Nerodia erythrogaster*	WB, WL	High
Northern watersnake	*Nerodia sipedon*	WB, WL	High
Brown watersnake	*Nerodia taxispilota*	WB, WL	High
Rough greensnake	*Opheodrys aestivus*	WL, UF	Moderate
DeKay's brownsnake	*Storeria dekayi*	UF, UO	Moderate
Red-bellied snake	*Storeria occipitomaculata*	UF, UO	Moderate
Eastern ribbonsnake	*Thamnophis sauitus*	UF, UO	High
Common gartersnake	*Thmnophis sirtalis*	UF, UO	High
Smooth earthsnake	*Virginia valeriae*	UF, UO	Moderate
Copperhead	*Agkistrodon contortix*	UO, UF	Moderate
Cottonmouth	*Agkistrodon piscivorus*	WB, WL	Moderate
Mammals*			
Virginia opossum	*Didelphis virginiana*	UF, UO	High
Pygmy shrew	*Sorex hoyi*	UF, UO	Moderate
Southern short-tailed shrew	*Blarina carolinensis*	UF, UO	High
Least shrew	*Cryptotis parva*	UO	High
Eastern mole	*Scalopus aquaticus*	UF, UO	High
Star-nosed mole	*Conylura cristata*	WL, UO	High
Eastern cottontail	*Sylvilagus floridanus*	UO, UF	High
Marsh rabbit	*Sylvilgaus palustris*	WL, UF	Low
Eastern chipmunk	*Tamias striatus*	UO, UF	High
Woodchuck	*Marmota monax*	UO, UF	High
Eastern gray squirrel	*Sciurus carolinensis*	UF	High
Eastern fox squirrel	*Sciurus niger*	UF	High
Southern flying squirrel	*Glaucomys volans*	UF	High
American beaver	*Castor Canadensis*	WB, WL	Moderate
Marsh rice rat	*Oryzomys palustris*	WL	Moderate
Eastern harvest mouse	*Reithrodontomys humulis*	UO	Moderate
Cotton mouse	*Peromyscus gossypinus*	WL	Moderate
White-footed mouse	*Peromyscus leucopus*	UF, UO	High

Table 4.4-1. Terrestrial Wildlife Species Potentially Occurring near the Project Area (continued)

Common Name	Species Name	Habitat Association [a/]	Likely to Occur [b/]
Golden mouse	*Ochrotomys nuttalli*	UF, UO	High
Hispid cotton rat	*Sigmodon hispidus*	UO	High
Meadow vole	*Microtus pennsylvanicus*	UO, UF	High
Woodland vole	*Microtus pinetorum*	UF	Moderate
Muskrat	*Ondatra zibethicus*	WB, WL	High
Southern bog lemming	*Synaptomys cooperi*	WL, UF	Moderate
Meadow jumping mouse	*Zapus hudsonius*	UO, WL	Moderate
Coyote	*Canis latrans*	UO, UF, WL	High
Gray fox	*Urocyon cineroargenteus*	UF, UO	High
Northern raccoon	*Procyon lotor*	UF, UO, WL	High
Long-tailed weasel	*Mustela frenata*	UF, UO	Moderate
American mink	*Mustela vison*	WB, WL	Moderate
Northern river otter	*Lontra Canadensis*	WB, WL	Moderate
Striped skunk	*Mephitis mephitis*	UF, UO	High
Bobcat	*Lynx rufus*	UF, UO, WL	Low
White-tailed deer	*Odocoileus virginianus*	UF, UO, WL	High

a/ Habitat association code: WB –Waterbodies, WL – Wetlands, UO- Upland Open habitat, UF- Upland Forested habitat, CI- Coastal or Intertidal
b/ Potential for Occurrence Onsite: Unlikely– no species range overlap with Project Area or unsuitable habitat in Project vicinity; Low– species range overlaps with Project Area and marginally suitable habitat in Project vicinity; Moderate– species range overlaps with Project Area and suitable habitat present in Project Area, or species known to occur in habitat similar to Project Area; High–highly suitable habitat present in Project Area, or known populations exist in Project vicinity, Present - species observed during field survey. Source: Rappole 2007

4.4.2 Potential Impact Producing Factors, Proposed Environmental Protection Measures, and BMPs

The onshore Project components will not impact conservation lands or other areas of high quality or protected habitat, as the Project has been sited to avoid such areas.

Potential impact producing factors associated with the Project in relation to terrestrial biological resources include the following:

1. Permanent alteration or displacement of vegetation communities and wildlife habitats created by the long-term physical footprint of Project facilities
2. Temporary disturbance to wildlife habitat and species resulting from construction activities
3. Ongoing disturbance of wildlife species as a result of Project operation and maintenance activities

The Export Cable landfall and the Onshore Interconnection Cable and Fiber Optic Cable will be installed using HDD. Use of HDD at the Export Cable landfall site will avoid impacts to sensitive beach and sand dune habitat. The Interconnection Cable and Fiber Optic Cable will be below grade and within the existing road ROW and/or previously disturbed areas. As a result, clearing of native vegetation is not expected during construction along the route. As such, the Project will avoid disturbance of existing natural communities and associated fragmentation of wildlife habitats. Best management practices for reducing sedimentation and controlling erosion will be developed in consultation with the VDEQ and the Virginia Soil and Water Conservation Board, pursuant to 9 VAC 25-840, and areas disturbed during construction will be repaved or revegetated to meet pre-construction conditions once Project installation activities have been completed.

The Switch Cabinet will measure approximately 5 ft long by 5 ft wide by 6 ft tall (1.5 m long by 1.5 m wide by 2 m tall). It will be constructed within the footprint of the proposed onshore HDD Work Area located in the existing parking lot associated with the proposed Export Cable landfall location, and will not permanently alter or displace any wildlife species or habitat.

Operation of the Interconnection Station will result in the permanent conversion of 0.11 acre (0.04 hectares) of upland habitat to a paved or graveled surface and will result in the removal of several trees. However, this area has been previously disturbed and does not represent a loss of significant wildlife habitat. In addition, the trees to be felled will consist of primarily low quality or diseased trees.

Terrestrial wildlife species found in and near the onshore portion of the Project Area may be temporarily displaced during construction. Noise and activity during installation of the Onshore Interconnection Cable and Fiber Optic Cable and construction of the Interconnection Station, HDD Work Area, and Switch Cabinet may cause nesting, foraging, or migratory species in the vicinity to temporarily alter their behavior and avoid the area. This effect will be limited to the duration of onshore construction, approximately 3 months. Upon completion of construction, areas disturbed will either be re-paved or revegetated to meet pre-construction conditions. Wildlife will likely return to their former habitats following cessation of construction activity with no long-term effects.

Operation of the onshore components of the Project is not expected to create ongoing disturbance impacts to terrestrial habitats or species. The VOWTAP's onshore electrical equipment, including the Onshore Interconnection Cable, Fiber Optic Cable, Switch Cabinet, and Interconnection Station, will be located entirely within the boundaries of Camp Pendleton.

Decommissioning of the onshore components of the VOWTAP will be similar to construction but in reverse, therefore resulting in similar potential impacts to terrestrial biological resources.

4.5 Avian and Bat Species

This section discusses the avian and bat species within the Project Area and adjacent offshore, nearshore, and onshore areas, as well as Project activities that could potentially affect either birds or bats. Information for this section was based on available literature, including interim results of the Mid-Atlantic Baseline Study (Williams 2013), the BOEM Compendium of Avian Occurrence Information (O'Connell et al. 2009; O'Connell et al. 2012), the *Environmental Assessment of Commercial Wind Lease Issuance and Site Assessment Activities on the Atlantic Outer Continental Shelf* (O'Connell et al. 2009, NJDEP 2010, O'Connell et al. 2011, BOEM 2012), and offshore avian studies completed along the Atlantic Coast (NJDEP 2010, Rhode Island Coastal Resources Management Council 2010).

In addition, Dominion has conducted site-specific avian surveys in the Project Area. Surveys of avian activity were initiated in May 2013 and ended in April 2014 (Appendix L-1). Protocols for the VOWTAP surveys were developed in consultation with USFWS, BOEM, and VDGIF, and finalized on April 23, 2013 (Appendix L-1). Surveys were conducted in the Project Area and in a 1-nm (1.6-km) buffer around the proposed lease blocks and Supplemental Survey Area (Offshore Study Area). Avian surveys were also performed onshore, at the proposed Export and Fiber Optic Cable landfall site at Camp Pendleton Beach, along the associated Onshore Interconnection Cable and Fiber Optic Cable route and at the Interconnection Station (Onshore Avian Study Area).

Final results of the VOWTAP pre-construction avian surveys from May 2013 to April 2014 (VOWTAP avian surveys) are summarized in this section. An interim report including the results of the portion of the surveys from May to October 2013 (Appendix L-2) was submitted to BOEM, USFWS, and VDEQ on December 6, 2013. Complete results from the full year of avian surveys are provided in Appendix L-1. Any threatened and endangered avian and bat species expected to occur within the Project Area are discussed separately in Section 4.6.

4.5.1 Affected Environment

4.5.1.1 Avian Species

The population of birds on the OCS is dynamic, with seasonal changes in species composition and abundance. The nature of the marine environment and the mobility of avian species make the occurrence of a variety of species possible at nearly any location on the OCS, throughout the year (Gaston 2004). Because of the limited duration and spatial scope of the Project surveys, they may not fully describe the possible populations of birds that could be present in the Project Area. However, in combination with data from available literature and known life-history characteristics, the survey data provide sufficient information to assess the dominant trends in spatiotemporal distribution, abundance, and diversity in the Project Area. In general, avian abundance and species diversity decrease with distance from land, as demonstrated by studies in Europe and the Mid-Atlantic (Petersen et al. 2006; NJDEP 2010).

The offshore waters and adjacent coastal areas of Virginia provide habitat for avian species with special state and federal conservation status. Many of these species utilize coastal, estuarine, and nearshore marine habitats, including Important Bird Areas, National Wildlife Refuges, and other conservation areas. Portions of the Mid-Atlantic coast are considered critical stopover habitat for many species of waterfowl, shorebirds, raptors, and wading birds migrating between breeding sites in the northern latitudes and wintering areas farther south (Erwin 1996). Migration routes for pelagic species are notoriously difficult to define and may depend on a variety of factors and interactions of these factors (Bellier et al. 2007, Drewitt and Langston 2006, Gonzalez-Solis et al. 2009).

The Offshore Study Area is located approximately 24 nm (43 km) from the southern Virginia coast. Waters within the Offshore Study Area may provide seasonal habitat for loons, grebes, sea ducks, gulls, terns, pelagic birds (e.g., shearwaters, storm-petrels, and allies), and alcids (e.g., dovekie [*Alle alle*], murre [*Alca* spp.]). Some avian species, such as peregrine falcons, shorebirds, and passerines, occur primarily on the mainland and on barrier islands, but may also occur in the Offshore Study Area, primarily during migration.

The behavior of birds using the Project Area, especially flight altitude, may influence potential impact producing factors from the Project. Flight altitudes are highly variable among species and are influenced by migratory strategy, winds aloft, topography, sea conditions, and seasonal weather patterns (Kerlinger 1995). Migrating birds generally conserve energy by flying at heights that are safe and efficient for fast flight, as dictated by current weather conditions, with songbirds generally flying lower than shorebirds and waterfowl (Gehring et al. 2009). Waterfowl may migrate at altitudes of several hundred meters over water, while at other times flying low, within about 98 ft to 197 ft (30 m to 60 m), depending on the proximity of suitable stopover habitat (Gehring et al. 2009). Some seabirds may fly just above the ocean surface during migration, in order to utilize dynamic soaring to conserve energy (Gaston 2004). Overall, there is little information on nocturnal migration over the OCS, although there is evidence that substantial nocturnal migration of passerines occurs over the western Atlantic and elsewhere (Myres 1964; Able 1977; Richardson 1978; Larkin 1979). Data from avian radar studies conducted on the eastern coast of the United States and offshore islands indicate that average flight altitudes of birds in the marine environment may range from less than 3 ft (1 m) to greater than 1,640 ft (500 m) above mean sea level (amsl), with average flight heights generally within the 196 ft (60 m) to 656 ft (200 m) range (Mizrahi 2011; Mizrahi et al. 2012; Svedlow et al. 2012).

Because of the diverse strategies of birds using the marine environment, there is a great deal of variability in foraging, seasonal occurrence, and flight behavior. Therefore, it is generally most useful to evaluate avian activity based on family groups. The following is an assessment of bird groups which are known or expected to occur in the Project Area. Table 4.5-1 provides general information on the temporal occurrence patterns and species richness of the family groups indicated.

Table 4.5-1. Avian Species Groups in the Project Area

Species Group present in Offshore Portions Project Area	Family	Number of Species Expected or Known to Occur in the Area	Seasonal Presence				Offshore or Onshore
			Winter	Spring	Summer	Fall	
Loons	Gaviidae	2	X	X	X	X	Offshore
Grebes	Podicipedidae	3	X				Offshore
Tubenoses (Shearwaters, Petrels, and Fulmars)	Procellariidae	7			X		Offshore
Storm-petrels	Hydrobatidae	2			X		Offshore
Pelicaniformes	Sulidae, Pelecanidae	2	X	X	X	X	Offshore
Cormorants	Phalacrocroacidae	2					Both
Wading birds	Ardeidae, Ciconiidae, Phoenicopteridae, Threkiornithidae	12		X	X	X	Onshore (occasionally offshore during migration)
Waterfowl	Anatidae	31	X	X		X	15 species primarily Offshore, 16 species primarily onshore
Raptors	Acciptridae, Falconidae, Cathartidae	15	X	X	X	X	Primarily Onshore, at least 3 species commonly migrate Offshore
Rails	Rallidae	7	X	X	X	X	Onshore
Shorebirds	Charadriidae, Haematopodidae, and Scolopacidae	34	X	X	X	X	30 species primarily coastal or offshore during migration, 2 species onshore in uplands, 2 species primarily offshore
Jaegers and skuas	Laridae	5			X		Offshore
Gulls and kittiwakes	Laridae	10	X	X	X	X	Primarily Offshore
Terns	Laridae	10		X	X	X	Primarily Offshore, but also coastal.
Alcids	Alcidae	5	X				Offshore, 2 of the 5 species only occur rarely in the Mid-Atlantic
Owls	Strigidaae and Tytonidae	8	X	X	X	X	7 species strictly onshore, 1 species known to occur offshore

Table 4.5-1. Avian Species Groups in the Project Area (continued)

Species Group present in Offshore Portions Project Area	Family	Number of Species Expected or Known to Occur in the Area	Seasonal Presence: Winter	Spring	Summer	Fall	Offshore or Onshore
Goatsuckers	Caprimulgidae	3		X	X	X	Onshore
Other landbirds and songbirds	Multiple (Primarily Passeriformes)	8 in offshore areas, >100 terrestrial species		X	X	X	Primarily Onshore, may occur Offshore during migration

Loons

Common loon (*Gavia immer*) and red-throated loon (*Gavia stellata*) regularly occur off the coast of Virginia during the winter and early spring (O'Connell et al. 2009; Evers et al 2010). Both species were observed during the Mid-Atlantic Baseline Study (n = 740, 9.7 percent and, n = 44, 0.6 percent, respectively) (Williams 2013). The interim results of the 2012 Mid-Atlantic Baseline Study indicate that loons are more abundant near the mouth of Chesapeake Bay and Delaware Bay than they are farther offshore, in the vicinity of the Project Area and the Virginia, Maryland, and Delaware WEAs (Figure II.2 in Williams 2013). Modeling of loon distribution in the Mid-Atlantic by O'Connell et al. (2009) confirms the general spatial distribution trends observed during the interim 2012 Mid-Atlantic Baseline Study (Williams 2013). The spatial distribution of loons on the OCS is likely a function of prey availability, weather conditions, and benthic habitats (Barr et al. 2000; Evers et al. 2010). Foraging loons are less constrained by water depths than are other diving birds, such as sea ducks, because their prey consists primarily of pelagic fish, in contrast to the infaunal and benthic prey of sea ducks (Evers et al. 2010). Therefore, loons may be attracted to certain portions of the Project Area if food resources concentrate there. The abundance of loons in the WTG Area is unlikely to be as high as in areas known to concentrate prey, such as near the mouths of the large Mid-Atlantic bays. During the VOWTAP avian surveys, loons generally flew at altitudes of less than 30 ft (10 m) amsl (26.7 percent), although approximately 11 percent of loons flew at heights between 82 ft (25 m) and 410 ft (125 m) (Appendix L-1).

Grebes

Grebes may occur off the coast of Virginia in low densities during migration or the wintering period (Stout and Nuechterlein 1999). Horned grebe (*Podiceps auritus*) was observed during the Mid-Atlantic Baseline Study aerial surveys in 2012, however, the species was not observed in the Offshore Study Area during Mid-Atlantic Baseline Study ship-based surveys (Williams 2013) or during the VOWTAP avian surveys. Horned grebes are expected to occur off the southern coast of Virginia at relatively low densities during the winter (O'Connell et al. 2009). Red-necked grebe (*Podiceps grisegena)* may occur in the area, primarily near shore during the winter months (Stout and Nuechterlein 1999). Horned grebe and red-necked grebe were observed during transit to the Offshore Study Area, and red-necked grebe were observed at the Onshore Study Area (Appendix L-1). Pied-billed grebe (*Podilymbus podiceps*) may use the coastal waters adjacent to the proposed Export Cable landfall site during the winter (Muller and Storer 1999), but were not observed during the VOWTAP avian surveys. Grebes are nocturnal migrants, and although flight heights during migration are not well documented, both species fly low above the water during the day, and may do so during nocturnal migration as well (Spear and Ainley 1997; Stedman 2000).

Cormorants

Cormorants may occur off the coast of Virginia during the winter residency period (approximately December through March), and during spring and fall migration periods. Double-crested cormorants (*Phalacrocorax auritus*) were observed infrequently (n = 137, 1.8 percent) during the Mid-Atlantic Baseline study in 2012 (Williams 2013). Great cormorants may occur off the coast of Virginia during the winter, but are likely restricted to coastal and near shore areas (Hatch et al. 2000). Both double-crested and great cormorants spend much of their time roosting and preening out of the water and are generally found no more than 3.1 mi (5 km) from shore, foraging in open water less than 26.2 ft (8 m) deep (Hatch and Weseloh 1999; Hatch et al. 2000).

Double-crested cormorants were not observed during the VOWTAP avian surveys in the Offshore Study Area, but were observed by the survey vessel field crew while transiting to and from the WTG Area, and were frequently encountered at the Onshore Study Area (Appendix L-1). Double-crested cormorants likely occur in the vicinity of the Project Area during winter, spring, and fall at low densities, and great cormorants may occur at very low to low densities during the winter (O'Connell et al. 2009). Paton et al. (2010) noted that cormorants tended to fly lower (less than 49.2 ft [15 m]) during local movements and higher (greater than 328.1 ft [100 m]) during migratory flights off the coast of New England; this likely holds true for the Mid-Atlantic as well.

Waterfowl

Sea ducks and diving ducks (Anatidae) may be present off the coast of Virginia throughout the year, but are most abundant from November to April in coastal and shoal waters (O'Connell et al. 2009). Sea ducks are the most common waterfowl on the OCS, and are likely the most common waterfowl in the area where the VOWTAP WTGs are proposed. Other ducks, including dabbling ducks such as American black duck (*Anas rubripes*), wood duck (*Aix sponsa*), and mallards (*Anas platyrhynchos*), may also occur offshore during migration.

During southward migration, sea ducks begin to arrive on the Virginia coast and OCS in November and December, and depart during spring migration to more northerly breeding areas in March and April (O'Connell et al. 2009; Williams 2013). Unidentified scoters (n = 201, 2.6 percent) and black scoters (*Melanitta nigra*) (n = 101, 1.3 percent) were the most frequently observed ducks during the 2012 Mid-Atlantic Baseline Study ship-based surveys (Williams 2013). Substantially greater numbers of sea ducks were observed during the aerial survey component of the Mid-Atlantic Baseline Study than during the ship-based surveys. A total of 9,409 scoters (*Melanitta* spp.), consisting of 526 surf scoters (*Melanitta perspicillata*), 8,273 black scoters, 3 white-winged scoters (*Melanitta*), and 607 unidentified scoters, were observed during the March aerial survey (Williams 2013). The results of the Mid-Atlantic Baseline Study 2012 surveys demonstrated that sea ducks occur at low to moderate densities during the wintering period in the Mid-Atlantic, but may not reach peak levels of abundance until after November, and likely before April (Williams 2013). Only two species of sea duck, black scoter and surf scoter, were observed in the Offshore Study Area during the VOWTAP avian surveys (Appendix L-1).

The spatial distribution of sea ducks in the Mid-Atlantic is largely a function of water depths and prey availability, as well as fluctuations in annual climatic trends (i.e. higher concentrations of some species nearer to shore during colder winters) (Bordage et al. 2011). O'Connell et al. modeled the spatial distribution of sea ducks in the western Atlantic; their results showed that sea ducks in general were more abundant near the mouth of Chesapeake Bay and along the Delmarva Peninsula than they were off the southern coast of Virginia and North Carolina (O'Connell et al. 2009). Sea ducks typically forage in water less than 32.8 ft (10 m) deep (Bordage et al. 2011). Water depths in the VOWTAP Project Area range from 22 ft (7 m) to 92 ft (28.3 m).

Other species of waterfowl, including dabbling ducks, Canada goose (*Branta canadensis*), brant (*Branta branta*), snow goose (*Chen caerulescens*), tundra swan (*Cygnus columibanus*), and mute swan (*Cygnus olor*), occur during migration nearshore and may be seasonally abundant near the coast of Virginia. Waters adjacent to the proposed Export Cable landfall site may provide foraging habitat for wintering ducks, including scoter species (*Melanitta* spp.), scaup species (*Aythya* spp.), American black, bufflehead (*Bucephala albeola*), goldeneye (*Bucephala* spp.), and merganser species (*Mergus* and *Lophodytes* spp.); brant (*Branta bernicla*), long-tailed duck (*Clangula hyemalis*), and harlequin duck (*Histrionicus histrionicus*) may also occur during the winter. Three species of dabbling duck were observed during the Mid-Atlantic Baseline surveys: mallard, green-winged teal (*Anas carolinensis*), and American black duck. These species were observed infrequently during September and November, presumably during the fall migration period (Williams 2013). The majority (96.2 percent) of waterfowl observed in the Offshore Study Area during the VOWTAP avian surveys flew less than 30 ft (10 m) above sea level (Appendix L-1).

Seabirds (Shearwaters, Storm-petrels, Northern Gannet, and Alcids)

Surveys of sea birds in the Mid-Atlantic demonstrate that the occurrence of pelagic birds, such as shearwaters and storm-petrels, is episodic and related to shifting patches of food resources, physical oceanographic variables, and changes in weather conditions (Prince and Morgan 1987, O'Connell 2009). Studies have shown that shearwaters and storm-petrels are most abundant in the western Atlantic during the summer months. Some species, such as Manx's shearwater (*Puffinus puffinus*), may occur year-round (O'Connel et al. 2009). Shearwaters generally occur off the coast of Virginia during the non-breeding austral-winter period, in May through September, although some species may be present year round (Lee and Haney 1996, O'Connell et al. 2009). Storm-petrels (Hydrobatidae) occur in the Project Area primarily during the non-breeding austral-winter period, but some species may also be present year round (Huntington et al. 1996, O'Connell et al. 2009).

Five species of shearwater were recorded during the Mid-Atlantic Baseline Study in June 2012: Manx's shearwater, sooty shearwater (*Puffinus griseus*), great shearwater (*Puffinus gravis*), Audubon's shearwater (*Puffinus lherminieri*) and Cory's shearwater (*Calonectris diomedea*) (Williams 2013). During the May 2013 VOWTAP avian survey, a single sooty shearwater (n = 1, less than 1 percent of total observations) was observed flying at less than 30 ft (10 m) amsl. A single Cory's shearwater and a single sooty shearwater were observed (n = 2, less than 1 percent of total observations) in the Offshore Study Area (Appendix L-1). An additional three Cory's shearwater and a single Audubon's shearwater were observed by survey crews during transit from Rudee Inlet to the VOWTAP avian survey Offshore Survey Area.

Two species of petrel, the black-capped petrel (*Pterodroma hasitata*), and the Bermuda petrel (*Pterodroma cahow*), may occur as vagrants on the Virginia OCS, typically within the Gulf Stream (Harrison 1987, AERC TAC 2003, O'Connell et al 2009). During the non-breeding season, Bermuda petrel have been recorded in the Gulf Stream, as far north as the Bay of Fundy, into the Gulf of St. Lawrence and over the Grand Banks (Bried and Mgalhaes 2003). There are numerous historical records of black-capped petrel from the Virginia OCS, primarily within the Gulf Stream (O'Connell et al. 2009). Neither species of petrel was observed during the VOWTAP avian surveys, and neither is expected to occur regularly in the Project Area.

Two species of storm-petrel, Wilson's storm-petrel (*Oceanites oceanicus*) and Leach's storm-petrel (*Oceanodroma leucorhoa*), are known to occur regularly on the Virginia OCS, primarily during the summer, but also during spring and fall (Huntington et al. 1996, O'Connell et al. 2009). A third species, the Band-rumped storm-petrel (*Oceanites castro*) may occasionally occur on the Virginia OCS from spring through fall (O'Connell et al. 2009). Storm-petrels seldom occur near shore. Wilson's storm-petrel was observed during the Mid-Atlantic Baseline Surveys in June, August, and September (n = 362, 4.8 percent of total observations), and 7 unidentified storm-petrels were also observed (Williams 2013). Wilson's storm-petrel was observed in the Offshore Study Area during the May and June 2013 VOWTAP avian surveys (n = 5, 10 percent of total observations) (Appendix L-1).

Northern gannet (*Morus bassanus*) migrate from breeding areas in Atlantic Canada to lower latitudes of the Mid-Atlantic in late summer and early fall, and individuals are known to over winter as far south as Georgia and Florida (Mowbray 2002, O'Connell et al. 2009). Northern gannet were frequently encountered during the Mid-Atlantic Baseline Study, during both aerial and ship-based surveys. A total of 408 individuals (3.2 percent of total observations) were observed during aerial surveys and 2,809 during ship-based surveys (37 percent of total observations) (Williams 2013). Gannets were only observed during March, April, May, June, and November (Williams 2013). Northern gannets were the most abundant species encountered (n = 1.222) in the Offshore Study Area during the VOWTAP avian survey (Appendix L-1). The majority of northern gannets were observed during a single survey even in the Offshore Study Area on February 7, 2014 (n =1,166, 95 percent of all northern gannets observed). Gannets were also observed during transit to the Offshore Study Area.

Northern gannet flight heights are variable, and depend on whether individuals are foraging, searching for prey, migrating, or resting on the water (Mowbray 2002). During surveys in southern New England for the Rhode Island Ocean Special Area Management Plan (RI Ocean SAMP), the majority (54 percent) of gannets were observed flying below 33 ft (10 m), 36 percent flew between 33 ft and 82 ft (10 m to 25 m), and 10 percent flew between 85.3 ft and 410.1 ft (26 m and 125 m). Similar flight ecology was observed in the study area for the Block Island Wind Farm, where 78 percent of gannets flew less than 33 ft (10 m) above the water, and 20 percent flew between 33 ft and 82 ft (10 m and 25 m) (Svedlow et al. 2012). During the VOWTAP avian surveys in the Offshore Study Area, northern gannets were generally encountered sitting on the water (47.9 percent) or flying below 30 ft (10 m) in altitude (34.2 percent) (Appendix L-1).

Brown pelicans (*Pelcanus occidentalis*) occur along coastal areas of Virginia year round, and may range as far as 47 mi (75 km) from shore during the non-breeding; however, the species generally occurs near shore and is unlikely to be abundant in the Project Area (Shields 2002). During the 2012 interim Mid-Atlantic Baseline Study ship-based surveys, 0.3 percent of total observations were of brown pelicans (n = 25). Brown pelicans were not observed during the VOWTAP avian surveys in the Offshore Study Area; however, brown pelicans were observed during surveys in the Onshore Study Area and during transit to the Offshore Study Area (Appendix L-1).

During the winter, alcids may migrate as far south as the Virginia OCS from northern breeding areas to forage on bait fish and invertebrates. Six species of alcids (Alcidae) may occur off the coast of Virginia during winter: razorbill (*Alca torda*), common murre (*Uria aalge*), thick-billed murre (*Uria lomvi*a), dovekie (*Alle alle*), black guillemot (*Cepphus grylle*), and Atlantic puffin (*Fratercula arctica*) (Proctor and Lynch 2005; Lavers et al. 2009; O'Connell et al. 2009). Alcids have not been encountered during the Mid-Atlantic Baseline Study to-date (Williams 2013). Razorbill were observed in the VOWTAP Offshore Study Area during the months of January, February, and March. Razorbill were the second most abundant species encountered in the Offshore Study Area (n = 52). Other alcids observed included dovekie (n = 1) (Appendix L-1). Alcids are not expected to be abundant in the Mid-Atlantic region (O'Connell et al. 2009).

Gulls and Allies

Gulls occur year round on the coast of Virginia and the Virginia OCS. Due to their overall abundance in the region and generalist habits, gulls are likely to be the most ubiquitous seabirds in the Project Area and at the proposed Export Cable landfall site (Pierotti and Good 1994, Good 1998).

During the ship-based surveys for the Mid-Atlantic Baseline Study in 2012, a total of six gull species were observed totaling 393 birds (5.2 percent). During the aerial component of the baseline study, 457 birds (3.6 percent) were observed (Williams 2013). Great black-backed gull (*Larus marinus*) was the most frequently encountered gull (n = 122, 1.6 percent) during the Mid-Atlantic Baseline ship-based surveys (Williams 2013). Great black-backed gull was also encountered during the VOWTAP avian surveys in the Offshore Study Area (n = 34, 2.3 percent), as well as during transit to the Offshore Study Area (n = 14) (Appendix L-1). Bonaparte's gull (*Chroicocephalus philadelphia*), lesser blackbacked gull (*Lasurs fuscus*), laughing gull (*Leucophaeus atricilla*) and ring-billed gull (*Larus delawarensis*) were also encountered during the VOWTAP avian surveys (Appendix L-1). Laughing gulls were infrequently encountered during the Mid-Atlantic Baseline Study (n = 6, less than 0.1 percent) (Williams 2013). The discrepancy between laughing gull encounters from the Mid-Atlantic Baseline Study and the VOWTAP avian survey may be a function of differences in survey period between the Mid-Atlantic Baseline Study in 2012 (March, April, May, June, August, September, and November) and the VOWTAP avian surveys, which included the entire annual cycle from May 2013 to April 2014. Northern fulmar (*Fulmaris glacialis*) were observed in, and during transit to, the Offshore Study Area.

Few (n = 5, 0.1 percent) black-legged kittiwakes (*Rissa tridactyla*) were observed during the November 2012 Mid-Atlantic Baseline Study ship-based survey (Williams 2013). Kittiwakes were not observed during the VOWTAP avian surveys.

Jaegers may occur uncommonly on the Mid-Atlantic OCS, primarily during fall and winter (O'Connell et al. 2009). Skuas rarely occur in the region during spring and fall migration (south polar skua [*Stercorarius maccormicki*]) or during the winter (great skua [*Sterocrarius skua*]) (Rappole 2007, O'Connell et al. 2009). Parasitic jaeger (*Stercorarius parasiticus*) was observed during both ship-based and aerial surveys for the Mid-Atlantic Baseline Study in 2012 (Williams 2013). A single unidentified skua was encountered during the June ship-based survey for the Mid-Atlantic Baseline Study (Williams 2013). No jaegers or skua were observed during the VOWTAP avian surveys. Jaegers are not thought to be particularly abundant anywhere in the western Atlantic, and are unlikely to be common in the Project Area (Wiley and Lee 2000). Jaegers tend to occur primarily along the edge of the continental shelf, or along the western edge of the Gulf Stream in the Mid-Atlantic region (Wiley and Lee 2000).

Terns (Sternidae) may occur in the Project Area, as well as near the proposed Export Cable landfall site, during spring and fall migration and during the summer residency period. A single tern species, Forster's tern (*Sterna forsteri*), is known to winter in coastal Virginia (McNicholl et al. 2001). Tern diversity is particularly high in the Mid-Atlantic region, where up to 12 species may occur (Table 4.5-2).

During ship-based surveys for the 2012 Mid-Atlantic Baseline Study, a total of 990 terns were observed, the majority of which were common tern (*Sterna hirundo*) (n = 583, 7.7 percent) (Williams 2013). A single roseate tern (*Sterna dougallii*) was observed during the June ship-based survey, although the location of this observation could not be ascertained from the study report (Williams 2013). Royal terns (n = 3, 4 percent) were observed during the July VOWTAP avian survey in the WTG Area. All of the royal terns observed in the VOWTAP Offshore Study Area flew below 82 ft (25 m) amsl. There were numerous additional observations of terns during transit to the Offshore Study Area, and at the Onshore Study Area (Appendix L-1). No roseate terns were observed during the VOWTAP avian surveys.

Table 4.5-2. Tern Species in the Vicinity of the Project Area

English Name	Scientific Name	Seasonal Presence				Likelihood of Occurrence	Observed during the VOWTAP Avian Survey in the Offshore Study Areas[b/]	Observed during the VOWTAP Avian Survey in Transit to the Offshore Study Area[c/]
		Winter	Spring	Summer	Fall			
Black tern	*Childonia niger*		X		X	Low	No	Yes (n = 2)
Caspian tern	*Sterna caspia*		X		X	High	No	Yes (n = 2)
Gull-billed tern	*Sterna nilotica*		X	X	X	Moderate	No	No
Royal tern	*Sterna maxima*		X	X	X	High	Yes (n = 3)	Yes (n = 579)
Sandwich tern	*Sterna sandvicensis*		X	X	X	High	No	Yes (n = 5)
Common tern	*Sterna hirundo*		X	X	X	High	No	Yes (n = 11)
Forster's tern	*Sterna forsteri*	X	X	X	X	High	No	No
Arctic tern	*Sterna paradisaea*		X		X	Low	No	No
Roseate tern	*Sterna dougallii*		X		X	Low	No	No
Least tern	*Sterna antillarum*		X	X	X	High	No	No
Sooty tern	*Sterna fuscata*		X		X	Low	No	No
Bridled tern	*Sterna anaethetus*		X		X	Low	No	No

Potential for Occurrence Onsite: Unlikely– no species range overlap with Project Area or unsuitable habitat in Project vicinity; Low– species range overlaps with Project Area and marginally suitable habitat in vicinity; Moderate– species range overlaps with Project Area and suitable habitat present in Project Area, or species known to occur in habitat similar to Project Area; High–highly suitable habitat present in Project Area, or known populations exist in Project vicinity, Present - species observed during field survey. **Source:** Rappole 2007

a/ Combined observations from the 2012 ship-based and aerial surveys, including all definite, probable, and possible aerial survey counts (Williams 2013)

b/ Observations from the VOWTAP Offshore Study Area only (Appendix L-1)

c/ Observations made during transit to the VOWTAP Offshore Study Area only (Appendix L-1)

Shorebirds

Shorebirds may occur at the proposed Export Cable landfall site year round, including during the spring-summer breeding periods (O'Connell et al. 2011). Red-necked phalarope (*Phalaropus lobatus*) and red phalarope (*Phalaropus fulicarius*) are the only shorebird species known to regularly occur on the OCS; other species may migrate over the open ocean, but are not known to land on the water's surface, and, therefore, spend considerably less time offshore than phalaropes (Tracy et al. 2002). An additional 32 shorebird species are known to regularly occur in coastal Virginia, 2 of which occur exclusively inland and are unlikely to be affected by the VOWTAP (upland sandpiper [*Bartamia longicauda*]) and Wilson's snipe [*Gallniago delicate*]) (Helmut 1999, Houston et al. 2011). The proposed Export Cable landfall site may provide stopover habitat for a variety of shorebirds breeding in more northern latitudes. Wilson's plover (*Charadrius wilsonia*) may breed in coastal Virginia, and piping plover (*Charadrius melodus*) may occur in dune, upper beach, and intertidal areas during migration (Corbat and Bergstrom 2000, VDGIF 2005). Wilson's plover is state-listed as endangered, and piping plover is federally listed as endangered. Red knot (*Calidris canutus*), a candidate species for federal listing, winters on the Mid-Atlantic coast, and may occur at the proposed Export Cable landfall site (Harrington 2001). Threatened and endangered species are further discussed in Section 4.6.

Two unidentified phalaropes were observed during the Mid-Atlantic Baseline Study aerial surveys in 2012 (Williams 2013). During the ship-based portion of the Mid-Atlantic Baseline Study, there were 23 unidentified phalaropes (0.3 percent) and 14 red-necked phalaropes (0.2 percent) observed (Williams 2013). Fourteen red phalaropes were observed sitting on the water during the September VOWTAP avian survey in the Offshore Study Area (Appendix L-1).

In addition to phalaropes, a total of four shorebird species were observed during the Mid-Atlantic Baseline Study ship-based surveys (n = 34, less than 1 percent) (Williams 2013). The majority of shorebird observations were "unidentified shorebird" (n = 15, less than 1 percent) and "unidentified peep sandpipers" (*Calidris* spp.) (n = 6, less than 1 percent) (Williams 2013). Wilson's plover (*Charadrius wilsonia*), whimbrel (*Numenius phaeopus*), sanderling (*Calidris alba*), and white-rumped sandpiper (*Calidris fuscicollis*) were also observed (n = 13, collectively) (Williams 2013). During the VOWTAP avian surveys, three sanderlings were observed in the Offshore Study Area during the May survey (Appendix L-1). Sanderling and whimbrel were also seen during transit to the Offshore Study Area in August 2013 (Appendix L-1). In the Onshore Study Area, at the proposed Export Cable landfall site and Onshore Interconnection Cable and Fibert Optic Cable route, seven species of shorebird were observed during the late-summer/early-fall migration period: sanderling, black-bellied plover (*Pluvialis squatarola*), dunlin, lesser yellowlegs (*Tringa flavipes*), greater yellowlegs (*Tringa melanoleuca*), stilt sandpiper (*Calidris himantopus*), and whimbrel (Appendix L-1).

Songbirds

Songbirds (Passeriformes) and other landbirds were rarely encountered during the Mid-Atlantic Baseline Study and the VOWTAP avian survey. During the ship-based surveys for the Mid-Atlantic Baseline Study, passerines represented 1.5 percent of all observations (n = 125). During the VOWTAP avian survey in the Offshore Study Area, 1.5 percent of all observations were passerine species, including purple martin (*Progne subis*) (n = 20), common grackle (*Quiscalus quiscula*) (n = 1), and song sparrow (*Melospiza melodia*) (n = 1) (Appendix L-1). Purple martins were also the most commonly observed passerine species observed during the Mid-Atlantic Baseline Study (Williams 2013). An additional 15 passerine species and 2 wading bird species were observed during the ship-based Mid-Atlantic Baseline Study (Williams 2013).

Coastal staging and stopover areas can be crucial to landbirds migrating over the ocean (Myers 1983). Nocturnal migrant songbirds are considered to be at high risk of collision with WTGs, especially during low visibility (Barrios 2004).). With the exception of blackpoll warbler (*Setophaga striata*), all of the songbirds observed offshore in the Mid-Atlantic Baseline breed in the Mid-Atlantic and adjacent states and are considered to be relatively common (Rappole 2007). As would be expected, the VOWTAP avian surveys at the Onshore Study Area documented substantially greater abundance and diversity of passerine species and other landbirds (Appendix L-1). During the Project point count surveys onshore, 2,667 songbirds were detected, representing 50 species (Appendix L-1).

Songbirds are most likely to occur in the Project Area during spring and fall migration, and primarily at night. Nocturnal migration surveys were not conducted as part of the Mid-Atlantic Baseline Study or the VOWTAP avian survey. Coastal avian radar surveys were conducted to characterize the spatial and temporal parameters of bird movements in the New Jersey Ecological Baseline Study. Results from the radar surveys seem to indicate that there may be less nocturnal migration activity occurring offshore than has been previously suspected (NJDEP 2010). Other similar radar studies conducted nearshore and offshore generally confirm these observations (Mizrahi et al. 2010; Mizrahi 2011; Svedlow et al. 2012). For species that avoid crossing open water, the marine environment may create either a barrier to movement or diversion lines that can funnel migrants along topographic features such as shorelines (Dunne et al. 1990).

Raptors

Falcons and osprey are the only raptors known to routinely undertake long, open-ocean migratory flights (Slack and Slack 1981, Mellone et al. 2011). Although primarily diurnal migrants, some species may migrate at night (DeCandido et al. 2006). Raptor species that rely on thermal updrafts and soaring (e.g *Buteo* spp.) for migration generally avoid water crossings (Kerlinger 2009). Other species, including accipiters (*Accipiter* spp.), osprey (*Pandion haliaetus*), and bald eagle (*Haliaeetus leucocephalus*), may undertake water crossings of variable length but are not frequently encountered on the OCS (Buehler 2000, Oikos 2003, DeCandido et al. 2006,) Peregrine falcon (*Falco peregrinus*) and merlin (*Falco columbarius*) were observed on the OCS during the Mid-Atlantic Baseline Study, and a single peregrine falcon was observed during transit to the Offshore Study Area during the VOWTAP avian survey. A single bald eagle and a single osprey were “probably” observed during the aerial surveys for the Mid-Atlantic Baseline Study, and two ospreys were observed during the Mid-Atlantic ship-based surveys (Williams 2013).

Two observations of bald eagles and 13 observations of osprey were made during point counts in the VOWTAP Onshore Study Area. Cooper’s hawk (*Accepiter cooperii*) and sharp-shinned hawk (*Accipiter striatus*) were also observed during surveys in the Onshore Study Area. Overall, it is unlikely that raptors, including eagles, occur regularly in the Project Area (Rappole 2007). Bald eagles may migrate through the region, but are not known to regularly occur on the OCS, and only occur locally on the Virginia mainland (Rappole 2005). No bald eagle or osprey nests are known to occur along the proposed Onshore Interconnection Cable and Fiber Optic Cable route or at the cable landfall site. Golden eagles are known to occur in Virginia during the winter, but are not known to migrate over the open ocean (Kochert et al. 2002). Peregrine falcons are listed as threatened in the state of Virginia (VDGIF 2013a). Bald and golden eagles are protected under the Bald and Golden Eagle Protection Act (16 USC 668-668d).

4.5.1.2 Bats

Twelve bat species are believed to have the potential to occur in coastal areas of Virginia, including the Project Area (VDGIF 2013b) (Table 4.5-3). No federal ESA-listed species are expected to occur in the Project Area, either offshore or onshore. Few data sources exist regarding the distribution of bats in coastal Virginia and adjacent offshore areas, although bats are known to occur offshore. Passive acoustic monitoring is ongoing at the Chesapeake Lighthouse and elsewhere along the Atlantic Coast (Stantec 2012, Pelletier et al. 2013). However, given the occurrence of estuaries, freshwater wetlands, and open water, it is expected that most of the more common bat species in the area occur or migrate through coastal Virginia. Some species may occur farther offshore during migration, primarily eastern red bat (*Lasiurus borealis*), hoary bat (*Lasiurus cinereus*), and silver-haired bat (*Lasionycteris noctivagans*). Because the Project Area is located 24 nm (43 km) from shore, bats are not expected to regularly occur in the area. No pre-construction bat surveys were required by BOEM, USFWS, or VDGIF for the VOWTAP (Appendix L-1).

The Northern long-eared myotis has been proposed for listing under the ESA, and Rafineque's big-eared bat is state-listed as endangered. These two species are discussed in Section 4.6.

Table 4.5-3. Bat Species that May Occur on the Coast near the Project Area

Common Name	Scientific Name
Little brown myotis	*Myotis lucifugus*
Northern long-eared myotis	*Myotis septentrionalis*
Tri-colored bat	*Perimyotis subflavus*
Big brown bat	*Eptesicus fuscus*
Southeastern myotis	*Myotis austririparius*
Silver-haired bat	*Lasionycteris noctivagans*
Eastern red bat	*Lasiurus borealis*
Hoary bat	*Lasiurus cinereus*
Northern yellow bat	*Lasiurus intermedius*
Seminole bat	*Lasiurus seminolus*
Evening bat	*Nycticeius humeralis*
Rafinesque's big-eared bat	*Corynorhinus rafinesquii*

4.5.2 Potential Impact Producing Factors, Proposed Environmental Protection Measures, and BMPs

Specific aspects of Project construction, operation, and decommissioning have the potential to impact both avian and bat species. This section addresses the following types of potential impact producing factors associated with the Project:

- Indirect effects associated with temporary displacement or disturbance of species and their associated habits from construction and/or decommissioning activities;
- Direct effects from habitat loss from construction and operation of Project facilities;
- Direct effects associated with collision with Project structures;
- Indirect effects to species associated with avoidance/permanent displacement from foraging habitats; and
- Indirect affects to species associated with barriers to movement.

4.5.2.1 Avian Species

Temporary Displacement or Disturbance

Potential indirect impacts of construction, both onshore and offshore, to avian species may include temporary displacement or disruption of normal avian behavior patterns (Drewitt and Langston 2006). Disturbance factors include increased vessel and vehicular traffic, noise, impacts to prey species, and construction lighting, which may disturb birds feeding, staging, transiting, or migrating through the Project Area.

In the offshore environment, a lack of validated research on displacement effects in general, and specifically for seabirds and other avian species using the marine environment, makes predicting the level of potential impact from VOWTAP offshore construction or operational activities difficult (Stewart et al. 2005). European studies suggest that disturbance and avoidance impacts may occur up to 2.5 mi (4 km) from offshore construction sites (BOWind 2008). Most marine construction activities are, however, anticipated to occur over a 4-month period from March to June during the time when the abundance of birds in the Project Area is at its lowest point in the annual cycle, as indicated by the results of the VOWTAP avian surveys (Appendix L-1). .

Birds such as sea ducks and allies that forage on epibenthic, benthic, and demersal prey (Goudie et al. 2000) may be temporarily affected by disturbances to the benthic habitat and associated species from installation of the WTG foundations and Inter-Array and Export Cable. However, this disturbance would be limited in both time and spatial extent. As stated in Section 4.3.2.1, the amount of benthic habitat estimated to be disturbed by construction activities is approximately (86.47 acre [35 hectare]); representing only a very small proportion of the subsea habitat available for foraging seabirds in similar water depths along the Mid-Atlantic Coast. In addition, benthic invertebrates are expected to quickly recolonize disturbed areas following construction.

Studies have shown that construction noise and general anthropogenic sounds (e.g. roadways and airports) may affect bird behavior (McClure et al. 2013). Noise during onshore and offshore construction may temporarily displace birds resting, foraging, or moving through the Project Area. Noise impacts will be short in duration (i.e. during active construction periods only) and, therefore, are unlikely to have adverse effects on avifauna.

As stated in Section 4.14.1.2, the vessel traffic associated with offshore construction will not result in a substantial increase in vessel traffic above current levels, and will be similar in nature to other commercial vessel and recreational traffic currently occurring in the Project Area. Therefore, disturbance or displacement of birds associated with increased vessel movement is unlikely. However, to ensure safety during nighttime operations, all construction support vessels will be lit and marked in accordance with USCG requirements. Research has demonstrated that steady burning lights attract birds (Gehring et al. 2009). For this reason, Dominion will use flashing lights on the WTG nacelles, and will investigate the possibility of using down-shielded lights (aka hooded lights) where possible on construction vessels.

Onshore construction activities, including the Export Cable landfall, installation of the Onshore Interconnection Cable and Fiber Optic Cable, and construction of the Interconnection Station also have the potential to create temporary displacement or disruption of normal avian behavior patterns. However, this is expected to be limited as the proposed Export Cable landfall site, Onshore Interconnection Cable and

Fiber Optic Cable route, and Interconnection Station are located in previously disturbed areas that are not known to support breeding shorebirds (Appendix L-1). Furthermore, construction practices such as HDD will avoid potential impacts to sensitive dune, beach, and intertidal habitats. As such, the primary disturbances to avian species onshore will be associated with the temporary increases in noise, vehicular traffic, and construction lighting. Onshore construction will be limited in both time and spatial extent, and Dominion will employ appropriate BMPs to ensure onshore construction impacts are minimized to the maximum extent possible, as follows:

- Construction activities will be restricted to the proposed impact area only;
- Vegetation clearing will be minimized to the extent practicable;
- Construction vehicles will not be driven on the beach, on dunes, or in other sensitive habitats.

Decommissioning of the onshore and offshore components of the VOWTAP will be similar to construction activity, but in reverse (see Section 3.7). Therefore, similar to construction, any displacement or disturbance impacts from decommissioning activities are unlikely to result in population effects in the Project Area.

Direct Habitat Loss

The only direct avian habitat loss caused by the VOWTAP will be associated with the 0.18 ac (0.08 ha) footprint of the WTG foundations offshore and the 0.11 ac (0.04 ha) footprint of the Interconnection Station onshore. The amount of subsea habitat that will be lost as a result of the WTG foundations represents an extremely small proportion of the subsea habitat available in similar water depths along the Mid-Atlantic Coast. Furthermore, the water depth at the WTGs of approximately 87 ft (26.5 m) is at the limit of the diving depth for sea ducks and would be considered marginal foraging habitat (Goudie et al. 2000, Robertson and Savard 2002, Bordage and Savard 2011). There will be very minimal habitat loss at the Interconnection Station onshore, because the proposed location of the Interconnection Station has been previously developed and consists of paved areas and maintained lawns. The magnitude of habitat loss from the construction and operation of the VOWTAP for avian species both on and offshore is extremely low.

Direct Collision

Due to the underground placement of the Onshore Interconnection Cable and Fiber Optic Cable, there is no potential risk of collision by avian species with VOWTAP onshore equipment. For offshore facilities, collision rates with the WTGs are difficult to quantify since it is not possible to conduct traditional mortality searches for birds (or bats) killed by WTGs offshore. Although technology has been employed to help evaluate fatality rates, including use of thermal imaging systems (Desholm 2003), there is currently little information on collisions at operating offshore wind farms to use for predictive modeling purposes.

Collision rates have been modeled for some species, primarily sea birds, at existing European offshore wind farms (Rothery et al. 2009). Collision modeling and results of post-construction monitoring in Europe provide evidence that collision rates for WTGs offshore are likely lower than collision rates for WTGs onshore and in coastal areas (Nicholson at al. 2005, Chamerlain et al. 2006, NJAS 2008, Tierney 2009, Lapena et al. 2010). However, the complex ways in which birds interact with the marine environment and the diversity of taxa present, are confounding factors for estimating collision risk.

Birds are thought to be more susceptible to collision with brightly lit structures, especially in offshore areas (Merkel and Johansen 2011; Hüppop and Hilgerloh 2012). In particular, neo-tropical migrants and/or other nocturnal migrants may be more attracted to lit WTGs and associated foundations during periods of low visibility, thereby increasing potential for collision. In addition, insect prey may also concentrate near WTGs and foundation lighting, resulting in the potential attraction of insectivorous birds (or bats).

The use of artificial lighting in the marine environment has the potential to affect bird behavior (Rich and Longcore 2005). Research has demonstrated that steady burning lights on tall structures attract birds (Gehring et al. 2009). However, the use of flashing lights, such as those proposed for the VOWTAP WTGs, has been shown to reduce mortality of nocturnal passerine migrants at tall structures (Gehring et al. 2009, Gehring et al. 2011). Similar studies have shown that flashing lights on WTGs do not attract nocturnal migrants (Kerlinger et al. 2010). Many seabirds are active at night, including some species of shearwaters, and can be attracted to artificial lighting on vessels or other man-made structures (Lee and Haney 1996, Rich and Longcore 2005). Aids to navigation and similar light structures generally have lights deployed low to the water and continuously lit. The WTG Area is near areas subjected to high vessel traffic, and the Virginia coastline is heavily developed. These areas already have artificial lighting in the form of aids to navigation buoys, the Chesapeake Lighthouse, vessels themselves, and from coastal development. Additional lighting required by USCG for the foundations of the proposed WTGs will add to the amount of artificial light in the area, but is unlikely to substantially increase the amount of artificial lighting over current ambient levels. USCG aids to navigation are common in marine environment, and are unlikely to be a novel source of lighting that would cause substantive changes in marine bird behavior. The USCG has evaluated potential impacts to wildlife from aids to navigation, and determined that aids to navigation and other standard marine navigation lighting are unlikely to have adverse effects on wildlife (USCG Title 50 CFR Part 224: Wildlife and Fisheries).

Seabirds, including gulls and cormorants, are known to routinely perch on manmade structures in the open ocean (Lock 2013). Dominion will consider installing anti-perching devices on the foundation structures to avoid attracting birds to roost in the WTGs, which should further reduce the potential for collisions.

The 2013 survey data on avian species abundance and flight behavior were analyzed in relation to the rotor-swept zone to assess the potential for impacts resulting from bird collision with the VOWTAP WTGs. Diurnal flight heights for all birds in all areas of the VOWTAP study area were generally low and below the rotor-swept zone of the proposed WTGs (See Appendix L-1). Only two birds, both red-throated loons, were observed flying within the rotor-swept zone of the proposed WTGs during the VOWTAP avian surveys (Appendix L-1).

Raptor mortality has received attention at land-based wind farms because of the relatively greater impact of mortality to long-lived species with low reproductive rates, and a concern for sensitive species such as bald and golden eagles. Previous research suggests that raptor use prior to construction may be useful in predicting potential impacts post-construction (e.g., Erickson 2007). Very few raptors were observed at the proposed WTG locations during the 2013 VOWTAP avian surveys. The potential collision risk posed to raptors from the WTGs is therefore likely very low.

One important aspect of the VOWTAP study program will be to evaluate impacts of WTGs on local marine avifauna. As such, Dominion will implement a post-construction monitoring program during operation of the Project to evaluate actual impacts from the WTGs. Details of the post-construction monitoring plan will be developed in coordination with state and federal agencies.

Displacement of Foraging and Resting Birds

Displacement of birds during operation of the Project may result in a shift in the distribution of foraging birds away from the Project Area. This displacement would constitute an effective loss of a portion of available habitat and may result in reduced food consumption or elevated energy expenditure that could affect fitness (Fox et al. 2006). Due to the placement of the Onshore Interconnection Cable and Fiber Optic Cable underground, there is no potential risk of displacing foraging or resting birds from the VOWTAP onshore equipment. Species thought to be most likely to be displaced from the WTG Area include loons, sea ducks, alcids, and shearwaters (Perrow et al. 2006). Research at European offshore wind farms demonstrated that displacement from a WTG area was not complete and that individuals were still able to forage in inter-turbine areas (Guillemette and Laresen 2007). For areas where birds did not forage or foraged less prior to construction, there was effectively no displacement (Guillemette and Laresen 2007).

Sea ducks and other species with similar foraging ecology have been shown to be at some level of risk from offshore wind development, primarily due to indirect impacts such as WTG-array avoidance behavior. Alternatively, artificial reef habitat, which is often created by WTG foundations, may attract some species of sea duck to forage within the WTG Area.

Avoidance behavior may be exhibited at a distance of between 0.6 mi to 1.2 mi (1 km to 2 km) for most species of gulls and sea ducks, and perhaps up to 2.5 mi (4.0 km) for species such as loons (Kahlert et al. 2000; Petersen et al. 2006). Those species that forage at higher densities in the Project Area (such as gulls, loons, and phalaropes) are likely to be more susceptible to displacement (Guillemette and Larsen 2007).

At a regional scale, the worst-case scenario assumes total loss of all effective foraging habitats within the entire 2.5 mi (4 km) area around the WTGs; however, it is likely that the actual loss of habitat will be considerably less. Because the size of the habitat area that may be effectively lost as a result of the VOWTAP is such a small proportion of the total available foraging habitat for all species in the region (even in the worst-case scenario), the potential displacement of foraging birds from the VOWTAP Area is expected to be negligible.

Permanent Barrier Effects

Due to the underground placement of the Onshore Interconnection Cable and Fiber Optic Cable, there is no potential risk of the VOWTAP onshore equipment creating a barrier to bird migration or movement. An avoidance response caused by the sight of novel structures such as WTGs in the marine environment could create a barrier to movement for some species (Petersen and Fox 2007). This barrier to movement would cause individuals to increase flight distances to circumvent the Project Area. Lengthening flight paths would increase energy consumption by individuals and could result in a reduction in fitness if the increase in energy demand were great enough (Fox et al. 2006) Avoidance of the Project Area by birds could also manifest as a long-term change in migrating or transiting behavior in response to the presence of the WTGs. Changes to flight routes have the potential to cause a reduction in fitness for birds migrating or transiting through the Project Area (Fox et al. 2006).

Post-construction studies at operational offshore wind farms in Europe evaluated barrier effects and avoidance. Avoidance behavior was observed at Nysted and Horns Rev wind farms at a distance of between 0.9 mi and 1.2 mi (1.5 and 2 km) from the WTG, and resulted in a change in flight direction for between 71 percent and 86 percent of the birds that were on a trajectory to enter the wind farms (Petersen et al.

2006). Loons and northern gannets never flew between the WTGs at Nysted, although other species (great black-backed gull and herring gull) flew between the WTGs with no sign of avoidance behavior. The Danish studies also concluded that avoidance responses differed by time of day and by species (Petersen et al. 2006; Fox et al. 2006). Birds at Nysted and Horns Rev made modifications to flight trajectory closer to the WTGs during the night than during the day (Petersen et al. 2006). Additional data from Nysted indicate that many of the birds at night may have increased flight altitude to avoid the wind farm (Petersen et al. 2006).

The installation of the WTGs is likely to elicit some level of avoidance response by individual birds using the airspace within and around the Project Area. The degree to which the VOWTAP presents a barrier to movement is likely to be more significant for some species (loons and northern gannets) than for others (gulls). This is especially true for those species that do not commonly encounter man-made structures in the environment, such as pelagic seabirds and alcids. Avoidance thresholds may be indicative of the magnitude of potential impact posed by barrier effects from the VOWTAP (Garthe and Hüppop 2004; Peteresen et al. 2006; Drewitt and Langston 2006). The magnitude of the potential impact is likely also directly related to the number of individuals that occur in the area, as well as the ability of species to accommodate increases in flight distance during migration or daily transit flights. Studies on avoidance thresholds and rates for birds in flight at existing offshore wind farms indicate that avoidance is not 100 percent and that the WTGs do not present a complete barrier to movement for many species (Fox et al. 2006; Desholm 2003).

The most abundant species in the Project Area (loons, gulls, terns, and shearwaters) are all capable of making long-distance migratory flights (Ryder 1993; Lee and Haney 1996; Goudie et al. 2000; Nisbet 2002; Lavers et al. 2009; Evers et al. 2010). The increased draw on energy budgets of birds avoiding and circumventing the Project Area is unlikely to have an effect on individual fitness or population viability. Loons, terns, sea ducks, shearwaters, gulls, as well as landbirds, that occur in the Project Area routinely undertake migrations of hundreds of kilometers, and therefore the need to fly a few extra kilometers out of their normal course is unlikely to adversely affect individuals or populations.

Dominion has minimized potential barrier effects to birds in the Project Area by orienting the WTGs in parallel with the prevailing avian flight direction through the Mid-Atlantic, which is predominantly north-south. Birds (and bats, see Section 4.5.2.2) traveling north to south would be confronted with a smaller barrier (i.e., a single WTG profile as opposed to the entire two WTG string). The proposed WTG string orientation minimizes the potential to cause increased flight distances for the majority of migrating and transiting birds in the Project Area.

Overall, operation of the VOWTAP is expected to cause at most a limited barrier to migration for some avian species. Post-construction monitoring data, including passage rates and trajectories of birds approaching the VOWTAP WTGs, will help to define the magnitude of the potential barrier effects.

4.5.2.2 Bats

VOWTAP construction and operation activities are not expected to impact bats. Construction at the Export Cable landfall site, the Onshore Interconnection Cable and Fiber Optic Cable route, and the Interconnection Station will require the removal of a minimum number of low-quality and/or diseased trees. However, bats are not known to be common in the onshore portion of the Project Area, and therefore would not be impacted by targeted tree removal. In addition, as the offshore Project Area is located 24 nm (43 km) from shore, bats are not expected to regularly occur in this area. Consequently, there is very limited potential for adverse impacts on bats from the construction, operation, and decommissioning of the offshore Project components.

4.6 Threatened and Endangered Species and Species of Special Concern

This section discusses potential Project effects on marine, terrestrial, and avian species listed under the federal ESA, or the Commonwealth of Virginia Endangered Species Act, or which have received a federal or state designation as a species of special concern.

The ESA of 1973, as amended (16 USC 1531 et seq.), prohibits unauthorized taking, possession, sale, and transport of listed species. Under Section 7 of the ESA, federal agencies must consult with the USFWS or NOAA Fisheries to ensure that any action authorized, funded, or carried out by that agency is not likely to jeopardize the continued existence of any endangered or threatened species or result in the destruction or adverse modification of critical habit. NOAA Fisheries has jurisdiction over most listed marine species and anadromous fish species, and the USFWS has jurisdiction over terrestrial and freshwater species and some marine species. This section has been developed to support BOEM's development of the Project's Biological Assessment (BA) and associated review of the VOWTAP by NOAA Fisheries and the USFWS under Section 7 of the ESA.

The VDGIF and the Virginia Department of Agriculture and Consumer Services (VDACS) are responsible for the enforcement of Virginia's endangered species statutes (VA ST Sections 29.1-563-570) (Gagnon et al. 2010). The VDACS Office of Plant Protection has regulatory authority to list and protect plants and insects under the Virginia Endangered Plant and Insect Species Act (Section 3.1 – 1020 through 20130, Code of Virginia) (Townsend 2012). The VDCR Natural Heritage Program (NHP) serves as a consulting agency for projects with potential to impact state-listed threatened and endangered animal species.

Federal and state agencies also monitor species that are at risk of becoming rare and/or are proposed for ESA listing, as follows:

- USFWS monitors bird populations under a federal mandate and compiles a list of birds of conservation concern (BCC) (USFWS 2008a). Species listed as BCC are not listed under the ESA, but are of greater conservation concern than other avifauna. BCC listing is a precautionary measure to assure that these species receive extra attention to avoid listing under the ESA (USFWS 2008a). BCC listing does not create any additional protection to the species other than that already accorded under the Migratory Bird Treaty Act (MBTA) or other relevant statutes (USFWS 2008a).
- NOAA Fisheries designates species of concern (SOC), as species for which NOAA Fisheries has some concerns regarding status and threats, but for which insufficient information is available to indicate a need to list the species under the ESA (NOAA 2010).
- VDGIF maintains a list of species of greatest conservation need (SGCN) in the Commonwealth. These species are identified as part of the state's Wildlife Action Plan, and include species with declining populations.
- The federal Bald and Golden Eagle Protection Act (BGEPA, 50 CFR Parts 13 and 22) provides additional protection to these two species.

- The USFWS maintains a list of federal species of concern; this designation is not a legal status and does not provide protection under the ESA. In Virginia, this list is maintained by the USFWS Virginia Field Office (VDGIF 2013a). All federal species of concern in Virginia are also state threatened or endangered species (VDGIF 2013), and this designation is, therefore, not used further.

4.6.1 Affected Environment

The Project Area primarily consists of open-water marine habitats east of Virginia Beach, but also includes coastal and some terrestrial habitats on the Virginia mainland. A list of protected species that may occur in the Project Area was developed based on agency consultation, site-specific surveys, and a review of publically available information. For the onshore portion of the Project Area, Dominion contracted with VDCR NHP to review the proposed Onshore Interconnection Cable and Fiber Optic Cable route for the potential presence of state-listed species. The results of this review are included in Appendix A. Table 4.6-1 lists both federal and state-listed species, as well as species of special concern with the potential to occur in the Project Area and their likelihood of occurrence.

Table 4.6-1. Listed Species and Species of Concern with Potential Occurrence within the Project Area

Common Name	Scientific Name	Federal Status [a/]	State Status [a/]	Likelihood of Occurrence
Invertebrates				
Northeastern beach tiger beetle	*Cicindela dorsalis dorsalis*	LT	LT	Unlikely
S-banded tiger beetle	*Cicindela trifasciata*		NHRC	Moderate
Fish				
Atlantic sturgeon	*Acipenser oxyrinchus*	LE	LE	Low
Atlantic halibut	*Hippoglossus hippoglossus*	SOC		Low
Blueback herring	*Alosa aestivalis*	SOC		High
Dusky shark	*Carcharhinus obscurus*	SOC		Low
Porbeagle shark	*Lamna nasus*	SOC		Moderate
Rainbow smelt	*Osmerus mordax*	SOC		Unlikely
Sand tiger shark	*Carcharias taurus*	SOC		Low
Shortnose sturgeon	*Acipenser brevirstrom*	LE	LE	Unlikely
Thorny skate	*Amblyraja radiata*	SOC		Unlikely
Amphibians				
Barking treefrog	*Hyla gratiosa*		LT	Unlikely
Terrestrial Reptiles				
Canebrake rattlesnake	*Crotalus horridus*		LE	Moderate
Eastern chicken turtle	*Deirochelys reticularia reticularia*		LE	Unlikely
Eastern glass lizard	*Ophisaurus ventralis*		LT	Unlikely
Northern diamond-backed terrapin	*Malaclemys terrapin terrapin*		SGCN	High
Marine Reptiles				
Kemp's ridley sea turtle	*Lepidochelys kempii*	LE	LE	High
Leatherback sea turtle	*Dermochelys coriacea*	LE	LE	High
Loggerhead sea turtle	*Caretta caretta*	LT	LT	High
Green sea turtle	*Cheloria mydas*	LT	LT	Low
Hawksbilll sea turtle	*Eretmochelys imbricata*	LE	LE	Unlikely

Table 4.6-1. Listed Species and Species of Concern with Potential Occurrence within the Project Area (continued)

Common Name	Scientific Name	Federal Status [a/]	State Status [a/]	Likelihood of Occurrence
Birds				
American bittern	*Botaurus stellaris*	BCC		High
Audubon's shearwater	*Puffinus lherminieri*	BCC		High
Bald eagle	*Haliaaetus leucocephalus*	BCC, BGEPA		Present (observed during May 2013 onshore point count surveys).
Bermuda petrel	*Pterodroma cahow*	LE		Low (may occur during non-breeding period on the Virginia OCS)
Black skimmer	*Rynchops niger*	BCC		High
Brown pelican	*Pelecanus occidentalis*	Delisted due to recovery	SC	Present
Buff-breasted sandpiper	*Tryngites subruficollis*	BCC		High
Caspian tern	*Sterna caspia*	-	SC	Present
Common tern	*Sterna hirundo*		SGCN	High
Forster's tern	*Sterna forsteri*		SGCN	High
Glossy ibis	*Plegadis falcinellus*		SGCN	High
Great shearwater	*Puffunus gravis*	BCC		High
Gull-billed tern	*Sterna nilotica*	BCC	LT/SGCN	Moderate
Horned grebe	*Podiceps auritus*	BCC		High
Hudsonian godwit	*Limosa haemastica*	BCC		Moderate
Least bittern	*Ixobrychus exilis*	BCC		High
Least tern	*Sternula antillarum*		SC	Present
Lesser yellowlegs	*Tringa flavipes*	BCC		High
Marbled godwit	*Limosa fedoa*	BCC	SGCN	Moderate
Peregrine falcon	*Falco peregrinus*		LT/SGCN	Present
Pied-billed grebe	*Podilymbus podiceps*	BCC		High
Piping plover	*Charadrius melodus*	LT	LT	Moderate (may occur during the non-breeding period on the Virginia OCS, and is known to occur on Virginia beaches)
Purple sandpiper	*Calidris martima*	BCC	SGCN	High
Red knot	*Calidris canutus ssp. rufa*	PT/BCC	SGCN	Low (may occur during the non-breeding period on the Virginia OCS, or on the Virginia coast)
Red-throated loon	*Gavia stellata*	BCC		Present
Roseate tern	*Sterna dougallii dougallii*	LE	LE	Low (may occur during migration on the Virginia OCS)
Royal tern	*Sterna maxima*		SGCN	High
Sandwich Tern	*Sterna sandvicensis*	-	SC	Present
Semipalmated sandpiper	*Calidris pusilla*	BCC		High
Short-billed dowitcher	*Limnodromus griseus*	BCC	SGCN	High
Snowy Egret	*Egretta thula*	BCC		High
Tricolored heron	*Egretta tricolor*		SGCN	High
Whimbrel	*Numernius phaeopus*	BCC		High
Wilson's plover	*Charadrius wilsoni*	BCC	LE	Moderate

Table 4.6-1. Listed Species and Species of Concern with Potential Occurrence within the Project Area (continued)

Common Name	Scientific Name	Federal Status a/	State Status a/	Likelihood of Occurrence
Terrestrial Mammals				
Virginia big-eared bat	*Corynorhinus townsendii virginianus*	LE	LE	Unlikely
Rafinesque's eastern big-eared bat	*Corynorhinus rafinesquii macrotis*		LE	Low
Northern long-eared bat	*Myotis septentrionalis*	PE		Moderate
Dismal swamp southeastern shrew	*Sorex longirostris fisheri*		LT	Low
Marine Mammals				
Killer whale	*Orcinus orca*	LE[b/]		Unlikely
Blue whale	*Balenoptera musculus*	LE	LE	Unlikely
Fin whale	*Balaenoptera physalus*	LE	LE	High
Humpback whale	*Megaptera novaeangliae*	LE	LE	High
North Atlantic right whale	*Eubalaena glacialis*	LE	LE	High
Sei whale	*Balaenoptera borealis*	LE	LE	Unlikely
Sperm whale	*Physeter catodon*	LE	LE	Unlikely
West Indian manatee	*Trichechus manatus*	LE	LE	Unlikely
Vascular Plants				
Seabeach amaranth	*Amaranthus pumilus*	LT		Low
White-top fleabane	*Erigeron vernus*		NHRC	High
Bog rush	*Juncus elliottii*		NHRC	High
Bluejack oak	*Quercus incana*		NHRC	High
Fasciculate beakrush	*Rhynchospora fascicularis*		NHRC	High
American halfchaff sedge	*Lipocarpha maculata*		NHRC	High
Long beach seedbox	*Ludwigia brevipes*	SC	NHRC	High

Sources: USFS 2008a; NOAA 2010; NOAA 2011; VDGIF 2005; USFWS 2013a

a/ Species Status: LE – Listed as an endangered species; LT – Listed as a threatened species; PT – Proposed for listing as threatened species; PE – Proposed for listing as endangered species; SOC – NOAA ESA Species of Concern, SC –Species of Concern; BCC – Bird of Conservation Concern; SGCN – Species of Greatest Concern, NHRC - natural heritage resources of concern.

b/ Certain populations of killer whales are listed as endangered.

The potential for occurrence in the Project Area was evaluated as follows:

- Unlikely– no species range overlap with Project Area or unsuitable habitat in Project vicinity;
- Low – species range overlaps with Project Area and marginally suitable habitat present in Project vicinity;
- Moderate – species range overlaps with Project Area and suitable habitat present in Project Area, or species known to occur in habitat similar to Project Area;
- High – highly suitable habitat present in Project Area, or known populations exist in Project vicinity,
- Present – species observed during field survey.

This section does not address in detail species with a likelihood of occurrence in the Project Area of low or unlikely.

4.6.1.1 Fish Species

The only federally listed marine fish species found off the coast of Virginia are the shortnose sturgeon and Atlantic sturgeon, both of which are listed as endangered. The remaining seven species identified in Table 4.6-1, including Atlantic halibut, blueback herring, dusky shark, porbeagle shark, rainbow smelt, sand tiger shark and thorny skate, are NOAA species of special concern. Both the dusky shark and sand tiger shark, have designated EFH in the Project Area. These two species are discussed in Section 4.7.

Shortnose Sturgeon – Federal and State Endangered Species

The shortnose sturgeon was listed as endangered in 1967. The shortnose sturgeon is found on the Atlantic Coast of North America, where its range extends from the Saint John River, New Brunswick, to the St. Johns River, Florida. It is anadromous, meaning spawning occurs in freshwater rivers while the rest of the adult life stage occurs preferentially in nearshore marine, estuarine, and riverine habitat of larger river systems (NOAA Fisheries 2013a).

Shortnose sturgeon remain predominantly associated with estuarine environments, visiting open ocean salt water areas such as the waters in the Project Area infrequently (Collette and Klein-MacPhee 2002). In addition, no EFH for this species has been identified in the Project Area (see Section 4.7). Because their primary habitats are not found within or near the Project Area, the likelihood of occurrence is low; consequently, potential impacts to shortnose sturgeon are unlikely and are not discussed further.

Atlantic Sturgeon – Federal and State Endangered Species

The Atlantic sturgeon was listed as endangered in 2012. Atlantic sturgeon are opportunistic, bottom-oriented feeders, preying on polychaetes, isopods, decapod crustaceans, amphipods, gastropods, bivalves, and small fish (Collette and Klein-MacPhee 2002) found in or near soft sediments. Stock abundance of Atlantic sturgeon steadily declined throughout the 20th century, largely due to overfishing and habitat degradation or destruction (Shepherd 2006). Primary threats to Atlantic sturgeon include habitat degradation and loss, ship strikes, and general depletion from historical fishing (NOAA Fisheries 2012).

This species is highly migratory; mark-recapture studies have documented movements of sturgeon from the Hudson and Delaware Rivers to as far north as coastal Maine and south to North Carolina (Shepherd 2006). Atlantic sturgeon spawn in freshwater but spend most of the adult life stage in the marine environment, inhabiting coastal, near-shore marine environments when not migrating into freshwater bays and estuaries to spawn (Collette and Klein-MacPhee 2002). In mid-Atlantic areas, spawning adults migrate upriver from April to May in mid-Atlantic waters. Juveniles and adults generally return to brackish and coastal environments in the fall (Collette and Klein-MacPhee 2002). Coastal features or shorelines where Atlantic sturgeon commonly aggregate include the Bay of Fundy, Massachusetts Bay, Rhode Island, New Jersey, Delaware, Delaware Bay, Chesapeake Bay, and North Carolina. Atlantic sturgeon were historically present in 38 rivers in the United States from, the St. Croix, Maine to the St. Johns River, Florida, and historic spawning populations have been confirmed in 35 of those rivers (Atlantic Sturgeon Status Review Team 2007).

Atlantic sturgeon require hard bottom substrates for spawning (Collette and Klein-MacPhee 2002). Sturgeon eggs adhere to hard bottom substrates (e.g., cobble), and hatch four to six days later. Newly hatched larval fish begin migrating downstream to rearing habitats after 8 to 12 days; as sturgeon develop into the juvenile stage they continue moving downstream into brackish waters, and eventually become resident in estuarine waters for months or years. Subadults move to coastal waters after reaching lengths of 30 in to 36 in (76.2 cm to 91.4 cm).

Adults return to their natal streams for spawning. Males return first and remain in the natal stream for the entire spawning period, whereas females leave the spawning grounds soon after eggs are laid (Atlantic Sturgeon Status Review Team 2007). Spawning intervals are irregular; males are thought to spawn every 1 to 5 years, and females every 2 to 5 years (Smith 1985; Collins et al. 2000; Caron et al. 2002; Vladykov and Greeley 1963; Van Eenennaam et al. 1996; Stevenson and Secor 1999).

Atlantic sturgeon are not believed to spawn in the Project Area, which is characterized by predominantly sandy substrates without the hard bottoms required by this species. Adult sturgeon may forage in the near-shore portions of the Project Area, but are not expected to occur in large numbers. In addition, no EFH for this species has been identified within the Project Area (see Section 4.7). For these reasons, the likelihood of occurrence for this species is rated as low. Therefore, potential impacts to Atlantic sturgeon are unlikely and not discussed further.

Atlantic halibut – Federal Species of Concern

The Atlantic halibut (*Hippoglossus hippoglossus*) was identified as a species of concern in 2004 (NOAA Fisheries 2009a). This species was heavily overfished in the 19th century and has not shown signs of recovery to date (Brodziak 2002). Atlantic halibut occur from Labrador to southern New England, and as far south as off the coast of Virginia (NOAA Fisheries 2009a). This species lives in coastal to upper slope areas and is bottom-oriented (NOAA Fisheries 2009a). Adults are found over sand, gravel or clay substrates and at depths of 328 ft to 2,300 ft (100 m to 700 m) (Collette and Klein-MacPhee 2002). As the Project is at the southern extent of the range of Atlantic halibut, and suitable habitat is present, this species has a low likelihood of occurrence within the Project Area. Therefore, potential impacts are unlikely and not discussed further.

Blueback herring – Federal Species of Concern

Blueback herring (*Alosa aestivalis*) were identified as species of concern in 2006 (NOAA Fisheries 2009b). Blueback herring occur from Cape Breton, Nova Scotia to the St. John's River in Florida (Collette and Klein-MacPhee 2002). They are anadramous and ascend coastal rivers in the late spring to spawn (NOAA Fisheries 2009b). Spawning substrate includes gravel, sand, detritus, and submerged aquatic vegetation (NOAA Fisheries 2009b). While at sea they form schools and migrate offshore to overwinter near the bottom (NOAA Fisheries 2009b). In August 2013, NOAA Fisheries determined that listing blueback herring as threatened or endangered under the ESA was not warranted (78 FR 48943). As the Project is within the range of this species and suitable habitat is present, this species has a high likelihood of occurrence within the Project Area.

Porbeagle shark – Federal Species of Concern

The porbeagle shark (*Lamna nasus*) was identified as species of concern in 2006 (NOAA Fisheries 2013c). This species occurs across the North Atlantic, and in a circumglobal band in the southern Atlantic, southern Indian, southern Pacific, and Antarctic Oceans (NOAA Fisheries 2013c). Porbeagle sharks are highly migratory and rarely enter shallow, coastal waters (Collette and Klein-MacPhee 2002, NOAA Fisheries 2013c). They are found at depths of up to 1,000 ft (300 m), and may move to the deeper water in the winter to avoid low surface water temperatures (Collette and Klein-MacPhee 2002). On July 12, 2010, NOAA

Fisheries determined that listing porbeagle sharks under the ESA was not warranted (75 FR 39656). Suitable habitat for this species is present within the Project Area; however, because the Project is at the southern edge of the range for this species, it has a low likelihood of occurrence. Therefore, potential impacts are unlikely and not discussed further.

Rainbow smelt – Federal Species of Concern

Rainbow smelt (*Osmerus mordax*) were identified as species of concern in 2004 (NOAA Fisheries 2007). In eastern North America, they occur in rivers and coastal areas from Labrador to New Jersey (NOAA Fisheries 2007). Rainbow smelt usually remain close to shore and in shallow water (Collette and Klein-MacPhee 2002). This species may migrate at sea, although their life history stage is not well understood (Collette and Klein-MacPhee 2002). This species may occur in the nearshore, shallow portion of the Project Area; however, as the Project Area is at the southern edge of the range of this species, it is unlikely to occur within the Project Area. Therefore, potential impacts are unlikely and not discussed further.

Thorny skate – Federal Species of Concern

The thorny skate (*Amblyraja radiata*) occurs off the northeastern coast of North America from Labrador to South Carolina (NOAA Fisheries 2009c). It generally occurs at depths of 20 ft to 3,900 ft (6 m to 1,200 m) over a wide variety of substrates, including sand, broken shell, gravel, pebbles and soft mud (Collette and Klein-MacPhee 2002). Thorny skates may make seasonal migrations, but details on timing and locations are not known (Packer et al. 2003). As the Project is within the range of this species and suitable habitat is present, this species has a high likelihood of occurrence within the Project Area.

4.6.1.2 Marine Mammals

There are seven marine mammal species listed under the ESA with the potential to occur off the coast of Virginia:

- Blue whale;
- Fin whale;
- Humpback whale;
- North Atlantic right whale;
- Sei whale;
- Sperm whale; and
- West Indian manatee.

All of these species are highly migratory and do not spend extended periods of time in a localized area. The offshore waters of Virginia, including the Project Area, are primarily used as a migration corridor for these species, particularly by right whales, during seasonal movements north or south between important feeding and breeding grounds (Knowlton et al. 2002; Firestone et al. 2008). There are no marine mammal sanctuaries in the waters off Virginia.

While the fin, humpback, and right whales have the potential to occur within the Project Area, the sperm, blue, and sei whales are more pelagic and/or northern species, and their presence within the Project Area is unlikely (Waring et al. 2007; 2010; 2012; 2013). The West Indian manatee has been sighted in Virginia waters; however, such events are infrequent. Because the potential for the sperm whale, blue whale, sei whale, or West Indian manatee to occur within the Project Area is unlikely, these species will not be described further in this analysis.

North Atlantic Right Whale – Federal and State Endangered Species

The North Atlantic right whale was listed as a federal endangered species in 1970. When the right whale was protected in the 1930s, it is believed that the North Atlantic right whale population was roughly 100 individuals (Waring et al. 2004). In 2009, the Western North Atlantic population size was estimated to be at least 444 individuals (Waring et al. 2013).

The North Atlantic right whale was the first species targeted during commercial whaling operations and was the first species to be greatly depleted as a result (Kenney 2002). Contemporary human threats to right whale populations include fishery entanglements and vessel strikes, along with habitat loss, pollution, anthropogenic noise, and intense commercial fishing (Kenney 2002). Ship strikes of individuals can impact North Atlantic right whales on a population level due to the intrinsically small remnant population that persists in the North Atlantic (Laist et al. 2001). Between 2002 and 2006, a study of marine mammal strandings and human-induced interactions reported that right whales in the western Atlantic were subject to the highest proportion of entanglements (25 of 145 confirmed events) and ship strikes (16 of 43 confirmed occurrences) of any marine mammal studied (Glass et al. 2008). From 2006 through 2010, 9 of 15 records of mortality or serious injury to right whales involved entanglement or fishery interactions (Waring et al. 2013). The NOAA marine mammal stock assessment for 2012 reports that the low annual reproductive rate of right whales, coupled with small population size, suggests human-caused mortality may have a greater impact on population growth rates for this species than for other whales (Waring et al. 2013).

To address the potential for ship strikes, NOAA Fisheries designated segments of the nearshore waters of the Mid-Atlantic Bight as Mid-Atlantic Seasonal Management Areas (SMAs) for right whales. NOAA Fisheries requires that all vessels 65 ft (19.8 m) or longer must travel at 10 knots or less within the right whale SMA from November 1 through April 30, when right whales are most likely to pass through these waters (NOAA 2010). The VOWTAP WTGs, Inter-Array Cable, and Export Cable are located within the vicinity of the right whale Mid-Atlantic SMA at the mouth of the Chesapeake Bay (Figure 4.14-1 [in Navigation section]).

The right whale is a strongly migratory species that moves annually between high-latitude feeding grounds and low-latitude calving and breeding grounds. The present range of the western North Atlantic right whale population extends from the southeastern United States, which is utilized for wintering and calving, to summer feeding and nursery grounds between New England and the Bay of Fundy and the Gulf of St. Lawrence (Kenney 2002; Waring et al. 2011). The winter distribution of North Atlantic right whales is largely unknown, although offshore surveys have reported 1 to 13 detections annually in northeastern Florida and southeastern Georgia (Waring et al. 2013). A few events of right whale calving have been documented from shallow coastal areas and bays (Kenney 2002).

North Atlantic right whales may be found in feeding grounds within New England waters between February and May, with peak abundance in late March (NMFS 2005). Mid-Atlantic waters likely are primarily used as a migration corridor during these seasonal movements north or south between important feeding and breeding grounds (Knowlton et al. 2002; Firestone et al. 2008).

Right whales have been observed in or near Virginia waters from October through December, as well as in February and March, which coincides with the migratory time frame for this species (Knowlton et al. 2002). Based on the migratory pattern and the establishment of an SMA around approaches to Chesapeake Bay, right whales have the potential to occur in the Project Area, particularly during peak migration times, and overall likelihood of occurrence in the Project Area is rated as high.

Humpback Whale – Federal and State Endangered Species

The humpback whale was listed as endangered in 1970 due to population decrease resulting from overharvesting. Humpback whales were hunted as early as the seventeenth century, with most whaling operations having occurred in the nineteenth century (Kenney and Vigness-Raposa 2009). By 1932, commercial hunting within the North Atlantic may have reduced the humpback whale population to as few as 700 individuals (Breiwick et al. 1983). North Atlantic humpback whaling ended worldwide in 1966 (NatureServe 2013). The humpback whale population within the western North Atlantic has been estimated to include approximately 4,894 males and 2,804 females, with an ocean-basin-wide estimate of approximately 11,570 individuals (Waring et al. 2013). According to the species stock assessment report, the best estimate of abundance for the Gulf of Maine stock of humpback whales is 823 individuals (Waring et al. 2013).

Humpback whales feed on small prey that is often found in large concentrations, including krill and fish such as herring and sand lance (Waring et al. 2013; Kenney and Vigness-Raposa 2009). A majority of female humpback whales migrate from the North Atlantic to the Caribbean in winter, where calves are born between January and March (Blaylock et al. 1995). Not all humpback whales migrate to the Caribbean during winter, and numbers of this species are sighted in mid- to high-latitude areas during winter (Clapham et al. 1993; Swingle et al. 1993). The Mid-Atlantic area may also serve as important habitat for juvenile humpback whales, evidenced by increased levels of juvenile strandings along the Virginia and North Carolina coasts (Wiley et al. 1995).

Contemporary human threats to humpback whales include fishery entanglements and vessel strikes. Glass et al. (2008) reported that between 2002 and 2006, humpback whales belonging to the Gulf of Maine population were involved in 77 confirmed entanglements with fishery equipment and 9 confirmed ship strikes. Humpback whales that were entangled exhibited the highest number of serious injury events of the six species of whale studied by Glass et al. (2008). A whale mortality and serious injury study conducted by Nelson et al. (2007) reported that the minimum annual rate of anthropogenic mortality and serious injury to humpback whales occupying the Gulf of Maine was 4.2 individuals per year. During this study period, humpback whales were involved in 70 reported entanglements and 12 vessel strikes, and were the most common dead species reported. NOAA Fisheries records for 2006 through 2010 indicate 10 reports of mortalities as a result of collision with a vessel, and 29 serious injuries and mortalities attributed to entanglement (Waring et al. 2013).

Humpback whales exhibit consistent fidelity to feeding areas within the northern hemisphere (Stevick et al. 2006), effectively creating six subpopulations that feed in six different areas during spring, summer and fall. These populations can be found in the Gulf of Maine, the Gulf of St. Lawrence, Newfoundland/Labrador, western Greenland, Iceland, and Norway (Waring et al. 2013). Humpback whales migrate from these feeding areas to the West Indies (including the Antilles, the Dominican Republic, the Virgin Islands and Puerto Rico) where they mate and calve their young (NMFS 1991; Waring et al. 2013).

While migrating, humpback whales utilize the Mid-Atlantic as a migration pathway between calving/mating grounds to the south and feeding grounds in the north (Waring et al. 2013). Humpbacks typically occur within the Mid-Atlantic region during fall, winter, and spring months (Waring et al. 2012). Therefore, humpback whales have the potential to occur in the Project Area during these seasons, and overall likelihood of occurrence in the Project Area is rated as high.

Fin Whale – Federal and State Endangered Species

The fin whale was listed as federally endangered in 1970. The best abundance estimate for fin whales in the western North Atlantic is 3,985 individuals (Waring et al. 2011). Present threats to fin whales are similar to those that threaten other whale species, namely fishery entanglements and vessel strikes. Fin whales seem less likely to become entangled than other whale species. Glass et al. (2008) reported that between 2002 and 2006, fin whales belonging to the Gulf of Maine population were involved in only eight confirmed entanglements with fishery equipment. Furthermore, Nelson et al. (2007) reported that fin whales exhibited a low proportion of entanglements (eight reported events) during their 2001 to 2005 study along the western Atlantic. NOAA Fisheries data indicate two records with substantial evidence of fishery interactions causing mortality, with an additional two interactions resulting in serious injury from 2005 through 2009 (Waring et al. 2011). On the other hand, vessel strikes may be a more serious threat to fin whales. Glass et al. (2008) reported eight vessel strikes, while Nelson et al. (2007) reported ten strikes. NOAA Fisheries data indicate that nine fin whales were confirmed killed by collision from 2005 through 2009 (Waring et al. 2011). A study compiling whale/vessel strike reports from historical accounts, recent whale strandings, and anecdotal records by Laist et al. (2001) reported that of the 11 great whale species studied, fin whales were involved in collisions most frequently (31 in the United States and 16 in France).

Fin whales are the second largest living whale species on the planet (Kenney and Vigness-Raposa 2009). The range of fin whales in the North Atlantic extends from the Gulf of Mexico, Caribbean Sea, and Mediterranean Sea in the south to Greenland, Iceland, and Norway in the north (Jonsgård 1966; Gambell 1985). They are the most commonly sighted large whales in continental shelf waters from the Mid-Atlantic coast of the United States to Nova Scotia, principally from Cape Hatteras northward (Sergeant 1977; Sutcliffe and Brodie 1977; CETAP 1982; Hain et al. 1992; Waring et al. 2011). Fin whales, much like humpback whales, seem to exhibit habitat fidelity to feeding areas (Waring et al. 2011; Kenney and Vigness-Raposa 2009). While fin whales typically feed in the Gulf of Maine and the waters surrounding New England, mating and calving (and general wintering) areas are largely unknown (Waring et al. 2011). Strandings data indicate that calving may take place in the Mid-Atlantic region during October to January for this species (Hain et al. 1992).

Fin whales are present in the Mid-Atlantic region during all four seasons, although sightings data indicate that they are more prevalent during winter, spring, and summer (Waring et al 2012). While fall is the season of lowest overall abundance off Virginia, they do not depart the area entirely. Consequently, the likelihood of occurrence in the Project Area is rated as high.

4.6.1.3 Sea Turtles

Five sea turtle species are known to be present, or have the potential to be present, within the waters off Virginia:

- Leatherback;

- Loggerhead;
- Kemp's ridley;
- Green; and
- Hawksbill turtle.

Based on reported sightings off the coast of Virginia, the loggerhead sea turtle is the most common and the Kemp's Ridley sea turtle is the second most common. The leatherback is common enough to have six to ten strandings every year; the green sea turtle is infrequently observed during late summer and early fall; the hawksbill turtle is extremely rare off the coast of Virginia (VIMS 2013). The hawksbill turtle prefers tropical, shallow coastal waters and rarely ventures into higher latitudes. Since the hawksbill sea turtle's range is outside of the Project Area, their presence is considered unlikely and this species is not discussed further.

Loggerhead Sea Turtle – Federal and State Threatened Species

The loggerhead sea turtle was listed as federally endangered in 1978. Threats to the loggerhead sea turtle include both naturally caused and anthropogenic destruction and alteration of nesting habitats, marine debris, coastal noise and light pollution, beach vehicle traffic, boat strikes, and fishery incidents (TEWG 2000; NMFS and USFWS 2007a).

The loggerhead is found in the open seas as far as 500 mi (805 km) from shore, but mainly lives over the continental shelf and in bays, estuaries, lagoons, creeks, and mouths of rivers. It favors warm temperate and subtropical regions not far from shorelines. Primary nesting areas in North America are South Carolina, Georgia, and Florida. The loggerhead sea turtle is one of the two larger-shelled species of sea turtle found in the North Atlantic, with carapace lengths reaching 213 centimeters (Kenney and Vigness-Raposa 2009). The carapace and head of the loggerhead are distinct. The shell is shaped like an oval that tapers towards the rear and the head is much larger relative to its overall size compared to other sea turtles. The loggerhead sea turtle is the most common turtle off the coast of Virginia (VIMS 2013).

Juvenile loggerhead sea turtles have been reported in high numbers around the Azore islands, feeding on pelagic invertebrates, including siphonophores, jellies, salps, barnacles, isopods, and gastropods (TEWG 2000; Bolten 2003). Loggerhead sea turtles return to coastal waters during the later stages of juvenile development. The later juvenile diet, which is dominated by crabs, changes to an adult diet consisting of bivalves, gastropods, anemones, sea pens, crabs, and seaweeds (Kenney and Vigness-Raposa 2009).

The western Atlantic population of loggerhead sea turtles can be further divided into five distinct subgroups. The northernmost subpopulation nests between Georgia and the Carolinas. There are two more nesting subpopulations within the United States, which can be found in southern Florida and the Florida Panhandle. Finally, two more nesting subpopulations exist in the Dry Torugas and the Yucatan (NMFS and USFWS 2007a). The western North Atlantic population of loggerhead turtles has been estimated at 53,000 to 92,000 nests and 32,000 to 56,000 nesting females (TEWG 2000; NMFS and USFWS 2007a). Between 1989 and 1998, the northern subpopulation harbored between 4,370 and 7,887 nests per year, while the south Florida population exhibited 48,531 to 83,442 nests per year (TEWG 2000).

The loggerhead occasionally nests on ocean-facing Virginia beaches from early June through August; however, Virginia is considered the northern limit of loggerhead nesting in the United States and has only had as many as eight nests reported in a single nesting season (VADGIF 2013). Nine loggerhead sea turtle nests were documented in 1991 at the Back Bay National Wildlife Refuge (DeGroot and Shaw 1993). Loggerhead nesting between Virginia and New Jersey is considered very rare (Center for Biological Diversity 2013). Loggerhead turtles were observed during the VOWTAP 2013 avian and geophysical surveys.

While the potential exists for nesting sea turtles to occur at the Export Cable landing area during June through August, the rarity of such events make such interactions unlikely. However, to protect potential nesting turtles, Virginia has instituted time-of-year restrictions on offshore dredging (no activity between April 1 and November 30) and beach construction (no activity between May 1 and August 31 or time of last hatch, extended through November 15 if no turtle nest surveys are conducted; VDGIF 2013c). As the loggerhead turtle is the most common sea turtle to be sighted off the coast of Virginia, the overall likelihood of occurrence in the Project Area is rated as high.

Leatherback Sea Turtle – Federal and State Endangered Species

The leatherback sea turtle was listed as federally endangered in 1970. While there are natural threats for leatherback sea turtles (e.g., recent large-scale habitat loss as a result of the 2004 tsunami in the Indian Ocean), most threats to this species are anthropogenic and include coastal tourism, habitat alteration and loss, artificial lighting on breeding beaches, pollution, global warming, and ingestion of marine debris (e.g., balloons); however, vessel strikes and commercial fishing are the largest threats to this species (NMFS and USFWS 2007b; TEWG 2007). Commercial longline fishing may be the most serious contemporary threat. Longline fishing data collected and summarized by NMFS-SEFSC (2001) found that between 1992 and 1999, the annual longline fishing industry take of leatherback sea turtles was between 308 and 1,054 animals. Furthermore, the United States shrimp trawl fishery has been estimated to take 650 leatherback sea turtles a year (NMFS and USFWS 1992).

Leatherback sea turtles exhibit the most expansive distribution of any sea turtle, with nesting occurring within tropical and subtropical climates and foraging occurring well into sub polar regions (NOAA Fisheries and USFWS 2007b). The leatherback turtle is mainly pelagic, inhabiting the open ocean, and seldom approaches land except for nesting (Eckert 1992). This species is one of the largest reptiles and the only turtle in the world that lacks keratin plates or scutes (Kenney and Vigness-Raposa 2009). The leatherback sea turtle instead has a bony shell, which is covered by a soft layer of leathery skin. Females dig nests on sandy beaches and hatchlings emerge from these nests after 2 months (Kenney and Vigness-Raposa 2009). Hatchlings usually emerge with a shell length just less than 2 in (5 cm) and are believed to move into pelagic waters upon leaving natal beaches (TEWG 2007). Leatherback hatchlings feed on aquatic plants and invertebrates, while adults feed mostly on jellyfish and other gelatinous invertebrates, especially lion's mane jellyfish (Kenney and Vigness-Raposa 2009).

Off the coast of Virginia, the leatherback is common enough to be observed every year, with 6 to 10 strandings (VIMS 2013). The most recent estimate of leatherback turtle population size within the North Atlantic is between 34,000 and 94,000 individuals (TEWG 2007). The Turtle Expert Working Group identified seven leatherback sea turtle populations in the eastern and western Atlantic. These populations can be found in Florida, the Western Caribbean, the Northern Caribbean, the Southern Caribbean, West Africa, South Africa, and Brazil (TEWG 2007). Foraging areas occupied by the leatherback sea turtle seem to vary based on seasonality. A satellite tracking study of 10 leatherbacks reported that most individuals were located on the North American OCS between spring and fall, and off the OCS during the winter

(Eckert et al. 2006). The seasonal distribution of leatherback sea turtles extends to the western North Atlantic and reaches northward into Canadian waters (NMFS-SEFSC 2001). Seasonal movements have been described by Shoop and Kenney (1992) to occur between Cape Hatteras and the Gulf of Maine, eastward to the 6,561.7 ft (2,000 m) isobath. While leatherback sea turtle detections have been reported throughout the East Coast of the United States during summer, densities decrease from Cape Hatteras to the Gulf of Maine, with a large concentration occurring south of Long Island (Shoop and Kenney 1992). Leatherback sightings decrease during the spring and fall and especially in winter (Shoop and Kenney 1992).

Notable differences in nesting densities have been reported within the seven Atlantic populations. Over the last 10 to 15 years, the number of nesting leatherback sea turtles has increased for the Florida, Northern Caribbean, Southern Caribbean, West African, and Brazilian populations, and decreased in the Western Caribbean population. Nesting activity in South Africa has not been recorded in the Atlantic (NOAA Fisheries and USFWS 2007b).

While the leatherback sea turtles have the potential to be encountered off the coast of Virginia, this species prefers deep ocean environments (Kenney and Vigness-Raposa 2009). There is a potential for this species to occur in the Project Area as they migrate through deep, open ocean areas (Kenney and Vigness-Raposa 2009). While sightings of leatherback sea turtles off the coast of Virginia are likely transient migrating individuals, both sightings and strandings data indicate that the overall likelihood of occurrence of this species in the Project Area is high.

Kemp's Ridley Sea Turtle – Federal and State Endangered Species

The Kemp's ridley sea turtle was listed as federally endangered in 1970. Threats to the Kemp's ridley include habitat destruction (both anthropogenic and storm events) and tourism at nesting beaches, disease and predation, egg harvesting, fishery interactions, and cold-stunning (USFWS and NOAA Fisheries 1992; NOAA Fisheries and USFWS 2007c). This species is one of the least abundant sea turtles in the world. Estimates of the Kemp's ridley sea turtle population off the northeastern United States are lacking, as adults of this species are too small to be detected during aerial surveys. Most individual Kemp's ridley sea turtles found in the North Atlantic have been in the juvenile stage. Kenney and Vigness-Raposa (2009) suggested that abundance estimates may be biased due to the small size of this turtle and the shallow bay habitats they prefer, which causes this species to be excluded from marine surveys.

Adult Kemp's ridley sea turtles range from the Gulf of Mexico north to Long Island Sound, New England, and Nova Scotia. The Kemp's ridley is usually found only in the Gulf of Mexico and the northern portions of the Atlantic Ocean, with more than half of the nesting population of this turtle species occurring along a 25-mi (40-km) beach line in Tamaulipas, Mexico, approximately 190 mi (306 km) south of the Rio Grande River (USFWS and NOAA Fisheries 1992). Off the coast of Virginia, the Kemp's ridley sea turtle is the second most common turtle, with approximately 200 to 300 individuals observed every year (VIMS 2013). Kemp's ridley sea turtles are a smaller-shelled species, with adult carapace lengths reaching 31.5 in (80 cm). This species normally takes 10 to 17 years to reach sexual maturity and nests between April and July, with hatchlings emerging from their nests within 45 to 48 days (NMFS and USFWS 2007c). Once hatchlings emerge, they enter the open water and passively drift in the Gulf of Mexico and North Atlantic for 1 to 4 years. At this point, juveniles feed benthically (mostly on crabs) in shallow habitats, and then transition to adult habitats, which are muddy and sandy bottom areas, where their prey base includes shrimp, sea urchins, sea stars, and assorted mollusks (NatureServe 2013). Foraging areas for the Kemp's ridley in the Atlantic include Chesapeake Bay, Pamlico Sound, Charleston Harbor, Delaware Bay, and Long Island Sound (NMFS and USFWS 2007c).

Kemp's Ridley sea turtles were observed during the VOWTAP 2013 avian and geophysical surveys. Therefore, the overall likelihood of occurrence in the Project Area is rated as present.

Green Sea Turtle – Federal and State Threatened Species

The green sea turtle was listed as federally endangered in 1978. Population estimates for this species off the northeastern United States coast are lacking (Thompson 1988), because adults of this species are too small to be detected during aerial surveys. However, data are available for nesting populations. Between 2001 and 2006, an average of 5,039 nests per year were found in Florida nesting areas (ranging between 581 and 9,644 nests per year; NMFS and USFWS 2007d). Historically, this species was harvested within the United States and the Caribbean, with over a million pounds of green sea turtles harvested in 1890 alone (Doughty 1984). Present-day threats to green sea turtles include natural and human-induced destruction or alteration of nesting habitats, marine debris, shark predation, coastal noise and light pollution on nesting beaches, beach vehicle traffic, boat strikes, and fishery incidents (Epperly et al. 1995; TEWG 2000; NMFS and USFWS 2007d).

The green sea turtle primarily utilizes shallow habitats such as lagoons, bays, inlets, shoals, estuaries, and other areas with an abundance of marine algae, sea grasses, and other submerged aquatic vegetation, their principal food sources (Bartlett and Bartlett 1999). Individuals observed in the open ocean are believed to be migrants en route to feeding grounds or nesting beaches (Meylan 1982). Green sea turtles reach approximately 59 in (150 cm) in length during the adult life stage (Kenney and Vigness-Raposa 2009). This species exhibits a late maturation age of 20 to 50 years (Balazs 1982). After hatching, green sea turtles spend between 5 and 6 years drifting passively, feeding mostly on grasses and algae, but may also consume jellyfish, salps, and sponges. Later in life, green sea turtles move into adult foraging habitats in nearshore areas, where they almost exclusively feed on sea grasses and algae, a unique trait among sea turtles.

Green sea turtles can be found throughout the world's oceans, including within the Pacific, Indian, and Atlantic, as well as the Mediterranean Sea (NOAA Fisheries and USFWS 2007d). In the western Atlantic during the summer, this species can be found in estuarine waters within Long Island Sound, Chesapeake Bay, and the many North Carolina sounds and into southern tropic areas (Musick and Limpus 1997; Morreale and Standora 1998).

Off the coast of Virginia, the green sea turtle is infrequently observed during late summer and early fall (VIMS 2013). During the winter, green sea turtles occur in more southerly United States waters, including those around Cape Hatteras (Epperly et al. 1995). While the green sea turtle has the potential to be a transient to the Project Area during the summer and fall, this species is not generally expected to occur and the overall likelihood of occurrence in the Project Area is rated as low. Therefore, potential impacts are unlikely and not discussed further.

4.6.1.4 Invertebrates

There is only one federal and state threatened invertebrate species known to occur in the vicinity of the Project: the Northeastern beach tiger beetle. An additional species, the tiger beetle (*Cicindela trifasciata*), is also known to occur in the vicinity of the Project, and is a natural heritage resource of concern.

Northeastern beach tiger beetle – Federal and State Threatened

The northeastern subspecies of beach tiger beetle (*Cicindela dorsalis dorsalis*) was listed as threatened in 1990. There is no critical habitat designated for northeastern beach tiger beetle. The northeastern beach tiger beetle is a large predatory beetle that occurs along the Atlantic coast from southern New Jersey to Florida. The species prefers broad sandy beaches with dunes and upper beach habitat above the high tide line. Adult beetles prey on insects and crustaceans, and scavenge on marine organisms that wash up on shore (VDCR 2008). The beetles hibernate from November to March, when larvae enter cocoons; adults emerge in June. Adults mate and lay eggs on sandy beaches between June and August. Primary threats to this species include human activity on beaches, including vehicle traffic. In Virginia, northeastern beach tiger beetles are known from Chesapeake Bay beaches, however, their presence is not documented at Virginia Beach, or other southern Atlantic coast beaches. The overall likelihood of this species occurrence in the Project Area is rated as unlikely, and this species is not discussed further.

Tiger Beetle - Natural Heritage Resource of Concern

Cicindela trifasciata is a tiger beetle that occurs close to water, especially around coastal and riparian mudflats and marshes (USGS 2013). This species is known to occur at the Camp Pendleton – Dam Neck Dune and Swale Conservation Site, which is adjacent to the Project Area. The VDCR noted potential for the Project Area to support populations of this species. As this species is known to occur in the vicinity of the Project and suitable habitat is present, this species has a high likelihood of occurrence in the Project Area.

4.6.1.5 Avian Species

Four federal and state-listed or proposed avian species have the potential to occur in Project Area: the roseate tern, piping plover, red knot, and the Bermuda petrel or cahow.

Bermuda Petrel (Cahow) – Federal Endangered Species

The Bermuda petrel was listed as endangered in 1970, and was one of the first foreign breeding species to be listed under ESA as part of Region 10 of USFWS. Bermuda petrel, or cahow, (*Ptreodroma cahow*) is a small sea bird endemic to islands in Bermuda. The species is known to breed only on the Castle Harbor Islands, Bermuda and was believed extinct up until the mid-20th century (Bried and Mgalhaes 2003). Eggs are deposited in cliff sides or burrows in loose soil, usually in January, and young fledge by early June. Bermuda petrels are thought to spend much of the non-breeding period at sea, but may forage more than 60 mi (100 km) during foraging bouts.

There are records of Bermuda petrel as far north as New England. Bermuda petrel may occur as a vagrant on the Virginia OCS within the Gulf Stream (Harrison 1987, AERC TAC 2003, O'Connell et al. 2009). During the non-breeding season Bermuda petrels have been recorded in the Gulf Stream, as far north as the Bay of Fundy, into the Gulf of St. Lawrence and over the Grand Banks (Bried and Mgalhaes 2003). There is limited information on the range and distribution of Bermuda petrel while at sea; however, it is improbable that the species occurs regularly on the Virginia OCS or in the proposed VOWTAP WTG Area because it is believed to be restricted to Gulf Stream waters, and primarily occurs in lower latitudes. Bermuda petrels were not observed during surveys conducted at the VOWTAP WTG Area in the late-summer and fall, when the species would be expected to occur. The overall likelihood of occurrence in the Project Area is rated as low. Bermuda petrel are not known to occur in coastal areas or onshore in Virginia. Therefore, potential impacts are unlikely and not discussed further.

Roseate Tern – Federal and State Endangered Species

The North Atlantic population of roseate terns (*S. d. dougallii*) was listed as endangered under the ESA in 1987. Roseate terns are migratory seabirds that breed in both the Caribbean and North Atlantic, and winter along the northern and eastern coasts of South America (USFWS 2010). No critical habitat has been designated for the North Atlantic population of roseate tern (USFWS 2010). Roseate terns have historically nested in coastal Virginia, but are not currently known to breed on the eastern seaboard anywhere south of New York (Roble 2010).

The cause of roseate tern population decline in the North Atlantic is, in part, a result of impacts on the species that occurred prior to the 20th century and continued into the 1970s (Gochfeld et al. 1998). Egging (harvesting of tern eggs for human consumption) during the late 19th century and early 20th century is thought to have significantly affected roseate tern colonies in the Atlantic (Gochfeld et al. 1998). In the mid and late 20th century accumulation of organochlorines, including DDT (**d**ichloro**d**iphenyl**t**richloroethane) and polychlorinated biphenyls, in tern tissues and eggs (especially in New York and Massachusetts pairs) is thought to have caused substantial declines in nest success (Gochfeld et al. 1998). Current threats to the species include habitat loss, nest predation, and increasing gull populations (USFWS 2010). Recent re-colonization of historic nesting sites in Maine and elsewhere indicate the North Atlantic roseate tern population may be recovering (USFWS 2010).

Roseate terns breed on small islands and barrier beaches from coastal New York north to Nova Scotia and the Madeleine Islands, Quebec; the species does not breed in Virginia or adjacent states (USFWS 2010). Roseate terns may migrate through the mid-Atlantic region, migration passing offshore North Carolina and Virginia in May, during northward migration. During southward roseate terns are presumed to migrate well offshore, passing through the mid-Atlantic region in late-summer (Gochfeld et al. 1998). The species is rarely observed south of New Jersey (Gochfeld et al. 1998). The species' migration is compressed and may occur in as few as 2 to 3 days of autumnal migration from New England staging areas to the Puerto Rico staging areas (Nisbet et al. 2009). Roseate terns are expected to migrate farther out over the OCS than the area where WTGs are proposed, and they are known to fly in groups, which should limit the number of discrete instances of potential exposure risk to the WTGs (Nisbet et al. 2009). Existing information on tern species' flight heights during migration indicate that migration may occur well above the height of offshore WTGs (Perkins et al. 2004, Nisbet et al. 2009, Burger et al. 2011). Lower migratory flight heights during poor visibility or opportunistic foraging bouts are possible (Perkins et al. 2004; Nisbet et al. 2009).

Roseate terns are unlikely to occur on the coast of Virginia. Although other tern species were routinely observed during surveys in the VOWTAP Offshore Avian Survey Area, and during the Mid-Atlantic Baseline Study Area, only a single roseate tern was observed by Williams (2013) near the mouth of the Chesapeake Bay in 2012 (K. Williams, Biodiversity Research Insitute, personal communication, 2013, Appendix L-1).

Roseate terns do not nest on the Virginia mainland (USFWS 2013a). During the breeding season, roseate terns generally forage approximately 4 mi to 7 mi (7 km to 11 km) from their nesting colonies (Rock et al. 2007, Vliestra 2008). Therefore, exposure of the species to impact producing factors from the VOWTAP during the breeding period is unlikely.

Foraging primarily occurs in nearshore waters, inlets, and sheltered bays in shallow waters (less than 9.8 ft [3 m] deep), although foraging behavior during migration is poorly understood (Heineman 1992, Vliestra 2008). Roseate terns were not observed foraging near the VOWTAP WTG Area during the Mid-Atlantic Baseline Study or during the VOWTAP avian surveys (Williams 2013, Appendix L-1). Based on the low abundance of terns and species with similar foraging habits (i.e. other *Sterna* spp.), there does not appear to be a consistent concentration of prey in the VOWTAP WTG Area during spring and fall migration for the area to be considered an important foraging location for terns. This is likely a result of water depths and the benthic habitat conditions present (i.e. primarily sandy bottom and potentially less biologically productive then coastal areas, or locations on the OCS with consistent upwelling and nutrient mixing).

There are no roseate tern breeding colonies near the VOWTAP Project area. The roseate tern is not anticipated to migrate through the proposed VOWTAP WTG Area in large numbers. High densities of foraging terns are not expected, or known to occur, in the VOWTAP WTG Area. Known roseate tern breeding colonies are more than 260 miles (420 km) from the VOWTAP WTG Area, the species does not breed south of New York, and the observed foraging behavior of breeding pairs at roseate tern colonies in the northeast indicates that they do not forage more than 10 miles from their breeding colonies during the non-migratory period. There is no evidence that roseate terns forage in the VOWTAP WTG Area during breeding, staging, or migratory periods. Roseate tern migration is compressed (i.e., occurs quickly over a brief period), their movements are clustered, and their flight heights during migration are thought to be above the height of the proposed WTGs under most climatic conditions.

Based on this information, the likelihood of occurrence in the Project Area is rated as low, with only limited potential for the species to occur in the Project Area during migration.

Piping Plover – Federal and State Threatened Species

The piping plover is listed as threatened in Virginia, and has been federally listed as threatened since 1985 (Boettcher et al. 2007; USFWS 2009; Roble 2010; Roble 2013). There are no critical habitat areas designated for piping plovers in Virginia (USFWS 2009).

Piping plovers are migratory shorebirds that breed along the North Atlantic coast and winter in the southern United States, around the Caribbean, and in Central America (Elliott-Smith and Haig 2004). Piping plovers nest on coastal beaches and in dune habitat, and forage in the inter-tidal zone (Elliott-Smith and Haig 2004).

The Atlantic coast piping plover population declined during the latter part of the nineteenth century as a result of the millinery trade. The population rebounded in the middle of the twentieth century following passage of the MBTA in 1918 (USFWS 2009). Recent threats to the Atlantic coast population include loss of nesting habitat, increased predation, and increased recreational use of nesting beaches, which has been directly correlated to low nesting success rates (USFWS 2009). Critical habitat for piping plovers has been designated for the Great Lake breeding population and for the wintering population in the southern United States; however, no critical habitat designations exist within for the Atlantic coastal breeding population of piping plovers (USFWS 2009). Approximately 188 pairs of piping plovers nested in Virginia in 2011, and perhaps as many as 259 pairs in 2012 (Boettcher 2012; USFWS 2012; USFWS 2013b).

Piping plovers generally restrict their activities to shorelines and are not known to make frequent flights over open water. No piping plovers were observed during the VOWTAP avian surveys, nor was the species observed during the Mid-Atlantic Baseline Surveys in 2012 (Williams 2013, Appendix L-1) The proposed location for the Export Cable landfall site at Camp Pendleton Beach is not suitable nesting habitat for piping plovers because it is used for military training exercises. Piping plovers may occur on some southern Virginia beaches during spring and fall migration (F. Smith, Center for Conservation Biology, personal communication, 2013).

There is limited information on the occurrence of piping plovers on the OCS (O'Connell et al. 2011). Piping plovers do not forage at sea; foraging is restricted to tidal and inter-tidal habitats, the species does not rest on the water, and it is not expected to occur in the area of the proposed VOWTAP WTGs except possibly during migration. Although there is little information available about piping plover migration, the species is thought to migrate close to shore and is not known, or expected to migrate in large numbers through the proposed VOWTAP WTG Area. Overall, there is low probability that piping plovers occur in the VOWTAP WTG Area, which is 23.3 nm (26.8 mi) from the coast of Virginia. The species has been observed on remote islands in the Caribbean indicating that long migration over open water does occur (USFWS 1996, Burger et al. 2011, USFS 2008). It is possible that the species migrates at high altitudes while traveling over open water, although migratory flight heights are not well established and likely vary with meteorological conditions (USFWS 2008b, Burger et al. 2011).

Red Knot - Proposed Federal Endangered Species

The *C. c. rufa* population of red knots was proposed as a candidate for ESA listing in August of 2006, and was proposed for listing as threatened on September 27, 2013; USFWS is likely to designate some areas of Delaware Bay as critical habitat for this species (USFWS 2006 71 FR 53756 – 53835, USFWS 2013a 78 FR 60023 - 60098).

Red knots are a holarctic breeding shorebird with a subspecies (*C.c. rufa*) population that winters along the coasts of South America, primarily in southern Chile and Argentina, and migrates through the United States during migration to and from the high arctic (Harrington 2001). Historical impacts on the species included excessive market and sport hunting during the late 19th and early 20th centuries (Harrington 2001). Little is known about red knot population dynamics, but the occurrence of large numbers during migration at staging sites in the mid-Atlantic may leave the species vulnerable to threats to these important foraging habitats (Niles et al. 2007). Loss of wintering habitat is also thought to be a significant threat to the *C.c. rufa* population (Niles et al. 2007).

In the mid-Atlantic region, red knots occur in the greatest numbers during southward migration, which peaks in early August. Southbound migrants may cross the Atlantic from staging areas along the eastern seaboard and migrate directly to Brazil in a single sustained flight (Harrington 2001; Niles et al. 2007). A few critical migration stopover points are known to concentrate large numbers of the *C.c. rufa* population. The bulk of the population stops in the Delaware Bay area during northward migration in late April and May (Harrington 2001; Niles et al. 2007). Red knots are known to occur on the Virginia barrier islands, primarily from mid-May through mid-June, in numbers reaching perhaps as many as 10,000 individuals

(Smith et al. 2008). The southernmost Virginia barrier island (Fisherman's Island) is 28 mi (46 km) northeast of the VOWTAP WTG Area. Red knots are not known or expected to occur on the southern Virginia coastline as frequently as on the barrier islands. Red knots were not observed during surveys in the VOWTAP Onshore Avian Survey Area or Offshore Avian Survey Area during the species' spring or fall migration periods, when they would be expected to occur if present. Red knots were not observed during the spring and fall migration period during the 2012 Mid-Atlantic Baseline Study (Williams 2013, Appendix L-1).

Although red knots were not observed during surveys at the proposed Export Cable landfall site, the species may occur in upper beach and inter-tidal habitat in the Project Area during migration (F. Smith, Center for Conservation Biology, personal communication, 2013).

Because there were no sightings of red knots during the VOWTAP avian surveys or the Mid-Atlantic Baseline Study in 2012, the evidence does not indicate that red knots regularly migrate, forage, or stage in the Project area. Based on the applicable survey and literature information, the likelihood of occurrence in the Project Area is rated as low, with only limited potential for occurrence during migration periods.

Bald Eagle – Federally Protected

Bald eagles are no longer listed under the federal ESA, and were also removed from the Virginia List of Endangered and Threatened Species effective January 1, 2013 (VDGIF and CCB 2012). However, they are protected under the Bald and Golden Eagle Protection Act, under Virginia law, and pursuant to regulations of the Virginia Department of Game and Inland Fisheries (VDGIF and CCB 2012). A number of known bald eagle nest locations have been documented in coastal Virginia (including in the Mackay Island NWR to the south of the Onshore Interconnection Cable and Fiber Optic Cable alignment). Bald eagles are protected under the Bald and Golden Eagle Protection Act, and any activities that constitute a "take", such as disturbances that affect reproductive success, are prohibited unless a take permit has been issued by the USFWS. Although two bald eagles were observed during the VOWTAP avian surveys in the Onshore Survey Area, no nests are known to occur along the Onshore Interconnection Cable and Fiber Optic Cable route, or near the proposed Export Cable landfall site. The closest known bald eagle nests are adjacent to Lake Redwing in the Dam Neck Annex of Naval Air Station Oceana, approximately 1.2 mi (2 km) south of the Project Area. These two nests are located northwest of Lake Redwing and were both occupied in 2013 (nests VB0601 and VB0702) (CCB 2013).

Wilson's Plover - State Endangered Species

Wilson's plover is a small plover that nests in the debris and wrack zone above the high tidelines on sandy beaches, including Virginia Beach (Rappole 2007). Spring migrants arrive in April, nesting occurs in May, and fall migration occurs in August and September (Rappole 2007). The species is at risk as a result of human use of beaches, and coastal development. Although Wilson's plovers have not been observed at the proposed Export Cable landfall sites, there is some potential for the species to occur during migration or the breeding period. Therefore, the likelihood of occurrence in the Project Area is rated as moderate, since the species may occur near the proposed Export Cable landfall site, especially during migration.

Peregrine Falcon – State Threatened Species

Peregrine falcons are uncommon residents during the summer, and may occur in greater numbers during spring migration (March – April) and fall migration (September – October) in coastal Virginia (Rappole

2007). Peregrine falcon populations have been impacted by pesticide use, but have been recovering as a result of intensive management and captive breeding programs. The species is not known to breed in the Virginia Beach area. One individual was observed offshore during transit to the Offshore Study Area during the VOWTAP avian surveys (Appendix L-1). For this reason the likelihood of occurrence in the Project Area is designated as present, although the species is only likely to occur in the Project Area in very low numbers during migration.

Gull-billed Tern – State Threatened Species

Gull-billed terns are uncommon summer residents (April – August) along the coast, in marshes and wet fields. The species is threatened by development of coastal habitat and increased predation associated with human development (Rappole 2007). Gull-billed terns were not observed during surveys for the VOWTAP or during the Mid-Atlantic Baseline Study (Williams 2013). The likelihood of occurrence in the Project Area is rated as moderate, since the species is known to occur in the vicinity of the VOWTAP Onshore Interconnection facility components, and there is suitable habitat for foraging at the proposed Export Cable landfall site.

Brown Pelican – State Species of Concern

Brown pelicans are large, heavy-bodied, piscivorous seabirds that are uncommon along the Virginia coast from April to October (Rappole 2007). Populations are at risk due to coastal development and disturbance of nesting sites. Some individuals may over winter in Virginia. Brown pelicans were documented during the VOWTAP avian surveys and the Mid-Atlantic Baseline Study 2012 (Williams 2013, Appendix L-1). For this reason, the likelihood of occurrence in the Project Area is rated as present.

Caspian Tern – State Species of Concern

Caspian terns are large, heavy-bodied terns that generally migrate through, but do not regularly breed, in Virginia. The species may occur along the coast during spring migration in April and May, and during fall migration in August and October (Rappole 2007). As with other tern species, Caspian terns are threatened by development and predation at nesting locations. The species was observed during the VOWTAP avian surveys and the Mid-Atlantic Baseline Study (Williams 2013, Appendix L-1). For this reason, the likelihood of occurrence in the Project Area is rated as present.

Least Tern – State Species of Concern

Least terns are small-bodied terns that migrate through Virginia in May and September, and breed in the region in April to May (Rappole 2007). Least terns forage in estuaries, bays, and along beaches. The species is at risk from human development, recreation, and predators. Least terns were not observed during the 2013 VOWTAP avian surveys (Appendix L-1), but were observed during the Mid-Atlantic Baseline Study in 2012 (Williams 2013). For this reason, the likelihood of occurrence in the Project Area is rated as present.

Sandwich Tern – State Species of Concern

Sandwich terns are medium-sized terns that are summer residents of Virginia's barrier islands from April to September (Rappole 2007). Sandwich terns prefer inshore bays and shallow coastal waters. The species is threatened by human disturbance at breeding colonies and habitat loss. Sandwich terns are not known to breed in the Project Area, although they were observed during the VOWTAP avian surveys and during the Mid-Atlantic Baseline Study in 2012 (Williams 2012, Appendix L-1). For this reason, the likelihood of occurrence in the Project Area is rated as present.

Other species of concern may occur along coastal portions of Virginia, as well as within the offshore study area. For example, red-throated loon (*Gavia stellata*), a bird of conservation concern, may be common within the VOWTAP WTG Area. Please refer to Section 4.5 for additional discussion of birds and potential impact-producing factors.

4.6.1.6 Terrestrial Mammals

Virginia big-eared Bat – Federal and State Endangered Species

The Virginia big-eared bat (also known as Townsend's big-eared bat) was listed as federally endangered in 1979 and as state endangered in 1987 (VGDIF 2013a). This species is found exclusively in limestone caves (VGDIF 2013a). Loss of habitat and human disturbance at maternity and hibernation are potential reasons for the decline in this species (VGDIF 2013a). According to the 1984 recovery plan, only two active colonies are known in Virginia (Bagley 1984). This species is presently known to occur only in caves in three counties in western Virginia (VGDIF 2013a). Because this species is not known to occur in the vicinity of the Project, is the overall likelihood of occurrence is rated as unlikely in the Project Area.

Northern long-eared bat – Proposed Federal Endangered Species

The Northern long-eared myotis (*Myotis septentrionalis*) was proposed for listing as endangered on October 2, 2013 (USFWS 2013a). This bat is found in dense forest areas and forages in a variety of habitats; it is closely associated with cave structures. Although myotis bats have been recorded in coastal and near shore locations, they are not known to occur offshore (Pelletier et al. 2013). This species has a moderate likelihood of occurrence near the Onshore Interconnection Cable and Fiber Optic Cable route.

Rafinesque's big-eared bat – State Endangered Species

Rafinesque's eastern big-eared bat (*Corynorhinus rafinesquii macrotis*; eastern big-eared bat) was state listed as endangered in Virginia in 1987 (VAFWIS 2013a). This species is associated with forests of the southeastern United States and roosts in hollow trees, houses, unoccupied buildings and culverts, under loose bark, or in caves and mines (VAFWIS 2013a). Rafinesque's eastern big-eared bat is incidental in Virginia, including a recent report from Virginia Beach (VAFWIS 2013a). This bat is uncommon throughout its range and is especially rare in Virginia, which is at the edge of its range (VAFWIS 2013a). As such, this species has a low likelihood of occurrence within the Project Area.

Dismal Swamp southeastern shrew – State Threatened Species

The Dismal swamp southeastern shrew (*Sorex longirostris fisheri*) was listed as state threatened in January 1992 (VAFWIS 2013b). It was also listed as federally threatened in 1986, but was delisted in 2000 after it was iscovered to be more widely distributed than previously believed, among other factors (USFWS 2013c). The distribution of this shrew coincides with the historical boundaries of the Great Dismal Swamp of extreme southeastern Virginia and adjacent North Carolina (VAFWIS 2013b), which consists of forested wetland with a mosaic of habitat types (USFWS 2013c). Within this region, this species is associated with areas of heavy ground cover; individuals can be found in habitats of all successional stages, from grassy openings to closed forests, generally in moist to wet areas or bordering swamps, marshes, or rivers (VAFWIS 2013b). This species has a low likelihood of occurrence within the Project Area.

4.6.1.7 Terrestrial Reptiles

Canebrake Rattlesnake – State Endangered Species

The Canebrake rattlesnake is a large venomous snake that occurs in the coastal plain and piedmont of Virginia. The species prefers wetlands and wooded areas, and may occur in suitable habitat near the proposed Onshore Interconnection Cable and Fiber Optic Cable route (Rappole 2007). Canebrake rattlesnake populations are declining as a result of historical management practices (e.g., wide spread eradication efforts), habitat change, and vehicle traffic (VDGIF 2013d). The likelihood of occurrence in the Project Area is rated as moderate, because suitable habitat exists adjacent to the proposed Onshore Interconnection Cable and Fiber Optic Cable route.

Eastern Chicken Turtle – State Endangered Species

The Eastern chicken turtle was listed as state endangered in October 1987 (VAFWIS 2013c). The Eastern chicken turtle is a medium-sized turtle that inhabits freshwater ponds among forested dunes (Rappole 2007). In Virginia, Eastern chicken turtles inhabit freshwater cypress ponds within forested dunes (VAFWIS 2013c). Some individuals also spend considerable time on land, and overwinter in the surrounding forest just beneath the surface of the ground (VAFWIS 2013c). Southeastern Virginia is the northern limit of this species' range, and it is extremely rare in Virginia (VAFWIS 2013c). Only two isolated populations are known to occur in Virginia: one in Isle of Wight County and the other at First Landing State Park in Virginia Beach (Rappole 2007; VAFWIS 2013c). First Landing State Park is approximately 8 miles (12.9 km) from the Project Area overland, and approximately 12 miles (19.3 km) along the beach. The likelihood of occurrence in the Project Area is, therefore, rated as low and this species is not discussed further.

Eastern Glass Lizard – State Threatened Species

The Eastern glass lizard is a legless lizard that inhabits pine woods and wet open habitats. It occurs along the coastal plain from Virginia to Louisiana, but is known in the Virginia only from Back Bay National Wildlife Refuge and False Cape State Park. This species is thought to be declining in Virginia as a result of its limited distribution in the state and habitat change. The likelihood of occurrence in the Project Area is rated as unlikely, because it is only known to occur in Back Bay National Wildlife Refuge and False Cape State Park; therefore, this species is not discussed further.

Northern Diamond-Backed Terrapin – State Species of Greatest Concern

The Northern diamond-backed terrapin is a State Species of Greatest Concern identified in Virginia's Wildlife Action Plan, and is also of collection concern in Virginia (VAFWIS 2013d). This species has likely declined in Virginia as a result of trapping for restaurants and incidental drowning in crab pots (VAFWIS 2013d). This species is found in the Chesapeake Bay and the ocean side of the Eastern shore and in southeast Virginia (VAFWIS 2013d). It inhabits brackish water of estuaries and tidal marshes and is sometimes seen in the Atlantic Ocean; nesting occurs on sandy beaches or dunes (VAFWIS 2013d). As it is known to occur in the vicinity of the Project, and suitable habitat is present, it has a high likelihood of occurrence within the Project Area.

4.6.1.8 Amphibians

Barking Treefrog – State Threatened Species

The Barking treefrog is a large treefrog that is endemic to the Delmarva Peninsula and southern Virginia (Rappole 2007). Barking treefrogs forage in a variety of forested upland and lowland habitats, but are generally associated with pine savanna (Rappole 2007). Population declines have been attributed to habitat loss and fragmentation. The species is not known to occur in Virginia Beach (Rappole 2007). The likelihood of occurrence in the Project Area is, therefore, rated as unlikely, and this species is not discussed further.

4.6.1.9 Vascular Plants

Seabeach Amaranth – Federal Threatened Species

Seabeach amaranth is a federally threatened plant species that grows on sandy beaches, primarily on barrier islands, along the Atlantic coast (USFWS 2012). Seabeach amaranth is not currently known to occur at the Camp Pendleton – Dam Neck Dune and Swale Conservation Site or in adjacent areas; however, it is known to occur on barrier beaches similar to those present at and near the proposed Export Cable landfall site. Seabeach amaranth was not found during VDCR NHP's review of state and federally listed species known to occur within the proposed Onshore Interconnection Cable and Fiber Optic Cable route or proposed Export Cable landfall site. This species, therefore, has a low likelihood of occurrence within the Project Area.

VDCR's NHP reviewed the location of the proposed onshore components and indicated that six vascular plant species (discussed below) that are natural heritage resources of concern occur at the Camp Pendleton – Dam Neck Dune and Swale Conservation Site, located adjacent to the Project, and have the potential to occur within the Project Area (Appendix A). None of these species are listed under the federal ESA or Virginia state law, although one species, the long beach seedbox (*Ludwigia brevipes*), is a federal species of concern (USFWS 2011).

Bluejack oak – State Natural Heritage Resource of Concern

Bluejack oak occurs in maritime dune woodlands and scrub (VBA 2013), typically in longleaf pine (*Pinus palustris*) communities (Sullivan 1994). This species occurs on the Atlantic and Gulf coastal plains from southeastern Virginia south to central Florida, west to Louisiana and eastern and central Texas, and north to southeastern Oklahoma and southwestern Arkansas (Sullivan 1994). The largest population of this species in Virginia can be found in or near First Landing State Park, in the city of Virginia Beach (VBA 2013). As this species is known to occur in the vicinity of the Project and suitable habitat is present, this species has a high likelihood of occurrence within the Project Area.

Long beach seedbox – Federal Species of Concern and State Natural Heritage Resource of Concern

Long beach seedbox is found in interdune swales, depression ponds, borrow pits, and impoundments (VBA 2013). As this species is known to occur in the vicinity of the Project and suitable habitat is present, this species has a high likelihood of occurrence within the Project Area.

Fasciculate beakrush – State Natural Heritage Resource of Concern

Fasciculate beakrush occurs in interdune swales and ponds, moist to wet clearings, edges of salt marshes and waterfowl impoundments (VBA 2013). This species occurs primarily in estuarine or maritime environments and is rare in the Coastal Plain province of southeast Virginia (VBA 2013). As this species is known to occur in the vicinity of the Project and suitable habitat is present, this species has a high likelihood of occurrence within the Project Area.

Bog rush – State Natural Heritage Resource of Concern

Bog rush occurs in open swales, seeps, and ditches (VBA 2013) in Alabama, Arkansas, Delaware, Florida, Georgia, Kentucky, Louisiana, Mississippi, North Carolina, New Jersey, South Carolina, Tennessee, Texas and Virginia (USDA, NRCS 2013b). This species is rare in the Coastal Plain province of southeast Virginia (VBA 2013). As this species is known to occur in the vicinity of the Project and suitable habitat is present, this species has a high likelihood of occurrence within the Project Area.

White top fleabane – State Natural Heritage Resource of Concern

White top fleabane occurs in sea-level fens, interdune swales, seasonally wet maritime forests, boggy clearings, and ditches (VBA 2013) in Alabama, Florida, Georgia, Louisiana, Mississippi, North Carolina, South Carolina, Virginia, and the District of Columbia (USDA, NRCS 2013b). This species is rare in the southeastern Coastal Plain province of Virginia (VBA 2013). As this species is known to occur in the vicinity of the Project and suitable habitat is present, this species has a high likelihood of occurrence within the Project Area.

American halfchaff sedge – State Natural Heritage Resource of Concern

American halfchaff sedge occurs on riverside sand bars, depressional ponds, interdune swales and ponds, borrow pits, and impoundment shores (VBA 2013) in the eastern and southern US (USDA, NRCS 2013b). This species is rare in the Coastal Plain province of Virginia (VBA 2013). As this species is known to occur in the vicinity of the Project and suitable habitat is present, this species has a high likelihood of occurrence within the Project Area.

4.6.2 Potential Impact Producing Factors, Proposed Environmental Protection Measures, and BMPs

Impacts to federal and state listed species and/or species of concern may result from construction, operation, or decommissioning of the VOWTAP. The following summarizes the potential impact-producing factors to listed and/or species of concern that are present or have the potential to be present (medium or high) in the Project Area.

4.6.2.1 Fish Species

Potential impacts on listed and/or fish species of special concern from construction, operation and decommission, and the associated proposed mitigation measures, would not be materially different from those described for non-listed fish species in Section 4.3.2.2. In summary, the greatest potential effect on fish will primarily be related to temporary disturbance of habitat from construction equipment and vessels and/or injury or disturbance from project-related construction noise, namely pile driving of the WTG foundations. However, given the mobile nature of these species, the fact that construction activities will be limited in both spatial extent and duration, and the implementation of mitigation measures such as the use of a jet plow and ROV jet trencher, DP cable installation vessel, and soft-starts during impact pile driving activities, it is unlikely that fish will be adversely affected by Project construction activities. During the operation of the VOWTAP, the WTG foundations themselves may represent a beneficial impact by providing artificial substrate for fish to dwell, forage, or hide from predators.

Atlantic sturgeon are the only listed species of fish with the potential to occur within the Project Area; as discussed in Section 4.6.1.1 the likelihood of occurrence is low. However should they occur, as a predominantly demersal species, they would experience similar impact producing factors as described in Section 4.3.2.2. Because very few individuals are expected to be present at any given time in the Project Area, potential impacts on those individuals, should they occur, would not likely lead to population-level effects.

4.6.2.2 Marine Mammals

Potential impacts on endangered marine mammal species from construction, operation, and decommission, and the associated proposed mitigation measures, would not be materially different from those described for non-listed marine mammal species in Section 4.3.2.3. In summary, the greatest potential effect on marine mammals will be acoustic harassment from project construction activities, including impact pile driving and DP vessel thruster use, and potential vessel strike from project construction and operational support vessels. However, given the transient nature of individual mammals, the lack of important breeding or feeding grounds in the Project Area for these species, and the proposed mitigation and minimization measures, including observations of time-of-year windows and speed restrictions, the application of protected species observers (PSOs) during project construction, and the establishment of exclusion and monitoring zones and associated start-up and shut-down procedures for noise producing equipment, potential impacts on listed marine mammals in the Project Area will be successfully mitigated.

4.6.2.3 Sea Turtles

Project construction, operation, and decommissioning activities have the potential to result in similar impacts on listed sea turtles as described for marine mammals in Section 4.3.2.3. As discussed in that section, the greatest potential impact to sea turtles would be acoustic impacts from impact pile driving and the use of DP thrusters during construction and installation of the WTG foundations, WTGs and the Inter-Array Cable and Offshore Export Cable.

NOAA Fisheries has established interim guidelines on underwater noise level that have the potential to cause injury or behavioral modification to sea turtles. The threshold for behavioral modification is 166 dBL re 1 μPa (RMS) Absolute. The threshold for injury to sea turtles is 207 dBL.

As discussed in Section 4.2.2.3, Dominion will establish monitoring and exclusion zones for marine mammals during offshore construction. The exclusion zone will be based on the 180 dB Level A harassment isopleth for marine mammals, and the monitoring zone will be based on the 120 and 160 dB isopleths for Level B harassment. These zones will be larger than the equivalent zone to avoid injury or behavioral modification to sea turtles.

Establishment of these zones, along with the additional measure listed in Section 4.3.2.3, would serve to reduce noise impacts to sea turtles and to comply with the NOAA Fisheries interim guidelines.

In addition, because nesting sea turtles have been known to occur at the proposed Export Cable landfall site, Dominion will not conduct any construction activities at the proposed Export Cable landfall site between the dates of May 1 through August 31, in accordance with VDGIF requirements. Dominion has also committed to landing the Export Cable onshore via HDD to ensure no potential sea turtle nesting habitat is disturbed (see Section 3.3.3). For these reasons, potential effects from the construction, operation, and decommissioning of the VOWTAP at the landfall site are expected to be low for sea turtle species.

4.6.2.4 Invertebrates

The only invertebrate species with the potential to occur within the Project Area is the tiger beetle, currently identified as a natural heritage resource of concern (S1 – extremely rare and critically imperiled in Virginia) (Roble 2013). The following factors have the greatest potential for effect on this species:

- Indirect effects associated with temporary displacement or disturbance of species and their associated habitats from construction and/or decommissioning activities; and
- Direct effects from habitat loss from operation of Project facilities.

While this species may occur in the Project Area, impacts from temporary habitat disturbance or permanent habitat loss are unlikely during any phase of the Project. Dominion has selected an HDD to land the proposed Export Cable at Camp Pendleton to avoid any impacts to the beach or dunes. In addition, Dominion has specifically chosen previously disturbed areas to site the proposed onshore project facilities, including the Switch Cabinet, Onshore Interconnection Cable, Fiber Optic Cable, and Interconnection Station. In addition, construction techniques at the Export Cable landfall site and along the proposed Onshore Interconnection Cable and Fiber Optic Cable route have been selected to avoid direct impacts to important habitats. Dominion will implement a Stormwater Manager Plan and an ESC Plan, as well as associated BMPs during construction to avoid and/or minimize indirect effects to surrounding habitat from run-off, sedimentation, and/or erosion to the maximum extent possible. Also, areas disturbed during construction will be restored to pre-construction conditions once Project installation activities have been completed.

4.6.2.5 Avian Species

Federal and State Listed Species

Thirty-three species that are federal listed species, federal birds of conservation concern, state listed species, and state species of greatest conservation need/species of concern have the potential to occur in the Project Area. Of those, a total of 30 species have a moderate or high likelihood of occurrence within the Project Area, or have been observed in the Project Area (Table 4.6-1). This includes three federally listed avian species and one species proposed for listing. Potential affects to listed species from construction, operation and decommissioning, and associated proposed mitigation measures, would not be materially different from those described for non-listed birds in Section 4.5.2, and include:

- Indirect effects associated with temporary displacement or disturbance of species and their associated habits from construction and/or decommissioning activities;
- Direct effects from habitat loss from operation of Project facilities;
- Direct effects associated with collision with VOWTAP structures;
- Indirect effects to species associated with avoidance/permanent displacement from foraging habitats; and
- Indirect effects to species associated with barriers to movement.

As discussed in Section 4.5.2, the most likely potential effects to birds in the offshore portion of the Project Area, including Bermuda petrel, roseate terns, piping plover, red knot, (as well as state listed species and species of concern), would be temporary disturbance during construction and displacement during operation. However, federal listed species are not known to occur in the offshore portion of the Project Area, except as transitory migrants.

Dominion has reduced the potential for adverse effects to listed species during construction and operation of the offshore portion of the Project by selecting a development location that is not known to have high numbers of Bermuda petrel, roseate terns, piping plover, red knot or other listed species at any time of year, and is not in proximity to breeding areas. Dominion has reduced potential impacts during construction by committing to a construction period that will be brief in duration, limiting potential exposure of listed species to potential impacts produced by construction activities. In addition, because avian species are highly mobile at sea, it is unlikely that listed avian species would be adversely affected by increased vessel traffic associated with construction of the VOWTAP WTGs.

During operation of the WTGs, the potential effect on birds has been minimized by locating the Project in an area where federal and state listed species are not known to regularly occur and, therefore, have lower exposure risk to collision. In addition, Dominion will implement mitigation measures that include anti-perching devices on the WTG foundations and the use of flashing lights on the WTGs. The occurrence of transitory migrants in the VOWTAP WTG Area cannot be excluded; however, the probability of occurrence is low and the adverse effects are unlikely.

Birds such as state listed shorebird species and terns may be affected during construction of the onshore VOWTAP facilities. To reduce potential impacts to listed species, the onshore and coastal portions of the Project Area were selected to avoid critical habitat and known nesting areas of listed species (USFWS 2009). Although listed species are not known to nest at the proposed Export Cable landfall site, Dominion will avoid impacts to other coastal nesting species by not conducting construction activity during the breeding period from May 1 to August 31. Due to the placement of the Onshore Interconnection Cable and Fiber Optic Cable underground, there is no potential effect on listed avian species during operation of the VOWTAP onshore equipment.

Bald Eagles

Potential effects to bald eagles from the construction, operation, and decommissioning of the Project are likely to be similar to affects evaluated for other avian species with special protection; however, bald eagle nests occur within 1.2 mi (1.9 km) of the onshore portion of the Project Area. Dominion has avoided direct impact to bald eagles by installing interconnection lines and communication cables below grade, avoiding clearing of forested habitat, avoiding siting Project components near known eagle nesting sites, and by siting the WTGs more than 20 nm (37 km) from shore and outside of known eagle migration routes.

Although no direct impacts to bald eagles or bald eagle nest sites are likely to occur as a result of the proposed Project, indirect effects to bald eagles could occur during construction. There is some potential for construction of the onshore facilities to cause disturbance to eagles nesting approximately 1.2 miles (1.9 km) south of the onshore portion of the Project Area at Lake Redwing in the Dam Neck Reserve. However, the proposed construction activities would have only temporary effects (loud machinery etc.), and would not be visible from the nest sites. There is a sufficient vegetated area between the eagle nests at Redwing Lake and the proposed VOWTAP onshore construction activities to sufficiently buffer any disturbance caused by construction.

The proposed construction of a linear utility such as the VOWTAP Onshore Interconnection Cable and Fiber Optic Cable, is defined as a Category A activity under the National Bald Eagle Management Guidelines (2007). However, because the construction area is greater than 660 ft (201.2 m) from the Lake Redwing nest site, it is outside of the zone where mitigation or time of year restrictions are required (UFWS 2007).

Other Avian Species of Special Concern

Impacts to USFWS designated BCC, state SGCN, and state SOC will be similar to those impacts described in Section 4.5.2. Most BCC, SGCN, and SC birds occur either entirely onshore or most frequently near the coast, rather than offshore in the area where the VOWTAP WTGs are proposed. These species are unlikely to be exposed to any potential impacts from the VOWTAP WTGs. Installation of the Export Cable landfall and Onshore Interconnection Cable and Fiber Optic Cable are unlikely to have substantive effects on coastal or near shore avian species. Dominion has reduced potential effects on terrestrial natural habitat areas by using HDD to route the interconnection cable under sensitive coastal habitat areas and by using previously disturbed areas for onshore Project components, including the Switch Cabinet and Interconnection Station. In addition, any disturbances associated with construction will be short in duration and limited in extent.

4.6.2.6 Terrestrial Mammals

As discussed in Sections 4.5.2.2 and 4.6.1.6, both listed and non-listed terrestrial mammals, including the northern long-eared bat which has been proposed as an endangered species, may occur in the onshore portion of the Project Area. Project construction, operation, and decommissioning activities will not result in the clearing or disturbance of potential bat habitat, or habitat for other sensitive terrestrial mammals. While northern long-eared bats and other bats and terrestrial mammals may occur in the Project Area, impacts from temporary habitat disturbance or permanent habitat loss are unlikely to occur during any phase of the Project. Dominion has chosen previously disturbed areas to site the proposed onshore project facilities, including the Switch Cabinet, Onshore Interconnection Cable, Fiber Optic Cable, and Interconnection Station, and will employ construction techniques (HDD) at the proposed Export Cable landfall sites and along the proposed Onshore Interconnection Cable and Fiber Optic Cable route that will avoid any direct impacts to sensitive habitats. Dominion will also implement a Stormwater Management Plan pursuant to VAR10 General Permit, 9 VAC25-880, and an ESC Plan, and associated BMPs during construction to avoid or minimize the potential indirect effects on natural habitat areas from run-off, sedimentation, and/or erosion.

Terrestrial Reptiles

Of the three state-listed terrestrial reptiles (canebrake rattlesnake, eastern chicken turtle, and eastern glass lizard) and one state SGCN (northern diamond-backed terrapin) that occur in southern coastal Virginia, only the canebrake rattlesnake and northern diamond-backed terrapin have a moderate to high likelihood of occurring within the vicinity of the VOWTAP Onshore Project Area. Potential impacts from the Project during construction include disturbance or potential take by installation equipment. Dominion will reduce the potential for disturbance and potential take of canebrake rattlesnakes and northern diamond-backed terrapin by requiring construction personnel to check under all construction vehicles prior to operating them, and by excluding construction vehicle traffic in natural habitat areas and on the beach (Kleopfer et al. 2011).

Habitat destruction and displacement would not occur, as the Onshore Interconnection Cable and Fiber Optic Cable will be installed underground using HDD within existing road-rights-of way. In addition, all other Onshore Project facilities will be installed within previously disturbed areas. For these reasons, operation of the onshore VOWTAP facilities will not result in potential impacts on these species.

4.6.2.7 Vascular Plants

The federally listed seabeach amaranth is not known to occur in the onshore portion of the Project Area. There are six vascular plant species that are natural heritage resources of concern that are known to occur within the vicinity of the onshore portion of the Project Area (bluejack oak, long beach seedbox, fasciculate beakrush, bog rush, white-topped fleabane, and American halfchaff sedge). Potential impacts to sensitive populations of vascular plants would be removal or disturbance from cable installation equipment during construction. Dominion has avoided the need to remove vegetation during construction of the VOWTAP onshore project components by using HDD and by locating the onshore Project components in previously disturbed areas. For this reason, the operation of the onshore VOWTAP facilities will not result in potential impacts on these plant species.

4.7 Essential Fish Habitat

The fisheries of the United States are managed within a framework of overlapping federal, state, interstate, and tribal authorities. Individual states typically have jurisdiction over fisheries in marine waters within 3 nm (5.6 km) of their coasts. Federal jurisdiction includes fisheries in marine waters inside the U.S. EEZ, which encompasses the area from 3 nm (5.6 km) out to 200 nm (370.4 km) offshore of any United States coastline (NOAA 1996).

In 1996, the MSFCMA was reauthorized and amended by the Sustainable Fisheries Act (SFA) (NOAA Fisheries 2013b). This statute mandated numerous changes to the existing legislation designed to prevent overfishing, rebuild depleted fish stocks, minimize bycatch, enhance research, improve monitoring, and protect fish habitat. One of the most significant changes was the EFH provision, which provided that federal agencies that fund, permit, or undertake activities that may adversely affect EFH are required to consult with NOAA Fisheries regarding the potential effects of their actions on EFH.

Congress defines EFH as “those waters and substrate necessary to fish for spawning, breeding, feeding, or growth to maturity” (Public Law [P.L.] 104-297). NOAA Fisheries further clarified the terms associated with EFH by the following definitions (50 CFR 600.05 through 600.930):

- **Waters** – Aquatic areas and their associated physical, chemical, and biological properties that are used by fish and, where appropriate, may include aquatic areas historically used by fish;
- **Substrate** – Sediments, hard bottoms, structures underlying the waters, and associated biological communities;
- **Necessary** – The habitat required to support a sustainable fishery and the managed species’ contribution to a healthy ecosystem; and
- **Spawning, breeding, feeding, or growth to maturity** – Stages representing a species’ full life cycle.

The NOAA Fisheries and regional Fishery Management Councils develop EFH descriptions for federally managed fish species and include them in their respective fishery management plans. The fishery management plans identify and describe EFH, describe the EFH impacts (fishing and non-fishing), and suggest measures to conserve and enhance EFH.

4.7.1 Affected Environment

The affected environments for the purpose of this assessment are those habitats that have been designated as EFH and the fish and invertebrates for which these habitats were designated.

The Mid-Atlantic Fisheries Management Council (MAFMC) publishes EFH data by ocean blocks consisting of 10-minute by 10-minute quadrants of latitude and longitude, based on the annual NOAA Fisheries data collected within those same areas. The Project crosses five of these quadrants. For ease of discussion and evaluation, each quadrant crossed by the Project has been assigned a reference number from 1 to 5. The location and boundaries of these five EFH quadrants are shown in Table 4.7-1 and Figure 4.7-1.

Table 4.7-1. Location of EFH Quadrants and the Project Components

Reference Number	Project Component	Latitude and Longitude Coordinates for the Boundaries			
		North	East	South	West
1	Export Cable	36º50.0'N	75º50.0'W	36º40.0'N	76º00.0'W
2	Export Cable	36º50.0'N	75º40.0'W	36º40.0'N	75º50.0'W
3	Export Cable	36º50.0'N	75º30.0'W	36º40.0'N	75º40.0'W
4	Export Cable	37º00.0'N	75º30.0'W	36º50.0'N	75º40.0'W
5	WTGs and Inter-Array Cable	37º00.0'N	75º20.0'W	36º50.0'N	75º30.0'W

Table 4.7-2 provides a summary of habitat types (by substrate type) that occur in the Project Area based on site-specific surveys as detailed in Sections 4.1 and 4.3.1 and Appendix F-1.

Table 4.7-2. Export Cable and Aliquots – Substrate Types by Kilometer Post

Route Location	Water Depth Range (ft)	Predominant Substrate
Export Cable		
KP 0-0.8 (MP 0 – 0.5)	0-23	Presumed to be fine to coarse sand [a/]
KP0.8-KP5.5 (MP 0.5 – 3.5)	23-34.5	Fine to coarse sand
KP5.5-KP7.5 (MP 3.5 – 4.7)	30-41	Fine to coarse sand
KP7.5-KP16.5 (MP 4.7 – 10.25)	42.5-59	Fine to coarse sand
KP16.5-KP22.0 (MP 10.25 – 13.7)	64-70.5	Fine to coarse sand with gravel
KP22.0-KP29.5 (MP 13.7 – 18.3)	56-69	Medium to coarse sands with gravels
KP29.5-KP31.0 (MP 18.3 – 19.2)	62-79	Fine sands and silt
KP31.0-KP39.0 (MP 19.2 – 24.2)	56-66	Fine to coarse sand
KP39.0-KP44.1 (MP 24.2 – 27.3)	62-85	Fine to coarse sand
WTGs and Inter-Array Cable		
Aliquot 6111 H	79-85	Fine to medium sands with silts/clays
a/ Not yet surveyed - Dominion to complete a supplemental survey of this area in support of the final engineering and design of the Export Cable route and associated cable landfall.		

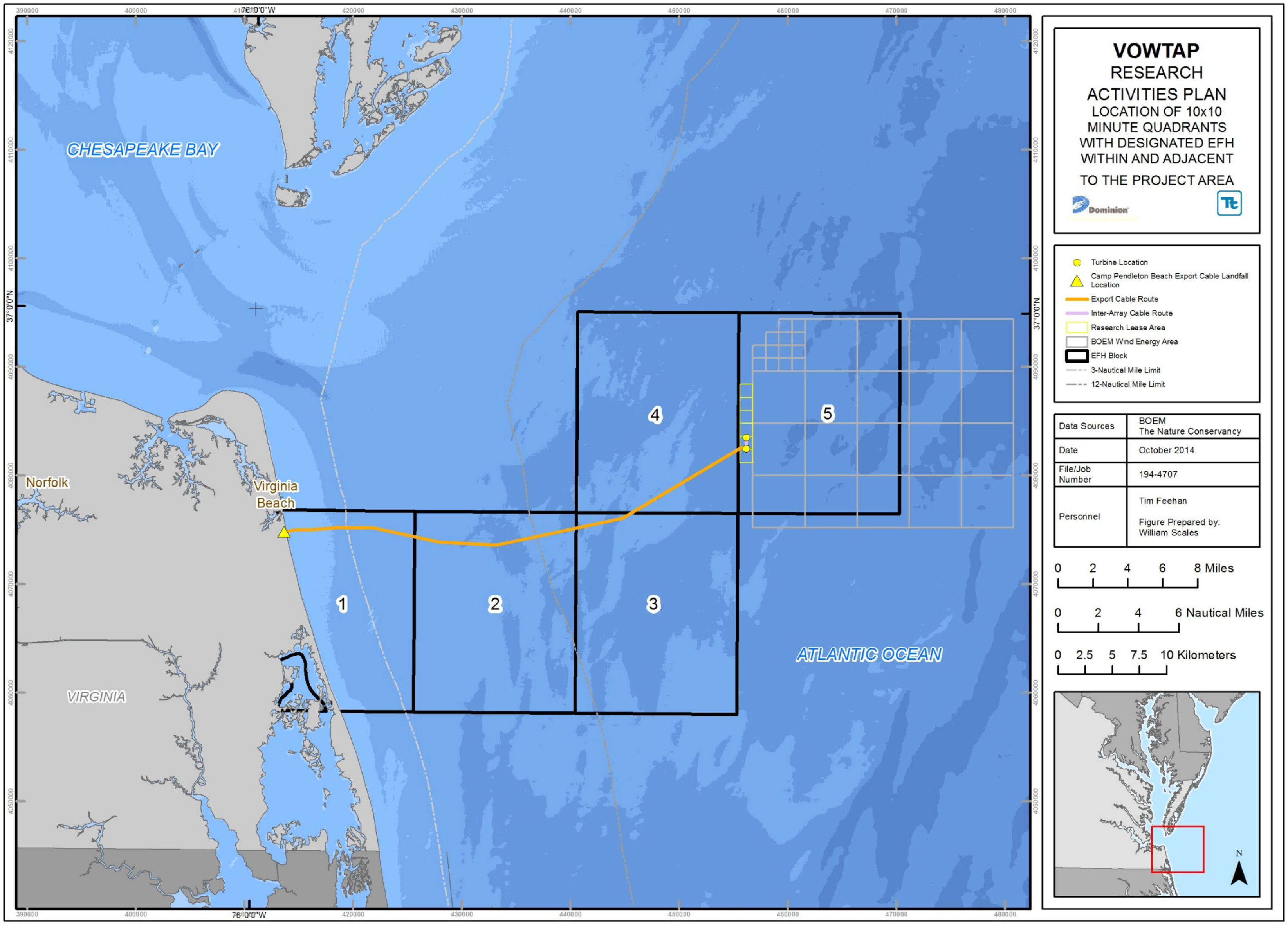


Figure 4.7-1. Location of 10x10 Minute Quadrants with Designated EFH within and Adjacent to the Project Area

Table 4.7-3 shows species within the five quadrants of the Project Area that have identified EFH. The table includes the life stage where each species can be found within the five quadrants.

Table 4.7-3. Species with EFH by Life Stage within the Project Area.

Species	Eggs	Larvae	Juveniles	Adults
whiting (Merluccius bilinearis)	4	4	4	
red hake (Urophycis chuss)	1	1	1	
witch flounder (Glyptocephalus cynoglossus)	1,2,4	5		
windowpane flounder (Scophthalmus aquosus)	1,2,3,4	2,3,4,5	1,2,3,5	
Atlantic sea herring (Clupea harengus)			2	1,2,3,4
monkfish (Lophius americanus)	2,3,4	2,3,4		
bluefish (Pomatomus saltatrix)	4	4	1,2,3,4,5	1,2,3,4
long finned squid (Loligo pealeii)	N/A[a/] 1-5	N/A 1-5	3,5	5
short finned squid (Illex illecebrosus)	N/A 1-5	N/A 1-5		
Atlantic butterfish (Peprilus triacanthus)			2,4	4
summer flounder (Paralichthys dentatus)	4	4,5	1,2,3,4,5	1,2,3,4,5
scup (Stenotomus chrysops)	N/A 1-5	N/A 1-5	1,2,3,4,5	1,2,3,4,5
black sea bass (Centropristis striata)	N/A 1-5	2,4	1,2,3,4,5	1,2,3,4,5
surf clam (Spisula solidissima)	N/A 1-5	N/A 1-5	2,3,4	3
ocean quahog (Artica islandica)	N/A 1-5	N/A 1-5		
spiny dogfish (Squalus acanthias)		N/A 1-5	1,2,3,4,5	2,3,4,5
king mackerel (Scomberomorus cavalla)	1,2,3,4,5	1,2,3,4,5	1,2,3,4,5	1,2,3,4,5
Spanish mackerel (Scomberomorus maculatus)	1,2,3,4,5	1,2,3,4,5	1,2,3,4,5	1,2,3,4,5
cobia (Rachycentron canadum)	1,2,3,4,5	1,2,3,4,5	1,2,3,4,5	1,2,3,4,5
red drum (Sciaenops occelatus)[b/]	1,2,3,4,5	1,2,3,4,5	1,2,3,4,5	1,2,3,4,5
sand tiger shark (Carcharias taurus)		1,2,3,4,5		1,2,3,4,5
Atl. sharpnose shark (Rhizopriondon terraenovae)				1,2,3,4,5
dusky shark (Carcharhinus obscurus)		1,2,3,4,5	1,2,3,4,5	
shortfin mako shark (Isurus oxyrinchus)		5		
sandbar shark (Carcharhinus plumbeus)		1 HAPC[c/],2,3,4,5	1 HAPC,2,3,4,5	1 HAPC,2,3,4,5
scalloped hammerhead shark (Sphyrna lewini)			1,2,3,4,5	
tiger shark (Galeocerdo cuvieri)		1,2,3,4,5	1,2,3,4,5	1,2,3,4,5
bluefin tuna (Thunnus thynnus)			5	5
swordfish (Xiphias gladius)			5	
skipjack tuna (Katsuwonus pelamis)				5

a/ N/A indicates some of the species either have no data available on the designated life stages, or those life stages are not present in the species' reproductive cycle

b/ Red Drum EFH is no longer designated outside of the Gulf of Mexico Fishery Management Council. However, designated EFH for this species was shown in the 10' x 10' minute squares overlapping the Project Area.

c/ HAPC is habitat area of particular concern

The following sections provide accounts of the habitat requirements for particular species and their life stages for which designated EFH potentially occurs within or in the vicinity of the Project Area. The primary sources of information for the habitat requirements of the EFH species were the EFH source documents developed by the Fishery Management Councils and issued by NOAA Fisheries. These documents provide descriptions of the habitat for locations where fish have been found to some degree of abundance. The mere occurrence of fish in a particular habitat is not an indication that it is essential, or even in its preferred habitat. It is only an indication that the fish was found in a particular habitat when a sampling event occurred. Regardless of these data limitations, the EFH source documents provide the best available descriptions of the habitat requirements for selected marine species.

Whiting

Whiting (silver hake) are found along the continental shelf of North America from Canada to the Bahamas and are most abundant between Newfoundland and South Carolina (Collette and Klein-MacPhee 2002). Two U.S. whiting stocks are managed: one is found in the Gulf of Maine and northern Georges Bank, and the other on southern Georges Bank and the Mid-Atlantic Bight. This species is usually found on sandy or pebbly ground or mud (Collette and Klein-MacPhee 2002). Spawning is most often observed from May through November, with peaks in June and July.

Eggs: EFH for whiting eggs is designated as the surface waters throughout their range. Eggs are typically mixed with the eggs of similar species such as red hake. Generally, whiting eggs are found where sea surface temperatures are below 20°C along the inner continental shelf. In Virginia waters, whiting eggs are most often observed during June through October in water depths ranging from 160 ft to 500 ft (50 m to 150 m) (NOAA Fisheries 2000). EFH for whiting eggs has been identified in Quadrant 4 only, and will likely be found in the water column above the near shore Export Cable within the Project Area; however, as these eggs are pelagic, potential impacts from the VOWTAP will be negligible.

Larvae: EFH for larval whiting is designated as surface waters off the coast of Virginia, from June through November. The larvae are typically observed when sea surface temperatures are below 19°C and salinity is greater than 0.5 percent (NOAA Fisheries 2000). EFH for whiting larvae has been identified in Quadrant 4 only, and will likely be found in the water column above the near shore Export Cable within the Project Area; however, as larvae for this species are pelagic, potential impacts from the VOWTAP will be negligible.

Juvenile: EFH for juvenile whiting is designated as the bottom habitats with a substrate of shell fragments, including areas with an abundance of live scallops throughout their range, but also includes all other substrates. Juvenile whiting migrate to deeper waters of the continental shelf as water temperatures decline in the autumn and return to shallow waters in spring and summer, preferring a wide range of water temperatures with salinities of greater than 20 parts per thousand (PPT) (NMFS 2000). EFH for juveniles has been identified in Quadrant 4 only; therefore, the VOWTAP Export Cable installation is the only aspect of the VOWTAP that could interact with this life stage of whiting.

Adult: No adult whiting EFH is found in the Project Area.

Red Hake

Red hake are found in the coastal waters off southern Newfoundland to North Carolina, with their center of abundance concentrated along Georges Bank, in the Gulf of Maine off Cape Cod, and in the northern Mid-Atlantic Bight off Long Island, New York. Within this range, red hake are managed as two U.S. stocks: a northern stock from the Gulf of Maine to northern Georges Bank, and a southern stock from southern Georges Bank into the Mid-Atlantic Bight. All life stages of the red hake are also found in estuaries from southern Maine to the Chesapeake Bay (Steimle et al. 1999a). Red hake make seasonal migrations to follow preferred temperature ranges.They are most common in depths less than 330 ft (100 m) during warmer months, and at depths greater than this during colder months. They commonly occur in coastal bays and estuaries less than 32 ft (less than 10 m) deep (Tyler 1971; Jury et al. 1994; Stone et al. 1994). Historically, red hake were targeted in coastal Virginia waters by commercial fishermen; however, the southern stock for red hake is considered overfished (Sosebee 1998). This species is usually found on sandy or pebbly ground or mud, preferring soft sediments over harder substrate (Collette and Klein-MacPhee 2002). Spawning is most often observed from April through November.

Eggs: EFH for red hake eggs is surface waters throughout their range. Eggs are typically mixed with the eggs of similar species such as whiting. Generally, the following conditions exist where hake eggs are found: sea surface temperatures below 10°C along the inner continental shelf with salinity less than 25 PPT (NMFS 2000). These preferred water column conditions limit the months where appropriate conditions exist in Virginia to early May or November. EFH for red hake eggs has been identified in Quadrant 1 only, and will likely be found in the water column above the near shore Export Cable within the Project Area; however, as eggs for this species are pelagic, potential impacts from VOWTAP will be negligible.

Larvae: EFH for red hake larvae is designated as surface waters throughout their range, including waters off the coast of Virginia. Larvae are present from May through December, with peaks in September and October. The larvae are typically observed when sea surface temperatures are below 19°C and salinity is greater than 0.5 PPT (NMFS 2000). These conditions are met within the Project Area in May, October or November, based on water temperature. EFH for whiting larvae has been identified in Quadrant 1 only and will likely be found in the water column above the near shore Export Cable within the Project Area; however, as these larvae are pelagic, potential impacts from VOWTAP will be negligible.

Juvenile: EFH for juvenile red hake is designated as the bottom habitats with a substrate of shell fragments, including areas with an abundance of live scallops throughout their range, but also includes all substrates. Juvenile red hake migrate to deeper waters of the continental shelf as water temperatures decline in the autumn and return to shallow waters in spring and summer, preferring water temperatures less than 16° C and salinities of 31-33 PPT (NMFS 2000). EFH for juveniles has been identified in Quadrant 1 only; therefore, the VOWTAP near shore cable installation operation is the only aspect of the VOWTAP that could interact with juvenile hake.

Adult: No adult whiting EFH is found in the Project Area.

Witch Flounder

Witch flounder are distributed from Cape Hatteras, North Carolina, to Labrador, Canada. The areas of highest abundance have been reported to be the Gulf of St. Lawrence, the southwestern edge of the Grand Bank, and deep waters directly north of the Grand Bank. In U.S. waters, witch flounder are most common in the Gulf of Maine off of Cape Ann, Massachusetts. Witch flounder is typically a deepwater fish that inhabits depths to approximately 4,921 ft (1,500 m). The egg and larval stages are pelagic, generally over deep water (Collette and Klein-MacPhee 2002). Witch flounder spawning occurs at or near the bottom, although the eggs become buoyant. Spawning occurs in the Mid-Atlantic Bight between April and August (Cargnelli et al. 1999b). Witch flounder tend to prefer muddy sand, clay, and mud bottoms (Collette and Klein-MacPhee 2002). The pelagic egg and larval stages are spent in the water column over deep water for this species. The juvenile stage occurs in very deep water, when fish settle to the bottom and remain separated from the adult population, occupying deeper waters until they are sexually mature. Witch flounder eggs and larvae have been reported in the waters east of Virginia Beach, but they are not considered an abundant finfish within the Project Area.

Egg: EFH for witch flounder eggs is the surface waters of the Gulf of Maine, Georges Bank, the continental shelf off southern New England, and the middle Atlantic south to Cape Hatteras. Witch flounder eggs typically occur over deep water with high salinities and where sea surface temperatures are below 13°C (NMFS 2000). Witch flounder eggs are most often observed from March through October; however, the preferred conditions associated with witch flounder eggs are only found within the Project Area in March and April, based on water temperature. EFH for witch flounder eggs has been identified in Quadrants 1, 2 and 4; therefore, potential impacts from VOWTAP will be negligible as witch flounder eggs are buoyant and pelagic, and the Export Cable in these areas is buried beneath the seabed.

Larvae: EFH for witch flounder larvae is designated as surface waters to 820 ft (250 m) in the Gulf of Maine, Georges Bank, the continental shelf off of southern New England, and the middle Atlantic south to Cape Hatteras (NMFS 2000). Witch flounder larvae are most often observed from March through November, with peaks in May through July; however, the above conditions are only met within the Project Area in March and early April, and late October and November based on water temperature. EFH for witch flounder larvae has been identified in Quadrant 5 only and may be found in waters associated with the VOWTAP WTGs and Inter-Array Cable.

Juvenile: No designated EFH for this life stage occurs within the Project Area.

Adult: No designated EFH for this life stage occurs within the Project Area.

Windowpane Flounder

Windowpane flounder are distributed from the Gulf of St. Lawrence to Cape Hatteras, but they are most common south of Nova Scotia. The largest catches of this species occur on Georges Bank. Windowpane flounder is a left-eyed flounder with a thin body and nearly round outline that prefers sandy bottom types (Collette and Klein-MacPhee 2002). The eggs of this species are buoyant and spawning occurs typically from February through May (Chang et al. 1999). Larvae settle to the bottom at approximately 0.4 to 0.8 inches (in) (10 millimeters [mm] to 20 mm) in length (Collette and Klein-MacPhee 2002). Windowpane flounder juveniles serve as important prey species for a number of other finfish species, including spiny dogfish, thorny skate, goosefish, Atlantic cod, black sea bass, weakfish, and summer flounder (NOAA Fisheries 2000).

Egg: EFH for windowpane flounder eggs is designated as the surface waters around the perimeter of the Gulf of Maine, on Georges Bank, southern New England, and the Mid-Atlantic south to Cape Hatteras. Windowpane flounder eggs typically occur where sea surface temperatures are less than 68° F (20°C) and water depths less than 230 ft (70 m). Windowpane flounder eggs are often observed from February to November with peaks in May and October (NMFS 2000). EFH for windowpane eggs has been identified in Quadrants 1, 2, 3, and 4 and may be found in waters associated with the Export Cable within the Project Area. Windowpane flounder eggs are pelagic; therefore, impacts on this life stage by the VOWTAP are not expected.

Larvae: EFH for larval windowpane flounder is designated as the pelagic waters around the perimeter of the Gulf of Maine, on Georges Bank, southern New England, and the middle Atlantic south to Cape Hatteras. Windowpane flounder eggs typically occur where sea surface temperatures are less than 68° F (20°C) and water depths less than 230 ft (70 m). Windowpane flounder larvae are often observed from February to November, with peaks in May and October in the Mid-Atlantic (NMFS 2000). EFH for windowpane larvae has been identified in Quadrants 2, 3, 4, and 5, and may be found in waters associated with the Export Cable as well as the WTGs. The larval life stage for this species is pelagic; therefore, impacts by the VOWTAP are not expected.

Juvenile: EFH for juvenile windowpane flounder are bottom habitats with substrates of mud or fine-grained sand around the perimeter of the Gulf of Maine, on Georges Bank, southern New England, and the Mid-Atlantic south to Cape Hatteras. Windowpane flounder juveniles typically occur where water temperatures are below 77°F (25°C), depths are 3 ft to 328 ft (1 m to 100 m), and salinities range between 5.5 and 36 PPT (NMFS 2000). EFH for juveniles has been identified in Quadrants 1, 2, 3, and 5. Site-specific habitat surveys indicate that potentially suitable habitat for juveniles may occur along the VOWTAP Export Cable route, as well as at the WTG locations.

Adult: No designated EFH for this life stage occurs within the Project Area.

Atlantic Sea Herring

Atlantic sea herring is a pelagic species that occurs in large schools and inhabits coastal and continental shelf waters from Labrador south to Virginia. Juvenile herring, which are commonly called sardines, migrate from shallow, inshore waters during the summer to deeper, offshore waters during the winter. Adult fish older than 3 years will migrate from their spawning grounds in the Gulf of Maine and Georges Bank to spend the winter months in southern New England and the Mid-Atlantic. Herring will spawn during October and November in the southern Gulf of Maine, Georges Bank, and Nantucket Shoals. They prefer rock, gravel, or sand bottoms between 50 ft and 150 ft (15 m and 45 m) in depth for spawning (ASMFC 2008). Herring are filter feeders and feed on plankton, primarily copepods. They usually feed at night, following the zooplankton that inhabit deeper waters during the day and travel to the surface to feed at night (ASMFC 2008). Herring themselves play a very important role in the ecosystem, as they are a significant source of food for many species of fish, including cod, haddock, silver hake, striped bass, bluefish, monkfish, mackerel, tuna, and spiny dogfish, as well as birds and marine mammals (Collette and Klein-MacPhee 2002).

Egg: No designated EFH for this life stage occurs within the Project Area.

Larvae: No designated EFH for this life stage occurs within the Project Area.

Juvenile: Juvenile Atlantic herring are known to occur in pelagic waters and bottom habitats in the Gulf of Maine, Georges Bank, southern New England and the middle Atlantic south to Cape Hatteras. Atlantic herring juveniles typically occur where water temperatures are below 50°F (10°C) at water depths from 49 ft to 443 ft (15 m to 135 m) throughout the water column as they seek prey (see above). They prefer a salinity range from 26 PPT to 32 PPT (NMFS 2000). EFH for juveniles has been identified in Quadrant 2, where juvenile herring may be found in waters associated with the VOWTAP Export Cable.

Adult: EFH for juvenile Atlantic herring is pelagic waters and bottom habitats associated with the Gulf of Maine, Georges Bank, southern New England, and the middle Atlantic south to Cape Hatteras. Atlantic herring adults typically occur where water temperatures are below 50°F (10°C), water depths are from 66 ft to 427 ft (20 m to 130 m), and salinities are above 28 PPT (NMFS, 2000). EFH for adults has been identified in Quadrants 1, 2, 3 and 4, and adult herring may be found throughout the water column in waters associated with the VOWTAP Export Cable.

Monkfish

Monkfish (also known as goosefish) range from Newfoundland to North Carolina, and in the Gulf of Mexico. They tolerate a wide range of depth, temperature, and habitat and are found from the tideline out to depths of greater than 2,000 ft (610 m) on the continental slope. They live on various types of substrate, including sand, gravel, rocks, mud, and beds of broken shells. They have also been found in a variety of temperatures, from 32°F to 70°F (0°C to 21°C), but prefer temperatures of 37°F to 48°F (3°C to 9°C) (Ross 1991). Reproduction for this species often occurs in shallow water from spring through early fall; however, it has been documented on the Mid-Atlantic OCS as well. They produce large masses of eggs (up to 2.8 million eggs at one time) in a single ribbon that can be up to 25 ft to 36 ft (7 m to 11 m) in length that floats within the water column. Adult monkfish are voracious predators, feeding on skates, herring, mackerel, and silver hake, as well as lobsters and crabs. The monkfish often feeds by lying motionless and waving its “lure” to attract fish. The monkfish is also known to eat seabirds, including cormorants, herring gulls, loons, and other sea birds (Collette and Klein-MacPhee 2002).

Egg: EFH for monkfish eggs is designated as surface waters from the Gulf of Maine, Georges Bank, southern New England, and the Mid-Atlantic Bight south to Cape Hatteras (NMFS, 2000). EFH for monkfish eggs has been identified in Quadrants 2, 3, and 4; therefore, eggs associated with this species have the potential to occur along the VOWTAP Export Cable route. However, Monkfish eggs are pelagic; therefore, impacts from the VOWTAP are not expected.

Larvae: EFH for monkfish larvae is designated as the pelagic waters from the Gulf of Maine, Georges Bank, southern New England, and the Mid-Atlantic Bight south to Cape Hatteras (NMFS, 2000). EFH for monkfish larvae has been identified in Quadrants 2, 3, and 4; therefore, larvae associated with this species have the potential to occur along the VOWTAP Export Cable route. However, larvae for this species are pelagic; therefore, impacts to this life stage by the VOWTAP are not expected.

Juvenile: No designated EFH for this life stage occurs within the Project Area.

Adult: No designated EFH for this life stage occurs within the Project Area.

Bluefish

The bluefish is a schooling species found in most oceans of the world, except the eastern Pacific Ocean. In the western Atlantic Ocean, the bluefish distribution ranges from Nova Scotia and Bermuda to Argentina, but is considered rare between southern Florida and northern South America (Goodbread and Graves 1996). Bluefish adults are highly migratory and perform both north-south and inshore-offshore movements. Bluefish move north in the spring to summer seasons, when their highest abundance is found off the coast of New York and coastal southern New England (Collette and Klein-MacPhee 2002). In the fall and winter, bluefish move both southward and offshore to overwinter in the South Atlantic Bight, between coastal Florida and the Gulf Stream. Light levels and water temperature are the primary triggers for migratory movements, but offshore and inshore migrations also parallel the movements of their prey (Collette and Klein-MacPhee 2002). There are two discrete spawning events for the western Atlantic bluefish: 1) a spring spawning event occurs near the edge of the continental shelf in the South Atlantic Bight during March through May; and 2) a summer spawning event occurs over the mid-continental shelf in the Mid-Atlantic Bight between June and August in waters with temperatures between 64.4°F and 77°F (18°C and 25°C) and salinities from 25 to 31 PPT (Collette and Klein-MacPhee 2002).

Eggs: EFH for bluefish eggs is designated as surface waters greater than 64° F (18° C) with a salinity of greater than 31 PPT on the continental shelf. They are usually spawned between April and August (NMFS 2000). EFH for bluefish eggs has been identified in Quadrant 4; therefore, eggs associated with this species have the potential to occur along the VOWTAP Export Cable route. However, Bluefish eggs are pelagic; therefore, impacts to this life stage by the VOWTAP are not expected.

Larvae: EFH for bluefish larvae is designated within the pelagic waters north of Cape Hatteras on the continental shelf to Montauk Point, New York. It is also found south of Cape Hatteras along the continental shelf south to Key West, Florida, within the Gulf Stream along the continental slope between latitudes 29° N and 40° N (NMFS 2000). EFH for bluefish larvae has been identified in Quadrant 4; therefore, larvae associated with this species have the potential to occur along the VOWTAP Export Cable route. However, Bluefish larvae are pelagic; therefore, impacts to this life stage by the VOWTAP are not expected.

Juvenile: The EFH for juvenile bluefish (a.k.a., snapper blues) north of Cape Hatteras is pelagic waters found over the continental shelf from the coast out to the limits of the EEZ and beyond north to Nantucket Island, Massachusetts within the areas of highest abundance for their range. Inshore, EFH is all major estuaries between Penobscot Bay, Maine, and St. Johns River, Florida (NMFS 2000). Juvenile bluefish can be found in waters with salinities as low as 3 PPT. EFH for juvenile bluefish has been identified in Quadrants 1, 2, 3, 4, and 5 and will likely be found in waters associated with all marine portions of the VOWTAP; however, the pelagic nature of these juvenile fish should minimize potential impacts to this life stage by the VOWTAP.

Adult: EFH for adult bluefish is the same as that described for juvenile bluefish. EFH for adult bluefish has been identified in Quadrants 1, 2, 3, and 4; therefore, these fish will likely be found in waters associated with the VOWTAP Export Cable. However, bluefish are a pelagic species; therefore, impacts to this life stage by the VOWTAP are not expected.

Long-Finned Squid

Long-finned squid are distributed from Cape Cod through Cape Hatteras. The greatest abundance of long-finned squid is found in continental shelf and slope waters at depths between 328 ft and 551 ft (100 m and 168 m). They generally migrate inshore to waters off of southern New England in May or June, and by late November/early December they migrate to deeper waters along the edge of the continental shelf (Macy and Brodziak 2001). Adult long-finned squid are demersal during the day, coming to the surface at night to feed. Egg masses are typically attached to hard substrates. Newly hatched squid are found at the surface and move deeper in the water column as they grow, becoming demersal when they reach just under 2 in (45 mm) in length (NEFSC 2005). There is evidence that squid spawn throughout the year, with two main spawning periods in the summer and winter (Macy and Brodziak 2001). Adults feed on small fish, while juveniles feed on small crustaceans (Rathjen 1973). Squid are an important prey species to a number of other species, including sharks, haddock, hake, striped bass, black sea bass, bluefish, scup, mackerel, summer flounder, and tuna (Ross 1991).

Pre-recruits: EFH is the pelagic waters found over the continental shelf (from the coast out to the limits of the EEZ), from the Gulf of Maine through Cape Hatteras in areas that comprise the highest 75 percent of the catch where pre-recruit long-finned squid were collected in the Northeast Fisheries Science Center (NEFSC) trawl surveys. Generally, pre-recruit long-finned squid are collected from shore to 700 ft (213

m) depth and temperatures between 39°F and 81°F (3.9°C to 27.2°C) (NMFS 2000). Given this broad range, there is the potential for pre-recruit long-finned squid to occur throughout all five quadrants within the Project Area.

Recruits: EFH is the pelagic waters found over the continental shelf (from the coast out to the limits of the EEZ), from the Gulf of Maine through Cape Hatteras in areas that comprise the highest 75 percent of the catch where recruited long-finned squid were collected in the Northeast Fisheries Science Center (NEFSC) trawl surveys. Generally, recruited long-finned squid are collected from shore east to the 1,000 ft (305 m) depth contour and temperatures between 39°F and 81°F (3.9°C to 27.2°C) (NMFS 2000). Given this broad range, there is the potential for recruit long-finned squid to occur throughout all five quadrants within the Project Area.

Juveniles: EFH is designated as pelagic waters found over the continental shelf in areas that comprise the highest 75 percent of the catch where juvenile long-finned squids have been collected in NEFSC trawl surveys from the Gulf of Maine through Cape Hatteras (NMFS 2000). EFH for long-finned squid juveniles has been identified in Quadrants 3 and 5, and is likely to be found along the VOWTAP Export Cable route. However, juvenile long-finned squid are pelagic; therefore, impacts on this life stage by the VOWTAP are not expected.

Adults: EFH for adult long-finned squid is designated as pelagic waters found over the continental shelf in areas that comprise the highest 75 percent of the catch where recruited adult long finned squid were collected in the NEFSC trawl surveys from the Gulf of Maine through Cape Hatteras (NMFS 2000). EFH for adults has been identified in Quadrant 5, and is therefore likely to be found at the WTG and Inter-Array Cable locations. However, long-finned squid are pelagic; therefore, impacts on this life stage by the VOWTAP are not expected.

Short-Finned Squid

Short-finned squid is a pelagic, schooling species generally distributed across the continental shelf and slope. In the western Atlantic Ocean, the northern short-finned squid distribution is from the Labrador Sea south to Florida (Wigley 1982). This species is most abundant in the Newfoundland region, is moderately abundant between Newfoundland and New Jersey (Wigley 1982), and is commercially exploited from Newfoundland south to Cape Hatteras (Cargnelli et al. 1999d). Northern short-finned squid are highly migratory and are capable of long-distance migrations of more than 869 nm (1,609 km) between boreal, temperate, and subtropical waters (Cargnelli et al. 1999d). They also undergo inshore-offshore migrations, which may be related to temperature, food, or both (MAFMC 1998). The northern short-finned squid forms dense aggregations in waters ranging from 46.4°F to 57.2°F (8°C to 14°C) in the winter from January to March along the OCS and upper slope, and they migrate shoreward in the spring from April to May (Wigley 1982). Spawning of the northern short-finned squid is believed to occur in the deep waters of the continental shelf primarily from August through March, depending on location. The principal spawning habitat is hypothesized to occur south of Cape Hatteras over the Blake Plateau (Cargnelli et al. 1999a; Hendrickson and Holmes 2004). The only confirmed spawning area was between southern New Jersey to Cape Hatteras along the shelf break in the Mid-Atlantic Bight during May (Hendrickson 2004).

Pre-recruits: EFH for these pre-recruits is designated as pelagic waters found over the continental shelf in areas that comprise the highest 75 percent of the catch where pre-recruits were collected in the NEFSC trawl surveys from the Gulf of Maine through Cape Hatteras. No short-finned squid egg masses have ever been found in nature (O'Dor and Dawe 1998). The NEFSC bottom trawl surveys have captured northern short-finned squid pre-recruits (under 3.4 in [10 cm] mantel length) during all seasons. Highest catches were made from the Middle Atlantic region. By summer, pre-recruits were caught throughout the continental shelf, from the shoreline out to the 600-ft (183-m) depth contour and from North Carolina to Georges Bank. The highest catches were made south of Cape Cod and Long Island. Given this broad range, there is the potential for pre-recruit short-finned squid to occur throughout the Project Area.

Recruits: EFH for these recruits is designated as pelagic waters found over the continental shelf in areas that comprise the highest 75 percent of the catch, where recruited adult northern short-finned squid were collected during NEFSC trawl surveys from the Gulf of Maine through Cape Hatteras. Recruits (4.3 in [11 cm] mantel length and greater) undergo seasonal migrations similar to pre-recruits and are also pelagic. The abundance of recruits during spring, autumn, and winter seems to be greater in NEFSC bottom trawl surveys. In winter, recruits were distributed offshore, with only low numbers taken at the 600-ft (183-m) depth contour. Recruits were taken at depths ranging from 32 ft to 1,378 ft (10 m to 420 m) and seem to inhabit shallower (i.e., inshore) waters in summer and autumn as opposed to during winter and spring. Recruits were also found at temperatures ranging from 39.2°F to 66.2°F (4°C to 19°C) (NEFSC 2005). Given this broad range, there is the potential for recruits of short-finned squid to occur throughout the Project Area.

Juveniles: No designated EFH for this life stage occurs within the Project Area.

Adults: No designated EFH for this life stage occurs within the Project Area.

Atlantic Butterfish

Butterfish are pelagic fish forming loose schools from Newfoundland to Florida (NEFSC 1999b). They will often come close to shore into sheltered bays and estuaries, and have a preference for sandy bottom (as opposed to rocky or muddy bottom). They spend much of their time near the surface when they are near to shore, but spend the winter and early spring near the bottom at depths of up to 600 ft to 690 ft (183 m to 210 m) (Collette and Klein-MacPhee 2002). Butterfish are found along the southern New England shoreline and estuaries from late spring through fall, spawning in the Gulf of Maine within a few miles of the coast during the late spring and early summer. They then migrate to the edge of the continental shelf during the winter (Collette and Klein-MacPhee 2002). Butterfish eggs are found within southern New England estuaries from June through August (NEFSC 1999b). Butterfish feed primarily on tunicates and mollusks, as well as cnidarians, polychaetes, crustaceans, and other invertebrates (Collette and Klein-MacPhee 2002). Ctenophores have been found to make up an important component of the diet of juvenile butterfish in southern New England estuaries (Oviatt and Kremer 1977). Butterfish themselves serve as prey to a number of species including hake, bluefish, weakfish, and swordfish, and are used commonly as bait in recreational tuna fisheries (Ross 1991).

Eggs: No designated EFH for this life stage occurs within the Project Area.

Larvae: No designated EFH for this life stage occurs within the Project Area.

Juvenile: Juvenile butterfish are distributed throughout the continental shelf from the Gulf of Maine to Cape Hatteras, North Carolina as well as in estuaries such as Massachusetts Bay, Cape Cod Bay, Raritan Bay, Delaware Bay, Chesapeake Bay and the associated York and James Rivers. They prefer a broad range of water temperatures from 37° F to 82° F (3° to 28° C) depending on the season. Accordingly, they are found on the continental shelf during the winter and in bays and estuaries from the spring through the fall. While these fish are generally pelagic, larger individuals can be found in close association with sandy and muddy substrate areas. They assemble in pelagic schools, but are also sometimes found near flotsam and large jellyfish (NMFS 2000). EFH for juvenile butterfish has been noted along the VOWTAP Export Cable route in Quadrants 2 and 4; however, as these small fish are usually pelagic, potential impacts from the VOWTAP will be minimal.

Adult: Adult butterfish are distributed throughout the continental shelf from the Gulf of Maine to Cape Hatteras, North Carolina as well as in estuaries such as Massachusetts Bay, Cape Cod Bay, Raritan Bay, Delaware Bay, Chesapeake Bay and the associated York and James Rivers. They prefer a broad range of water temperatures from 37° F to 82° F (3° to 28° C) depending on the season (NMFS 2000). Accordingly, they are found on the continental shelf during the winter and in bays and estuaries from the spring through the fall. While these fish are generally pelagic, larger individuals can be found in close association with sandy and muddy substrate areas. EFH for adult butterfish has been noted in Quadrant 4 along the VOWTAP Export Cable route.

Summer Flounder

Summer flounder (or fluke) are found in both inshore and offshore waters from Nova Scotia to Florida, although they are most abundant from Cape Cod south to Cape Fear, North Carolina (ASMFC 2008). They are left-eyed flatfish (family bothidae) and are concentrated in bays and estuaries from late spring through early fall, when they migrate offshore to the continental shelf to waters between 120 ft and 600 ft (37 and 183 m) in depth. These fish usually spend the fall and winter seasons offshore. Adult summer flounder spend most of their lives near the bottom, and prefer to bury themselves into sandy substrate. During the summer, they are often found on hard sand, and prefer mud during the fall. They are often found hiding motionless in eelgrass or among the pilings of docks, but swim very quickly if disturbed (Collette and Klein-MacPhee 2002). This species spawns offshore in the fall. Larvae will migrate inshore to coastal and estuarine areas from October through May. Upon reaching the coast, the larvae will move to the bottom, and spend the first year of their lives in bays and other inshore areas. Summer flounder have well-developed teeth that allow them to capture such prey as small fish, squid, sea worms, shrimp, and other crustaceans (ASMFC 2008). Summer flounder are common to Virginia waters and are considered a key species for commercial and recreational fisheries.

Egg: EFH for summer flounder eggs is comprised of the pelagic waters over the continental shelf (from the coast out to the limits of the EEZ) from the Gulf of Maine to Cape Hatteras. Summer flounder eggs are found between October and May, being most abundant between Cape Cod and Cape Hatteras, with the heaviest concentrations within 9 mi (14.5 km) of shore off of New Jersey and New York. Eggs are most commonly collected at depths of 30 ft to 360 ft (9.1 m to 109.7 m) (NMFS 2000). EFH for summer flounder eggs has been identified in Quadrant 4; therefore, eggs may occur within the waters associated with the VOWTAP Export Cable route.

Larvae: EFH for summer flounder larvae is comprised of the pelagic waters found of the continental shelf (from the coast out to the limits of the EEZ), from the Gulf of Maine to Cape Hatteras. Inshore, EFH is estuarine systems including Waquoit Bay, Narragansett Bay, Raritan Bay and the Hudson River, Barnegat

Bay, Chesapeake Bay and its major rivers, Albemarle Sound, and Pamlico Sound and the Indian and Neuse Rivers. In general, summer flounder larvae are most abundant near shore (within 12 mi to 50 mi [20.9 km to 80.5 km] from shore) at depths between 30 ft and 230 ft (20.9 m to 370.1 km). They are most frequently found in the northern part of the Mid-Atlantic Bight from September to February (NMFS 2000). EFH for summer flounder larvae has been identified in Quadrants 4 and 5; therefore, larvae may occur within the waters associated with the seaward end of the Export Cable, as well as the WTGs and inter-array cable within the Project Area. As larval summer flounder are pelagic, however, impacts on this life stage by the VOWTAP are not expected.

Juvenile: Juveniles are typically found in the demersal waters of the continental shelf from the Gulf of Maine to as far south as Florida. Inshore, EFH is estuaries from Waquoit Bay to the James River to the Indian River and Albemarle Sound. In general, juveniles use several estuarine habitats as nursery areas, including salt marsh creeks, sea grass beds, mudflats, and open bay areas in water temperatures greater than 37ºF (2.8°C) and salinities from 10 PPT to 30 PPT range (NMFS 2000). EFH for summer flounder juveniles has been identified in all five quadrants of the Project Area; therefore, juveniles may occur within the waters associated with the Export Cable, as well as the WTGs and Inter-Array Cable within the Project Area.

Adult: EFH for adult summer flounder comprises the demersal waters of the continental shelf (from the coast out to the limits of the EEZ), from the Gulf of Maine to Cape Hatteras in the highest 90 percent of all the ranked 10-minute squares for the area where adult summer flounder are collected in the NEFSC trawl survey. Inshore, EFH consists of estuaries such as Buzzards Bay, Narragansett Bay, the Connecticut River, the James River, Albemarle Sound, the Broad River, the St. Johns River, and the Indian River. Generally, summer flounder inhabit shallow coastal and estuarine waters during warmer months and move offshore on the OCS at depths of 500 ft (152.4 m) in colder months (NMFS 2000). EFH for adults has been identified in all five quadrants, and may be found in waters associated with the Export Cable as well as the WTGs and Inter-Array Cable within the Project Area.

Scup

Scup (porgy) are a migratory species found from Cape Cod to Cape Hatteras. Scup are most commonly found in waters between 55°F and 77°F (13°C and 25°C). They spend the winters in offshore waters from southern New Jersey to Cape Hatteras, and spawn in the summer in inshore waters from southern New England to Long Island, moving north and into New England waters in the spring and returning south the fall. Scup spawn in inshore waters during the summer, with spawning reaching its peak in June off of southern New England. The eggs will hatch about 40 hours after fertilization and then scup form into schools of similarly sized individuals. Juvenile scup use coastal habitats, and will sometimes dominate the fish population of estuarine areas during the summer months (ASMFC 2008). They prefer areas with smooth or rocky bottoms, and are often found around piers, rocks, offshore ledges, jetties, and mussel beds. During the winter, they prefer depths of 240 ft to 600 ft (73 m to 183 m) where the water temperature is at least 45°F (7.2°C). Adult scup feed on benthic invertebrates, including small crabs, squid, worms, clams, mussels, amphipods, jellyfish, and others. They are eaten by a variety of different fish. It is estimated that as many as 80 percent of all juvenile scup annually are eaten by fish such as cod, bluefish, striped bass, and weakfish (Ross 1991).

Eggs: EFH for scup eggs is comprised of pelagic waters from New England to coastal Virginia, at depths of less than 98 ft (30 m) and in waters between 55°F and 73°F (12.8°C and 22.8°C). They are found in salinities greater than 15 PPT (NMFS 2000). There is currently insufficient EFH data for this life stage within the Project Area; however, it is possible that eggs could occur in the waters associated with all five quadrants.

Larvae: EFH for scup larvae is comprised of pelagic waters from New England to coastal Virginia, at depths of less than 66 ft (20 m). In general, scup larvae are most abundant near shore from May through September, in waters between 55°F and 73°F (12.8°C and 22.8°C), and in salinities greater than 15 PPT (NMFS 2000). There is currently insufficient EFH data for this life stage in the Project Area; however, it is possible that larvae could occur in the waters associated with all five quadrants.

Juvenile: Juvenile scup EFH is comprised of the demersal waters of the continental shelf (from the coast out to the limits of the EEZ) from the Gulf of Maine to Cape Hatteras in the highest 90 percent of all the ranked 10-minute squares of the area where juvenile scup are collected in the NEFSC trawl survey. Inshore, EFH consists of estuaries including Massachusetts Bay, Cape Cod Bay, Long Island Sound, Gardiners Bay, Delaware Bay and Chesapeake Bay. During the summer and spring, juvenile scup are found in estuaries and bays between Virginia and Massachusetts, in association with various sands, mud, mussel, and eelgrass bed type substrates and in water temperatures greater than 45°F (7.2°C) and salinities greater than 15 PPT (NMFS 2000). EFH for juveniles has been identified in all five quadrants, and may be found in waters associated with the Export Cable as well as the WTGs and Inter-Array Cable within the Project Area.

Adult: Adult scup EFH is comprised of the demersal waters of the continental shelf (from the coast out to the limits of the EEZ) from the Gulf of Maine to Cape Hatteras in the highest 90 percent of all the ranked 10-minute squares of the area where adult scup are collected in the NEFSC trawl survey. Inshore, EFH includes Cape Cod Bay, Long Island Sound, Gardiners Bay, Hudson River, Raritan Bay, Delaware Bay and Chesapeake Bay. Generally, wintering adults (November through April) are usually offshore, south of New York to North Carolina, in waters above 45°F (7.2°C) (NMFS 2000). EFH for these adult fish has been identified in all five quadrants, and may be found in waters associated with the Export Cable as well as the WTGs and Inter-Array Cable within the Project Area.

Black Sea Bass

Black sea bass are concentrated from Cape Cod to Cape Canaveral, Florida and prefer to inhabit rock bottoms near pilings, wrecks, and jetties within this range. There are two distinct and overlapping stocks of black sea bass along the Atlantic coast. They are found in inshore waters at depths of less than 120 ft (37 m) in the summer, and move offshore to deeper waters to the south during the winter and prefer water about 48.2°F (9°C) (ASMFC 2008). Larger adults are usually found in deeper waters than smaller individuals, and larger adults typically begin their migration earlier than the younger adults and juveniles, starting in August (Ross 1991). Juvenile sea bass migrate inshore and prefer sheltered habitats such as SAV, oyster reefs, and man-made structures. Black sea bass are protogynous hermaphrodites, beginning life as females and then changing to males when they reach about 9 in to 13 in (23 cm to 33 cm) in length. In the Mid-Atlantic, 38 percent of females will change sex between August and April, after the majority of the fish have already spawned. The northern stock of black sea bass spawns off New England from mid-May until the end of June (Ross 1991), and an average-sized fish will produce roughly 280,000 eggs. The eggs float in the water column, hatching a few days after fertilization. The larvae will drift offshore until they grow to 0.5 in (1 cm) in length, at which point the young sea bass will migrate inshore into estuaries, bays, and sounds (ASMFC 2008). Black sea bass are common in Rhode Island waters and are considered important to both commercial and recreational fisheries.

Eggs: EFH for black sea bass eggs is designated as pelagic waters at depths of about 98 ft (30 m). Generally, black sea bass eggs are found from May through October on the continental shelf, from southern New England to North Carolina (NMFS 2000). There is currently insufficient EFH data for this life stage in the Project Area; however, it is possible that eggs could occur in the waters associated with all five quadrants.

Larvae: EFH for black sea bass larvae is found within any pelagic waters of the continental shelf from the Gulf of Maine to Cape Hatteras, North Carolina. These larvae require temperatures of between 52° to 78° F (11° to 26° C) and salinities of 30 to 35 PPT. Seasonally, these larvae are observed from May to November but their peak is in June and July (NMFS 2000). EFH for these larvae has been identified in Quadrants 2 and 4; as they transform from larvae into juveniles, they prefer demersal structure such as sponge beds. These structured areas of seabed are generally avoided by the VOWTAP transmission cable in these two quadrants.

Juvenile: Juvenile black sea bass EFH is comprised of the demersal waters over the continental shelf (from the coast out to the limits of the EEZ) from the Gulf of Maine to Cape Hatteras in the highest 90 percent of all the ranked 10-minute squares of the area where juvenile black sea bass are collected in the NEFSC trawl survey. Generally, juvenile black sea bass are found in waters warmer than 42.8°F (6°C) with salinities greater than 18 PPT and coastal areas between Virginia and Massachusetts. These juveniles spend winter offshore from New Jersey south to North Carolina. Juvenile black sea bass are usually found in association with rough bottom, shellfish and eelgrass beds, man-made structures in sandy-shelly areas; offshore clam beds and shell patches may also be used during overwintering (NMFS 2000). EFH for juveniles has been identified in all five quadrants, and may be found in waters associated with all marine components of the VOWTAP. In general, the VOWTAP avoids areas of distinguishable seabed structure, which should minimize potential impacts to juvenile black sea bass. Once installed, the WTG foundations will likely be a favored area of offshore structure for black sea bass.

Adult: Mature black sea bass EFH is comprised of the demersal waters of the continental shelf (from the coast out to the limits of the EEZ), from the Gulf of Maine to Cape Hatteras in the highest 90 percent of all the ranked 10-minute squares of the area where adult black sea bass are collected in the NEFSC trawl survey. Temperatures above 42.8°F (6° C) are preferred, as are salinities greater than 20 PPT. Habitats of seabed relief (natural and man-made) are preferred, although sea bass can also be found in association with sand and shell substrates (NMFS 2000). EFH for adults has been identified in all five quadrants; therefore, adult sea bass may be found in waters associated with all marine components of the VOWTAP. In general, the VOWTAP avoids areas of distinguishable seabed structure, which should minimize potential impacts to black sea bass. Once installed, the VWTG foundations will likely be a favored area of offshore structure for adult black sea bass.

Surf Clam

The Atlantic surf clam is a bivalve mollusk that inhabits sandy continental shelf habitats from the southern Gulf of St. Lawrence to Cape Hatteras. This species may reach a maximum size of 8.9 in (226 mm) and a maximum age of approximately 31 years (Cargnelli et al. 1999c). High concentrations of the planktonic eggs and larvae of Atlantic surf clams can occur from May to June and September to October. Juveniles settle to the substrate and remain there through adulthood. They burrow in medium to coarse sand and gravel substrates, as well as silty to fine sand, but have not been found to burrow in mud (Cargnelli et al. 1999c). The greatest concentrations of Atlantic surf clams are usually found in well-sorted, medium grained sand (Cargnelli et al. 1999c). The size and age of sexual maturity in surf clams is variable. Off of New Jersey, Atlantic surf clams may reach maturity as early as 3 months after settlement, while at the northern extreme of their range, maturity may not be reached until 4 years of age (Cargnelli et al. 1999c). Atlantic surf clams serve as a prey item for finfish species such as haddock and Atlantic cod (Cargnelli et al. 1999c). In the New York Bight, crabs account for 48.3 to 100 percent of Atlantic surf clam mortality, while moon snails accounted for 2.1 percent (MacKenzie et al. 1985).

Juveniles: EFH for juvenile surf clams is defined as federal waters from the eastern edge of Georges Bank and the Gulf of Maine throughout the Atlantic EEZ, in areas that encompass the top 90 percent of all the ranked 10-minute squares for the area where surf clams were caught in the NEFSC surf clam and ocean quahog dredge surveys. Juvenile and adult surf clams are found within the substrate to a depth of 3 ft (0.9 m) below the water/sediment interface. Surf clams generally occur from the beach zone to a depth of about 200 ft (61 m), but beyond about 125 ft (38.1 m) their densities are low (NMFS 2000). EFH for juveniles has been identified in Quadrants 2, 3, and 4 and may occur along the VOWTAP Export Cable route.

Adults: EFH for adult surf clams is defined as federal waters from the eastern edge of Georges Bank and the Gulf of Maine throughout the Atlantic EEZ, in areas that encompass the top 90 percent of all the ranked 10-minute squares for the area where surf clams were caught in the NEFSC surf clam and ocean quahog dredge surveys. Adult surf clams are found within the substrate to a depth of 3 ft (0.9 m) below the water/sediment interface. Surf clams generally occur from the beach zone to a depth of about 200 ft (61 m), but beyond about 125 ft (38.1 m) their densities are low (NMFS 2000). EFH for adults has been identified in Quadrant 3, and adult surf clams may occur along the VOWTAP Export Cable route.

Spiny Dogfish

Spiny dogfish range from Labrador to Florida. They migrate north during the spring and summer, and south in the fall and winter. Juvenile and adult spiny dogfish are abundant in the Mid-Atlantic waters extending to the southern part of Georges Bank during the winter. During the summer months, they are found farther north through Canadian waters, and will move inshore into bays and estuaries (ASMFC 2008). In the fall, they are commonly found closer to shore, and are abundant in southern New England waters (NEFSC 2006). Spiny dogfish are ovoviviparous and usually give birth in the fall or winter. Newborn spiny dogfish are about 10 in (26 cm to 27 cm) in length at birth and they do not reach maturity for 10 years or more. Mating occurs in the winter months, and pups are delivered on the offshore wintering grounds (ASMFC 2008). Females will produce a litter of between 1 and 15 pups each, usually averaging 6 to 7 pups, and females do so every 2 years. Spiny dogfish eat a variety of fish of many sizes, including herring and hake, squid, and ctenophores. They also eat bivalves, especially scallops, off southern New England and within the mid-Atlantic.

Eggs: Not applicable, since this species is ovoviviparous.

Larvae: There is not enough data in the literature to determine larval dogfish EFH.

Juveniles: North of Cape Hatteras, EFH for juvenile spiny dogfish is designated as the waters of the continental shelf from the Gulf of Maine through Cape Hatteras, in areas that encompass the highest 90 percent of all ranked 10-minute squares for the area where juvenile dogfish were collected in the NEFSC trawl surveys. Spiny dogfish are usually epibenthic, but occur throughout the water column and are found from near shore shallows to offshore shelf waters to 1,279 ft (390 m). In the spring, juveniles occur in deeper, generally warmer waters on the outer shelf from North Carolina to Georges Bank. In the fall, they occur in the shallower, moderately warm waters from the mid-Atlantic into the Gulf of Maine. Their seasonal distribution is similar in coastal areas. Dogfish are transient visitors to estuaries where they prefer higher salinities (NMFS 2000). EFH for juveniles has been identified in all five quadrants, and may occur throughout the Project Area.

Adults: EFH for adult spiny dogfish is designated as the waters of the continental shelf from the Gulf of Maine through Cape Hatteras, in areas that encompass the highest 90 percent of all ranked 10-minute squares for the area where adult dogfish were collected in the NEFSC trawl surveys. Spiny dogfish are usually epibenthic, but occur throughout the water column and are found from near shore shallows to offshore shelf waters to 1,476 ft (450 m). In the spring, adults occur in deeper, generally warmer waters on the outer shelf from North Carolina to Georges Bank. In the fall, they occur in the shallower, moderately warm waters from the mid-Atlantic into the Gulf of Maine. Their seasonal distribution is similar in coastal areas. Dogfish are transient visitors to estuaries where they prefer higher salinities of 30 to 32 PPT (NMFS 2000). EFH for adults has been identified in Quadrants 2, 3, 4, and 5, and may occur throughout the offshore portion of the Project Area.

King Mackerel

King mackerel, a coastal migratory pelagic species, are commonly distributed along the continental shelf in the warmer waters of the western Atlantic Ocean from North Carolina to Brazil, but occasionally stray as far north as Massachusetts (Collette and Klein-MacPhee 2002). This species does not typically occur beyond the continental shelf break (GMFMC and SAFMC 2004). King mackerel have a protracted spawning season, which runs from May to October, and their eggs are pelagic (Godcharles and Murphy 1986). King mackerel exhibit seasonal movements. During the summer, these fish migrate north occurring in the waters off of Virginia and the Carolinas, remaining there through fall. As the waters become cooler in the winter, they migrate south again towards Florida (Godcharles and Murphy 1986; Schaefer and Fable 1994).

Eggs, Larvae, Juveniles, and Adults: EFH for all life stages of this species includes all estuaries; the United States/Mexican border to the boundary between the areas covered by the Gulf of Mexico Fishery Management Council (GMFMC) and the South Atlantic Fishery Management Council (SAFMC) from estuarine waters out to depths of 600 ft (183 m). EFH also includes sandy shoals of capes and offshore bars, high profile rocky bottom and barrier island ocean-side waters, from the surf to the shelf break zone, but from the Gulf Stream shoreward, including Sargassum. In addition, EFH includes all coastal inlets and all state-designated nursery habitats of particular importance to coastal migratory pelagic species (NMFS 2000). EFH for all king mackerel life stages has been identified in all five quadrants; therefore, all life stages of king mackerel may be found within the Project Area during summer and early fall, based on water temperature.

Spanish Mackerel

Spanish mackerel, a coastal migratory pelagic species, are abundant from the waters surrounding the Chesapeake Bay south through the Gulf of Mexico; however, they occasionally occur as far north as coastal southern New England (Collette and Klein-MacPhee 2002). Spanish mackerel have a protracted spawning season, which runs from April to September (GMFMC and SAFMC 2004; Godcharles and Murphy 1986). The onset of spawning progresses from south to north and occurs over the inner continental shelf in waters 39 ft to 112 ft (12 m to 34 m) deep. Spawning of this species' pelagic eggs starts in April off the Carolinas, occurs in mid-June in the Chesapeake Bay and from late August into September off the coasts of New Jersey and New York (Godcharles and Murphy 1986; Collette and Klein-MacPhee 2002). Spanish mackerel make seasonal migrations along the Atlantic coast. They are found off of Florida during the winter and migrate north as coastal waters warm. They arrive off of the Carolinas in April, off of Virginia by May, and as far north as Martha's Vineyard, Massachusetts by July in some years. They remain in the cooler northern waters until September before beginning their migration south again following their preferred water temperatures (GMFMC and SAFMC 2004).

Eggs, Larvae, Juveniles, and Adults: EFH for all life stages of Spanish mackerel includes all estuaries; the U.S./Mexican border to the boundary between the areas covered by the GMFMC and the SAFMC from estuarine waters out to depths of 600 ft (183 m). EFH also includes sandy shoals of capes and offshore bars, high profile rocky bottom and barrier island ocean-side waters, from the surf to the shelf break zone, but from the Gulf Stream shoreward, including Sargassum. In addition, EFH includes all coastal inlets and all state-designated nursery habitats of particular importance to coastal migratory pelagic species (NMFS 2000). EFH for all Spanish mackerel life stages has been identified in all five quadrants; therefore, all life stages of the Spanish mackerel may be found within the Project Area during summer and early fall, based on water temperature.

Cobia

Cobia, a coastal migratory pelagic species, is distributed worldwide throughout tropical, subtropical, and warm-temperate waters, with the exception of the eastern Pacific Ocean (Williams 2001). In the northwest Atlantic, cobia range from Massachusetts to Argentina, including Bermuda, but are most common along the U.S. coast from Virginia to the northern Gulf of Mexico (Franks et al. 1999). Spawning occurs in the daylight hours between April and September in estuarine or shelf waters (Ditty and Shaw 1992). Cobia are batch spawners and form large breeding aggregations during spawning events (Bester 1999; Williams 2001). Cobia eggs and larvae are pelagic and found at the surface or within the upper meter of the water column (Ditty and Shaw 1992). Following the spawning season, cobia migrate south to warmer offshore waters of the Florida Keys during the autumn and winter. In the spring, they begin their migration north to the poly/mesohaline waters of coastal Virginia and the Carolinas for the summer and to spawn (Williams 2001).

Eggs, Larvae, Juveniles, and Adults: EFH for all life stages of cobia includes all estuaries; the U.S./Mexican border to the boundary between the areas covered by the GMFMC and the SAFMC from estuarine waters out to depths of 600 ft (183 m). EFH also includes high salinity bays, estuaries, and sea grass habitat. In addition, the Gulf Stream is an EFH because it provides a mechanism to disperse coastal migratory pelagic larvae. EFH also includes sandy shoals of capes and offshore bars, high profile rocky bottom and barrier island ocean-side waters, from the surf to the shelf break zone, but from the Gulf Stream shoreward, including Sargassum. In addition, EFH includes all coastal inlets and all state-designated nursery habitats of particular importance to coastal migratory pelagic species (NMFS 2000). EFH for all cobia life stages has been identified in all five quadrants; therefore, cobia may be found throughout the Project Area during summer and early fall, based on water temperature.

Red Drum

Red drum EFH is no longer designated outside of the GMFMC; however, designated EFH for this species was shown in the 10 by 10 minute squares overlapping the Project Area. Therefore, for the sake of completeness, it has been discussed here. According to the Atlantic States Marine Fisheries Council (ASMFC), the historic distribution of red drum on the Atlantic coast is from Massachusetts through Florida, though few fish have been reported north of Delaware Bay in recent years. Juveniles are quite abundant in estuarine waters and inlets, while fish older than age 4 inhabit deeper, coastal waters. The adult fish migrate seasonally, moving offshore or south in the winter and inshore or north in the spring. Spawning occurs at night in the near shore waters during the summer and fall. Red drum are known for their spawning events when large females produce up to 2 million eggs in a single spawning season. Eggs hatch within 24 to 36 hours of being spawned, and the larvae are carried by wind and tidal action into shallow, low-salinity estuarine nursery areas. Juveniles and sub-adults stay in estuarine areas feeding on zooplankton and micro-invertebrates such as small crabs and shrimp. As they grow, red drums start to consume finfish and larger invertebrates. Depending on the area, males mature between age 1 and 4 (20-28 inches in length), while females mature between age 3 and 6 (31-36 inches in length). Red drum may reach 60 years of age and 60 inches in length (corresponding to greater than 90 pounds in weight (ASMFC 2013).

Eggs, Larvae, Juveniles, and Adults: Eggs and pelagic larvae utilize low-salinity waters inside inlets, passes and bays as well as estuarine systems within their range as a whole. As such, these life stages are unlikely to be present within the Project Area.

Redfish juveniles utilize a variety of inshore habitats, including those potentially found in the Project Area, such as shell banks and areas of unconsolidated substrate (soft sediments). Sub-adults are found along coastal beaches during certain times of the year. During fall migrations, adults use hard/live bottom areas and artificial reefs, especially off South Carolina and Georgia. As such, juvenile and adult redfish seem more likely to be found within the Project Area. It is not appropriate to use sea surface temperature tolerances to predict the presence or absence of redfish, as these fish are considered nearly eurythermic (ASMFC 2013).

Sand Tiger Shark

Sand tiger sharks are known to have a broad inshore distribution in tropical and warm-temperate waters throughout the world, but are nonexistent in the eastern Pacific Ocean (Castro 1983; Collette and Klein-MacPhee 2002). In the western Atlantic, the sand tiger sharks occur from the Gulf of Maine to Florida, the northern Gulf of Mexico, the Bahamas, Bermuda, and southward to Argentina (Castro 1983; Compagno 1984). In warmer months, this species is common from Cape Cod to the Chesapeake Bay (Castro 1983). Sand tiger sharks mate in the winter and spring, with parturition beginning during the early winter months from late October to the end of November (Collette and Klein-MacPhee 2002). In Florida, sand tiger sharks are born from November to February (Castro 1983). The neonates then migrate northward to their summer nurseries. Sand tiger sharks are migratory in the northern portion of their range, moving northward and shoreward during the summer and south and offshore in the fall and winter (Castro 1983; Compagno 1984). Sand tiger sharks are demersal sharks found primarily in shallow bays and around coral or rocky reefs (depths less than 65.6 ft [20 m]), but also can be found to depths of 627 ft (191 m) over the continental shelf (Compagno 1984; Collette and Klein-MacPhee 2002). Neonate and juvenile sand tiger sharks utilize estuarine waters as nurseries from Massachusetts to South Carolina (McCandless et al. 2002). As with many shark species, the sand tiger shark is common in the waters of Virginia and is frequently targeted by recreational fishermen.

Neonates: EFH for neonate sand tiger sharks is designated as the shallow coastal waters to 82 ft (25 m) from Cape Cod to Cape Canaveral, Florida. EFH for neonate sand tiger sharks has been identified in all five quadrants, and has the potential to occur throughout the Project Area.

Juveniles: No designated EFH for this life stage occurs within the Project Area.

Adult: EFH for adult sand tiger sharks extends from southern New Jersey to the east coast of Florida. EFH has been identified in all five quadrants; therefore, these sharks have the potential to occur throughout the Project Area.

Atlantic Sharpnose Shark

The Atlantic sharpnose shark has a broad distribution and can be commonly found from New Brunswick, Canada, through the Gulf of Mexico as well as along the coast of Brazil. This shark commonly inhabits both temperate and tropical waters from the Canadian maritime coast to Mexico's Yucatan peninsula. As year round residents off the shore of South Carolina, Florida, and the Florida Keys, this species makes regular inshore to offshore migrations. Atlantic sharpnose sharks have been observed to form large sexually segregated schools during these migrations. As winter approaches, the sharks move offshore into deeper water, returning inshore to mate in spring and give birth after a 10 to 11 month gestation period. They are found at depths to 920 ft (280 m), but most remain in waters less than 32 ft (10 m) deep. Along with being common residents of the surf zone, the Atlantic sharpnose shark is also found in estuaries and harbors. Although this shark is able to tolerate lower salinity levels, they do not venture into freshwater like the bull shark (*Carcharhinus leucas*) (FMNH 2013).

Adults: EFH for adult sharpnose sharks has been identified in all five quadrants; therefore, these sharks have the potential to occur throughout the Project Area.

Dusky Shark

The dusky shark has a wide-ranging distribution in warm-temperate and tropical continental waters throughout the world and can be found in the western Atlantic from southern Massachusetts and Georges Bank southward through the northern Caribbean Sea and Gulf of Mexico to as far south Nicaragua and southern Brazil (Compagno 1984; Castro 1993). Dusky sharks are coastal and pelagic in distribution and occur from the surf zone to well offshore and from surface waters to depths of 1,312 ft (400 m) (Compagno 1984; Branstetter 2002). Mating for this species in the western Atlantic occurs in the spring, and birth to live young can occur over several months from late winter to summer (Compagno 1984). Females mate in alternate years as a result of their long gestation period (9 to 16 months). The dusky shark undertakes long seasonal, temperature-related migrations. On both coasts of the United States, this species migrates northward in summer as the waters warm and retreats southward in fall as water temperatures decline (Compagno 1984). Major nursery areas have been identified in coastal waters from Massachusetts to the

South Carolina coast, including Bulls Bay, South Carolina (Castro 1993). As with many shark species, the dusky shark is common in the waters of Virginia and typically targeted by recreational fishing.

Neonates: Unlike other shark species of the western Atlantic, these newborn sharks do not use estuarine habitats for protection during their development. These sharks are usually born at 33 to 39 in (0.8 to 1 m) long and are, therefore, less vulnerable to predators than smaller, inshore species. In addition, they do not tolerate water of lower salinities, as is often found in river-fed estuaries. These sharks are more often found in the surf zone and offshore. That said, female dusky sharks can birth their young at a variety of sizes and ages and in locations that they select based upon how likely their young are to thrive. Neonatal dusky shark EFH has been identified in all five quadrants, and has the potential to occur throughout the Project Area.

Juvenile: Juvenile dusky sharks consume a wide variety of prey including boney fish and cephalopods as well as occasional crustaceans, sea stars, bryozoans, sea turtles, marine mammals, carrion, and even garbage (NOAA Fisheries 2011). EFH for juvenile dusky sharks has been identified in all five quadrants, and has the potential to occur throughout the Project Area.

Adult: No designated EFH for this life stage occurs within the Project Area.

Shortfin Mako Shark

The shortfin mako shark has a worldwide distribution. It ranges from the Grand Banks and Gulf of Maine in the western Atlantic southward to the tropics, including the Gulf of Mexico (Schultz 2004). It is commonly found offshore from Cape Cod to Cape Hatteras, though it can be scarce during specific years (Castro 1983). Relatively little data exist on the migratory patterns of the shortfin mako shark. Within the northern extent of its range, this species is believed to follow the movement of warm-water masses towards the poles in the summer (Compagno 1984). The shortfin mako shark has a 2- or 3-year reproductive cycle, a gestation period of approximately 18 months, and a late winter to mid-spring parturition (Mollet et al. 2000). The shortfin mako shark is found in warm-temperate to tropical waters around the world, but is rarely found in water temperatures lower than 60.8°F (16°C) (Compagno 1984). This shark is an epipelagic species typically found from the surface to depths of 498 ft (152 m), but has been recorded as deep as 2,427 ft (740 m) (Compagno 1984, Wood 2007). The shortfin mako shark is common in the waters of Virginia and typically targeted by offshore recreational fishing.

Neonates: EFH for neonate shortfin mako is designated between 164 ft and 6,561 ft (50 m and 2,000 m) water depth from southeast of Georges Bank to Cape Lookout, North Carolina and from 82 ft to 164 ft (25 m to 50 m) offshore from the Chesapeake Bay to a line running west of Long Island, New York to just southwest of Georges Bank. Localized areas in the central Gulf of Mexico and around the Florida Keys have been designated EFH, as well as areas off South Carolina (NMFS 2009). EFH for neonatal shortfin mako sharks has been identified in Quadrant 5; therefore, neonatal shortfin makos have the potential to occur in and around the WTG foundation areas.

Juvenile: No designated EFH for this life stage occurs within the Project Area.

Adult: No designated EFH for this life stage occurs within the Project Area.

Sandbar Shark

Sandbar sharks are found in shallow coastal waters from Cape Cod southward to Brazil, including the Gulf of Mexico and the Caribbean Sea, but are most common from South Carolina to Florida and in the eastern

Gulf of Mexico (Castro 1983; Branstetter 2002). This bottom-dwelling species is found in temperate to tropical waters over the continental shelf and in deep water adjacent to the shelf break. Sandbar sharks are found in water depths ranging from the intertidal zone to 918 ft (280 m) during migration, but are common in 66 ft to 213 ft (20 m to 65 m) depths (Compagno 1984). Sandbar sharks avoid surf zones, coral reefs, or rough benthic substrates, preferring smooth substrates (Castro 1983; Compagno 1984). They are common in inshore areas with mud or sand substrates such as estuaries, river mouths, and harbors, but do not enter freshwater (Compagno 1984). Sandbar sharks make an extensive seasonal migration, moving to the northern part of their range in the summer and the southern part during the winter (Castro 1983). Seasonal temperature changes are the primary trigger for the migration; however, oceanographic features also influence this behavior (Compagno 1984). In the northwest Atlantic, mating occurs from May to June with young being born from March to August after a gestation period of approximately 1 year (Castro 1983). This species segregates by sex, with large females dominating shallow, nursery areas from Delaware Bay to Cape Canaveral, Florida, as well as the Gulf of Mexico (Castro 1983). The Chesapeake Bay is regarded as one of the primary nursery grounds in the mid-Atlantic (Branstetter 2002). As with many shark species, the sandbar shark is common in the waters of Virginia and typically targeted by recreational fishing.

Neonates, Juveniles and Adults: EFH for juvenile and neonatal sandbar sharks is designated as all coastal and pelagic waters offshore from Cape Poge Bay and the south shore of Cape Cod to Long Island, New York; shallow coastal areas out to the 82-ft (25-m) depth contour from Barnegat Inlet, New Jersey to Cape Canaveral, Florida; and in the Mid-Atlantic Bight during the winter, the benthic areas underlying the shelf break between the 295-ft to 656-ft (90-m to 200-m) depth contours. Neonatal sandbar sharks are born between June-August in the western Atlantic and are born live at 22 to 28 in (55 to 70 cm) in length. While the neonates are not known to travel into riverine environments, they are often found in large estuaries like Delaware and Chesapeake Bay. Recent studies indicate that this preference is likely due to the prevalence of soft shelled blue crabs, a preferred food item for these newborn sharks. EFH for juvenile and neonatal sandbar sharks has been identified in all five quadrants, and Quadrants 2, 3, 4, and 5 are designated habitat areas of particular concern (HAPC NOAA Fisheries 2000).

EFH for the adult sandbar shark is shallow coastal waters to the 82 ft (25 m) depth contour from Barnegat Inlet, New Jersey to south of Cape Canaveral, Florida. Additional EFH designated for this life stage is areas north of Barnegat Inlet, New Jersey and regions off western Florida. A comprehensive stock assessment for this species is considered difficult as they are found in the United States to Yucatan, Mexico, Cuba and Bahamas; possibly to Belize, Honduras, Costa Rica, Panama, Columbia, Trinidad and Tobago, and Venezuela, with a southern population extending from southern Brazil to northern Argentina. EFH for sandbar shark adults has been identified in all five quadrants, and Quadrants 2, 3, 4, and 5 are designated as HAPC (NOAA Fisheries 2000).

Scalloped Hammerhead Shark

Scalloped hammerhead sharks are fairly large sharks with a nearly universal oceanic distribution. The eight species of hammerhead sharks are characterized by the flat, extended head called a cephalofoil. The cephalofoil of a scalloped hammerhead shark is characterized by an indentation located in the center of the head. Two additional indents are seen on both sides of the first, giving this shark its name. They feed on various crustaceans, teleost fish, cephalopods, and rays. The scalloped hammerhead is a coastal pelagic shark that can also be found well offshore. It is commonly found on continental shelves adjacent to deeper water. It has been observed close inshore and even entering estuarine habitats, as well as offshore to depths of 3,280 ft (1,000 m). Adult aggregations are common at seamounts, especially near Malpelo Ridge, Columbia, Revillagigedo Islands, Jalisco, Mexico, and in specific locations within the Gulf of California, but otherwise adults are solitary or found in pairs.

Neonates: No designated EFH for this life stage occurs within the Project Area.

Juveniles: EFH for juvenile scalloped hammerhead sharks has been identified in all five quadrants within the Project Area. Recent research shows that juveniles usually remain near shore to avoid predation by larger pelagic sharks, as well as to remain close to concentrated prey such as small schooling fish like mackerel and herring.

Adults: No designated EFH for this life stage occurs within the Project Area.

Tiger Shark

The tiger shark is found throughout the Atlantic coast of the United States from Cape Cod, Massachusetts, to the Gulf of Mexico and the Caribbean Sea. This shark inhabits coastal waters close to shore as well as the outer continental shelf. One of the largest shark species, the largest individuals are believed to exceed 18 ft (5.5 m) and 2,000 lb. Tiger sharks are opportunistic feeders that take advantage of nearly any prey item they can find including sea turtles, rays, other sharks, bony fishes, sea birds, dolphins, squid, various crustaceans, and even carrion and human refuse. Adults mature at approximately 9 feet in length and litters are large, often comprising from 35 to 55 pups. In the Northern Hemisphere, mating takes place between March and May and the young are born between April and June of the following year. It is believed by some scientists that because of the large size of the young at birth, uterine nutrition is supplemented by 'uterine milk' secreted by the lining of the uterus – a very unique anatomical trait. The pups are long and slender, measuring from 20 to 30 in (51 to 76 cm). These neonates have clearly defined vertical stripes which fade as they mature into adults. They grow slowly and feed readily, which makes them vulnerable to declines in population due to overfishing.

Neonates, Juveniles and Adults: EFH for neonatal, juvenile and adult tiger sharks has been identified in all five quadrants within the Project Area.

Bluefin Tuna

Bluefin tuna have a worldwide distribution in tropical and temperate waters from Argentina and South Africa north to Labrador and northern Scandinavia in the Atlantic Ocean, including the Gulf of Mexico and the Caribbean Sea (Schultz 2004). The western Atlantic bluefin tuna spawns from mid-April to mid-June in the Gulf of Mexico, the Florida Straits, the western edge of the Bahamas Banks, and along the eastern portion of the Florida current at temperatures of 76.8°F to 85.1°F (24.9°C to 29.5°C) (Gusey 1981; Collette and Nauen 1983). The Gulf of Mexico spawning site is considered the primary spawning area of the northwest Atlantic (Mather et al. 1995; Block et al. 2001). The adult bluefin tuna moves seasonally from offshore spawning grounds in the Gulf of Mexico through the Straits of Florida to inshore seasonal feeding grounds in the northern part of their range in the northwestern Atlantic (Jeffreys Ledge, Stellwagen Bank, Cape Cod Bay, Great South Channel, the continental shelf south of Martha's Vineyard and Nantucket) in the early spring and summer and finally to North Carolina, Blake Plateau, or the Bahamas during the winter (Gusey 1981; Block et al. 2001; Chase 2002). Data on the three-way movements of adults from these feeding areas to wintering areas and back to breeding areas are limited. It is postulated that juveniles have a shorter two-way movement from feeding to wintering areas (Mather et al. 1995; Chase 2002). This species can tolerate a considerable range of temperatures and has been observed at depths greater than 3,280.8 ft (1,000 m) (Block et al. 2001). Although bluefin tuna are epipelagic and oceanic, they often occur over continental shelf waters and in embayments during the summer months (Collette and Klein-MacPhee 2002). Juveniles typically inhabit regions off the continental shelf, from North Carolina to Maine, in waters with depths less than 131 ft (40 m) and temperatures greater than 68°F (20°C) in the summer (Schuck 1982; Brill et al. 2002). Juveniles along the continental shelf utilize the entire water column, including the benthic habitat, but spend the majority of their time near the surface (Brill et al. 2002). Fertilized eggs are buoyant (Collette and Klein-MacPhee 2002).

Eggs: No designated EFH for this life stage occurs within the Project Area.

Larva: No designated EFH for this life stage occurs within the Project Area.

Juvenile: EFH for the juvenile bluefin tuna is designated as all inshore and pelagic surface waters warmer than 53.6°F (12°C) from the Gulf of Maine to Cape Cod Bay, and Nantucket Shoals south to Cape Hatteras between the 82-ft and 656-ft (25-m and 200-m) isobaths. Additional EFH designated for this life stage is found in the Florida Straits. EFH for juvenile bluefin tuna has been identified in Quadrant 5 of the Project Area.

Adult: EFH for adult bluefin tuna is designated in the Gulf of Maine, Georges Bank, the Mid-Atlantic Bight, and the Gulf of Mexico. EFH for adults has been identified in Quadrant 5 of the Project Area.

Swordfish

The swordfish is a unique and poorly understood animal. Swordfish are pelagic fish, living within the water column rather than on the bottom or in coastal areas. They are found at depths of between 590 to 1,900 ft (180 to 580 m), and are distributed worldwide in temperate and tropical waters. They are believed to prefer waters where the surface temperature is above 58° F (15° C), although they can tolerate temperatures as low as 50° F (10° C), especially larger individuals. Male swordfish rarely exceed 200 pounds, so nearly all of the largest specimens are female (Schwartz et al. 1993).

Swordfish are summer and fall visitors to Mid-Atlantic and New England waters, entering the warming Atlantic coastal waters from far offshore in the Gulf Stream around June and departing in late October. Evidence suggests that such onshore-offshore seasonal migrations are more prevalent than are migrations between the northern feeding areas off Cape Hatteras and the southern spawning grounds off Florida and the Caribbean. Swordfish reach sexual maturity at about 2 to 3 years of age, and live for at least 9 years. While they may survive longer, no such documentation exists. The majority of swordfish caught in the North Atlantic sport fishery are thought to be 4 to 5 years old. Spawning is year-round in the Caribbean Sea, Gulf of Mexico, the Florida coast and other warm equatorial waters but seasonal in the north Atlantic. Spawning is known to occur in the Sargasso Sea in water warmer than 73 ° F (23 ° C) and less than 246 ft (75 m) deep (Schwartz et al. 1993).

Eggs: No designated EFH for this life stage occurs within the Project Area.

Larvae: No designated EFH for this life stage occurs within the Project Area.

Juveniles: EFH for juvenile swordfish has been identified in Quadrant 5 within the Project Area. Young adult and juvenile are eaten by a variety of sharks and other large predatory fish including blue marlin, black marlin, sailfish, yellowfin tuna and the mahi mahi, some of which are also expected in the Project Area.

Adults: No designated EFH for this life stage occurs within the Project Area.

Skipjack Tuna

The skipjack tuna is found throughout many of the world's oceans, mainly in the tropical areas of the Atlantic, Indian, and Pacific Oceans. The greatest abundance of skipjack in all these oceans is seen near the equator. It is a small tuna and matures at an early age, making it resilient to extremely high levels of fishing when compared to most other tuna species. It is the smallest of all the commercially harvested tunas worldwide and is often found schooling with small yellowfin and bigeye tuna. It is an important commercial fish, especially in the equatorial distant water fleet, and is usually caught using purse seine nets. Skipjack tuna was the world's second most important captured fish species in 2009, with reported global commercial landings of almost 2.6 million tons.

Skipjack are oviparous. In warm equatorial waters, skipjack spawn year-round while further away from the equator, spawning season is limited to warm months. Sexual maturity may occur as small as 15 inches (40 cm) in length, however, most fish appear to mature at larger sizes. Large females produce significantly more eggs than smaller females, with the average adult producing 80,000 to 2 million eggs per year (Collette and Nauen 1983).

Eggs: No designated EFH for this life stage occurs within the Project Area.

Larvae: No designated EFH for this life stage occurs within the Project Area.

Juveniles: No designated EFH for this life stage occurs within the Project Area.

Adults: EFH for adult skipjack tuna has been identified in Quadrant 5. Aggregations of skipjack tuna are often associated with convergences and/or other hydrographic discontinuities, such as thermoclines or haloclines. Skipjack tuna schools also associate with birds, drifting objects, whales, sharks, and schools of other tuna species (Colette and Nauen 1983). The optimum temperature for the species is 81° F (27° C) with a range from 68° F (20° C) to 88° F (31° C; ICCAT 1995).

4.7.2 Potential Impact Producing Factors, Proposed Environmental Protection Measures, and BMPs

As discussed in Section 4.3.2, the Project has the potential to produce the following types of impacts to marine resources, including EFH and their associated fish species:

1. Direct mortality or injury to marine species
2. Disturbance or displacement of habitat for marine resources
3. Direct or indirect effects on marine species through potential changes in water quality
4. Disturbance or injury of marine species through Project-related noise
5. Indirect effects on marine species through changes in prey availability
6. Direct or indirect effects on marine species through Project-related electromagnetic fields (EMFs)
7. Direct or indirect effects on marine species through Project-related lighting

Impacts to EFH and their associated fish species are expected to be similar to the discussion of benthic, epibenthic, demersal, and pelagic species discussed in Sections 4.3.2.1 and 4.3.2.2. Section 4.3.2.2 also identifies BMPs and other protective measures that the VOWTAP Team has incorporated into the plans for Project construction, operation, and decommissioning. As discussed in those sections, impacts to EFH and associated fish species are expected to be minimal. The offshore Project components have been located in an area that contains no hard-bottom substrates, sea grasses, or other important marine habitat. The sand substrates found in the Project Area are generally similar to the Mid-Atlantic Bight and are not unique.

Of the EFH species identified as potentially occurring in the Project Area, many organisms have a completely pelagic lifestyle, including the bluefish, Atlantic sea herring, bluefin tuna, skipjack tuna, and most sharks. In addition, most species with designated EFH in the Project Area have pelagic early life histories (eggs and larvae) and are not dependent on benthic habitat. Therefore, modification and/or disturbance of the substrate during construction, including temporary increases in total suspended solids (TSS), will not impact these species or life stages. There may be some temporary impacts on the use of specific areas by these species during construction resulting from increased TSS in the lower water column; however, as stated in Section 4.2.2, any sediment plume generated during Project construction is expected to be small, localized, and temporary, and will not produce concentrations that are known to cause harm to fish. In addition, given their mobile nature, pelagic juvenile and adult life stages should largely avoid these areas.

As discussed in Section 4.3.2.2, pelagic fish most likely have the highest potential for noise impact, primarily from pile driving. However, most fish are expected to avoid areas of construction noise. Section 4.3.2.4 lists BMPs and other measures to reduce potential impacts from noise. The proposed use of ramp-up/soft-start procedures as well as limiting impact pile-driving to daylight hours will be the primary means to reducing impacts to fish.

As discussed in Section 4.3.2.2, both pelagic and demersal fish species may be sensitive to the presence of EMFs. As discussed in Section 4.3.2 and Appendix K, EMF levels would not impact demersal or pelagic fish due to cable design and burial depth.

Demersal fish species and benthic species, such as mollusks, have the greatest potential for impact in the Project Area during construction, because they are directly dependent on the substrate for at least some portion of their life cycle. Juvenile whiting, juvenile red hake, juvenile windowpane, juvenile and adult butterfish, juvenile and adult summer flounder, all life stages of red drum, neonatal and adult sand tiger sharks, neonatal, juvenile and adult sandbar sharks, and surf clams and ocean quahogs all have a close affinity for soft substrates. Species such as juvenile and adult scup, juvenile and adult black sea bass, and longfin squid eggs have a strong affinity for hard substrates. However, no hard bottom habitat was identified in the Project Area during site-specific surveys.

Immobile species such as surf clams and ocean quahogs in the direct footprint of the WTG foundations, anchors, jack-up barge spuds, the jet plow/ROV jet trencher and additional cable protection will likely experience mortality. In addition, the presence of sand waves throughout much of the Project Area is a strong indicator that bottom currents transport surface sediments routinely, making the presence of any demersal eggs unlikely. Furthermore, benthic fauna are likely well adapted and able to withstand small amounts of sedimentation, and will recover quickly. Overall, the area of benthic habitat potentially affected by construction is extremely small compared to the total area of available surrounding habitat.

Upon completion of construction, the substrates within the offshore Project Area will remain fundamentally the same as pre-existing conditions, except for the maximum permanent conversion of 23.6 ac (9.5 hectares) of soft substrate associated with the combined presence of the two WTGs and proposed cable protection. As detailed in Section 4.3.2.1, epifaunal and infaunal species will recolonize the sediments disturbed through the mechanisms of larval recruitment, and mobile species of both fish and invertebrates will return to the Project Area, allowing this area to continue to serve as foraging habitat for EFH species. The WTG foundations and additional cable protection are likely to provide some additional habitat that would be suitable for both demersal species (especially structure-oriented species like the black sea bass) and colonization by sessile benthic species. For example, the Chesapeake Light Tower, located at the mouth of the Chesapeake Bay, has been recognized as an exceptional source of habitat for aquatic life, especially structure-oriented species, including black sea bass, flounder, king mackerel, Spanish mackerel, and cobia.

Decommissioning of the VOWTAP at the end of the Project's projected 20-year life will have the same type of impacts described for installation, resulting in only a temporary short-term disturbance to EFH and EFH species from substrate disturbance and increased TSS in the Project Area. The sessile fouling community that is expected to have developed on the IBGS foundation will also be removed, which will result in a small reduction in the habitat diversity and forage available to EFH species in the Project Area; however, this will represent a return to pre-Project conditions.

Overall, the EFH species assemblage in the Project Area following decommissioning will be similar to that described for the five quadrants traversed by the project. As detailed, impacts on pelagic EFH species, their life stages, and habitat will be limited to the temporary and localized suspension of TSS in the water column, and associated short-term avoidance of the construction area during removal of the Project components in the same manner as described for Project construction.

As described above, the substrates along the transmission cable corridor, except at the locations of the proposed additional cable protection, will remain fundamentally the same as pre-existing conditions, and will allow for continued use by designated EFH species. Epifaunal and infaunal species will recolonize disturbed sediments through mechanisms of larval recruitment. In addition, mobile macroinvertebrates will return to the cable trench area, which will continue to serve as foraging habitat for EFH species.

4.8 Wetlands and Other Jurisdictional Waters

This section describes wetlands and other jurisdictional waters that occur in the onshore VOWTAP Project Area, along with potential Project impacts to these waters and proposed mitigation measures and best management practices (BMPs). Project Area wetlands and surface waters were field delineated in October of 2013. Subsequent route changes were either field verified for the presence/absence of wetlands in November of 2013, or field delineated boundaries were extended by desktop analysis in December of 2013. The results of the delineation efforts are provided in Appendix H.

4.8.1 Affected Environment

Field investigations identified and delineated four jurisdictional wetlands and waters in the Project Area, including two palustrine wetlands (PFO) and two lacustrine open water area (L1). Both occur along the

Onshore Interconnection Cable and Fiber Optic Cable route (See Table 4.8-1, Figure 4.8-1 and Appendix H). No other jurisdictional waterbodies were identified within the onshore Project Area.

Forested broad-leaved deciduous/needle-leaved evergreen (hardwood-pine forest) wetlands total 0.43 acre (0.17 hectare) deciduous forest wetland plant communities are characterized as an association of red maple (*Acer rubrum*), sweetgum (*Liquidamber styraciflua)*, and black gum (*Nyssa sylvatica*) with southern wax myrtle (*Morella cerifera*) dominating the shrub layer. Plant communities in mixed deciduous/needle-leaved evergreen forested wetlands include an association of loblolly pine (*Pinus taeda*), willow oak (*Quercus phellos*), black gum, and cherry bark oak (*Quercus pagoda*). Lacustrine open waters totaled 0.1 acres (0.04 hectares). All of the lacustrine area identified along the proposed Onshore Transmission Route was associated with the crossing of Lake Christine.

Table 4.8-1. Wetland and Lake Summary for the VOWTAP Proposed Onshore Interconnection Cable and Fiber Optic Cable Route

Area	Map Label	Sample Point	Soil Type[a/]	Classification	Acres/ Hectares[b/]	Comments
Rifle Range Road - north side	Wetland 5	none/connects Wetland 4	Nawney silt loam	PFO1/4	0.09	Mixed deciduous/ needle-leaved evergreen forested wetland
Rifle Range Road south side	Wetland 6	19-Alt 1/ across Dam Neck fenceline	Dragston fine sandy loam, Tomotley loam, Acredale silt loam, and Nawney silt loam	PFO1	0.34	Forested wetland
Rifle Range Road - north side	Lake 1	none/open water	open water	L1UB	0.09	Lake Christine
Rifle Range Road south side	Lake 2	none/open water	open water	L1UB	0.01	Lake Christine

a/ Listed as hydric soil (http://soils.usda.gov/use/hydric/)
b/ USACE provided a preliminary jurisdictional determination on February 7, 2014 (see Appendix A).

Figure 4.8-1. Surveyed Wetlands

4.8.2 Potential Impact Producing Factors, Proposed Environmental Protection Measures, and BMPs

Because Dominion has sited the Project to avoid jurisdictional wetlands and waterbodies the only potential impact producing factor on wetlands would be indirect disturbance from sedimentation or stormwater runoff. No impacts to wetlands are anticipated during operation.

As stated in Section 3.3.2, all onshore construction activities will occur along existing road rights-of-way and/or within previously disturbed areas. Dominion will construct the proposed Onshore Interconnection Cable and Fiber Optic Cable via HDD to further minimize impacts to surrounding habitats including wetlands. As depicted on the preliminary design plans provided in Appendix D-2, all construction activities and associated disturbances will be located outside of delineated wetlands. This includes the HDD Work Area, proposed locations for the Switch Cabinet, the proposed Onshore Interconnection Cable and Fiber Optic Cable along with the associated splice pits and construction work areas, and the Interconnection Station. For these reasons, construction and operation will not result in permanent removal or fill to wetlands or other jurisdictional waters. There will be no conversion of forested wetlands to other wetland types.

Dominion will also implement a Stormwater Management Plan pursuant to VAR10 General Permit, 9 VAC25-880 and an ESC Plan and associated BMPs in accordance with 9VAC25-840 to avoid or minimize potential erosion impacts from all onshore construction activities. These plans will be provided to relevant agencies for review and approval prior to construction.

At the end of the Project's useful life, the decommissioning of the onshore components of the VOWTAP will be similar to construction but in reverse. As with construction, potential impacts to wetlands will be avoided.

4.9 Cultural Resources

This section discusses cultural resources in the offshore and onshore portions of the Project Area, the potential Project impacts to those resources, and the environmental protection measures and BMPs that will be employed during Project construction.

Cultural resources include archeological sites, historic standing structures, objects, districts, and traditional cultural properties that illustrate or represent important aspects of prehistory or history or that have important and long-standing cultural associations with established communities or social groups. Significant archeological and architectural properties are generally defined by the eligibility criteria for listing in the National Register of Historic Places (NRHP).

Consultation under Section 106 of the National Historic Preservation Act (NHPA) of 1966 (16 USC §470f) is triggered when projects require federal permits, the use of federal funds, or occur on federal lands. Such federal undertakings require consultation by federal agencies with the State Historic Preservation Office (SHPO) and interested Native American tribes. These consultations identify the Area of Potential Effects (APE) and potential adverse effects to archeological, architectural, or other cultural resources that are listed in or are potentially eligible for listing in the NRHP.

To ensure compliance with Section 106 requirements, BOEM has developed guidelines for providing geological and geophysical, hazards, and archaeological information for wind development on the OCS (BOEM 2011). The information in this section has been developed in compliance with those guidelines.

BOEM has jurisdiction to manage cultural resources on the OCS within its lease areas, along with any indirect visual impacts to terrestrial historic properties (MMS 2007). Portions of a project located in state waters or onshore are outside of BOEM's jurisdiction and fall under the authority of the relevant state.

4.9.1 Marine Cultural Resources

Dominion conducted a desktop review and Phase I marine archaeological remote sensing survey to identify NRHP-listed and NRHP-eligible submerged archaeological properties, geological features with pre-contact period archaeological sensitivity, and remote sensing anomalies or targets with the potential to be post-contact submerged cultural resources.

Marine surveys covered the entirety of the Research Lease Area, covering approximately 1,482 acres (568 hectares), along with an approximately 27-mi (44-km) long by 984-ft (300-m) wide survey corridor to accommodate the Export Cable. Survey activities adhered to the Survey Protocols for Marine Archeological Assessment developed in accordance with BOEM's Guidelines for Providing Geological and Geophysical, Hazards, and Archaeological Information Pursuant to 30 CFR Part 585. All work was performed in accordance with the NHPA of 1966, as amended; the NEPA of 1969, as amended; and VDHR regulations. The appropriate state and federal regulatory agencies reviewed and approved the Survey Plan prior to execution of the field operations. The VOWTAP Marine Archeological Assessment Report is presented in Appendix N. This report contains sensitive site location information and, therefore, will be made available only to the reviewing agencies engaged in the Section 106 process for the Project.

The following section discusses known submerged cultural resources within the survey area and presents a summary of the marine cultural resources survey results.

4.9.1.1 Affected Environment

In the offshore portion of the Project Area, cultural resources may include both submerged prehistoric and historic archeological sites. Potential prehistoric archeological sites would include archaeological sites from the area's earliest inhabitants located on flooded prehistoric landforms (paleolandscape features). Within the VOWTAP APE this would include Paleo-Indian and Early to Middle Archaic occupations ranging from 10,000 to 8,000 BCE and 8,000to 3,000 BCE (VDHR 2011). Such sites could possibly have been occupied prior to post-glacial inundation, when portions of the Continental Shelf were exposed upland. Historic period archaeological sites that could potentially occur within offshore portions of the VOWTAP APE are predominantly related to marine activity, such as historic shipwrecks.

The evaluation of potential submerged pre-historic and historic sites in the VOWTAP project were based on both a desk-top evaluation of existing literature and on the interpretation of geophysical and geotechnical data used to characterize the seabed and subsurface. This data included the acquisition and interpretation of water depths and bottom topography, sidescan sonar imagery, marine magnetic data, shallow- and medium-penetration sub-bottom profiling, and a geotechnical investigation that included the collection, processing, and laboratory testing of sea bottom grab samples and vibracores. The results of the geophysical and shallow geotechnical surveys conducted within the Project Area are provided in Appendix F-1 through F-3.

Marine surveys covered the area proposed for the Export Cable, from the WTGs to the maximum anticipated HDD punch-out area located approximately 3,281 ft (1,000 m) offshore from the proposed landfall site (Figure 3.3-1), as well as the entirety of the Research Lease Area. In a meeting dated September 4, 2013, the VDHR confirmed that cultural surveys of the intertidal zone would not be required. However, to ensure protection of potential sites, the VDHR indicated that an Unanticipated Discoveries Plan would be required for both the intertidal area and offshore portions of the Project during construction.

The sub-bottom (CHIRP) profiler data collected during the marine surveys was analyzed to identify paleolandscape features within the Project APE. Evaluation of this data indicated the presence of eight buried paleochannels in the Project Area in water depths of approximately 49.2 ft to 65.2 ft (15 to 20 m) mean lower low water. However, evidence from the CHIRP data, sediment cores collected in the general vicinity, and a literature review, suggest that natural levee deposits in this area have experienced intense erosion and sediment reworking. Therefore, even though this area may have been favorable for Paleolithic human occupation, site destruction processes are indicative of a low-to-moderate preservation of natural levee deposits and associated culture materials.

Archeological analyses of the geophysical survey data identified a total of 653 magnetic anomalies and 79 side scan sonar contacts. The majority of these were determined to having little or no probability for representing submerged cultural resources. However, three anomaly clusters were identified within the APE that could represent submerged cultural resources. Two are located in proximity to the proposed outer extent of the Export Cable construction corridor[1], and one was located within the proposed WTG construction area and Inter-Array Cable construction corridor. Dominion will establish a minimum avoidance area, determined through consultation with the relevant authorities, and centered on each of these identified targets.

4.9.1.2 Potential Impact Producing Factors, Proposed Cultural Resource Protection Measures, and BMPs

Potential impacts to submerged pre-historic and historic cultural resources would include direct physical disturbance from construction activities. All three of the potential submerged cultural sites identified in the geophysical surveys will be avoided to prevent disturbance during construction, operation, and decommissioning.

Dominion recognizes that disturbance of the seafloor during construction has the potential to encounter and affect unidentified submerged cultural resources. Although remote sensing surveys conducted in accordance with current professional standards for cultural resource identification are expected to be highly effective at recognizing submerged cultural resources, the possibility of encountering an unidentified and unanticipated submerged cultural resource is always present during construction activities. Therefore, Dominion will implement an Offshore Unanticipated Discoveries Plan, including archeological resource identification training, in consultation with the VDHR and BOEM in support of VOWTAP construction activities.

[1] During Section 106 consultations in August 2014, BOEM indicated they had conducted further investigation of the anomalies and one was eliminated from further consideration as a possible cultural resource.

4.9.2 Terrestrial Archaeological Resources

The APE for the onshore portions of the VOWTAP consists of the footprint of the proposed onshore facilities and any associated construction right-of-ways or work areas. A phased approach was used to identify and evaluate terrestrial archaeological resources within the onshore portion of the Project's APE. Desktop studies consisting of archival research were completed to identify known sites and areas with potential to contain cultural resources. To evaluate archaeological sensitivity and identify areas of previous disturbance within the APE, a full coverage pedestrian reconnaissance was undertaken. Pedestrian reconnaissance was followed by the excavation of shovel tests in areas identified as potentially sensitive for the presence of cultural resources.

All work was performed under an Archaeological Survey Plan developed in consultation with the VDHR, which serves as the SHPO. The Survey Plan was approved by the VDHR on September 30, 2013, and the archaeological survey was initiated on October 8, 2013 under the VDHR Permit issued for VOWTAP, DHR File No. 2013-0452.

The following is a summary of the terrestrial archaeological survey results. The complete terrestrial archaeological survey report is presented in Appendix O; however, this report contains sensitive site location information and, therefore, will be made available only to the reviewing agencies engaged in the Section 106 process for the Project.

4.9.2.1 Affected Environment

Terrestrial archeological resources within the onshore portions of the VOWTAP APE may include archeological sites that date to as early as pre-contact time periods (also known as prehistoric time periods) dating to as early as 10,000 B.C., and as recently as contact periods (also known as historic time periods) dating from around 1600 to 1963 A.D. Sites may potentially represent a wide range of types, such as small lithic scatters, village sites, Euroamerican agricultural sites, nineteenth century tourism-related sites, twentieth century industrial sites, and military coastal defense sites.

Background research undertaken for the archaeological investigation revealed little information regarding precontact use of the Project Area. Based on regional patterns of precontact settlement and land use within southern Virginia, onshore portions of the VOWTAP have the potential to contain sites related to the three major prehistoric cultural periods: Paleo-Indian, 10,000 B.C to 8000 B.C.; Archaic, 8000 B.C. to 1000 B.C.; and Woodland, 1000 B.C to 1600 A.D. (VDHR 2013). The environmental setting of the Project Area, on level terrain near coastal resources and navigable waterways, is ideal for precontact resource procurement and settlement. Due to their abundance and size, Woodland period sites were considered most likely to be identified within the Project Area. The Project Area was also considered sensitive for the potential presence of Archaic and Paleo-Indian period sites; however, Pleistocene glacial melting which resulted in sea levels rising throughout the Paleo-Indian and Archaic periods resulted in the submergence of many coastal sites. As such, the potential for Paleo-Indian and Archaic period sites to be located within the Project Area was considered lower than that of Woodland period sites.

Through much of the historic period (which in this region began in the early 1600s), human use of the Project Area was largely limited to small-scale agricultural pursuits. Northern portions of the historic Princess Anne County supported large-scale plantation agriculturethat began to develop in the 17th century. The southern part of the county, which includes the onshore Project Area, remained relatively unsettled due to poorly drained soils that exhibited low fertility. In addition, the area was inaccessible as it lay beyond navigable portions of the Lynnhaven and Elizabeth Rivers (Mansfield 1988).

Coastal resort and urban development in Virginia Beach, to the north of the onshore Project Area, bgean in the 1880s. In 1912, major landscape modifications were undertaken in and near the Project Area during the construction of the State Rifle Range (now Camp Pendleton). Throughout the historic period, the property witnessed numerous construction and deconstruction phases, land exchanges, lease periods, and name changes (NRHP 2005). An aggressive building campaign was undertaken when the property was leased to the U.S. Navy during World War I, and in World War II Camp Pendleton experienced the height of its use when it was leased to the U.S. Army as a summer encampment training facility and year-round Army post. After World War II, military use of Camp Pendleton began to decline as Virginia Beach's residential population expanded, leading to increased pressure to reduce military activities. In 2005, Camp Pendleton was listed on the Virginia State Register of Historic Places and the NRHP as a National Historic Landmark District (National Park Service Reference Number: 04000852, DHR File No. 134-0413). The property meets NRHP eligibility Criteria A and C, due to Camp Pendleton's association with significant historic events relevant to architecture, military, and transportation, and its embodiment of distinctive landscape and structural characteristics related to a period of significance spanning from 1911 to 1950 (NRHP 2005).

Due to environmental features, such as level terrain and proximity to fresh water, historic military use of the area, and the results of previous archaeological surveys, the Project's APE was determined as having moderate sensitivity for the presence of both precontact and historic cultural resources. However, as described in Section 3.3.2, the proposed locations for all of the VOWTAP onshore facilities and associated construction right-of-ways and work areas are located in areas that have experienced some level of previous disturbance, including paved roads, maintained road shoulders, and gravel parking areas. As such, the subsurface testing within the Project APE focused on undisturbed areas potentially sensitive for the presence of cultural resources associated with the proposed and alternative construction footprints. The dune areas adjacent to the proposed Export Cable landfall site in the Camp Pendleton Beach parking lot were also inspected but not excavated. This approach was based on consultation between the VDHR, Dominion, and Tetra Tech at the September 4, 2013 technical planning meeting, where it was determined that no subsurface testing would be performed in sand dune or intertidal areas adjacent to the landfall locations. Although there is the possibility for sand dunes and the intertidal zone to contain buried cultural surfaces and materials, it was determined that hand or mechanical subsurface excavation is not practical in these areas.

Subsurface excavations within the Project's APE identified isolated historic period artifacts, such as glass, brick, or bullet fragments. Three isolated precontact lithic artifacts were recovered during excavations; however, these finds are located well outside of the proposed locations for the VOWTAP onshore facilities, and are in areas no longer being considered for the construction and operation of the Project (see Section 2.3.2). These isolated artifacts do not constitute an archaeological site or consideration for listing on the NRHP.

Since the completion of the terrestrial archaeological survey in October 2013, Dominion has made minor modifications to portions of the Project layout. Layout modifications include:

- Shifting the Switch Cabinet and SCADA System at the Export Cable landfall to the west side of the Camp Pendleton Beach parking lot;
- Moving the Onshore Interconnection Cable and Fiber Optic Cable route to the east side of the Gate 10 Access Road;
- Expanding the area for the Interconnection Station located at the southern extent of the Gate 10 Access road east into upland terrain adjacent to the road shoulder;
- Eliminating alternative landfall locations for the offshore Export Cable other than the preferred alternative at Camp Pendleton Beach; and
- Eliminating alternative routes for the Onshore Interconnection Cable and Fiber Optic Cable other than the preferred route.

Dominion has consulted with the VDHR to determine if additional testing should be performed at revised Project facility locations. In a letter dated September 11, 2014 (see Appendix A), VDHR concurred that no further study is warranted for the terrestrial portion of the project unless changes are made to the impact area.

4.9.2.2 Potential Impact Producing Factors, Proposed Cultural Resource Protection Measures, and BMPs

The potential impact producing factor for terrestrial pre-historic and historic cultural resources would involve direct physical disturbance from construction activities for the onshore Project components. The potential to disturb cultural resources is considered extremely low given the location of these facilities in disturbed areas, the use of HDD for installation of the Onshore Interconnection Cable and Fiber Optic Cable, and the negative results of the terrestrial archaeological survey within the areas under consideration for the VOWTAP onshore facilities.

Nevertheless, during the construction of the onshore facilities, there is the potential for construction crews to encounter unanticipated archaeological discoveries. To ensure the proper handling of any unanticipated cultural resources, an Unanticipated Discovery Plan including archeological resource identification training will be developed in consultation with jurisdictional federal and state agencies and will be implemented prior to construction.

4.9.3 Historic Properties

Historic properties are defined as districts, buildings, structures, objects, or sites that are 50-years old or older and are listed or determined eligible for inclusion in the NRHP. Dominion conducted an aboveground historic properties survey to identify previously recorded and designated aboveground historic properties near the Project Area, and to identify any additional properties that may be eligible for listing in the NRHP (Appendix P).

The aboveground historic properties survey was coordinated with the visual impact assessment for the Project (see Section 4.10 and Appendix P for further discussion of visual resources). The viewshed analysis informed the selection of the historic properties recommended for evaluation, and the identified historic properties were subsequently included as a type of visually sensitive receptor in the Visual Impact Assessment (Appendix Q).

All work was performed under a Historic Properties Survey Plan developed in consultation with the VDHR, The Survey Plan was approved by the VDHR on October 10, 2013.

The following is a summary of the historic property survey results. The complete survey report is presented in Appendix P.

4.9.3.1 Affected Environment

The historic properties inventory considered aboveground historic resources potentially affected by the construction and operation of the proposed Project. BOEM does not have existing guidelines for conducting historic properties inventories. Therefore, the historic properties inventory method used for this project was based on standard practices within the discipline and consultation with the VDHR. Based upon these consultations, the APE for the Project was defined as a three part area.

- Area 1 (Offshore APE): For assessing visual impacts of the WTGs to historic properties, an APE was established consisting of a 25-mi (40-km) buffer from the WTGs. This area was chosen based on the BOEM study *Preliminary Assessment of Offshore Wind Turbine Visibility and Visual Impact Threshold Distances* (Sullivan et al. n.d.).
- Area 2 (Onshore APE): For assessing visual impacts of the Switch Cabinet and Interconnection Station, an APE was established consisting of a 0.5-mi (0.8-km) radius around these facilities (Figure 4.9-1). This buffer was determined based upon the scale of the onshore components and the wooded vegetative cover of the surrounding landscape.
- Area 3 (Shoreline APE): For assessing the effect of the Project on previously documented properties on the list of National Historic Landmarks (NHL) or in the NRHP that due to their proximity to the shore would be most likely to be affected by the Project (Figure 4.9-2), a shoreline APE was established which included the following NRHP-listed properties: Cape Henry Lighthouse (NHL), Cape Henry Light Station (NRHP), deWitt Cottage (NRHP), and the Virginia Beach U.S. Coast Guard Station (NRHP). The standard for inclusion of these shoreline properties was taken from the BOEM study, *Evaluation of Visual Impact on Cultural Resources/Historic Properties: North Atlantic, Mid-Atlantic, South Atlantic, and Florida Straits* (Klein et al. 2012).

The offshore portion of the Project and the attendant APE are located entirely within the Atlantic Ocean. There is only one historic property within the offshore APE, the Chesapeake Light.

The two onshore APEs are in more heavily developed areas, within or adjacent to the NRHP-listed Camp Pendleton (NRHP 2005). The APE encompasses Camp Pendleton, the Croatan Beach development to the north, and the Lincoln Military Housing Wadsworth Shores Development and Dam Neck Naval Base to the south. Camp Pendleton is a mix of woodlands, open space, and a gridded streetscape with uniform housing, both single and multiple unit buildings. The vegetation on this facility limits visibility to portions of Rifle Range Road, Regulus Road, Lake Road and Camp Pendelton's Gate 10 Access Road to the south

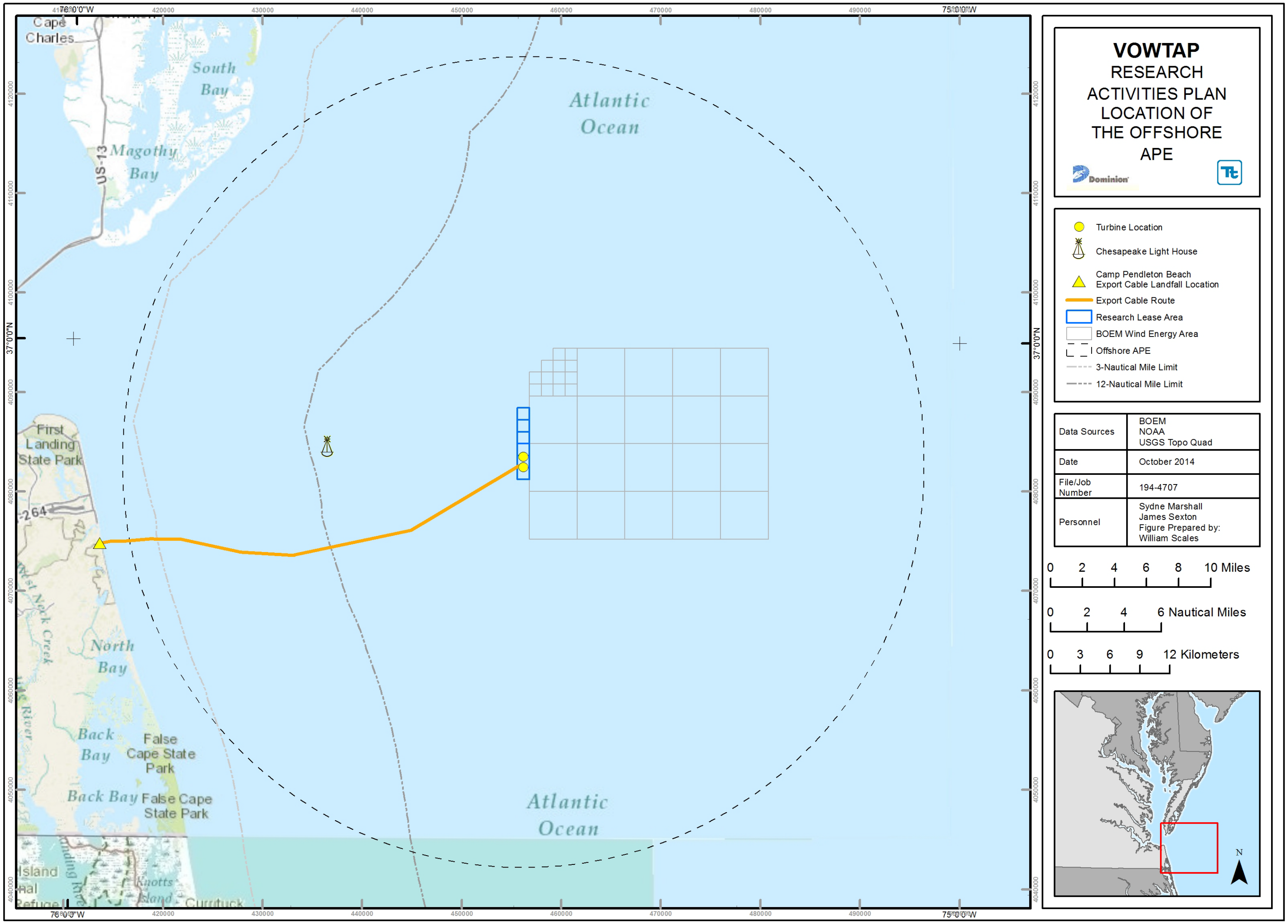


Figure 4.9-1. Offshore APE

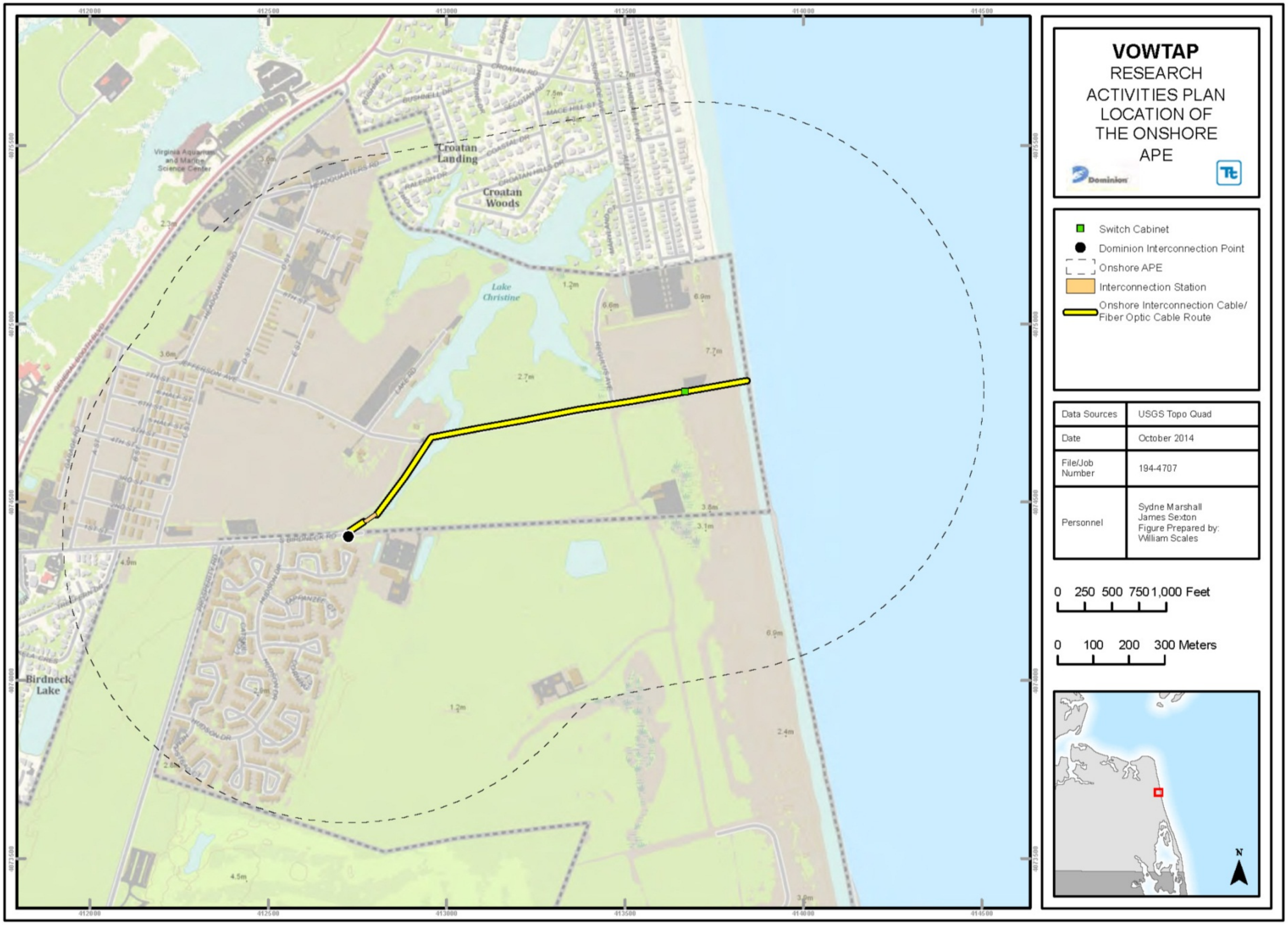


Figure 4.9-2. Onshore APE

of Rifle Range Road. Croatan Beach is a densely settled seaside settlement with a gridded street plan, most of which was developed after 1965 (USGS 1965). Wadsworth Shores is a development of garden apartments on a naturalistic street plan, also developed after 1965. Dam Neck Naval Base was inaccessible for security reasons; however, aerial photos show that it is, for the most part, undeveloped with only one group of buildings within 0.5 mi (0.8 km) of the Project; these buildings were not shown on the 1965 USGS map of the area (USGS 1965) and are, therefore, not old enough to qualify as historic properties.

The NRHP-listed properties along the shoreline are in a mix of settings: The Cape Henry light houses are located to the east of First Landing State Park close to the Atlantic shore in the U.S. Army's Fort Story. They sit in the cleared, developed portion of the base with undeveloped woodlands to the west. DeWitt Cottage and the USCG Station are located in Virginia Beach in a heavily settled area surrounded by high-rise hotels and low-rise businesses catering to tourists.

4.9.3.2 Potential Impact Producing Factors, Proposed Cultural Resource Protection Measures, and BMPs

Potential impacts to historic properties may be either direct or indirect. Direct impacts are those that physically change a historic property, and. indirect impacts are those that affect the setting of a property, including visual impacts to historic properties. Other potential indirect impacts, such as those caused by sound or shadow flicker from the WTGs, will take place offshore, at a great distance from any of the historic properties, and are not anticipated to be impact producing factors for this Project.

Historic Properties within the Offshore APE

There is one historic property in the offshore APE, the Chesapeake Light. Based on communication with the VDHR, the facility is being treated as potentially eligible under NRHP eligibility Criterion C as the last Texas Tower-style light still in active use (see Appendix A). Texas Tower lights built upon advancements in technology from offshore oil-drilling platforms to create an alternative to lightships as an aid to navigation (NRHP 2002). Seven Texas Tower lights were constructed in the 1960s. However, Chesapeake Light is the only Texas Tower still in use as an aid to navigation..

Assessment of the effect of the Project on Chesapeake Light suggests that the aspects of the Chesapeake Light which led to it being recommended as potentially eligible to the NRHP (i.e., its role as the sole functioning example of a Texas Tower light) will not be affected by the introduction of the Project into its viewshed. Of the National Park Service's seven aspects of integrity—location, design, setting, materials, workmanship, feeling, and association—only one, setting, is likely to be affected by the construction of the Project. Because the Chesapeake Light is eligible under Criterion C—the property embodies distinctive characteristics of a type, period, or method of construction—the setting is not a character defining feature/aspect of integrity related to why the property is National Register eligible. Therefore, any change to the setting including the viewshed would have no impact on the National Register eligibility of the Chesapeake Light Tower.

Historic Properties within the Onshore APE

There is one historic property within the onshore APE for the Project: the Camp Pendleton Historic District (NRHP 2005). Camp Pendleton is listed in the NRHP under Criteria A and C for its association with the military training and build-up associated with both world wars, and for its collection of exemplary military architecture.

The onshore Project elements will also not adversely affect the resources within the Camp Pendleton NRHP Historic District. The height of the Project elements and the screening provided by the thick vegetation in the area will likely limit its visibility. Additional screening will be established in conformance with Virginia Beach zoning requirements for utility facilities. In addition, the small size of the onshore Project elements will limit their effect on the 328-acre (133-ha) Camp Pendleton Historic District and the 114 elements that contribute to the Historic District.

Historic Properties within the Shoreline APE

As discussed above, there are four previously documented NHL or NRHP properties that due to their proximity to the shore, have the potential to be affected by the Project. Impact to these coastline historic properties from the Project will be minimal. Because the WTGs will be located at approximately 24 nm (27 statute miles, 43 km) from these properties, they will not alter the characteristics that led to the listing of any of the four NRHP-listed properties examined.

- **Cape Henry Lighthouse** – The Cape Henry Lighthouse is an NHL, because it was “the first structure authorized and completed by the newly organized Federal Government in 1789” and because it symbolized the “advantages of a strong national authority” (NHL, 1964) The addition of the Project at a distance of 27 mi (24 nm, 43 km) will not adversely affect these characteristics.
- **Cape Henry Light Station** – The Cape Henry (Second Tower) Light Station is listed in the NRHP as part of the Light Stations of the United States MPS under NRHP Criteria A and C, for its locally significant roles in maritime history, transportation, and architecture. The addition of the Project at a distance of 27 mi (24 nm, 43 km) will not adversely affect these characteristics.
- **DeWitt Cottage** – De Witt Cottage is listed in the NRHP as a locally significant resource under NRHP Criteria A and C for its role in the development of Virginia Beach and as an example of Victorian/Queen Anne beach architecture. The building is currently surrounded by modern high-rise hotels and beach front development; the addition of the Project at a distance of 27 mi (24 nm, 43 km) will not affect the characteristics that qualified it for listing in the NRHP.
- **U.S. Coast Guard Station –** The Virginia Beach Coast Guard Station is listed in the NRHP as a resource with state-wide significance under NRHP Criteria A and C for its role in the maritime history of the area and for its design. The building is currently surrounded by modern high-rise hotels and beach front development; the addition of the Project at a distance of 27 mi (24 nm, 43 km) will not affect the characteristics that qualified it for listing in the NRHP.

4.10 Visual Resources

This section addresses visual resources in the vicinity of the Project Area and the potential impact producing factors on these resources from the construction and operation of the Project. The following sections provide a description of the visual resource inventory methods, affected environment, assessment results, and proposed mitigation measures for the Project.

4.10.1 Affected Environment

The visual resource inventory considered visual resources that could be potentially affected by the construction and operation of the Project. BOEM does not have existing guidelines for conducting visual resource inventories; therefore, a standard inventory and assessment approach that applied certain elements of the U.S. Bureau of Land Managements (BLM) Visual Resource Management System was used for the Project. The BLM Visual Resource Management System is widely used for a variety of projects, and with some modifications, has been applied successfully to projects that do not occur on lands under the jurisdiction of BLM. A more detailed description of the methods used for the visual resource inventory is included in Appendix Q.

A 25-mi (40.2 km) Project Study Area was established for the visual assessment, consistent with the approach used for Project cultural resource studies. The Study Area is based on the offshore components of the Project and the results of a recent study prepared for BOEM (Sullivan et al. n.d.). This study found that small to moderately sized wind facilities (wind farms with turbine hub/nacelle heights ranging from approximately 219 ft to 295 ft (66.8 m to 90 m) above MSL) "were noticeable to casual observers at distances of almost 18 mi (29 km); and were visible with extended or concentrated viewing at distances beyond 25 mi (40 km)" (Sullivan et.al. n.d.). WTGs for the proposed Project will be 338 ft (103 m) from MSL to the nacelle, or approximately 43 ft (13 m) higher than the turbines observed in the BOEM study. Although the WTGs may be partially visible under some conditions at locations beyond the identified Project Study Area, it is not anticipated that the WTGs would be noticeable to the casual observer. Section 4.10.2 provides additional information regarding WTG characteristics and their visibility at long distances.

Additionally, a 0.5 mi (0.8 km) Project Study Area was used for assessing the visibility and visual contrast of the two aboveground onshore facilities; the Switch Cabinet and Interconnection Station. The 0.5-mi (0.8-km) buffer was determined based upon the scale of the onshore components and the wooded vegetation coverage of most of the surrounding landscape.

Both Project Study Areas established for the onshore and offshore Project sites were discussed with BOEM and the VDHR prior to the commencement of conducting the visual inventory and assessment. VDHR issued formal approval on October 10, 2013 (see Appendix A).

4.10.1.1 Landscape Setting/Existing Conditions

The offshore Project Study Area is located entirely within the Atlantic Ocean. The onshore Project Study Area is located within the Atlantic Coastal Plain Physiographic Region. The Coastal Plain Province is comprised of the coastal plain, which is relatively level terrain exposed above sea level, and the continental shelf, which is submerged below sea level offshore to the end of the North American continent (approximately 50 mi to 75 mi [80.5 km to 120.7 km] offshore) (VDCR 2013a).

The topographic character within the onshore Project Study Area and along the eastern coastline of Virginia Beach can be described as relatively flat, with low terraces, dunes and beaches along the coast. There are many streams and rivers that traverse the area and form estuaries where they discharge into the Atlantic Ocean. There are also swamps, coastal marshes and a few inland lakes within the Project Area (Wiken et. al. 2011). The vegetation within the Project Study Area includes loblolly and shortleaf pine, oak, sweetgum, and cypress near major streams. Cordgrass, saltgrass, and rushes are found in coastal marshes, and beach grass and sea oats are found along coastal dunes (Wiken et al. 2011).

Cultural modifications that have locally altered the Project visual setting include urban development associated with Virginia Beach, including hotels, restaurants, and shops along the Virginia Beach shoreline, and military development within Camp Pendleton. Local infrastructure modifications that are present in both jurisdictions include roadways and electric distribution lines.

Sensitive Viewers and Key Observation Points

The term "sensitive viewers" refers to specific user groups associated with various land uses that have a sensitivity to landscape change and, therefore, could be adversely affected by the construction and operation of the proposed Project. In this regard, viewing locations are typically associated with key travel routes, recreation areas, and residential areas. Key Observation Points (KOPs) represent critical or typical viewpoints within or along an identified viewing location and are used to assess potential visual impacts of a proposed Project.

The inventory considered:

1. The most critical viewpoints, generally views from communities, residential areas, or recreational areas;
2. Views from specific scenic areas specifically identified in county and local planning documents; and
3. Views that best represent the general area or landscape setting.

The following includes descriptions of the sensitive viewers and KOPs identified during the inventory process.

Key Travel Routes

Scenic/Historic Routes

The CBBT/U.S.13 is a four-lane, 20-mi (32-km) long bridge and tunnel crossing the Chesapeake Bay. This travel route is considered to have high sensitivity based on the formal scenic designation by the Commonwealth of Virginia (Chesapeake Bay Bridge and Tunnel Commission, 2013). The CBBT carries U.S. 13, which is the main north-south highway along Virginia's eastern shore. The CBBT and U.S. 13 south of the bridge are designated as a scenic road; U.S. 13 north of the CBBT is designated as a state scenic byway.

Local Travel Routes

Local travel routes throughout the onshore Project Study Area provide access to the beach, residential areas, and commercial areas along the shoreline. Examples include Atlantic Avenue, General Booth Boulevard, and Birdneck Road. For local routes, the majority of viewers travel at a slower rate of speed, and concern for aesthetics is secondary to commuting; therefore, these viewers are considered to have moderate sensitivity. Travelers along these routes typically have enclosed views where sight is limited to short distances, as the landscape is surrounded by residential and commercial development and vegetation.

Recreation Areas

In general, parks and other public recreation areas are destinations for visitors, and thus viewers, who are considered to have a high sensitivity for aesthetics.

First Landing State Park

First Landing State Park is the site of the first landing of the Jamestown colonists in 1607 (VDCR n.d). The park is considered to have high sensitivity based on recreational use and its designation as a National

Natural Landmark and Natural Historic Landmark (VDCR n.d). Today the park is used for hiking, camping, boating, fishing, picnicking, and for educational purposes.

Cape Henry Lighthouse

The Cape Henry Lighthouse is located on the south side of the Chesapeake Bay on the Fort Story military base. The lighthouse was built in 1792 and is maintained by Preservation Virginia (Virginia Tourism Corporation). The lighthouse is considered a high sensitivity viewing location based on its recreational use and national historic designation. Today, visitors can climb to the top of the lighthouse and view Chesapeake Bay and the Atlantic Ocean.

Virginia Beach

Virginia Beach, as defined for the inventory, is the approximately 3-mi (4.8-km) long Atlantic beachfront between Cape Henry/Fort Story and Rudee Inlet. The area is considered to have high sensitivity because it is a popular destination for local residents and tourists.

Croatan Beach

Croatan Beach, located in the City of Virginia Beach and south of Rudee Inlet, was inventoried as high sensitivity because it is a popular destination for local residents and tourists.

Camp Pendleton Beach

Camp Pendleton Beach, located at the end of Rifle Range Road on the Camp Pendleton facility, is located just south of Croatan Beach but it is not accessible to the general public. The beach was inventoried as high sensitivity because it is a popular recreational area for residents and visitors to the Camp Pendleton facility.

Lake Christine

Lake Christine is located approximately 0.25 mi (0.4 km) west of Croatan Beach, and partially within Camp Pendleton. The lake offers recreational opportunities to military personnel and their families, and to residents located along the lake’s northern edge. In addition, there are camp grounds along the eastern side of the lake that are used by the Boy Scouts for overnight trips. This area was inventoried as high sensitivity due to the residential area along the northern edge of the lake.

Residential Areas

Residents are considered to have high sensitivity because of their long viewing duration and presumed strong concern for aesthetics. Residential development in the onshore Project Study Area and along the eastern coastline is primarily associated with Virginia Beach and Camp Pendleton.

4.10.2 Potential Impact Producing Factors and Proposed Mitigation

The purpose of the visual impact assessment is to identify and characterize the level of visual change to the landscape from the construction and operation of the Project, and the expected response of sensitive viewers to those changes. Modification of the landscape is described in levels of visual contrast, which affects scenic quality and is perceived by sensitive viewers.

The level of visual contrast introduced by an action is measured by changes in form, line, color, and texture. Visual contrast is used as the baseline of change that would affect sensitive viewers. The level of contrast is based upon the level of modification to existing landscape features. In the context of the Project, existing landscape scenery is defined by the visual characteristics (form, line, color, and texture) associated with the landform (including water), vegetation, and existing facilities within and adjacent to the Project. Visual contrast was assessed considering (1) landscape contrast – landform modifications that are necessary to prepare the project for access and/or construction, and the removal of vegetation to construct and maintain the facilities; and (2) structure contrast – the introduction of new, aboveground facilities into the landscape. Visual contrast was rated from KOP locations using visual contrast rating worksheets.

The expected response of sensitive viewers was assessed based upon (1) level of visual contrast (i.e., form, line, color, and texture), (2) distance from the Project, (3) viewing condition (i.e. level, inferior or superior), (4) visibility (screened, backdropped, or skylined), and (5) viewer sensitivity (high or moderate).

See Appendix Q for further description of visual assessment methods.

4.10.2.1 Project Visibility and Contrast

Project Construction

During the construction period for offshore Project components, viewers onshore will be able to observe marine traffic associated with the Project. Based on the small volume of Project-related vessel traffic relative to baseline marine traffic and the short duration of the construction period, it is not likely that viewers will perceive a change.

During the construction period for onshore Project components, viewers will be able to observe construction equipment, laydown areas and crews. Varying degrees of visual contrast will occur when equipment and construction crews are present; however, contrast will be short-term since equipment and support facilities will be removed once construction is complete. In addition, Dominion will incorporate the following mitigation measures into the Project design to minimize potential visual impacts for the onshore Project Area:

- Implementation of a Fugitive Dust Control Plan to minimize dust during onshore construction activities; and
- Maintenance of onshore construction areas to remove trash and debris.

Key Viewing Locations Related to Project Operation

Following are the characterizations of potential changes to scenic quality during operation of the Project and how they would be perceived by sensitive viewers.

Potential viewers located along the Virginia Beach coastline (which is outside of the 25-mi (40.2 km) Project Study Area) would have limited visibility of the WTGs. Due to the curvature of the earth's surface, objects viewed on the horizon are not seen in their entirety, because they begin to fall below the visible horizon; as the distance from the viewing location to the object continues to increase, less of the object will be visible. The impact the earth's curvature has on views of objects on the horizon are lessened by the refraction of light in the earth's atmosphere, which at long distances, curves our line of sight downwards (see Appendix Q, Figure 5).

For sensitive viewers in Virginia Beach, Croatan Beach, and Camp Pendleton Beach, at a distance of 27 mi (24.5 km) from the WTGs, 177 ft (54 m) of the 584-ft (178-m) WTGs would be above the visible horizon (or 30 percent of the total height of the WTGs). In the photographic simulation from the picnic area at Camp

Pendleton Beach (see Appendix Q, Exhibit C, Simulation 1), the simulation was created so that it is true to scale when viewed at a distance of 18 in (45.7 cm). Under those conditions, the theoretically visible portion of the turbine would amount to 0.02 in (0.05 cm) when measured on the simulation graphic. Based on only this small proportion of the turbine being visible, the WTGs are not evident in the simulation and would not be noticeable to the casual observer.

For viewers at the CBBT, at a distance of 35 mi (56.3 km) from the offshore Project Area, the WTGs would be completely below the horizon line and would not be visible. Sensitive viewers located away from the coast, including residents, recreational users at First Landing State Park, and along local travel routes would not have views of the offshore Project Area, because they would be completely screened by urban development and vegetation (see Appendix Q, Exhibit A, Photograph 12).

Viewers with a superior viewing position, such as recreational visitors at Cape Henry Lighthouse, would have unobstructed views toward the offshore Project Area. At a distance of 29 mi (46.7 km) from the WTGs, 501 ft (152.7 m) of the WTGs (86 percent of the total height) would be above the visible horizon creating a weak contrast:. In the photographic simulation from Cape Henry Lighthouse (see Appendix Q, Exhibit C, Simulation 2), the simulation was created so that it is true to scale when viewed at a distance of 18 in (45.7 cm). Under those conditions, the theoretically visible portion of the turbine would amount to 0.06 in (0.15 cm) when measured on the simulation graphic. The resulting size of the WTG visible in the simulation is due to the superior viewing location at the top of the lighthouse (approximately 134 ft [40.8 m]) above MSL. The visible portions of the WTG blades would be seen in the context of existing vessels within the bay and along the coast. The WTGs may be apparent to some viewers; however, they would not be prominent elements in the characteristic landscape. Superior viewing locations are not common along the Virginia Beach coastline.

The distance of the offshore components from the shore (27 mi [43.5 km] or greater) has mitigated many of the potential effects of the proposed Project. As noted above, visible portions of the turbines would not be noticeable to the casual observer; therefore further mitigation measures have not been deemed necessary.

Key Travel Routes

Local Routes

Views along local routes toward the proposed onshore Project Area would typically be completely screened by existing topography, vegetation, or commercial and residential development. However, travelers along South Birdneck Road would be able to view the onshore Interconnection Station at approximately 0.1 mi (0.2 km) or less. This facility would be seen in the context of the existing utility cabinet located on the southern side of South Birdneck Road, that are similar in form, line, and texture. The structures within the Interconnection Station will be similar in color to the existing utility cabinet on South Birdneck Road, which will help to reduce visual contrast by blending the structures into the surrounding environment. In addition, the proposed 8-ft-high (2.4-m) chain link fence around the facility would be similar to the fence along the northern side of South Birdneck Road. The facility will also be partially screened by existing vegetation just south of the facility along South Birdneck Road. Views will be further screened by planting vegetation, as needed, around the southern side of the Interconnection Station. At distances greater than 0.1 mi (0.21 km), the facility would be completely screened by vegetation along the northern side of South Birdneck Road.

Recreation Areas

Camp Pendleton Beach

Weak contrast would be created by onshore Project components located in the southwest corner of the parking lot south of the Camp Pendleton Rifle Range. Views from the Camp Pendleton Beach picnic area, located in between the gravel parking lot and the beach, would have views ranging from unobstructed to views completely screened by dunes along the coast. Portions of the onshore Switch Cabinet that would be visible would be seen in the context of existing cultural modifications, such as portable toilets and waste receptacles that are similar in form, line, and texture. The Switch Cabinet will be a neutral color that will help to reduce visual contrast by blending the structure into the surrounding environment (see Appendix Q, Simulation 3). Views from the beach toward the Switch Cabinet would be completely screened by the dunes along the coastline.

Lake Christine

Viewers at Lake Christine are not expected to have views of onshore Project facilities, because the Onshore Interconnection Cable and Fiber Optic Cable will be buried. The cables will also be completely screened by existing vegetation along the shore of the lake, as will The Switch Cabinet and Interconnection Station (see Appendix Q, Exhibit C, Contrast Rating Worksheet 1).

Residences

Weak contrast would be created by onshore Project components located along South Birdneck Road, south of Camp Pendleton. The onshore Project Area is located in the immediate foreground for high sensitivity residential viewers, where views of the Interconnection Station would be partially to completely screened by existing vegetation along the northern side of South Birdneck Road. Portions of the Interconnection Station that are visible would be seen in the context of the existing utility cabinet (located on the southern side of South Birdneck Road) that are similar in form, line, color, and texture. In addition, the proposed 8-ft (2.4 m) high chain link fence around the facility would be similar to the fence along the northern side of South Birdneck Road (see Appendix Q, Exhibit B, Simulation 4, and Exhibit C Contrast Rate Worksheet 2). The structures within the Interconnection Station with similar colors as the existing utility cabinet will help to reduce visual contrast by blending the structures into the surrounding environment. In addition, views will be further screened by planting vegetation, as needed, around the southern side of the Interconnection Station.

Views from residents within Camp Pendleton towards the proposed onshore Project Area would typically be partially to completely screened by existing vegetation along the driveway leading into Camp Pendleton from South Birdneck Road. Weak contrast would be created by the portions of the Interconnection Station that would be visible. This facility would be seen in the context of existing cultural modificaitons such as residential buildings, bleachers, and chain link fences. The facility would also be painted green similar to the surrounding vegetation; thus further reducing contrast.

Nighttime Lighting

Lighting will be located atop each turbine on the nacelle and on the foundation platform as discussed in Section 3.6. These lights will be situated below the horizon line and, therefore, will not be visible to viewers along the shoreline and will create no change to nighttime viewing conditions (see Appendix Q, Attachment B Simulation 4).

No proposed lighting is associated with the onshore Project components; therefore, these components will not be an additional source of nighttime lighting within the area.

4.11 Socioeconomic Resources

This section discusses the socioeconomic resources that could be affected by construction, operation, and decommissioning of the Project, including population, employment and other aspects of the economy, such as housing, public services, commercial shipping and fishing, recreational fishing and boating, and other recreation and tourism. This section also addresses federal policy regarding environmental justice. Socioeconomic data was obtained from publicly available resources, including U.S. Census Bureau programs such as the 2010 decennial Census of the United States population and the American Community Survey, which is an ongoing survey that annually provides inferred data from a sample population.

4.11.1 Affected Environment

4.11.1.1 Population, Economy, and Employment

Virginia Beach is the largest city in Virginia, and makes up 5.5 percent of the state's overall population and 5.5 percent of the overall civilian labor force. Virginia Beach is also home to 15.1 percent of the overall population in the armed forces in Virginia. The percentage of the armed forces population is high, since Virginia Beach is home to four major military installations. The major categories of employment include educational services; health care and social assistance; professional, scientific, management, administrative and waste management services; and retail trade (U.S. Census Bureau 2013). Table 4.11-1 provides a summary of population, income, labor force, and related statistics for Virginia and Virginia Beach.

Both Virginia and Virginia Beach experienced population growth from 2000 to 2010. At the time of the 2000 Census, the population of Virginia was 7,078,515 and the population of Virginia Beach was 425,257. Comparing those figures to the corresponding data for 2010, Virginia experienced a 13 percent population increase and Virginia Beach experienced a 3 percent population increase from 2000 to 2010 (U.S. Census Bureau 2013).

Table 4.11-1. Existing Economic Conditions in the Vicinity of the VOWTAP

Locality	2010 Population	Population Density (people per square mile) [a/]	2010 Per Capita Income	2010 Civilian Labor Force	2010 Armed Forces	2010 Unemployment Rate (% of Civilian Labor Force)	Top 3 Industries [b/]
Virginia	8,001,024	202	$32,145	4,141,905	114,601	7.9%	E, P, R
Virginia Beach	437,994	1,764	$30,873	228,554	17,337	6.6%	E, P, R

Source: U.S. Census Bureau 2013

[a/] Calculated based on land area obtained from internet sources

[b/] E = Educational services, and health care and social assistance; P = Professional, scientific, management, administrative and waste management services; R = Retail trade

4.11.1.2 Housing and Property Values

Virginia Beach offers many temporary accommodation options, including five bed and breakfasts, eight campgrounds, and nearly 100 hotels and motels (Virginia Beach Convention and Visitors Bureau 2013).

Of the 12,790 vacant housing units in Virginia Beach in 2010, 4,593 (35.9 percent) of the units were for rent and 3,555 (27.8 percent) were for seasonal, recreational, or occasional use (U.S. Census Bureau 2013). Virginia Beach is a popular summer tourism destination and beach rentals are the largest category of available rentals in the city.

The median home value of owner-occupied units in Virginia Beach in 2013 was 10.4 percent greater than the median home value in Virginia as a whole (U.S. Census Bureau 2013). Table 4.11-2 provides a summary of housing statistics in Virginia Beach.

Table 4.11-2. VOWTAP Project Area Housing Statistics

Locality	Total Housing Units	2010 Housing Vacancy Rate (%)	Number of Vacant Units	Median Value of Owner-Occupied Units (Dollars)
Virginia	3,364,939	9.1	308,881	$249,100
Virginia Beach	165,089	7.7	12,790	$275,100
Source: U.S. Census Bureau 2013				

4.11.1.3 Public Services

A wide range of public services and facilities are available in Virginia Beach, including hospitals and emergency medical services, law enforcement, paid and volunteer fire departments, and schools. Table 4.11-3 provides a summary of the public services in the city.

Table 4.11-3. Public Services in Virginia Beach

Locality	Hospitals [a/]	Emergency Medical Services Personnel [b/]	Fire Department Personnel [c/]	Law Enforcement Personnel [d/]	Schools [e/]
Virginia Beach	1 acute care hospital with 276 beds	Over 900 EMS volunteers, 50 paid paramedics and supervisors	413 paid firefighters, 64 volunteer firefighters	806 sworn police officers	85 Public Schools, 5 special purpose schools

[a/] Source: Sentara 2013
[b/] Source: Virginia Beach Rescue Squad Foundation 2012
[c/] Source: Fire Departments Network 2011
[d/] Source: VBPD 2012
[e/] Source: VBC Public Schools 2013

Hospitals and Emergency Medical Services

The Sentara Virginia Beach General Hospital is a 276-bed acute care facility that contains a heart center; a stroke center; a 24-hour, 7-day a week intensive care unit; and the region's only Level III Trauma Center (Sentara 2013).

Emergency medical services (EMS) in Virginia Beach are coordinated by the City of Virginia Beach EMS Department, which oversees ten volunteer squads that operate 11 stations with over 900 volunteers, 50 paid paramedics and supervisors, 33 ambulances, three squad trucks, six boats, support and command vehicles, and a dive truck and locating equipment. The ten squads within the Virginia Beach EMS system respond to almost 39,000 calls per year (Virginia Beach Rescue Squad Foundation 2012).

Fire Protection

The City of Virginia Beach runs the City of Virginia Beach Fire Department, which has 19 fire stations, 413 paid firefighters, 64 volunteer firefighters, and 26 non-firefighting employees. The Ocean Park

Volunteer Fire and Rescue Unit has one fire station and is run by 25 volunteer firefighters and ten non-firefighting volunteers (Fire Departments Network 2011).

Law Enforcement

The Virginia Beach Police Department has four precincts with a total of 806 sworn police officers, 133 non-sworn personnel, and 44 animal control officers. The Police Department was dispatched to a total of 12,557 crimes in 2012. Overall, the number of crime reports decreased by 3.3 percent from 2011 to 2012 and the crime rate has been steadily decreasing since 1990 (VBPD 2012).

Schools

Virginia Beach has 85 public schools, including 56 elementary schools, 14 middle schools, 11 high schools, and one charter school. In addition, there are five special purpose schools for adults and technical careers. There are 68,408 students enrolled in the public schools from kindergarten to 12th grade and 15,183 total employees, including 5,306 teachers (VBC Public Schools 2013).

4.11.1.4 Recreation and Tourism

Recreation and tourism is an important component of the local and regional economy. The Virginia Tourism Authority commissioned an economic impact assessment on the impact of traveler spending by U.S. residents while visiting Virginia. The study found that the travel industry is the fifth largest private employer in Virginia, with domestic travel expenditures amounting to $21.2 billion in 2012 and supporting 210,000 jobs in Virginia as a whole. Virginia Beach had the fourth greatest domestic travel impact among the counties and independent cities of Virginia (Virginia Tourism Authority 2013). Table 4.11-4 shows expenditures, payroll, and state and local tax receipts resulting from tourism in Virginia Beach.

Table 4.11-4. Economic Impact of Domestic Travel on Virginia Beach in 2011 and 2012

Year	Expenditures ($ Millions)	Payroll ($ Millions)	Employment (Thousands)	State Tax Receipts ($ Millions)	Local Tax Receipts ($ Millions)
2012	1,284.5	226.2	12.0	53.3	48.8
2011	1,222.9	217.4	11.8	51.0	47.0
Source: Virginia Tourism Authority 2013					

In addition, the National Ocean Economics Program, which "provides a full range of the most current policy-relevant economic and demographic information available on changes and trends along the United States coast, Great Lakes, and coastal waters," identified 1,019 establishments related to the ocean economy in the tourism and recreation sector in Virginia Beach in 2010. These establishments employed 19,770 people, provided over $308 million in wages, and resulted in a Gross Domestic Product (GDP) of nearly $636 million (NOEP 2013).

Onshore Recreation

The City of Virginia Beach provides a wide variety of recreation resources distributed among the 307 square mi (795 square km) of area included within the City. The City of Virginia Beach (2009) Comprehensive Plan identifies a total of 39 major recreation sites within the City, including two signature parks, five metro parks, 12 community parks, six athletic complexes, five golf courses, six recreation centers, and three natural resource areas. The City owns more than 6,050 ac (2,448 hectares) of open space, parkland property and public beaches that are available for public recreational use (City of Virginia Beach 2008). Counting resources provided by public schools, the City's recreation resources include 255 playgrounds, 131 ballfields and 66 multi-purpose fields, 236 basketball courts, 161 tennis courts, two dog parks, two skate parks, 19 water access sites, and four major beach-use facilities.

Resources identified as major city recreation sites and located within 5 mi (8 km) of the Project Area include the following (City of Virginia Beach 2009):

- Red Wing Metro Park;
- Beach Garden Community Park;
- Dunwoody Community Park;
- Ocean Lakes Community Park;
- Lynnhaven Community Park;
- Three Oak Community Park;
- Seatack Recreation Center;
- Princess Anne Recreation Center;
- Red Wing Lake Golf Course;
- Owl Creek Tennis Center; and
- Seashore to Cypress Loop (a wildlife and biking trail on General Booth Boulevard).

The onshore Project facilities, including the Switch Cabinet, Onshore Interconnection Cable, Fiber Optic Cable, and Interconnection Station, are located adjacent to the Oceanfront Planning Area, as defined in the Virginia Beach Comprehensive Plan and Outdoors Plan. Camp Pendleton and other military lands are not within any of the planning areas defined by the City. The Oceanfront Planning Area is bounded by 42nd Street, the Atlantic Ocean, Rudee Inlet, and South Birdneck Road. Public beach area extends along the entire Atlantic Ocean front within the planning area. A 3-mi (4.8-km) boardwalk and separate bike path located along the beachfront provide numerous recreational opportunities in the Project vicinity. Rudee Inlet, near the southernmost point of the Oceanfront Planning Area, is located 1 mi (1.6 km) northwest of the proposed Export Cable landing location (City of Virginia Beach 2009). The section of the public beach between Rudee Inlet and Camp Pendleton is identified as Croatan Beach Park; the park is an 11-acre (4.5 hectare) property that is one of 182 neighborhood parks in the City's recreation sites inventory (City of Virginia Beach 2008).

The waterfront areas of Virginia Beach include 22 beaches that are popular destinations for residents and visitors alike (EPA 2012). Existing recreational uses along the 34.5 mi (55.5 km) of beaches in Virginia Beach include recreational power boating, sailing, fishing, swimming, sunbathing, hiking, camping, picnicking, and other water borne activities, including wildlife viewing tours, parasailing, and jet skiing. The City of Virginia Beach promotes the protection and long-term preservation of open space and development of recreation resources through adoption of the Virginia Beach Outdoors and the Virginia Beach Bike and Trails plans.

Recreational Boating and Fishing

Recreational boating is one of the most popular pastimes in Virginia, as well as a major tourist attraction that brings many visitors from out of state. In 2010, 245,940 boaters were registered in Virginia, of which 237,023 were traditional power boats, sailboats, or personal watercraft (USDOT Research and Innovative Technology Administration 2010). Recreational boaters spend nearly $1.3 billion annually on boating in

Virginia (Virginia Marine Trades Association 2013). Of this expenditure, over 40 percent of those dollars are estimated to be spent on trip-related activity such as fuel, lodging, and meals at local establishments. In addition, the recreational boating industry directly employs nearly 5,000 Virginians and contributes to another 4,000 boating-related jobs (Virginia Marine Trades Association 2013).

Recreational boating activities occur year round but peak during the spring and summer months (See Appendix R). Most recreational boating activities occur closer to shore in the vicinity of the local marinas and inlets that feed the lower Chesapeake Bay and Atlantic Ocean. However, recreational boating activities such as fishing (discussed further below) and offshore sailing events such as the Annapolis to Newport Race and the annual "Carib 500" do occur farther offshore in the vicinity of the Project Area.

The closest recreational vessel ports of note in Virginia to the VOWTAP are Rudee Inlet and Lynnhaven Inlet which area located over 25 nm (46.3 km) and 30 nm (55.6 km) from the proposed WTGs. At this distance from the Project Area recreational boating activity is anticipated to be low (see Appendix R). Recreational boating activity along the proposed Export Cable route is also expected to be low due to the cable's location within the military live fire and danger zones, which is generally avoided by pleasure craft. To the east of the live fire and danger zones, the Export Cable also passes just south of the traffic separation scheme and the Southern Approach Navigation Channel into and out of Chesapeake Bay. This is an area is denoted on the NOAA navigational charts as an area where mariners are advised to exercise extreme care while navigating as many large vessels with limited maneuverability are often found transiting this area. Accordingly, this area is often avoided by recreational vessels (see Appendix R).

Marine recreational fishing, including recreational anglers, recreational fishing aboard private boats, and party/charter boats, is a major recreational activity for Virginia. The VDCR estimates that each year 26 percent of households, including 384,000 saltwater recreational fishermen and 721,000 freshwater recreational fishermen, fish in Virginia. Recreational fishermen spend an estimated $640,728,000 annually on fishing-related expenses, and account for a total economic output of $1,213,253,000; supporting 11,238 jobs with $278,441,000 in earnings (VDCR 2013b). The VMRC manages the regulations, licensing, reporting, and other programs related to saltwater recreational fishing in Virginia. Both residents and non-residents of Virginia must register with the VMRC for an annual saltwater fishing license. Most of the saltwater recreational fishing activities occur in coastal areas from fishing piers and other public access areas, or within 3.5 mi (3 nm) (5.6 km) of the Virginia coast aboard private boats and party and charter boats (VMRC 2013b).

Recreational fishing is also a major tourist attraction that brings many visitors from out of state and has a significant impact on the state's economy. The results of the NOAA Fisheries Marine Recreational Fisheries Statistics Survey Program indicate that during the period 2000 through 2013, an average of nearly 684,000 people participated in recreational ocean fishing in Virginia each year (NOAA Fisheries 2013). Of the participants in recreational fishing from 2000 through 2013, an average of nearly 319,000 per year were from out of state.

There are three types of saltwater recreational fishing activities common in Virginia: shore-based fishing, fishing by private vessels, and fishing by charter vessels. Recreational fishing vessels operate out of numerous Virginia ports, including Virginia Beach/Lynnhaven, Hampton, and Wachapreague.

Recreational fishing occurs year-round, but peak season occurs between March and November for many species. The most commonly targeted recreational species in the state include amberjack, Atlantic mackerel, black drum, blue marlin, bluefin tuna, bluefish, blueline tilefish, cobia, Atlantic croaker, dolphin, summer flounder, gray trout, king mackerel, kingfish, red drum, black sea bass, sheepshead, spadefish, Spanish mackerel, speckled trout, spot, striped bass, tarpon, tautog, wahoo, white marlin, and yellowfin tuna (VMRC 2013c). Approximately 29 individual saltwater fishing tournaments occur annually.

According to data presented in the BOEM Mid-Atlantic EA (2012), recreational fishing activities (party and charter boats) from 2004 through 2008 were low throughout the VOWTAP Area. Angling data from private fishing vessels is not available. Recreational boat anglers target bottom types that provide structure or areas of steep depth changes such as shoals, ridges, lumps, banks, ship wrecks, and reefs. Areas of uniform, flat sediment types (mud and silt) are not known to be productive fishing areas. The VOWTAP components are located in soft, uniform bottom types. Hard substrates, such as cobbles and boulders, do not occur in the Project Area.

4.11.1.5 Commercial Shipping and Fishing

The offshore portion of the VOWTAP Project Area is located approximately 24 nm (43 km) offshore from the Virginia coast. Commercial shipping and fishing activities in the waters surrounding the Project Area are economically important activities for the Mid-Atlantic region.

The Chesapeake Bay and the waters surrounding the Project Area serve as a vital conduit for maritime commerce in the Mid-Atlantic region. These waters are used by a large variety of commercial vessels including large passenger cruise vessels, dry cargo vessels (e.g., roll-on-roll-off cargo ships, container ships and dry bulk ships), and liquefied natural gas and liquid petroleum tankers.

The Ports of Virginia and Baltimore are the seventh and sixteenth busiest ports in the United States in terms of total cargo volume, respectively (AAPA 2011). The Port of Virginia is rank third among U.S. East Coast ports, handling over 2 million Twenty-foot Equivalent Units in 2012 (Virginia Port Authority 2013). Foreign trade ports in Virginia include Alexandria, Hopewell, Newport News, Norfolk, and Richmond-Petersburg. In 2012, the total value of all types of cargo imported into Virginia from foreign countries was $35.7 billion and the total value of all types of cargo exported from Virginia to foreign countries was $27.5 billion. Ports in the remainder of the Mid-Atlantic States including Delaware, Maryland, New Jersey, New York, Pennsylvania, and Washington, D.C., imported a total value of $227.3 billion of all types of cargo from foreign countries and exported a total value of $88 billion of all types of cargo to foreign countries in 2012 (NOEP 2013).

The Ports of Virginia and Baltimore are the only deepwater ports on the East Coast that can accommodate the supersized ships that will navigate the Panama Canal once its expansion is complete in 2015. The wider and deeper Panama Canal will provide a less expensive option for shipping companies to move goods from Asia to ports in the Gulf of Mexico and along the East Coast. These ships, referred to as post-Panamax ships, can carry over twice the amount of cargo as Panamax ships (J. Vickers 2013) and could contribute significantly to the state's economy in the future.

Commercial fishing for ground fish, pelagic, and invertebrate species is an economically important activity in the state and federal waters off the coast of Virginia. Virginia is home to three of the top ten fishing ports in the Mid-Atlantic (Table 4.11-5); however, many local ports support commercial fishing operations in some form. These fishing ports serve commercial fishermen and fishing vessels from Virginia and other states along the East Coast.

The predominant fishing port in Virginia by value, Hampton Roads, is situated in the middle of the Eastern seaboard where the James, Nansemond, and Elizabeth rivers enter the Chesapeake Bay. Hampton Roads is located in the USCG Fifth District which reports an estimated 9,400 commercial fishing vessels, (USCG 2013). In 2011, Hampton Roads ranked 51st in terms of pounds landed and 13th in terms of dollars landed out of all major ports in the U.S. (NOAA Fisheries 2013b, 2013c).

While Hampton Roads is the predominant port based on value, Reedville is considered the number one port in Virginia based on pounds landed, ranked 5th in 2012 out of all major ports in the U.S. (NOAA Fisheries 2013c) (see Table 4.11-5). In 2010, the aggregate catch for commercial fishers based in the Hampton Roads area ranked second among the fishing ports by value, and fifth by weight. The National Ocean Economics Programs (NOEP) ocean economy dataset includes data on the living resources sector of the ocean economy, including fishing, fish hatcheries, seafood markets, and seafood processing. In Virginia Beach in 2010, there were 15 establishments related to the living resources sector of the ocean economy. These establishments employed 71 people, provided nearly $1.1 million in wages, and resulted in a GDP of over $2.2 million (NOEP 2013).

Table 4.11-5. Virginia Ports Ranked in the Top 10 Mid-Atlantic Fishing Ports in 2010

Port	Landing Weight		Landed Value	
	Rank	Pounds	Rank	Dollars
Reedville	1	426,000,000	3	34,200,000
Hampton Roads Area	5	16,000,000	2	75,400,000
Chincoteague	10	3,000,000	10	3,500,000
Source: NOEP 2013				

Commercial fishing vessels from states surrounding Virginia, including all the states in the Mid-Atlantic region, may travel to waters off Virginia to fish. In more recent years, commercial fishermen are traveling fewer miles to access fishing grounds due to increases in fuel costs and decreases in the need to search for fish due to advancements in technology and available information, which allow vessel captains to maximize catch and profits while remaining closer to their homeports. In 2011, Mid-Atlantic commercial fishermen landed a total of nearly 778 million pounds of fish valued at more than $527 million.

Commercial fishing is generally segregated into either mobile or fixed gear fishing. Mobile gear fisheries are those in which fishing gear such as a purse seine, otter trawl or scallop dredge, deployed while in motion aboard a vessel, while fixed gear fisheries use gear such as lobster/crab pots, fish traps, and gillnets, which are set in one location and then checked or retrieved later. Fishing effort is variable both seasonally and yearly, depending on individual fisherman's preferences, vessel type, species, regulatory environment, and market demand. Fishing effort also varies in location and intensity throughout the year because fishermen follow their target species on their seasonal migrations.

Commercial fisheries are managed by the VMRC, the MAFMC, the Atlantic States Marine Fisheries Commission, and NOAA Fisheries through a number of fishery management plans. Fishing within state waters requires a Virginia commercial permit, managed by the VMRC. In 2011, the VMRC sold a total of

11,463 commercial fishing licenses (VMRC 2013d). Fishing within federal waters requires both a federal and state commercial permit, since vessels fishing in federal waters must transit through state waters.

Management entities for each species, as well as the current status of each fish stock, are codified in the MSFCMA (16 U.S.C. 1801 et. seq.). Species-specific regulations are managed by the NEFMC, MAFMC, and the Atlantic States Marine Fisheries Commission.

According to data presented in the Mid-Atlantic Regional Council on the Ocean data portal, between the years of 2000 and 2009 the VOWTAP area experienced generally low to below average levels of commercial fishing effort across the major commercial harvest categories including gill net, pot and trap, bottom trawling, and long line fishing (MARCO 2014). Additionally, any bottom contact fishing and other maritime activities that involve bottom contact or loitering are prohibited along the segment of the Export Cable that crosses the active military practice areas (see Section 4.12).

4.11.1.6 Environmental Justice

Executive Order 1298 requires federal agencies to take appropriate steps to identify and address disproportionately high and adverse health or environmental effects of federal actions on minority and low-income populations. According to the CEQ's environmental justice guidance under NEPA (CEQ 1987), minorities are those groups that include American Indian or Alaskan Native; Asian or Pacific Island; Black, not of Hispanic origin; or Hispanic ethnicity. Minority populations are defined as places where either (a) the minority population of the affected area exceeds 50 percent of the total or (b) the minority population of the affected area is meaningfully greater than the minority population percentage in the general population or other appropriate unit of geographic analysis. The CEQ guidance also directs low-income populations to be identified based on the annual statistical poverty thresholds from the U.S. Census Bureau. For the purpose of analysis in this RAP, low-income populations are defined as those individuals with reported income below the poverty level.

Table 4.11-6 provides a summary of the minority or low-income percentages of state county/city populations for the purpose of analysis in this RAP. Because the minority populations in the communities surrounding the Project Area do not exceed 50 percent of the total, and the percentages of minorities and people with income below the poverty level are not significantly higher than the corresponding figures for the state of Virginia, there are not any communities of environmental justice concern near the Project Area.

Table 4.11-6. Income and Minority Population Levels

Locality	Total Population	2010 Percentage of People with Income Below Poverty Level	Hispanic or Latino (% of Total Population)	Minority not Hispanic or Latino (% of Total Population)	Total Minority (% of Total Population)
Virginia	8,001,024	11.1%	7.9%	27.4%	35.3%
Virginia Beach	437,994	7.5%	6.6%	28.8%	35.4%
Source: U.S. Census Bureau 2013					

4.11.2 Potential Impact Producing Factors, Proposed Environmental Protection Measures, and BMPs

4.11.2.1 Population, Economy, and Employment

The primary potential impact producing factor to population, the economy, and employment would be the influx of workers seeking employment with the Project which would be larger than the work force needed and could lead to an increase in unemployment. Given the relatively small size of the Project compared to the local and regional economy, this potential impact is unlikely.

Potential impacts to the local economy would be positive, through creation of employment and tax revenue. These impacts are divided between a one-time effect during construction followed by a smaller but ongoing effect during operation (Chumura 2013).

In the Hampton Roads Metropolitan Statistical Area, preliminary analysis shows that the Project could directly create 360 cumulative jobs in the six-year period between 2012 and 2017, mostly in the construction trades. An additional 77 cumulative indirect jobs could be created in firms supporting construction. A final 163 cumulative induced jobs could be created through spending in the local economy by workers on the Project. During operation of the Project, total direct, indirect and induced employment is estimated at 31 jobs. Employment figures would be somewhat higher for the state as a whole.

Tax revenue from the Project would include the Business, Professional and Occupational License (BPOL) tax and property tax. Between 2012 and 2017, total BPOL tax revenue is estimated at approximately $136,000. The state government is expected to receive a total of around $1.5 million in individual income tax revenue and $400,000 in corporate income tax revenue. During operation, individual income tax revenue is estimated at around $40,000 per year.

Once the facility is in operation, local property tax revenue from the onshore components is estimated at $142,500 per year. It is not anticipated that the Project would lead to new local infrastructure or service requirements (roads, schools, etc.).

4.11.2.2 Housing and Property Values

The potential impact producing factor for housing would be the use of temporary housing by Project workers leading to a shortage of housing for recreation. Given the small number of workers relative to the available rental housing stock, this impact is considered very unlikely.

4.11.2.3 Public Services

The potential impact producing factor for public services would be the use of these services, particularly law enforcement and emergency services, by the Project work force to the extent that these services would be less available to the public at large. Given the small number of workers relative to the available services, this impact is considered very unlikely.

4.11.2.4 Onshore Recreation

The primary impact producing factors to onshore recreation associated with the Project would be temporary disturbance to recreational use of Camp Pendleton Beach during construction of the onshore Project components, and minor and temporary increases to local traffic during construction for the area as a whole.

Disturbance at Camp Pendleton Beach would be temporary and limited to the period of construction and the immediate area of the beach. In order to minimize impacts to users on the beach, Dominion plans to complete all construction activities prior to the start of the summer tourist season (May 31). Areas inland of the shore associated with the construction and operation of the Onshore Interconnection Cable, Fiber Optic Cable, and Interconnection Station are located entirely within Camp Pendleton and are not used for recreation. Therefore, there will be no impact to recreation. Furthermore, there will be no disturbance to onshore recreation by operation of the WTGs, since the WTGs will not be visible to the casual observer from shore (See Section 4.10 and Appendix Q).

4.11.2.5 Commercial Shipping, Recreational Boating, and Commercial and Recreational Fishing

Impact producing factors to commercial shipping, recreational boating, and commercial and recreational fishing associated with the Project would include temporary disturbance to mariners during the construction of the offshore Project components through increases in vessel traffic during construction; the introduction of a potential navigational hazard, namely the WTGs. For commercial and recreational fishing, potential impact producing factors include habitat loss, displacement of fishing vessels, changes to revenues associated with commercial fishing, or a change in target species availability.

Disturbances and risks to mariners during construction, operation and decommissioning of the Project are discussed in Section 4.14.1 and Appendix R. As discussed in Section 4.14.1, impacts from construction and future decommissioning of the VOWTAP will be limited both spatially and temporally. Construction of the offshore Project components is expected to take place over a 12-week construction period. Dominion will temporarily restrict access to the proposed work areas during construction, requiring that both mobile and fixed gear fisheries temporarily relocated outside of the construction area. Restriction of commercial fishing in the Project will result in the short-term displacement of commercial fishing activities, and would not result in any long-term impacts related to the values of fisheries in the area.

To ensure the safety of the local mariners, Dominion will establish a 95-ac (38.5-ha) temporary work area around each WTG location and a 200-ft-wide (61-m) construction right-of-way along the routes of the Export Cable and Inter-Array Cable (Figure 3.2-2). As appropriate, these areas will be marked and lit in accordance with USCG requirements and monitored by a security boat that will be available to assist local mariners. In addition, prior to construction, a project-specific website will be established to share information about VOWTAP construction progress with the community and also to give guidance on the daily construction activities and how they may affect the area. Dominion will also issue specific local notices to mariners in coordination with the USCG throughout the construction period. In addition, with the implementation of mitigation measures such as establishment of designated offshore work areas monitored by construction security vessels, and application of appropriate construction lighting at night, impacts on commercial and recreational mariners will be successfully mitigated and/or avoided.

During operations, the presence of the VOWTAP WTGs will not have a significant impact on commercial or recreational mariners and, by virtue of their fixed position, may present attractive position fixing landmarks. Their presence in the Project Area does, however, represent an obstruction to navigation that has not existed in the area in the past and, therefore, the potential for collision between a vessel and the WTG(s) does exist. This would, however, be true for any new structure installed offshore. To mitigate this risk, the WTGs will each be lit, individually marked, and maintained as Private Aids to Navigation (PATON) per USCG ATON requirements. No permanent exclusion zones are proposed around the VOWTAP WTGs during operation.

Impacts to commercial and recreational fishing are also expected to be minimal. As discussed in Section 4.3, construction may result in potential impacts on various benthic, demersal, and pelagic species targeted by commercial and recreational fishermen. However, these impacts will largely be associated with temporary avoidance and short-term disturbance of habitat during construction. Operation of the VOWTAP will result in the permanent loss of a very small area of possible fishing ground immediately surrounding the WTGs and introduce a potential obstacle to navigation. However, Dominion does not propose any operational phase vessel exclusions that would prevent fishing from occurring within the Project Area. The Export Cable will be buried at a depth that is sufficient to allow continued use of mobile gear in the Project Area. The Project has been sited in an area where important habitats such as eelgrass and hard bottom substrates do not occur. The prevalence of sandy substrates removes the potential for the creation of a seabed hazard or 'snag' that could be detrimental to mobile fishing gear.

The Project does, however, have the potential to enhance the fishing in the region once the WTG foundations are installed. The WTG foundations will provide hard bottom and structure where neither previously existed, which will extend from the substrate to the water surface. As is the case surrounding the offshore petroleum infrastructure within the Gulf of Mexico, offshore wind infrastructure will likely act as a FAD for a wide variety of species along the Atlantic coast (Brownlee 2011). A more proximate example of offshore hardware acting as a FAD is the Chesapeake Light tower (Ball 2013). The Chesapeake Light Tower is located in Federal waters east of Virginia Beach and has a "Texas oil rig" foundation design. A wide variety of structures have also been deployed to the seabed surrounding the light tower including sunken barges, box cars, tires, tug boats and a wide variety of tangled steel. This debris field and tower has become a prime recreational fishing location for black sea bass, summer flounder, tautog, triggerfish, king mackerel, spadefish, Spanish mackerel, and cobia; each caught at different levels of the water column (Ball 2013). While the VOWTAP foundations will not have the benefit of a surrounding debris field or the approximately 40 years of benthic organism settlement that the light tower has, it is expected that the VOWTAP foundation structure will provide increased opportunity for recreational fishermen in the years following Project construction.

As discussed in Section 3.7, decommissioning of the VOWTAP will follow a similar sequence as construction, but in reverse, and will therefore result in similar potential impacts to commercial and recreational fishermen.

4.11.2.6 Environmental Justice

The potential impact producing factor with respect to environmental justice is that a federal action might have disproportionately high and adverse health or environmental effects on minority and low-income populations. Given the determination that there are no communities of environmental justice concern near the Project Area, the Project will not have any disproportionately high and adverse health or environmental effects on minority and low-income populations, and there is no need for protective measures to address such concerns.

4.12 Military Maritime Uses

This section describes DoD and OCS National Security Maritime Uses that occur within and surrounding the Project Area. This section also identifies how Project activities may be affected by military maritime uses, including location of VOWTAP facilities, and construction, operation, and decommissioning activities. Other marine activities occurring within the Project Area that are contributing factors to the local economy, such as commercial and recreational fishing and boating, and maritime transport, are discussed in Section 4.14.

4.12.1 Affected Environment

The offshore areas associated with the Project have a long history of supporting military activities. The Port of Norfolk is home to the U.S. Navy's Atlantic Fleet, which includes more than 75 ships. Operations involve vessels ranging in size from 362 ft (110 m) for a nuclear-powered attack submarine to 1,092 ft (333 m) for a nuclear-powered aircraft carrier. Operations occur intermittently, with substantial variability in duration, ranging from a few hours up to two weeks, and are widely dispersed off the coast of Virginia; however, they are largely concentrated within the Virginia Capes (VACAPES) Operating Area (OPAREA) (see Appendix R, Figure 3-5). The VACAPES OPAREA is comprised of a set of ocean surface and subsurface operating and maneuvering areas used by the U.S. Navy for various exercises and training. Included in this area is a "Live Fire Area" designated as a "Danger Zone" on nautical charts. Navy fleet and Marine Corps amphibious warfare training occurs nearly every day along the United States East Coast in these areas, as well as open ocean areas (MMS 2007).

Training activities occurring in the VACAPES OPAREA include various types of Surface Warfare exercises involving the use of explosive ordnance, Amphibious Warfare exercises involving firing from ships to targets onshore, and Strike Warfare involving firing air-to-surface missiles. VACAPES OPAREA activities typically result in about 1,400 total vessel days per year (see Appendix R) and there may be as many as 10 ships operating in the VACAPES OPAREA at any one time. Naval training exercises in the VACAPES OPAREA are controlled through the Fleet Area Control and Surveillance Facility, VACAPES, in Virginia Beach.

The Project Area for the Offshore Export Cable crosses a portion of the Dam Neck Live Fire Danger Zone (see Appendix R, Figure 3-5). The Dam Neck Live Fire Danger Zone extends seaward 15 nm (24 km) from shore and closely borders the Southeast Approach traffic lanes. Vessels proceeding through the area are instructed to do so with caution and remain within the area no longer than necessary for purposes of transit (33 CFR 334.390). This Live Fire Danger Zone has been in use for more than 40 years. A smaller danger zone, mostly located within the Dam Neck danger zone, is also used as a naval firing range, and any activities inside the zone are conducted in accordance with applicable regulations (33 CFR 334.380). The Project would not be located within this smaller zone (see Appendix R, Figure 3-5).

Near the entrance to Hampton Roads, an additional danger zone extends from shore across Thimble Shoal and infringes on the North Auxiliary Channel near buoy 18. This area serves as a firing range for Fort Monroe and vessels are not allowed to loiter or anchor during announced firing periods (33 CFR 334.350). A restricted area is also in place adjacent to the firing range at Fort Monroe. The area extends from Old Point Comfort across the channel to Willoughby Bank and includes portions of Thimble Shoal Channel (NOAA Chart 12245) (see Appendix R, Figure 3-5).

The Navy's Shipboard Electronic Systems Evaluation Facility (SESEF) range provides electromagnetic system test and evaluation services to both the Navy and USCG commands. The SESEF range is located between 8 to 18 nm (15 to 33 km) offshore from the entrance to Chesapeake Bay and is supported by the Joint Expeditionary Base Little Creek/Fort Story, Virginia. On average, 300 major test and evaluation events occur at the facility annually.

In addition to naval vessels, military aircraft test and train within special use airspace overlying the coast and in offshore warning areas (MMS 2007). The U.S. Navy, USCG, U.S. Air Force and Air National Guard are responsible for various search and rescue missions that may be conducted anywhere on the Atlantic coast, including the areas in the vicinity of the VOWTAP. This may include the use of low flying aircraft and helicopters offshore. The Project has been reviewed through the DoD Clearinghouse; there will be no impact on long range radars resulting from the two WTGs. Section 4.14.3 discusses aviation activities, including military operations in the Project Area.

As depicted on Figure 4.12-1, the VOWTAP WTGs would not be located within any military use areas; however, the Export Cable will cross the identified Dam Neck Live Fire Danger Zone (33 CFR 334.390) and the Camp Pendleton live fire area (referred to as R-6606). Project vessels supporting construction, operation, and decommissioning will likely have to traverse both the military use areas as well as the live fire and danger zones.

4.12.2 Potential Impact Producing Factors, Proposed Environmental Control Measures, and BMPs

The potential impact producing factors related to military marine uses by the DoD could include potential disruption of military testing and training exercises, and an increased risk of vessel collision due to VOWTAP support vessel movement during Project construction, maintenance, and decommissioning activities.

Dominion recognizes that the DoD will reserve the right to temporarily suspend operations or require evacuation of the Project Area in the interest of national security. Dominion has been consulting with military stakeholders regarding Project siting and development since 2012, including Dam Neck and Camp Pendleton personnel, the U.S. Naval Office of Seafloor Cable Protection, and the Fleet Forces Atlantic Exercise Coordination Center at Naval Air Station Oceana. In order to minimize any potential conflicts with military and defense uses of the OCS, including training exercises, Dominion will coordinate all Project construction, operation, and decommission activities closely with the Fleet Area Control and Surveillance Facility, VACAPES, the SESEF range, and the Fleet Forces Atlantic Exercise Coordination Center at Naval Air Station Oceana. As a result, the VOWTAP should not have any impacts on military maritime activities.

Due to a portion of the Export Cable route crossing the military live fire zone, additional surveys specifically designed for MEC detection and evaluation will also be conducted as necessary within the military practice areas prior to Export Cable installation. These surveys will be performed in close coordination with applicable military stakeholders to ensure the safe installation of the Export Cable in this area (see Section 4.1.3).

4.13 Land Use

This section discusses land uses and land use regulations applicable to the onshore Project facilities, based on review of local regulations and spatial data, and including the potential impact of these regulations to the Project.

4.13.1 Affected Environment

4.13.1.1 Existing Land Uses

The proposed onshore Project facilities will be located in the City of Virginia Beach, Virginia. Existing land use in Virginia Beach consists of residential, commercial, industrial, institutional, and public uses. The southern part of Virginia Beach remains largely rural, while the northern sector is dominated by urban uses. In 2007, approximately 45 percent of the land area in the city was characterized by residential use, with 30 percent of the land in agricultural use and 10 percent in federal and state government use. This state and federal land includes several United States military installations.

The proposed onshore Project facilities, including the Switch Cabinet, the Onshore Interconnection Cable, Fiber Optic Cable, and the Interconnection Station, are located entirely within the boundaries of Camp Pendleton. Camp Pendleton is a 325-acre (132-hectare) site located along the Atlantic Ocean, approximately 2 mi (3 km) south of the main oceanfront resort area of Virginia Beach. Camp Pendleton is owned by the State of Virginia and is primarily used for on-site training of Virginia National Guard personnel, although it is also used by National Guard units from other states, components of the United States Armed Forces, and state and local civilian agencies when facilities are not in use by military organizations.

The proposed Export Cable landfall location is located within an existing gravel parking area at the eastern end of Rifle Range Road, just west of the beach dune area (see Figure 3.1-1). The cleared area extends approximately 650 ft (198.1 m) to the north and 750 ft (228.6 m) to the west from the parking area. Immediately to the east of the parking area is a concrete pad that previously supported a World War II-era lookout post; benches and picnic tables have been installed on the pad, and the site now supports recreational access to the Camp Pendleton beach.

4.13.1.2 Land Use Regulation

Land and land uses in the onshore portions of the Project Area have the potential to be governed by various local land use regulations and land use plans. These are discussed in the following sections.

Virginia Beach Comprehensive Plan

The City of Virginia Beach Comprehensive Plan (City of Virginia Beach 2009) includes various elements related to the scenic and aesthetic values of the proposed Project. The Environmental Stewardship Framework provides a comprehensive set of planning policies that protect and manage Virginia Beach's environmental assets.

Under the Comprehensive Plan, the onshore Project Area, including all of Camp Pendleton, is in the State Military Reservation planning area (City of Virginia Beach Comprehensive Plan Policy Document Technical Report 2009). No specific land use goals or policies are established for the area.

Virginia Beach Zoning Regulations

The City of Virginia Beach (2013b) regulates land use and development proposals through the City's comprehensive Zoning Ordinance, which was adopted in 1973 and most recently amended on August 28, 2012. As depicted on Figure 4.13-1, the onshore components of the Project and associated interconnection point are located in two zoning districts (Virginia Beach Planning Department 2013). The Onshore

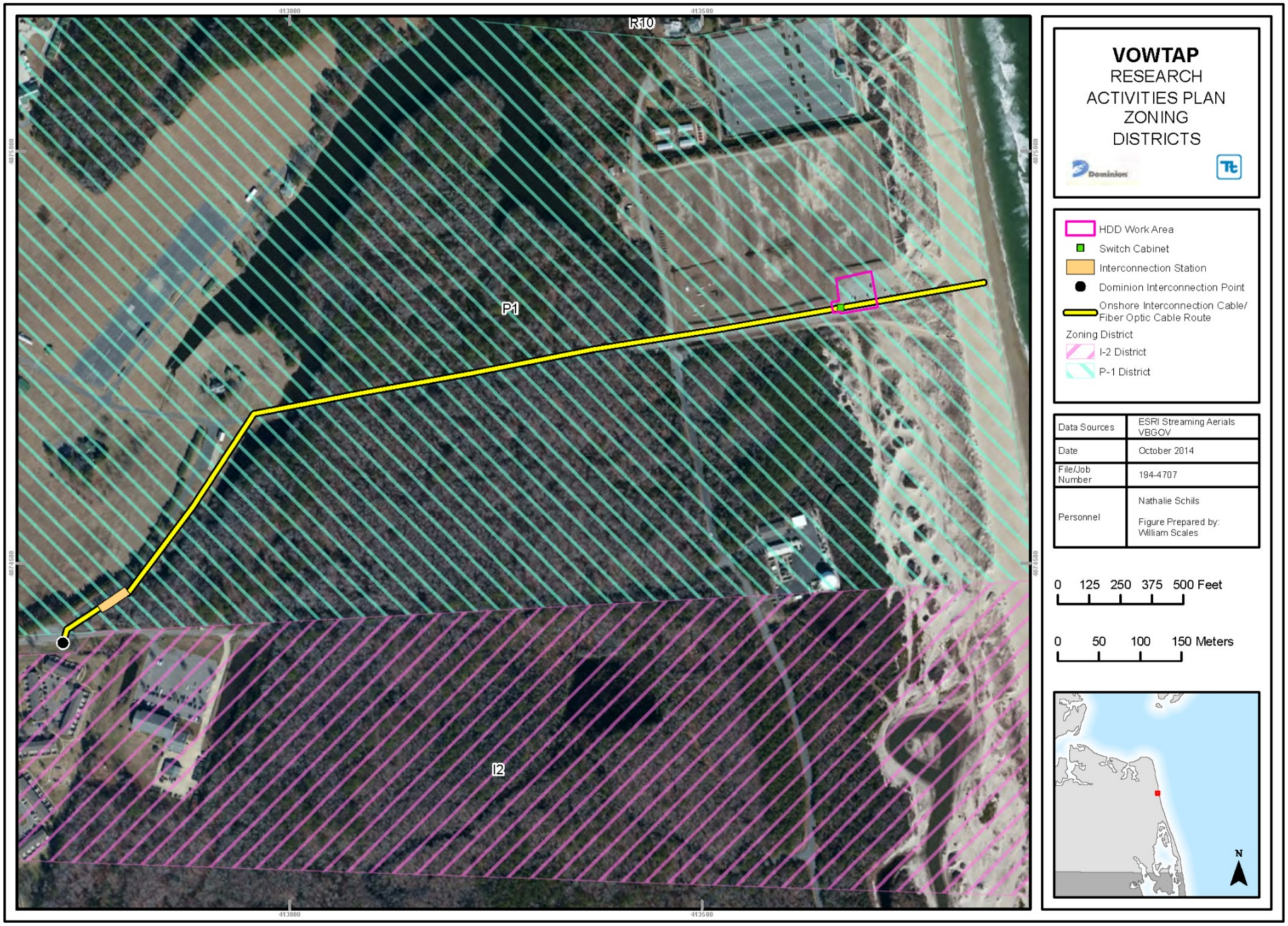


Figure 4.13-1. Zoning Districts

Interconnection Cable and Fiber Optic Cable, Switch Cabinet, and Interconnection Station are all located in the P-1 District. The existing Dominion electrical infrastructure, where minor upgrades will occur, is located in Heavy Industrial District 2 (I-2) within an existing Dominion right-of-way.

Camp Pendleton Integrated Natural Resources Management Plan

The Camp Pendleton Integrated Natural Resources Management Plan (INRMP) was developed to ensure that military training activities at Camp Pendleton are integrated and consistent with federal land stewardship objectives. The INRMP serves as the principal management plan governing all natural resource activities on Camp Pendleton (VDMA 2013).

The Water Resource Protection Program assesses water quality at Camp Pendleton and identifies current and potential water quality problems. Lake Christine is a water resource within Camp Pendleton and the values attributed to this resource include recreation and aesthetics. The Program recommends the following to conserve and enhance water resources:

- Re-establish the natural riparian buffer along the edges of Lake Christine to reduce undesirable runoff that decreases water quality of the lake and surrounding wetlands.

The Forest Management Plan addresses military training needs, forest protection, invasive species, reforestation, and pest control. This Program makes the following recommendations:

- Wherever feasible, existing groupings and/or clusters of trees and natural vegetation should remain on the site to provide aesthetic and environmental benefits.
- Protection of the existing forest should be considered. Trees not slated for removal can be protected from the effects of construction activities associated with future construction.

4.13.2 Potential Impact Producing Factors

Potential impact producing factors for land use would include inconsistencies with existing land use regulation or impacts from the Project that would change the existing patterns of land use. The Virginia Beach Comprehensive Plan does not establish land use goals or policies specific to the Military Reservation planning area (and thus to the onshore Project Area) and, therefore, is not considered further.

4.13.2.1 Consistency with Local Land Use Regulation

Virginia Beach Zoning Code

The purpose of the P-1 zoning district is to allow the City of Virginia Beach to protect its atmosphere, lands, and waters from pollution, impairment, or destruction (City of Virginia Beach 2013b). One of the principal uses permitted within the P-1 district is for "public utility installations and substations," although offices, storage, or maintenance facilities are not permitted. All of the onshore VOWTAP facilities in the P-1 zone, including the Switch Cabinet, Onshore Interconnection Cable and Fiber Optic Cable, and Interconnection Station are consistent with the defined P-1 district principal use. Per the P-1 zoning requirements for public utility installations, Category I screening will be required for both the Switch Cabinet and Interconnection Station (Virginia Beach Code of Ordinances, Appendix A, Article 3, Section 301 [VBCO 2013a]). See Section 4.10 and Appendix Q for additional information on facility screening, including simulations of the proposed Project facilities.

The purpose of the I-2 district is to permit operations, wholesaling, warehousing, and distribution in areas suitable for these functions (City of Virginia Beach 2013b). Accepted principal uses permitted within the I-2 district are "public utilities installations and stations including offices," although storage or maintenance facilities are not permitted. The proposed upgrade to the existing Dominion infrastructure in support of the VOWTAP is consistent with the defined I-2 district principal use. Per the I-2 zoning requirements for public utility installations, Category I screening will be applied in support of the existing infrastructure upgrades, as appropriate (Virginia Beach Code of Ordinances, Appendix A, Article 3, Section 1001 [VBCO 2013b]).

Camp Pendleton INRMP

The INRMP does not specify allowed uses beyond the stated military mission for the site. Dominion has been coordinating closely with Camp Pendleton staff regarding the proposed installation and operation of the VOWTAP onshore facilities, and will continue to work with staff to ensure that the appropriate measures are adopted to meet the goals of both the INRMP Water Resource Protection Program and Forest Management Plan. As further described in Section 4.2, Dominion will implement a Stormwater Management Plan pursuant to VAR10 General Permit, 9 VAC25-880 and an ESC Plan and associated BMPs in accordance with 9VAC25-840 to avoid or minimize potential erosion impacts from all onshore construction activities. These plans will be provided to relevant agencies for review and approval prior to construction.

As described in Section 3.3.2, the installation of the Interconnection Station may require the clearing of some trees along the Camp Pendleton Gate 10 Access Road. Consistent with the Forest Management Plan, Dominion is working with Camp Pendleton staff to minimize the need for tree removal to the maximum extent possible.

Changes to Existing Patterns of Land Use

The Onshore Interconnection Cable and Fiber Optic Cable will be located underground, and the other onshore components will be both relatively small and similar to existing utility infrastructure. Therefore, these facilities will not cause impacts to existing patterns of land use.

4.14 Transportation

This section discusses the marine, land, and air transportation networks surrounding the Project Area. This section also identifies the Project activities that may affect transportation and traffic conditions within the Project Area both on and offshore, including location of the Project facilities, and construction, operation, and decommission activities. A detailed navigational risk assessment has also been conducted for the Project in accordance with USCG guidance for Offshore Renewable Energy Installations (OREIs) contained in Navigation Vessel Inspection Circular (NVIC) 02-07, and through consultation with the USCG and marine transportation stakeholders. An Aviation Impact Assessment has also been completed. These reports are included as Appendices R and T.

4.14.1 Marine Transportation and Navigation

4.14.1.1 Affected Environment

The offshore portion of the VOWTAP Project Area is located approximately 27 mi (24 nm, 43 km) offshore from the Virginia coast near the entrance to the Chesapeake Bay. The Chesapeake Bay and the waters surrounding the Project Area serve as a vital conduit for maritime commerce in the Mid-Atlantic region. These waters are used by a large variety of commercial vessels, military vessels, and recreational watercraft; commercial and military traffic operates within these waters throughout the year, while recreational vessels are influenced by season and variations in the weather. The volume of commercial traffic is shown in Figure 4.14-1.

A Traffic Separation Scheme has been established in the approaches to Chesapeake Bay between Fisherman's Island on the north and Cape Henry on the south. The Traffic Separation Scheme includes the Northeast Approach, Southeast Approach, Southeast Deep-Water Route, and a 2-mi (3.2-km) radius Precautionary Area centered on Chesapeake Bay Entrance Lighted Whistle Buoy CH. The Project Area is more than 17 mi (27 km) from the Northeast Approach, and 15 mi (24 km) from the Southeast Approach. Larger commercial vessels bound to and from ports in Chesapeake Bay can be expected to follow the Traffic Separation Scheme; and typically approach or depart from either the Northern Approach or Southeast Approach traffic lanes making up the Traffic Separation Scheme, with deep draft vessels, both commercial and military, taking the Southeast Approach. However, recreational vessels and smaller commercial vessels, such as charter boats, towing vessels, and fishing boats, are not limited to the Traffic Separation Scheme and may use portions of the Project Area.

The Northeast Approach consists of both inbound and outbound traffic lanes divided by a separation zone and five yellow fairway buoys. All buoys are lighted and equipped with sound signaling appliances. Coastwise vessels approaching from the north will typically use the Northeast Approach if their draft is sufficiently shallow and minimum underkeel clearance can be maintained.

The Southeast Approach is situated in deeper water and runs from the CB buoy to the CH buoy. The inbound and outbound traffic lanes are separated by a Deep-Water Route between the two lanes, and lateral aids to navigation mark the waterway to the Chesapeake Bay entrance Precautionary Area. This Deep-Water Route is intended for use by deep draft commercial vessels and aircraft carriers entering or departing Chesapeake Bay (NOAA Coast Pilot 2013). Vessel traffic is heaviest within the Southeast Approach traffic lanes.

The traffic lanes and Precautionary Area making up the Chesapeake Bay entrance Traffic Separation Scheme serve as both safe and recommended access to the Ports of Virginia and Baltimore, the seventh and sixteenth busiest ports in the U.S. in terms of total cargo volume, respectively (AAPA 2011). The Port of Virginia is third in the nation in terms of containership cargo, handling over two million Twenty-foot Equivalent Units in 2012 (Virginia Port Authority 2103).

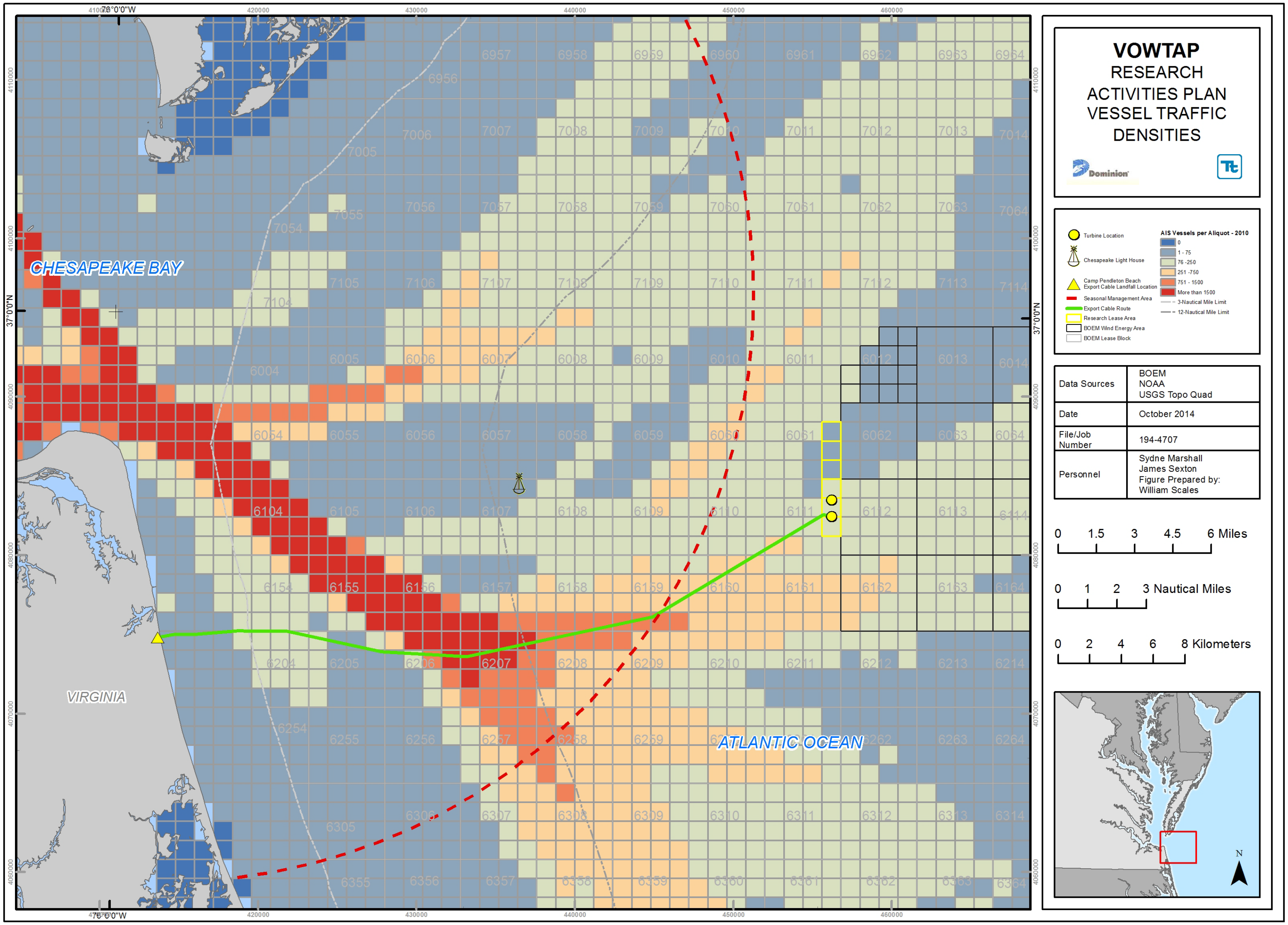


Figure 4.14-1. Vessel Traffic Densities

4.14.1.2 Potential Impact Producing Factors, Proposed Environmental Control Measures, and BMPs

Potential impacts to marine transportation and navigation could include increased vessel traffic and congestion in Traffic Separation Scheme lanes during construction and decommissioning and an increased risk of vessel collision with the WTGs once installed.

The proposed vessels and vessel transit routes necessary to support construction and decommissioning of the VOWTAP are described in Section 3.3.4 and depicted on Figure 3.3-1. It is estimated that these vessels will conduct a total of approximately 559 trips to and from the Project Area during the proposed construction period. While construction and decommissioning of the VOWTAP will result in temporary increases to vessels operating in the Project Area, this increase is not significant compared to the current number of vessels operating in the vicinity of the proposed VOWTAP facilities offshore. In addition, Dominion has worked closely with maritime stakeholders to site the VOWTAP in an area that will minimize both short- and long-term effects on marine transportation and navigation (see Section 2.2).

Offshore construction is expected to take place during an approximate 12 week period, most likely during the months of May through July. Prior to the start of construction, a Project-specific website will be established to share information about VOWTAP construction progress with the community, and to give guidance on daily construction activities. Dominion will also issue specific, local notices to mariners in coordination with the USCG throughout the construction period.

To ensure the safety of mariners operating in the Project Area during construction, Dominion will establish a temporary 95-acre (38.5-ha) work area around each WTG location, a 200-ft-wide (61-m-wide) construction right-of-way along the routes of the Inter-Array Cable and Export Cable, and a 20-acre (8-ha) Offshore HDD Work Area and Nearshore Work Area. As appropriate, these areas will be marked and lit in accordance with USCG requirements, and monitored by a security boat to assist local mariners. Project construction vessels anchoring in the area will also use buoys with navigation lights to indicate the position of the anchor. In addition, if the construction vessels have to leave the WTG Work Area before installation of an IBGS foundation or WTG is completed (e.g., in case of adverse weather), temporary USCG-approved navigational aids will be placed on the structures.

The USCG considers vessels laying cable as restricted in their ability to maneuver due to the nature of their work, and as a result applies additional responsibilities to other vessels that may be navigating in close proximity to the installation vessel (USCG 2013). These rules specifically require power-driven vessels, sailing vessels, and vessels engaged in fishing to keep out of the way of a vessel restricted in its ability to maneuver. To further support navigation in the Project Area during cable-installation activities, Dominion may also elect to deploy additional buoys with lights to indicate the location of the cable as it is being installed.

The USCG considers vessels laying cable as restricted in their ability to maneuver due to the nature of their work, and as a result applies additional responsibilities to other vessels that may be navigating in close proximity to the installation vessel (USCG 2013). These rules specifically require power-driven vessels, sailing vessels, and vessels engaged in fishing to keep out of the way of a vessel restricted in its ability to maneuver. To further support navigation in the Project Area during cable-installation activities, Dominion may also elect to deploy additional buoys with lights to indicate the location of the cable as it is being installed.

During operations, the presence of the VOWTAP WTGs will not have a significant impact on navigation or safety in the Project Area, and by virtue of their fixed position, may present attractive position fixing landmarks for mariners. Their presence in the Project Area does represent an obstruction to navigation that has not existed in the area in the past and, therefore, the potential for collision between a vessel and the WTG(s) does exist. This would however be true for any new structure installed offshore. To mitigate this risk the WTGs will each be lit, individually marked, and maintained as PATON per USCG requirements (USCG 2010) in the following manner:

- All WTG foundation structures will be painted yellow (Munsell Chip 2.5 Y 8/12) from MLW to 50 ft (15.3 m) above mean high water (MHW).
- Alphanumeric marking in black, letters 15 ft (4.6 m) in height, located 120° apart with the letters mounted vertically from 45 ft (13.7 m) above MHW to 30 ft (9.1 m) above MHW. Three (3) ft of retro-reflective material above and below the letters.
- Turbines above the yellow demarcation line for navigational aids will be painted bright white or slightly off white color (less than 5 percent grey tone).
- In consideration of the relative close proximity and arrangement of the WTGs, the lighting on both WTGs will be identical, specifically, two amber lights with 4 nm (7 km) visibility on the same horizontal plane at a height of not more than 50 ft (15.3 m) above highest astronomical tide (HAT), 180° apart providing 360° visibility, quick flashing (ISO 50 flashes per minute [FPM]). Flashing of both WTGs should be synchronized.

Operation of the Project will also not result in a detectable increase in vessels operating in the Project Area over their current levels, adding only an estimated 134 vessel trips to VOWTAP each year. Additional information on the navigational risk associated with the construction, operation, and decommissioning of the Project is provided in Appendix R.

4.14.2 Onshore Transportation and Traffic

4.14.2.1 Affected Environment

Major roadways in the vicinity of the Project Area include U.S. Route 264, U.S. Route 58, and Virginia State Route 615. U.S Route 264 (Virginia Beach-Norfolk Expressway) experiences traffic counts of 26,000 vehicles per day between Birdneck Road and Parks Avenue. At locations in Virginia Beach farther inland from the Project Area, daily traffic counts for U.S. Route 264 increase to 185,000 vehicles per day. U.S. Route 58 experiences traffic counts of 12,000 vehicles per day between Oceana Boulevard (State Route 615) and Atlantic Avenue. Farther inland from the Project Area, daily traffic counts for U.S. Route 58 increase to 29,000 vehicles per day (VDOT 2012). Daily traffic count data was not available for Virginia State Route 615 (Oceana Boulevard and General Booth Boulevard). Traffic in the wider Virginia Beach area is often very high during the summer tourist season. Local roads that may be used in support of the Project are primarily located on Camp Pendleton. While traffic data is not available for these roads, they are primarily used for Camp Pendleton military activities and not by the general public. Traffic volumes during field visits at Camp Pendleton were observed to be low.

4.14.2.2 Potential Impact Producing Factors, Proposed Environmental Protection Measures, and BMPs

The primary impact producing factors to onshore transportation would occur during construction from additional workers traveling to and from the onshore construction laydown areas, Construction Port, and Base Port. All of these potential impacts are anticipated to be small.

Worker traffic to Camp Pendleton will not be sufficiently large to impact the existing low levels of traffic. Further, work will be staged in a manner that will minimize impact on training and daily activities at Camp Pendleton. No trenches or holes will be left open or unsecured overnight, and roadways will not be blocked for long periods of time to base vehicular traffic. Project areas will be coordinated with Camp Pendleton staff.

Worker traffic volumes to the Construction Port will be small compared to the normal flow of worker traffic to any of the existing ports, and should not have a measureable impact on current levels of service. Small amounts of equipment and materials for the onshore components will be transported to the construction sites using local roads, most likely U.S. Route 264 and Virginia State Route 615. However, the major offshore components will be transported directly to the Lease Area by vessel or barge.

During operation of the Project, the volume of workers transiting the Base Port to the Lease Area will be sufficiently small so that no impact to local traffic will be created.

4.14.3 Aviation

The FAA is authorized under 14 CFR Part 77 to conduct aeronautical studies to ensure that proposed structures do not have an effect on the safety of air navigation and the efficient utilization of navigable airspace, if those structures will be located onshore or within 12 nm (14 mi, 22 km) offshore. Since the WTGs will be located beyond 12 nm (14 mi, 22 km) offshore, Dominion is not required to file a Notice of Proposed Construction or Alteration with FAA for the construction and operation of the turbines. At this distance from shore, the USCG will have jurisdiction over both airspace and navigational lighting. Nevertheless, Dominion conducted an Aviation Risk Assessment using the same criteria that would be applied during an FAA aeronautical study; this document is presented in Appendix T.

4.14.3.1 Affected Environment

There are multiple public and private-use airports located within the general proximity of the Project Area. The largest are the Norfolk International Airport, located 3.7 mi (6 km) northeast of the City of Norfolk, and Naval Air Station Oceana (Apollo Soucek Field), a military airport located in Virginia Beach (see Appendix T). The proposed WTGs are located outside the boundaries of instrument departure and approach procedures for these airports, and would not have an impact on their departure or approach procedures.

Aviation volume in the general area is varied and increases during the summer season. Excluding high performance jet and turbo prop aircraft, which generally file and follow instrument flight rules routes, general aviation uses visual flight rules (VFR). Aircraft operating under VFR are required to see and avoid terrain, obstacles, and other air traffic. Obstacles that exceed obstruction standards are normally required to have appropriate marking and lighting in order to increase their conspicuity. Low flying aircraft operating under VFR are required to maintain a minimum 500 ft (152.5 m) clearance from any structure or vessel as required by 14 CFR 91.119. Over water, in the absence of any structures or vessels, there is no minimum altitude restriction. The FAA has also established departure procedures and instrument approach procedures to aid pilots with navigation during marginal weather conditions.

Minimum vectoring altitude (MVA) charts define sectors with the lowest altitudes at which air traffic controllers can issue radar vectors to an aircraft based on obstacle clearance. The FAA requires that sectors have a minimum of 1,000 ft (305 m) of obstacle clearance in non-mountainous areas, and normally 2,000 ft (610 m) in mountainous areas. The VOWTAP WTGs are located inside the boundaries of multiple Norfolk ASR-9 MVA sectors.

Enroute airways provide pilots a means of navigation when flying from airport to airport. The FAA publishes minimum enroute altitudes for airways to ensure clearance from obstacles and terrain. The FAA requires that each airway have a minimum of 1,000 ft (305 m) of obstacle clearance in non-mountainous areas such as the Project Area. The proposed WTGs are located inside the boundaries of AR9, an oceanic route with a 5,500 ft (1,676 m) minimum enroute altitude (MEA). The associated obstacle clearance surface is 4,500 ft amsl. Since the two WTGs are well below this obstacle clearance surface, they should not have an impact on enroute airways.

The Aviation Risk Assessment used the FAA/DoD preliminary screening tool (FAA 2013) to review potential Project interference to Long Range and NEXRAD radars. According to the Long Range Radar tool, the two proposed wind turbines are located in an area designated as "Yellow." The screening tool defines this designation as "Impact likely to Air Defense and Homeland Security radars. Aeronautical study required." Since the project is located in a "Yellow" area of the FAA/DoD preliminary screening tool, Dominion has initiated an informal review of the two WTGs with the DoD Clearinghouse. This informal review will indicate the anticipated impact, if any, on long range radars resulting from the two WTGs. The project has been reviewed, and there will be no impact on long-range radar (Appendix T).

According to the NEXRAD tool, the two WTGs are located in an area designated as 'Green: No Impact Zone', which is defined as "Impacts not likely. NOAA will not perform a detailed analysis, but would still like to know about the project."

Dominion reviewed Special Use airspace, which includes Prohibited, Restricted, Warning, and Military Operations Areas. Each of these areas has defined rules and access restrictions to ensure either separation or awareness of incompatible aviation operations. Military training routes are used for high speed low altitude training, including terrain following operations. Obstacles located within or below these segments of airspace can cause a compression of airspace, increase minimum altitudes, or pose a hazard to the special operations within the special-use airspace. The two WTGs are located in proximity to Warning Areas 72A and 386. However, they are located outside these warning areas' lateral boundaries and should not have an impact on their operations.

4.14.3.2 Potential Impact Producing Factors, Proposed Environmental Protection Measures, and BMPs

Potential impact producing factors to aviation resulting from the VOWTAP include impacts to instrument approach procedures, departure procedures, MVAs, enroute airways, radar, or special-use airspace and military training routes.

As the VOWTAP WTGs are located more than 12 nm (14 mi, 22 km) offshore, they are not expected to impact typical VFR operations, such as airport traffic patterns and VFR routes. The two WTGs are also located outside the boundaries of instrument departure and approach procedures for the closest airports (Norfolk International and Apollo Soucek Field) and would not have an impact on these procedures.

The WTGs are located within Norfolk ASR-9 MVA sectors. One MVA is established at 1,200 ft (366 m) amsl and the other at 1,700 ft (518 m) amsl. However, the WTGs would only potentially impact the lower of the two MVAs. This altitude is below the floor of controlled airspace and only used in emergency situations. At 584 ft (178 m) above ground level, the WTGs would necessitate a 1,600 ft (488 m) amsl MVA, which would be a 400 ft (122 m) increase from the current 1,200 ft (366 m) amsl. However, since the 1,200 ft (366 m) amsl MVA is below the floor of controlled airspace (1,700 or 5,500 ft [528 m or 1,676 m] amsl as appropriate), it is likely that would be used only in emergency situations, and would not impact normal aviation traffic. FAA's Norfolk Air Traffic Control Tower (ATCT)/Terminal Radar Approach Control (TRACON) and the Navy's Fleet Area Control & Surveillance Facility, Virginia Capes (FACSFAC VACAPES) have requested notification of the start of construction in order to make necessary charting revisions.

Impacts to any other offshore aviation activities will be negligible. Such activities would primarily consist of private planes operating under VFRs.

In order to increase pilot awareness and mitigate potential impacts from the newly constructed WTGs, Dominion will request that the FAA issue a Notice to Airmen (NOTAM) indicating the location and height of the WTGs prior to the start of construction. In addition, once constructed, each WTG will have nighttime lighting. Nighttime lighting will be consistent with standard FAA requirements and will consist of one L-864 medium intensity aeronautical light with a flash rate of 20 FPM atop each WTG nacelle. Aeronautical lights will be synchronized and arranged so as to not be visible below the horizontal plane.

4.15 Acoustics

This section describes the potential noise impacts in both the in-air and underwater environments resulting from the construction and operation of the Project. The purpose of the in-air acoustic assessment is to identify and characterize the level of acoustic impact related to Project construction and operation at identified noise-sensitive receptors (NSRs). Construction and operation of the Project also has the potential to cause acoustic harassment to marine species, in particular marine mammals, sea turtles, and fish populations.

The following subsections provides an overview of applicable regulatory criteria and scientific based thresholds, an assessment of the affected environment and proposed environmental protection measures and BMPs, as they relate to the in-air and underwater acoustic environment. A more detailed description of the acoustic terminology and the modeling methods used in the in-air and underwater acoustic assessment is included in Appendices M-1 and M-2, respectively.

4.15.1 In-Air Acoustic Environment

4.15.1.1 Affected Environment

The onshore portions of the Project Area consist of undeveloped natural areas, developed lands ranging from low density to medium-high density in certain locations, and active military training areas. The offshore portions of the Project Area consist of the open ocean; areas that are heavily traveled by commercial, recreational and military vessels; and areas used for military practices. Actual ambient measurements have not been conducted to document the existing acoustic environment in the Project Area; however, ambient sound levels in the onshore portions of the Project Area located in Camp Pendleton are expected to experience a wide range of elevated noise levels, primarily due to training activities for the Virginia Army National Guard, as well as National Guard units from other states (VaANG 2005). Overall, background sound levels in the Project Area both onshore and offshore will vary both spatially and temporally depending on a number of factors, including proximity to other area sound sources, such local land and marine uses and activities, population densities, and vehicle and vessel traffic, as well as proximity to existing recreational, commercial, and industrial sound sources, and even time of day. Closer to the coastline, waves breaking on the seashore may also contribute to the soundscape. The VOWTAP is expected to contribute to the in-air acoustic environment on a short-term basis during construction as well as during operation.

The criteria for the in-air acoustic assessment are thresholds established by guidelines or regulations at the federal, state, and local level. The following federal, state, and local acoustic criteria may be applicable to the Project. In situations where provisions of local ordinances conflict with federal standards, it is assumed that the stricter provisions take precedent.

Federal

EPA Recommended Guidelines

In 1974, EPA published *Information on Levels of Environmental Noise Requisite to Protect Public Health and Welfare with an Adequate Margin of Safety* (EPA 1974). This report represents the only published study that includes a large database of community reaction to noise to which a proposed project can be readily compared. EPA has developed widely accepted recommendations for long term exposure to environmental noise with the goal of protecting public health and safety. The publication evaluates the effects of environmental noise with respect to health and safety, and provides information for state and local governments to use in developing their own ambient noise standards. For outdoor residential areas and other locations in which quiet is a basis for use, the recommended EPA guideline is a day-night sound level (L_{dn}) of 55 dBA. EPA also suggests an equivalent sound level ($L_{eq(24)}$) of 70 dBA (24-hour) limit to avoid adverse effects on public health and safety at publicly accessible property lines or extents of work areas where extended periods of public exposure are possible. The EPA cause and effect criteria limits are summarized in Table 4.15-1.

Table 4.15-1. Summary of EPA Cause and Effect Noise Levels

Location	Level	Effect
All public accessible areas with prolonged exposure	70 dBA $L_{eq(24)}$	Safety
Outdoor at residential structure and other noise sensitive receptors where a large amount of time is spent	55 dBA L_{dn}	Protection against annoyance and activity interference
Outdoor areas where limited amounts of time are spent, e.g., park areas, school yards, golf courses, etc.	55 dBA $L_{eq(24)}$	
Indoor residential	45 dBA L_{dn}	
Indoor non-residential	55 dBA $L_{eq(24)}$	
Source: Appendix M-1		

The application of the EPA noise guidelines is a common compliance approach to help ensure adequate protection of human health and welfare. The EPA sound level guidelines state that the levels identified are low enough to be protective with an adequate margin of safety. The EPA sound level guidelines do not impose federal decisions about the appropriateness of noise environments upon any level of government, nor are they a source of instructions for solving local noise problems, but they are best viewed as a technical aid for local decision makers who seek to balance scientific information about effects of noise on people, and to reconcile local economic and political realities such as cost and technical feasibility. While the EPA criteria limits cannot be used to infer audibility thresholds, designing to adequately meet EPA guidelines would likely result in the reduced probability of dissatisfaction from NSRs and below which there is no evidence that the general population would be at risk to EPA identified health effects. The EPA limit is not a regulatory limit but is intentionally conservative to protect the most sensitive portion of the population with an additional margin of safety.

Department of Housing and Urban Development (HUD) Noise Standards

HUD, in its efforts to provide decent housing and a suitable living environment, is concerned with noise as a major source of environmental pollution and issued 24 CFR 51, Sub-part B on Noise Abatement and Control. HUD's objectives are to make the assessment of the suitability of the noise environment at a site: (1) easy to perform; (2) uniformly applicable to different noise sources; and (3) as consistent as possible with the assessment policies of other federal departments and agencies.

HUD has identified noise standards for new housing construction, which are given in Table 4.15-2. Sites with sound levels of 65 community noise equivalent level (CNEL) or L_{dn} and below are considered "acceptable."

Similar to the EPA guidelines, the HUD standards are not regulatory limits; but they have been used previously to assess noise on military installations. Considering many of the onshore Project activities will occur within Camp Pendleton, the HUD standards were included for consideration when analyzing the potential for Project noise impacts.

Table 4.15-2. HUD Site Acceptability Standards

Approval [a/]	L_{dn} or CNEL (dBA) [b/]	Requirements
Acceptable	≤ 65 [c/]	None
Normally Acceptable	65 – 75	Special Approvals [d/] Environmental [e/] Attenuation [f/]
Unacceptable	> 75	Special Approvals [d/] Environmental [e/] Attenuation [g/]

Notes:
a/ The noise environment inside a building is considered acceptable if: (i) The noise environment external to the building complies with these standards, and (ii) the building is constructed in a manner common to the area or, if of uncommon construction, has at least the equivalent noise attenuation characteristics.
b/ Where the building location is determined, the standards shall apply at a location 6.5 ft (2 m) from the building housing noise sensitive activities in the direction of the predominant noise source. Where the building location is undetermined, the standards shall apply 6.5 ft (2 m) from the building setback line nearest to the predominant noise source. However, where quiet outdoor space is desired at a site, distances should be measured from important noise sources to the outdoor area in question. (It is assumed that quiet outdoor space includes single-family private yards and multi-family patios or balconies that are greater than 6 ft (1.8 m) in depth).
c/ Acceptable threshold may be shifted to 70 dBA in special circumstances pursuant to Section 51.105 (a).
d/ See Section 51.104(b) (Special Requirements) for requirements.
e/ See Section 51.104(b) (Special Requirements) for requirements.
f/ Five (5.0) dBA additional attenuation required for sites above 65 dB but not exceeding 70 dBA, and 10 dBA additional attenuation required for sites above 70 dBA but not exceeding 75 dB; see Section 51.104(a).
g/ Attenuation measures can be submitted to the Assistant Secretary for CPD for approval on a case-by-case basis.

State

There are no statewide noise standards; however, Virginia legislation enables local counties and municipalities to establish planning commissions to develop and carry out comprehensive plans for the coordination of the physical development and future needs of those municipalities and counties. These plans may include local noise standards. The governing authority of each municipality may then adopt, amend, and enforce the planning commission's recommendations. In situations where provisions of local ordinances conflict with other standards, the stricter provisions govern.

Local

Section 23-69 of the City of Virginia Beach Code of Ordinances prescribes daytime and nighttime sound limits applicable at residences:

> *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 four (4) feet from the wall nearest the source, with doors and windows to the receiving area closed.*
>
> *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 dBA when measured inside the residence at least four (4) feet from the wall nearest the source, with doors and windows to the receiving area closed.*

In addition, construction activities are exempt from daytime regulations, but operation of such equipment between the hours of 9:00 p.m. and 7:00 a.m. is prohibited unless otherwise authorized as described in the ordinance. It should be noted, however, that all onshore construction activities will be occurring exclusively on, over and under property owned and controlled by the Commonwealth of Virginia and to which the City of Virginia Beach ordinances do not apply.[2]

4.15.1.2 Potential Impact Producing Factors, Proposed Environmental Control Measures, and BMPs

Specific aspects of Project construction, operation, and decommissioning have the potential to impact the in-air acoustic environment and associated nearby NSRs. Unlike in the marine environment, in-air NSRs are humans and the term does not apply to wildlife. NSRs are locations where people reside or where the presence of unwanted sound could adversely affect the use of land. Examples of NSRs include residences, schools, hospitals, churches, and nursing homes. To support the assessment of in-air noise impacts, NSRs were identified within an approximate distance of 0.5 mi (0.8 km) from onshore construction and operations activities. Based upon these criteria, a total of 991 NSRs were identified within both Camp Pendleton and

[2] Precedent for exemption to local ordinances for offshore wind project activities occurring on, over, and under state-owned property has recently been set by the Deepwater Wind Block Island Wind Farm (BIWF) and Block Island Transmission System (BITS) Project off the coast of Rhode Island. In its permit applications Deepwater Wind asserted this exemption to local ordinances. The Deepwater Wind BIWF and BITS were provided with the authorization to proceed with the construction and operation of the Project by the state (the Coastal Resources Management Council) and lead federal (USACE) permitting agencies on June 13, 2014, and September 4, 2014, respectively.

the City of Virginia Beach, Virginia. An acoustic modeling analysis was conducted to predict received sound levels at these NSRs from the following types of potential impact producing factors:

1. Direct impacts on NSRs from onshore construction activities;
2. Direct impacts on NSRs from onshore HDD installation activities, including the Export Cable landfall, Onshore Interconnection Cable, and Fiber Optic Cable;
3. Direct impacts on NSRs from pile driving of the IBGS foundations;
4. Direct impacts from the operation of the Interconnection Station; and
5. Direct impacts from the operation WTGs.

The following sections summarize the results of the in-air acoustic analysis. The complete In-Air Acoustic Assessment Report including modeling methodologies and sound source levels is included as Appendix M-1.

Direct Impacts from Onshore Construction Activities

Construction noise, although temporary, can be a source of concern for NSRs. Received sound levels at NSRs from construction will depend on the type of equipment used, the mode of equipment operation, the length of time the equipment is in use, the amount of equipment used simultaneously, and the distance between the sound source and NSR. All of these factors are expected to vary regularly throughout the construction period making the calculation of a specific received sound-level value at each NSR location difficult. For the purpose of this analysis, composite received sound levels from the VOWTAP onshore construction activities at various reference distances were calculated at the proposed HDD Work Areas located within the Camp Pendleton Beach parking area and at the site of the proposed Interconnection Station (Table 4.15-3).

Table 4.15-3. Onshore Construction Equipment Sound Attenuation at Reference Distances

Construction Phase	Composite Sound Levels (dBA L_{eq})					
	50 feet	100 feet	200 feet	500 feet	1000 feet	2000 feet
HDD Work Area [a/]	92	86	80	72	66	60
Interconnection Station	92	86	80	72	66	60
a/ Excludes HDD.						

Criteria applicable within Camp Pendleton are not clearly defined; however, it is reasonable to assume that if construction is limited to daytime hours, disturbance to NSRs will be minimized, especially considering the elevated noise levels produced by military activities conducted at Camp Pendleton (VaANG 2005). In order to reduce the level of disturbance to NSRs within the Project Area during construction, Dominion will:

- Not conduct construction activities between 7:00 p.m. and 7:00 a.m. on weekdays or Saturday, or at any time on Sunday;
- Establish and enforce construction site and access road speed limits during the construction period;
- Utilize electrically-powered equipment instead of pneumatic or internal combustion powered equipment, where feasible;
- Locate material stockpiles and mobile equipment staging, parking, and maintenance areas as far as practicable from NSRs at the HDD Work Area;

- Only use noise-producing signals, such as horns, whistles, alarms, and bells, for safety warning purposes;
- Not make Project-related public addresses or allowing on-site music systems to be audible at adjacent receptors; and
- Ensure all noise-producing construction equipment and vehicles using internal combustion engines are equipped with mufflers, air-inlet silencers, where appropriate, and other shrouds, shields, or other noise-reducing features in good operating condition that meet or exceed original factory specification. Mobile or fixed “package” equipment (e.g., arc-welders, air compressors) will also be equipped with shrouds and noise control features that are readily available for that type of equipment.

Direct Impacts from Onshore HDD Installation Activities

As discussed in Section 3.14, the Export Cable will make landfall at Camp Pendleton Beach via a conduit installed via HDD. In addition, installation of the Onshore Interconnection Cable and Fiber Optic Cable will be installed using a guided drill in a point-to-point fashion from the Switch Cabinet located within the Camp Pendleton Beach parking area to the Interconnection Station. Export Cable landfall construction is anticipated to take approximately 11 weeks. Onshore Interconnection Cable and Fiber Optic Cable installation is estimated to approximately 8 weeks, and construction of the Interconnection Station is approximately 8 weeks.

Modeling results indicate that NSRs closest to the Export Cable landfall HDD activities occurring at the Camp Pendleton Beach Parking Area, would experience a received sound level of 63 dBA. (See Appendix M-1, Figure C-2). As stated previously, Dominion has committed to not conducting construction activities at night to minimize disturbance to NSRs.

Received sound levels were also evaluated for the HDD of the Onshore Interconnection Cable and Fiber Optic Cable at three separate locations along the proposed installation routes. Modeling results indicate that the closest NSR, located within Oceana military housing area, would experience a received sound level of 54 dBA (see Figure C-3 of Appendix M-1). Similar to Export Cable landfall HDD activities, if drilling is limited to daytime hours, it is not expected that any noise mitigation measures would be required. In addition to sound contour figures, tabulated results showing received sound levels at the top 50 most impacted NSRs resulting from landfall HDD activities, and HDD of the Onshore Interconnection Cable and Fiber Optic Cable, are given in Tables B-2 and B-3 of Appendix M-1.

Direct Impact from Pile Driving of the IBGS Foundations

Pile driving will only take place at the offshore Lease Area, far from any in-air NSRs. The potential in-air noise impacts associated with pile driving were modeled for meteorological conditions, including downwind propagation and anomalous meteorological conditions that may occur periodically due to frictional convergence at coastlines. Results of the two modeling scenarios are shown in Figures C-4 and C-5, in Appendix M-1 and indicate that received sound levels associated with pile driving will likely be inaudible onshore; however, audibility could potentially occur during certain meteorological conditions. Therefore, pile driving activities are expected to generate sound levels well below the EPA noise guidelines and other acoustic criteria identified in the Project regulatory review.

Interconnection Station Operation

Onshore facilities will include an Interconnection Station, which will generate noise during operation mostly attributed to the onsite transformer and shunt reactor. Modeling of the Interconnection Station assumed simultaneous operation of the transformer and shunt reactor under normal operating conditions. Modeling results showed that highest predicted received sound level as a result of Interconnection Station operation was 41 dBA, which occurred at Oceana military housing. This received sound level shows compliance with all identified criteria, including the City of Virginia Beach Noise Ordinance, HUD noise standards, and the EPA noise 55 L_{dn} noise guideline, which equates to an L_{eq} of 48.6 dBA. Sound contours corresponding to Interconnection Station operation are displayed in Figure C-6 of Appendix M-1, and tabulated results showing received sound levels at the top 50 most impacted NSRs are given in Table B-4 of Appendix M-1.

WTG Operation

Sound generated by an operating WTG is comprised of both aerodynamic and mechanical sound with the dominant sound component from utility scale WTGs being largely aerodynamic. Aerodynamic sound refers to the sound produced from air flow and the interaction with the WTG tower structure and moving rotor blades. Mechanical sound has been minimized in most modern upwind WTGs. Wind farms, in comparison to conventional energy projects, are somewhat unique in that the sound generated by each individual WTG will increase as the wind speed across the site increases. WTG sound is negligible when the rotor is at rest, increases as the rotor tip speed increases, and is generally constant once rated power output and maximum rotational speed are achieved.

Acoustic modeling was conducted assuming both WTGs are operating continuously and concurrently at the maximum rated sound power level of 112.3 dBA. In addition, the k-factor of 2 dBA was added to this sound power to account for the inherent uncertainty associated with the sound measurements. Sound propagation calculations assumed the water surrounding the wind turbines was perfectly reflective. In addition, though propagation in the atmosphere is not strongly dependent on temperature and humidity, parameters selected for temperature (10°C [50°F]) and relative humidity (70 percent) are representative of favorable sound propagation conditions.

Modeling was completed for the same two meteorological conditions used to analyze pile driving. Modeling results are presented as sound contours in Figures C-7 and C-8 in Appendix M-1, and indicate that received sound levels are reduced to an L_{eq} of 48.6 dBA, which directly corresponds to the EPA L_{dn} guideline of 55 dBA, at a distance of approximately 2,543 ft (775 m) from the WTGs. Sound generated by WTG operation would be inaudible at onshore NSRs due to the significant separation distance.

4.15.2 Underwater Acoustic Environment

4.15.2.1 Affected Environment

Underwater sounds, if they are intense enough, may cause behavioral responses, injury, or even death from concussion (Richardson et al. 1995). However, actual thresholds for behavioral responses to sounds in the natural environment depend on the range and levels of ambient noise that are persistently present. As is routine when conducting noise surveys in air, the significance of any noise as an annoyance can be related to the extent to which it exceeds background levels. Therefore, the prediction of possible masking effects, and the behavior of marine life, will also be influenced by the anticipated background noise levels. The propagation modeling considers the contribution of the Project in isolation; therefore, existing conditions and potential masking effects are not accounted for. In addition, review of the modeling results alone does not provide an indication of when marine life will acclimatize to certain sound levels.

The existing underwater acoustic environment can be described as a combination of many possible noise sources of both natural and man-made origins. Noise from natural sources is generated by physical or biological processes. 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. Shallow water has been defined for the purposes of this hydroacoustic analysis as a water column less than 656 ft (200 m) deep. Research has shown that ambient noise is 5-10 dB higher in shallower water, which is linked to the influence of surface agitation and reflection by the bottom and may also be dependent on localized conditions of sea state and wind speed, varying both spatially and temporally. The ambient noise for frequencies above 1 kHz is due largely to waves, wind, and heavy precipitation; however, it may be evident at frequencies down to 100-300 Hz during otherwise quiet times (Simmonds et al. 2004). Surface ocean wave interaction and breaking waves with spray have been identified as important sources of noise. Wind induced bubble oscillations and cavitation are also near-surface noise sources. Major storms can give rise to noise in the 10-50 kHz band, which can propagate to long ranges with the same mechanism and directionality as distant shipping. At areas within distances of 5 mi to 6.2 mi (8 km to 10 km) of the shoreline, surf noise will be prominent in the frequencies ranging up to a few hundred Hz (Richardson et al. 1995), even during calm wind conditions.

Man-made noise sources can consist of contributions related to industrial development, offshore oil industry activities, naval operations, and marine research but the most predominant contributing noise source is generated by commercial ships and recreational watercraft. Noise from such ships 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. Other potential ship-related sources include vortex shedding from the hull and noise associated with the wake, and noise generated by pipes open to and discharging into the sea. Most shipping contributes in a frequency range of less than 1 kHz. In general, older vessels produce more noise than newer ones and larger vessels produce more than smaller ones, but this is not always the case. Although shipping typically produces frequencies below 1 kHz, small leisure craft may generate sound with frequency components from 1 kHz up to the 50 kHz range due to propeller cavitation at elevated speeds, which may generate noise at somewhat higher frequencies (Simmonds et al. 2004).

In addition to these sound sources, a considerable amount of background noise may be caused by biological activities. Aquatic animals make sounds for communication, echolocation, and prey manipulation, and also 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_{RMS} re 1 microPascal (μPa) at 1 m. 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). With all of the complexities involved, the capacity for acoustic models to estimate background levels is limited, so for that reason the acoustic modeling analysis presented is restricted to future Project construction and operational scenarios only.

The potential harmful effects of high-level underwater sound can be summarized as lethal, physical injury and hearing impairment. In general, biological damage as a result of sound is either related to a large pressure change (barotrauma) or to the total quantity of sound energy received. Other ways in which sound or noise can be detrimental to marine mammals and fish is by causing behavioral disturbance and auditory masking. A regulatory and literature review was conducted to obtain and summarize the most relevant impact criteria in order to assess the impact on marine mammals, sea turtles, and fishery resources.

MMPA Thresholds for Lethal and/or Injurious Auditory Effects

Under the MMPA, Level A harassment is statutorily defined as any act of pursuit, torment, or annoyance that has the potential to injure a marine mammal or marine mammal stock in the wild. NOAA Fisheries recognizes three kinds of noises that could be potentially harassing to marine mammals: continuous, intermittent, and pulse. NOAA Fisheries defines the zone of injury as the range of received levels from 180 dB referenced to 1 μPa root RMS, for marine mammals. The MMPA defines Level B harassment as any act of pursuit, torment or annoyance that has the potential to disturb 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. Current thresholds established for Level B harassment are 160 dB re 1μPa from a non-continuous noise source averaged over the duration of the signal, and 120 dB re 1μPa from a continuous noise source or an intermittent non-pulse source.

These thresholds are based on a limited number of experimental studies on captive odontocetes, a limited number of controlled field studies on wild marine mammals, observations of marine mammal behavior in the wild, and inferences from studies of hearing in terrestrial mammals. In addition, marine mammal responses to sound can be highly variable, depending on the individual hearing sensitivity of the animal, the behavioral or motivational state at the time of exposure, past exposure to the noise which may have caused habituation or sensitization, demographic factors, habitat characteristics, environmental factors that affect sound transmission, and non-acoustic characteristics of the sound source, such as whether it is stationary or moving (NRC 2003).

Criteria levels consider instantaneous sound pressure levels at a given receiver location. Being expressed in RMS units, the criteria account for not only the energy of the signal, but also the length of the pulse. The NOAA Fisheries acoustic guidelines were purposely developed to be protective of all marine mammal species from high sound pressure levels and are assessed from unweighted acoustic signals, so they do not account for the different hearing abilities of marine species at different frequencies. Also, the NMFS (2005) states that such criteria have the disadvantage of not accounting for important attributes of exposure such as duration, sound frequency, or rate of repetition. The NOAA Fisheries cause and effect noise criteria are summarized in Table 4.15-4.

Table 4.15-4. Summary of NOAA Fisheries Cause and Effect Noise Criteria

	Criteria Level	Type
Level A Harassment	180 dBL re 1 µPa (RMS)	Absolute
Level B Harassment	160 re 1 µPa ($RMS_{90\%}$) 120 re 1 µPa (RMS)	Impulse Continuous
Source: Federal Register: January 11, 2005 (Volume 70, Number 7)		

Fish Species

The hearing capabilities and sensitivities of fish vary from species to species but are believed to form three functional hearing groups, e.g., fishes with swim bladders mechanically linked to the ears, fishes with swim bladders not linked to the ears, and fishes without swim bladders. Fish species with a reduced or no swim bladder tend to have a relatively low auditory sensitivity, fish having a fully functional swim bladder tend to be more sensitive, and fish with a close coupling between the swim bladder and the inner ear are most sensitive. In addition, while some fish are sensitive to sound pressure, all fish are capable of detecting particle motion or the rate of displacement of fluid particles by acoustic pressure. The existing body of literature relating to the impacts of sound on marine species can be divided into three categories: (1) pathological, (2) physiological, and (3) behavioral. Pathological effects include lethal and sub-lethal physical damage; physiological effects include primary and secondary stress responses; and behavioral effects include changes in exhibited behaviors. Behavioral changes might be a direct reaction to a detected sound or a result of anthropogenic sound masking natural sounds that fishes make use of in their normal behavior. Risk of injury or mortality resulting from noise is generally related to the effects of rapid pressure changes, especially on gas-filled spaces in the animal's body.

While impact pile driving activity has been linked to fish mortality, there are insufficient data to indicate the percentage of fish killed, whether some species are more susceptible to sound than others, and the distance at which fish are killed (Hastings and Popper 2005). It is possible that fish outside a designated zone of influence are damaged and that ultimately this damage would lead to death. Moreover, there are numerous complicating factors with pile driving that might impact fish.

An interagency work group, including the USFWS and NMFS, has reviewed the best available scientific information and developed criteria for assessing the potential of pile driving activities to cause injury to fish (FHWG 2008). The workgroup established dual sound criteria for injury, measured 33 ft (10 m) away from the pile, of 206 dB re 1µPa Peak and 187 dB accumulated sound exposure level (dB cSEL; re: 1µPa^2 sec) (183 dB accumulated SEL for fish less than 2 grams). While this work group is based on the U.S. West coast, similar East coast species such as the Atlantic sturgeon were considered in developing this guidance (green sturgeon). As these species are biologically similar to the species being considered herein, it is reasonable to use the criteria developed by the FHWG to assess fish injury resulting from Project pile driving operations.

NOAA Fisheries also currently recognizes a 150 dB_{RMS} re 1µPa level as the threshold for disturbance to salmon and bull trout. Based on their assessment, sound pressure levels in excess of 150 dB_{RMS} re 1 µPa are expected to cause temporary behavioral changes, such as elicitation of a startle response or avoidance of an area. Those levels are not expected to cause direct permanent injury. That is not to say that exposure to noise levels of 150 dB_{RMS} re 1µPa will always result in behavioral modifications, but that there is the potential, upon exposure to noise at this level, to experience some behavioral response (e.g., temporary startle to avoidance of an insonified area). In summary, based on the best available information on other fish species, underwater noise at or above the presented in Table 4.15-5 have the potential to cause injury or behavioral modification to fish.

Table 4.15-5. Interim Fisheries Cause and Effect Guidelines

	Criteria Level	Type
Physiological Effects	206 dBL re 1 µPa	Absolute Peak SPL
	187 dBL re 1 µPa²s	SEL_{cum}, For fishes above 2 grams (0.07 ounces)
	183 dBL re 1 µPa²s	SEL_{cum}, For fishes below 2 grams (0.07 ounces)
Behavioral Effects	150 dBL re 1 µPa (RMS)	Absolute
Reference: U.S. Department of the Interior, BOEM. Effects of Noise on Fish, Fisheries, and Invertebrates in the U.S. Atlantic and Arctic from Energy Industry Sound-Generating Activities, Literature Synthesis, 2012		

Sea Turtles

The hearing capabilities of sea turtles are poorly known and there is very little available information on the effects of noise on sea turtles. Some studies have demonstrated that sea turtles have fairly limited capacity to detect sound, although all results are based on a limited number of individuals and must be interpreted cautiously. Most recently, McCauley et al. (2000) noted that decibel levels of 166 dB_{RMS} re 1µPa were required before any behavioral reaction (e.g., increased swimming speed) was observed, and decibel levels above 175 dB_{RMS} re 1µPa elicited avoidance behavior of sea turtles. The study done by McCauley et al. (2000), as well as other studies done to date, used impulsive sources of noise (e.g., air gun arrays) to ascertain the underwater noise levels that produce behavioral modifications in sea turtles. As no studies have been done to assess the effects of impulsive and continuous noise sources on sea turtles, McCauley et al.(2000) serves as the best available information on the levels of underwater noise that may produce a startle, avoidance, and/or other behavioral or physiological response in sea turtles. Based on this and the best available information, NOAA Fisheries believes any sea turtles exposed to underwater noise greater than 166 dB_{RMS} re 1µPa may experience behavioral disturbance/modification (e.g., movements away from insonified area). Table 4.15-6 summarizes the present NOAA Fisheries interim guidelines on underwater noise level which have the potential to cause injury or behavioral modification of sea turtles.

Table 4.15-6. Interim Sea Turtle Cause and Effect Guidelines

	Criteria Level	Type
Behavioral Modification	166 dBL re 1 µPa (RMS)	Absolute
Injury	207 dBL re 1 µPa (RMS)	Absolute
Source: McCauley et al. 2000		

4.15.2.2 Potential Impact Producing Factors, Proposed Environmental Protection Measures, and Best Management Practices

The impact producing factors associated with underwater noise would include direct impacts on marine species from:

- DP thruster use during cable lay operations;
- vessel activities associated with WTG installation;
- impact pile driving during wind turbine foundation installation; and
- WTG operation.

Acoustic modeling was completed with the widely-used the Range Dependent Acoustic Model, which is based on the U.S. Navy's Standard Split-Step Fourier Parabolic Equation. The modeling methodologies were presented and accepted by NOAA Fisheries in a meeting dated October 31, 2013. The following summarizes the results of the modeling analysis. Modeled distances to MMPA threshold and interim guidelines for sea turtles and fish species are provided in Table 4.15-7. The complete Underwater Acoustic Assessment Report including methodologies and sound source levels is included as Appendix M-2.

Table 4.15-7. Minimum and Maximum Modeled Distances to MMPA Thresholds and Interim Guideline for Marine Mammals, Sea Turtles, and Fish Species a/

Regulatory Threshold	Criteria Level	Pile Driving 1.4 meter pile b/ 60 kJ / 600 kJ	Pile Driving 2.4 meter pile b//100 kJ / 1000 kJ	Cable Lay Operations	Wind Turbine Installation	Operational WTGs
Marine Mammal Level A Harassment	180 dBL re 1 µPa (RMS)	32 m / 625m	140 m / 0.9 to 1.7 km	-	-	-
Marine Mammal Level B Harassment	160 dBL re 1 µPa (RMS_{90})	0.9 to 1.7 km / 3 to 7.2 km	1.8 to 3.4 km / 5.6 to 12.2 km	5m or less	20m or less	-
Marine Mammal Level B Harassment	120 dBL re 1 µPa (RMS)	11.7 to 34 km / 15 to 64 km	13 to 47 km / 17.5 to 89.5 km	1.4 to 3.2 km	5.6 km to 13.5 km	100m or less

Table 4.15-7. Minimum and Maximum Modeled Distances to MMPA Thresholds and Interim Guideline for Marine Mammals, Sea Turtles, and Fish Species a/ (continued)

Regulatory Threshold	Criteria Level	Pile Driving 1.4 meter pile b/ 60 kJ / 600 kJ	Pile Driving 2.4 meter pile b//100 kJ / 1000 kJ	Cable Lay Operations	Wind Turbine Installation	Operational WTGs
Sea Turtle Injury	207 dBL re 1 µPa (RMS)	5m or less	5 m or less / 15m or less	-	-	-
Sea Turtle Behavioral Modification	166 dBL re 1 µPa (RMS)	400 to 650 m / 1.8 to 3.4 km	1.4 to 2.8 km / 3 to 8.2 km	-	10m or less	-
Fish Behavioral Modification	150 dBL re 1 µPa (RMS)	2.2 to 5.1 km / 5.9 to 13.5 km	3.5 to 9.3 km / 9.1 to 17.7 km	20m or less	m or less	-

a/ Distances reported for the lightest and worst case hammer forces. The majority of the forces, and therefore distances, will reside between these values. Variations in distances for a given force are related to changes in bathymetry.
Source: Appendix M-2
b/ As of October 2014, the proposed IBGS piles diameters were increased from 7.9 ft. (2.4 m) for the central caisson and 4.6 ft (1.4 m) for the three raked piles to 10.2 ft (3.1 m) and 5.9 ft. (1.8 m), respectively. However, the increased pile diameters fall within the range of sample pile sizes used in the noise modelling analysis. The impact forces associated with the proposed pile drivers have remained unchanged. Therefore, under this underwater modelling scenario the conservative distances to the MMPA thresholds and interim guideline for marine mammals, sea turtles, and fish species remain unchanged.

Direct Impact from Cable Lay Operations

The use of DP thrusters and trenching activities was modeled at four locations along the cable lay route. The locations were chosen to provide analysis on different water depths and bathymetry profiles within the area of impact. Cable lay procedures and DP thrusters were modeled to determine the distances to assess the potential for adverse impacts to aquatic life. For the Level A Harassment marine mammal 180 dB_{RMS}

threshold and the 166 dB_{RMS} behavioral for sea turtles, it was concluded that the distance will be negligible. Distances to the Level B Harassment threshold for marine mammals will be approximately 0.9 mi to 2 mi (1.4 km to 3.2 km). As described in Section 4.3.2.3, to protect marine mammals from underwater noise, Dominion will implement mitigation and minimization measures including observations of time of year windows, application of PSOs during project construction and the establishment of exclusion and monitoring zones and associated startup and shutdown procedures for noise-producing equipment.

The distances to the 150 dB_{RMS} behavior threshold for the fish would be 66 ft (20 m) or less from a DP vessel with thrusters operating at full power. The variation of these distances is due to changing bathymetries and water depths present at the four different cable lay positions reviewed. Additionally, if a fish remains near the construction area, and the vessels operate for a continuous 24-hour period, then the distance to the fisheries interim guideline of 187 dB cSEL accumulated sound exposure level ranges from 410 ft to 984 ft (125 m to 300 m). However, this assumes that the fish species would remain within the ensonified zone in proximity to the DP vessel, resulting in a continuous exposure. The real-time received noise that could potentially result in a cumulative exposure of 187 dB re 1µPa cSEL is approximately equivalent to 1-second SEL of 137 dB_{RMS} for 24 hours, well below the known threshold for physiological effects for fish of 206 dB re 1µPa Peak or even for potential behavioral impacts for fish species, which has been established at 150 dB re 1µPa dB RMS.

Direct Impact from WTG Installation

Vessels associated with WTG installation were also evaluated in terms of potential impacts to marine species. For the marine mammal 180 dB_{RMS} threshold, distances will be no more than 3.3 ft (1 m) from the vessel. Therefore, the distance to the 166 dB_{RMS} physiological effect for sea turtles will be even closer to the vessel. Noise impacts to distances further out will vary based on differences in the bathymetry, but could result in Level B harassment to marine mammals. The distance to the Level B harassment threshold will be approximately 3.5 mi to 8.4 mi (5.6 km to 13.5 km). However, with the application of the mitigation measures described previously, Dominion will be able to successfully minimize impacts to marine mammals.

For the screening level analysis, the distances to the 150 dB_{RMS} behavior limit for fish would be 100 meters or less. Additionally, if we assume that a fish remains near the construction area and that multiple thrusters are continually in use over a 24-hour period, then the distance reached for the 187 dB cSEL accumulated sound exposure level would be 1 mi (1.6 km). However, at this worst-case distance, and assuming continuous exposure of a stationary fish, the real-time received noise that would potentially result in a cumulative exceedances of 187 dB cSEL are approximately equivalent to 1-second SEL of 137 to 138 dB_{RMS}, well below the known thresholds which cause physiological or even a potential behavioral impact for fish.

Direct Impact from Pile Driving

Pile driving activities will occur during daylight hours starting approximately 30 minutes after dawn and ending 30 minutes prior to dusk, unless a situation arises where ceasing the pile driving activity would compromise safety (both human health and environmental) and/or the integrity of the Project. Each IBGS foundation is anticipated to require up to 7 days to complete the installation.

A soft-start procedure, starting at 60 kJ (5.9 ft [1.8 m] raked piles) and 100 kJ (10.2 ft [3.1 m] central caisson pile) will reduce the initial range over which instantaneous injury may occur and be effective in deterring aquatic life to a safe distance before the full energy piling is reached. Impact pile driving included the analysis for the maximum 600 kJ (5.9 ft [1.8 m] raked piles) and 1000 kJ (10.2 ft [3.1 m] central caisson pile) impact forces, thereby describing the full range of sound levels expected to be experienced throughout an entire piling sequence. The resulting distances to the Level A harassment of marine mammals will range from 105 ft to 2,051 ft (32 m to 625 m) for the raked piles and 0.6 mi to 1.1 mi (0.9 km to 1.7 km) for the central caisson. The resultant distances to the Level B harassment of marine mammals threshold of 160 dB_{RMS90} threshold is ranges from 0.6 mi (0.9 km) and 4.5 mi (7.2 km) for the rake piles and 1.1 mi (1.8 km) and 7.6 mi (12.2 km) for the central caisson. The distance to the 166dB_{RMS} will be even closer to the construction area, ranging from 0.2 mi (0.4 km) to 2.1 mi (3.4 km) for the rake piles and 0.8 mi (1.4 km) to 5.1 mi (8.2 km) for the central caisson. The variation in distance to thresholds is mostly due to changes in bathymetry and impact force.

The calculation of cSEL only considers the noise dose received from a single pile installation; the increased dose from all three inward battered piles and the central caisson of the IBGS foundation would not be significant assuming that the animal swims away. Given the zone over which piling is expected to occur, the movement of the marine mammals or sea turtles away from the source of noise should be sufficient to minimize the risk of auditory injury during longer installation operations. Hearing recovery time would be expected during significant gaps in piling. The 12-hour period represents the daylight time window that pile driving is in operation and accounts for overnight recovery time. In addition, as stated previously, Dominion will further minimize impact to marine mammals and sea turtles using various methods including soft-starts, the application of PSOs, the establishment of startup and shutdown procedures as well as exclusion and monitoring zones.

The distances to the 150 dB_{RMS} limit for fisheries resources are 1.4 mi (2.2 km) to 3.2 mi (5.1 km) for the initial 60 kJ impact force and up to 3.7 mi (5.9 km) to 8.4 mi (13.5 km) for the worst case 600 kJ impact force. For the larger central caisson pile, the distances to the 150 dB_{RMS} limit are 2.2 mi (3.5 km) to 5.8 mi (9.3 km) for the initial 100 kJ impact force, and up to 5.7 mi (9.1 km) to 11 mi (17.7 km) for the maximum expected impact force necessary to seat the pile at 1,000 kJ.

To evaluate the 187 dB accumulated sound exposure level, it is assumed that the fish remain stationary. To achieve the necessary penetration depth, the pile driving will require an estimated 2,000 blows per pile for the rake piles and 500 strikes for the larger diameter caisson pile. The lower number of strikes for the caisson pile is due to the fact that the target depth of penetration is lower than the longer raked piles, yielding a shorter duration of pile hammering.

The resulting distance for determining the accumulated 187 dB cSEL is 1.1 mi (1.7 km) to 6.2 mi (10.0 km) for the rake piles and 1.1 mi (1.7 km) to 7.5 mi (12.1 km) for the central caisson pile. However, at this worst case distance and assuming continuous exposure at maximum impact force, the real-time received noise levels that would potentially result a cumulative exceedances of the 187 dB cSEL are approximately equivalent to a 1-second SEL of 153 to 154 $dB_{RMS,}$ for the pile and 160 and 161dB_{RMS} for the central caisson. At these distances, the received sound levels are below established thresholds of 206 dB re 1µPa Peak, which would not cause physiological effects for fish, but may result in short term behavioral changes.

Direct Impact from WTG Operation

Possible noise from the operation of the WTGs has also been modeled based on actual measurement data and shows that noise levels within the boundary of the Project are not likely to be significantly above ambient noise, but may increase the ambient noise slightly during periods of calm seas and low shipping traffic. It should be noted that a major contribution to the ambient noise would result from sea-state, which would be expected to increase as the turbines rotational speed increases with wind speed.

Acoustic modeling of underwater operational sound was performed for the design wind condition during normal operations. The predicted sound level from operation of a wind turbine has been estimated at only 130 dBL at 66 ft (20 m) from the wind turbine foundation and attenuates to the 120 dB re 1 µPa threshold level at a relatively short distance of 328 ft (100 m). These levels are very close to the expected regularly reoccurring ambient noise levels. The VOWTAP WTGs are located approximately 3,450 ft (1,050 m) apart from one another, so no cumulative effects above 120 dB_{RMS} re 1 µPa threshold will occur.

The operational effects of the Project are anticipated to be minimal, with no adverse effect to marine mammals and aquatic life. Underwater noise levels in this range may be perceptible to marine mammals that swim close to an operating WTG, but would not likely adversely affect them or their prey. Although the effect on fish response is more difficult to establish given the lack of information available in the scientific literature, there is indicative evidence that fish would be unlikely to show significant avoidance to the noise levels radiating from the turbine and received sound levels will be below the 150 dB_{RMS} behavioral threshold set for listed species. Vessels servicing the Project site will produce underwater sounds typical of existing vessel traffic in the area; therefore, the Project poses no unique or special risk to marine life.

To evaluate the 187 dB accumulated sound exposure level, a 24-hour window of operation was assumed, and that the fish remain stationary. The distance for measuring the accumulated 187 dB cSEL is less than 16 ft (5 m). However, at this worst case distance, and assuming continuous exposure, the real-time received noise levels that would potentially result in a cumulative exceedance of the 187 dB cSEL are approximately equivalent to a 1-second SEL of 137 to 138 dB_{RMS}, well below the threshold level to cause a physiological or even a potential behavioral response for fish species.

4.16 Air Quality

This section discusses existing air quality in and near the Project Area, describes the construction and operational activities associated with the Project that will generate air emissions, and addresses air quality protective measures. This section also provides a summary of the resulting emissions and applicable regulations.

The specific air pollutants addressed in this section consist of the criteria air pollutants which are pollutants for which the EPA has established National Ambient Air Quality Standards (NAAQS), and greenhouse gases (GHGs). The criteria air pollutants are nitrogen oxides (NO_X), volatile organic compounds (VOC), carbon monoxide (CO), particulate matter 2.5 and 10 micrometers in diameter or less ($PM_{2.5}/PM_{10}$), sulfur dioxide (SO_2), and hazardous air pollutants (HAPs), and the GHGs which consist of carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O), and sulfur hexafluoride (SF_6).

4.16.1 Affected Environment

The Project Area is within the Hampton Roads air quality planning area of Virginia, including the coastal and offshore waters of Virginia. The Hampton Roads planning area consists of the cities of Chesapeake, Hampton, Newport News, Norfolk, Poquoson, Portsmouth, Suffolk, Virginia Beach, and Williamsburg; and the counties of Gloucester, Isle of Wight, James City, and York. The Hampton Roads area has had a long history of planning requirements for various ozone NAAQS (VDEQ 2013). The Hampton Roads area was originally designated a marginal nonattainment area on November 6, 1991 (56 Federal Register [FR] 56694), under the 1991 1-hour NAAQS. The regional area established the Hampton Roads Air Quality Committee, and submitted to the EPA a re-designation request and maintenance plan. EPA approved the re-designation request on March 12, 1997 (62 FR 34408), and the area was re-designated to attainment/maintenance status.

On April 30, 2004 (69 FR 23941), the Hampton Roads area was designated as a marginal nonattainment area for the 1997 8-hour ozone NAAQS, and the 1991 1-hour ozone NAAQS was subsequently revoked. Under the lead of the Hampton Roads Air Quality Committee, the area implemented a number of control measures that resulted in significant reductions of ozone precursors, and due to the air quality improvements, the area qualified for attainment status. Subsequently, the Committee developed a re-designation request and maintenance plan. On June 1, 2007, the area was designated attainment/maintenance for the 1997 8-hour ozone NAAQS with EPA approval (72 FR 30490). On June 6, 2013, EPA proposed to revoke the 1997 8-hour NAAQS, but this has not yet been finalized.

In 2010, EPA strengthened the 8-hour "primary" ozone standard (2008 ozone NAAQS) and on May 21, 2012, the Hampton Roads area was designated as attainment for the 2008 ozone NAAQS. Due to implementing a number of control measures, air quality in the Hampton Roads area has significantly improved in the last 10 years. In addition to being in attainment of the current (2008) ozone NAAQS, the area is in attainment (or unclassified) for all other NAAQS. This trend of improving air quality is expected to continue even though population in the area is expected to grow. Until the 1997 8-hour ozone NAAQS is revoked, the Hampton Roads area is considered an ozone maintenance area potentially subject to General Conformity requirements (see Section 4.16.3.2).

4.16.2 Potential Impact Producing Factors

Other than limited testing of small emergency generator engines on the WTG platforms, normal operation of the Project will not directly generate emissions of any regulated air pollutants, including greenhouse gases. However, there will be indirect emissions associated with construction and operation of the Project as well as indirect emissions associated with the decommissioning of the turbines.

4.16.2.1 Construction Air Emissions

Emissions associated with the construction phase of the Project will result from transport of construction materials and the use of construction equipment. The construction process is described in Section 3.5.

Detailed equipment listings and information for each type of construction activity, and resulting air emission calculations and methodology, are presented Appendix I. A summary of the types of vessels and their function during the construction phase of the Project can be found in Section 3.3, Table 3.3-1.

Table 4.16-1 summarizes emissions resulting from onshore and offshore construction. Detailed emission calculations and methodology are presented in Appendix I.

Table 4.16-1. Estimated Construction Emissions

Activity	Estimated Annual Emissions (tons)							
	VOC	NO_X	CO	PM_{10}	$PM_{2.5}$	SO_2	HAPs	GHG (CO_2e)
Onshore Construction Emissions								
Export Cable Landfall Construction	0.18	1.78	0.67	0.12	0.11	0.003	0.04	329
Onshore Interconnection Cable & Switch Cabinet Installation	0.13	1.27	0.48	0.08	0.08	0.002	0.03	247
Interconnection Station Installation	0.05	0.49	0.19	0.03	0.03	0.001	0.01	129
Subtotal	**0.37**	**3.54**	**1.34**	**0.23**	**0.22**	**0.01**	**0.09**	**705**
Offshore Construction Emissions								
Offshore Turbine Installation	9.40	203.11	102.79	11.19	10.85	0.047	1.91	14,677
Offshore Cable Installation	1.21	33.44	16.62	1.22	1.18	0.007	0.22	2,546
Subtotal	**10.61**	**236.55**	**119.41**	**12.41**	**12.03**	**0.05**	**2.13**	**17,223**
TOTAL	**10.98**	**240.09**	**120.75**	**12.63**	**12.26**	**0.06**	**2.22**	**17,223**
Note: All construction emissions are assumed to occur in 2017.								

4.16.2.2 Emissions During WTG Operations

As mentioned previously, the only potential air emissions directly associated with the operation of the WTGs would be those generated from the diesel-powered backup power system. These generators will each operate only during emergency situations and during testing and maintenance purposes for no more than an estimated maximum of 500 hours per year. It is currently anticipated that there will be two emergency generators, one for each WTG. The emergency generators have an approximate power rating of 125 kW. Each generator will have a 170-gallon sub-base tank as well as a 1,000-gallon external tank providing enough fuel to operate the generators for up to one week.

In addition to the backup power system, there will be some minor indirect annual operating emissions, related to the equipment needed to periodically maintain the WTGs and to perform various research and testing activities. These emissions will primarily be from diesel-fueled crew boats and maintenance equipment traveling to and from the VOWTAP demonstration site.

Fugitive GHG emissions from circuit breakers will also be associated with the Project. The circuit breakers will be insulated with SF_6, a colorless, odorless, non-flammable greenhouse gas that is an efficient electrical insulator. Three circuit breakers are being proposed for the Project, one associated with WTG 1 and two with WTG 2, each containing a maximum of approximately 7.1 pounds of SF_6.

Table 4.16-2 provides a summary of the annual estimated air emissions resulting from the operational phase of the Project. Detailed emission calculations and methodology are presented in Appendix I.

Table 4.16-2. Estimated Annual Operating Emissions

Activity	Estimated Annual Emissions (tons per year)							
	VOC	NO_X	CO	PM_{10}	$PM_{2.5}$	SO_2	HAPs	GHG (CO_2e)
Operations & Maintenance Activities	0.40	11.59	5.92	0.43	0.42	0.002	0.08	475
Emergency Generators	0.01	0.44	0.11	0.03	0.03	0.001	0.001	31
Circuit Breaker Fugitive GHG	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.2
TOTAL	**0.41**	**12.03**	**6.02**	**0.46**	**0.45**	**0.003**	**0.08**	**508**

4.16.2.3 Decommissioning Emissions

The operational life of the Project will be 20 years, upon which the WTGs and associated equipment may be decommissioned. The decommissioning process would basically be the reverse of construction utilizing similar vessel types and similar operating scenarios. Since decommissioning of the Project would occur in the distant future, estimating emissions would be impractical and highly speculative. However, the emissions associated with this activity would probably be comparable to but lower than the emissions from the offshore construction activities.

4.16.2.4 Air Emission Summary

As shown above in Tables 4.16-1 and 4.16-2, the largest air emissions associated with the VOWTAP will be generated during the construction phase of the Project. Table 4.16-3 presents a comparison of expected emissions from the Project with emissions estimates for the greater Hampton Roads planning area.

Table 4.16-3. Comparison of Emissions, VOWTAP and Hampton Roads Area

Pollutant	2017 –Emissions Estimates (TPY) [a]		
	Hampton Roads Area	VOWTAP	% VOWTAP of Hampton Roads Area
VOC	48,019	11.2	0.02
NO_X	47,405	246.1	0.52
CO	249,476	123.8	0.05
PM_{10}	22,864	12.9	0.06
SO_2	27,733	0.06	0.0002

[a] Note: 2017 VOWTAP emission estimates assume all construction activity is occurring in 2017 and the annual operational emissions occur for 6 months in 2017. The 2017 Hampton Roads Area emission estimates are from Table 5 in the Hampton Roads Ozone Advance Action Plan, April 2013 (VDEQ 2013).

As presented in the table above, the total emissions from the Project will be less than 0.6 percent of the total emissions for each pollutant estimated for the entire Hampton Roads area.

4.16.3 Regulatory Applicability

The VOWTAP will be located approximately 24 nm (27 mi [43 km]) off the coast of Virginia in the Hampton Roads Area, in federal waters on the OCS.

4.16.3.1 OCS Air Permit

The EPA is authorized to regulate the air emissions associated with sources situated in the OCS in accordance with the OCS regulations presented in 40 CFR Part 55. OCS sources are defined in 40 CFR Part 55.2 and would include offshore wind turbines, any vessels for the purposes of constructing, servicing, or decommissioning the wind turbines, and seafloor boring. The OCS source definition includes vessels only when they are permanently or temporarily attached to the seabed; and erected thereon and used for the purpose of exploring, developing, or producing resources from the seabed; or physically attached to an OCS facility, in which case only the stationary sources aspects of the vessels will be regulated. Under the EPA rules, for all OCS sources located within 25 mi (40 km) of a state's seaward boundaries, the requirements are the same as they would be otherwise applicable if the source were located in the corresponding onshore area. Since the VOWTAP demonstration site is located approximately 24 nm (43 km) from the coast line of Virginia (approximately 20.3 nm [43.2 km] from the Virginia seaward boundary), the OCS sources will be subject to all of the requirements of 40 CFR Part 55. This includes, but is not limited to the federal requirements as set forth in 40 CFR Part 55.13, and the federal, state, and local requirements of the nearest onshore area (Hampton Roads Area, Virginia).

Any CAA permits required in accordance with EPA regulations would be issued by the VDEQ. On October 7, 2011, VDEQ sent a letter to the EPA requesting formal delegation of authority to implement and enforce the requirements of the OCS regulations within 25 mi (40 km) of Virginia's seaward boundary. Subsequently on February 2, 2012, EPA sent VDEQ a letter authorizing VDEQ to implement, enforce, and administer the following Sections of 40 CFR Part 55 for the OCS sources in which Virginia will be the corresponding onshore area (as published in Federal Register [Federal Register, July 27, 2012]):

- 55.1 Statutory authority and scope;
- 55.2 Definitions;
- 55.3 Applicability;
- 55.4 Requirements to submit a notice of intent;
- 55.6 Permit requirements;
- 55.7 Exemptions;
- 55.8 Monitoring, reporting, inspections, and compliance;
- 55.9 Enforcement;
- 55.10 Fees;
- 55.13 Federal requirements that apply to OCS sources;
- 55.14 Requirements that apply to OCS sources located within 25 mi (40 km) of States' seaward boundaries, by State;
- 55.15 Specific designation of corresponding onshore areas; and
- Appendix A to Part 55—Listing of State and Local Requirements Incorporated by Reference Into Part 55, by State).

In June 2014, Dominion submitted a notice of intent to EPA, which is required prior to submitting an application for a preconstruction permit and for EPA to designate the Corresponding Onshore Area, in accordance with the EPA's OCS air regulations specified in 40 CFR 55.

To determine the permit applicability for the Project's OCS source, the VOWTAP's Potential to Emit (PTE) emissions have been estimated as described above and in Appendix I. In determining the Project's PTE emissions, vessels that are servicing or associated with the operations of the VOWTAP must be counted as direct emissions if the vessels are at the Project or in transit to or from the Project and within 25 mi (40 km) of the VOWTAP site. This includes emission associated with the construction phase of the Project as well as the operational phase. Based on the VOWTAP's PTE emission estimates, presented in Tables 4.16-1 and 4.16-2, the Project will be considered a major source requiring an air permit issued by VDEQ. The Project will be considered a state major source since the PTE emissions were estimated to more than 100 tons per year of any criteria pollutant; however, it will not require a Prevention of Significant Deterioration permit since the emissions are estimated to be less than 250 tons per year of any criteria pollutant, and less than 100,000 tons per year of GHGs. Subsequently, an OCS permit application has been submitted to VDEQ in October 2014 for this proposed Project, in accordance with 40 CFR Part 55.6 and with VDEQ air regulations specified in 9VAC5 Chapter 80 Part II Article 6, Permits for New and Modified Stationary Sources.

4.16.3.2 General Conformity

The EPA General Conformity Rule (40 CFR Part 51 and 93) ensures that federal actions comply with the NAAQS, in order to meet CAA requirements. The CAA requires that federal actions that result in emissions in nonattainment areas and maintenance areas within states conform to the federally approved State Implementation Plan. Because vessels supporting the Project during both construction and operational phases travel through state waters, a General Conformity determination would be required if emissions exceed 100 tons per year in the Hampton Roads maintenance area.

General Conformity requirements can apply in areas designated as "nonattainment" with respect to NAAQS, or areas which are "attainment" but which were previously designated as nonattainment—such areas are referred to as "maintenance" areas. The Hampton Roads area is currently an ozone maintenance area with respect to the 1997 ozone NAAQS; however, it is in attainment with respect to the 2008 ozone NAAQS. This area was not designated as a nonattainment area with respect to the 2008 ozone standard, and is not a maintenance area with respect to that standard. On June 6, 2013, EPA proposed that the 1997 ozone NAAQS be revoked, and therefore it is anticipated the Hampton Roads area will cease to be a maintenance area when that proposed rule is finalized, and become exempt from General Conformity requirements altogether. In the event the 1997 ozone standard is not revoked, or the rule is altered in such a way that the area remains designated as a maintenance area, and the VDEQ does not consider the VOWTAP a research and demonstration project exempt from the General Conformity regulations, then these requirements will apply to the Project. However, this will not require that individual pieces of equipment comply with any new limits; instead, if VOC or NO_X (ozone precursor pollutants) emissions (excluding the stationary sources that require an air permit, per 9VAC5-160-30.G.1) exceed the General Conformity 100 ton per year threshold, as specified in 9VAC5-160-30.E.2, a separate general conformity analysis will be prepared and submitted by BOEM to evaluate the emissions from the VOWTAP, less OCS sources, and will be presented to VDEQ for an applicability determination. VDEQ will determine if these emissions can be accommodated by the existing maintenance plan for the Hampton Roads area by demonstrating that the Project emissions, when combined with the regional emissions estimates in the maintenance plan, would remain below the maintenance emissions cap for the area.

4.16.4 Proposed Air Quality Protection Measures and Best Management Practices

The International Maritime Organization established the International Convention on the Prevention of Pollution from Ships (MARPOL), a treaty first adopted in 1997 to limit the exhaust gas from ships, including SO_X and NO_X. MARPOL established an Emission Control Area (ECA) that consists of the U.S. coastline out to 200 nm (230 mi [370 km]) from land. Starting on January 1, 2015, the maximum fuel sulfur limit will be 0.1 percent by weight within ECAs. However, since June 1, 2012, EPA's sulfur limit on diesel fuel sold in the U.S. has been 0.0015 percent by weight (40 CFR Part 80, Subpart I). Since vessels providing construction or maintenance services for the Project will be using this low-sulfur fuel, SO_X emissions and fine particulate matter from diesel engines will be minimized to the extent practicable. In addition to the restrictions of the sulfur content in fuel, MARPOL Annex VI has established NO_X limits for engines dependent on engines size and displacement. Separately, diesel engines installed on marine vessels constructed on or after January 1, 2016 are required to meet Tier III NO_X requirements when operating within ECAs.

During construction, Dominion will comply with the OCS air rule (40 CFR 55 et. seq.), under which jack-up vessels and other vessels/barges attached to the sea floor used for construction are considered stationary sources and emissions controls on the engines used for construction activities need to be consistent with those that would be required onshore. The engines located on these vessels, along with engines located on the WTG substructures, will be considered OCS sources and designated as stationary engines subject to the applicable Federal regulations at 40 CFR 60 Subpart IIII – Standards of Performance for Stationary Compression Ignition Internal Combustion Engines. In addition, these diesel stationary engines will be subject to EPA regulations at 40 CFR 63 Subpart ZZZZ – National Emission Standards for Hazardous Air Pollutants for Stationary Reciprocating Internal Combustion Engines.

Dominion will require its equipment and fuel suppliers to provide equipment and fuels for the Project that have been certified to be in compliance with the applicable EPA standards or equivalent. These standards are reflective of the best available control technology for non-road and marine engines, and account for the use of state-of-the-art fuels, combustion controls and optimization, and available add-on controls for the power rating and model year of the specific engine. All equipment and fuel suppliers will implement the relevant BMPs in the OCS air permit when approved by VDEQ.

The stationary engines that will be considered OCS sources during construction activities, situated on the derrick barge, jack-up vessel, and support barge, and the WTG emergency generators, will be subject to permitting under VDEQ regulations 9VAC5-80-1100, which requires that best available control technology (BACT) apply for each regulated pollutant for which there would be an uncontrolled emission rate equal to or greater than the levels specified in 9VAC5-80-1105 C. Based on the estimated emission rates for the Project, the regulated pollutants to which BACT applies will be NO_X, CO, and $PM_{2.5}$.

The OCS source engines situated on the vessels and used during construction are unlike stationary source installations, because they will be owned and operated by contractors and used for this project on a one-time basis only. When evaluating the cost-effectiveness (dollars per ton removed) of BACT alternatives for stationary source installations, costs are annualized and divided by the emissions per year. For these engines, the entire cost of any BACT alternatives would need to be divided by the emissions during just the construction year, making add-on controls not cost-effective. That being said, Dominion believes that it is feasible to require contractors to use model year 2007 or later marine engines certified by EPA under 40 CFR 94 or 1042, or non-marine engines (e.g., non-road engines) certified by EPA to meet "Tier 2" standards or better (under 40 CFR 89 or 1039). Therefore, Dominion is proposing that marine engines having a model year of 2007 or later and non-road engines complying with the Tier 2 standards (in 40 CFR 89 or 1039) or better would satisfy BACT.

The Project will also include circuit breakers insulated with SF_6. This gas is used for electrical insulation, arc quenching, and current interruption in high-voltage electrical equipment. SF_6 will be enclosed and sealed under pressure within the circuit breaker, which under normal circumstances do not leak gas. However, fugitive losses of SF_6 may occur and contribute to the GHG emissions from the Project. Currently, three circuit breakers, one associated with WTG 1 and two with WTG 2, are proposed for the Project.

Dominion is proposing to meet BACT standards for the circuit breakers by installing the circuit breakers with a low pressure alarm and a low pressure lockout. The alarm will alert operating personnel of any leakage in the system and the lockout prevents any operation of the breaker due to lack of "quenching and cooling" SF_6 gas. The maximum annual leakage rate for SF_6 will not exceed 0.5 percent of the total SF_6 storage capacity of the Project's circuit breakers. Dominion will monitor emissions annually in accordance with the requirements of the Mandatory Greenhouse Gas Reporting rules for Electrical Transmission and Distribution Equipment Use in 40 CFR Part 98, Subpart DD. Annual SF_6 emissions will be calculated according to the mass balance approach in Equation DD-1 of Subpart DD.

4.17 Public Health and Safety

Offshore wind energy is a non-emitting, non-combustible, waste-free energy source that poses minimal risks to public health and safety. Dominion is committed to carrying out its business activities with a primary focus on health, safety, and well-being of its employees, contractors, third parties, and general public.

This section addresses the health and safety issues relevant to an offshore wind energy project and associated facilities, including public access, hazardous materials, non-routine events, and EMF. Public health and safety issues related to marine vessel traffic, onshore transportation, and aviation are discussed in Section 4.14. Onshore emergency response facilities are discussed under public services in Section 4.11. The draft VOWTAP SMS is provided in Appendix S.

4.17.1 Affected Environment

The affected environment as it relates to public health and safety depends on the location of facilities in relation to existing infrastructure, public areas, and user and community groups that may be affected by health and safety risks related to the Project. The area associated with the VOWTAP WTGs, Inter-Array Cable, and Export Cable consists of open ocean; there are no permanent structures or other facilities near the offshore portion of the Project Area. Commercial, military, and recreational vessels are transient features of the affected environment surrounding the offshore Project Area.

The proposed onshore Project facilities, including the Switch Cabinet, Onshore Interconnection Cable, Fiber Optic Cable, and Interconnection Station, will be located entirely within the boundaries of Camp Pendleton within the City of Virginia Beach, Virginia. Camp Pendleton is a state-owned military installation primarily used for on-site training of Virginia National Guard personnel. There are no public areas immediately adjacent to the VOWTAP onshore facilities.

The Construction Port, O&M facilities, and Base Port will be located in the cities of Virginia Beach, Norfolk, and/or Newport News, Virginia. As stated in Section 3.2.6, Dominion will locate these Project support facilities at existing waterfront industrial or commercial site(s) that are currently supporting similar marine construction and O&M activities.

4.17.2 Potential Impact Producing Factors, Proposed Health and Safety Protection Measures, and BMPs

The primary factors that could result in impacts on public health and safety include accidents during construction, operation, or decommissioning, are public access to Project facilities, accidental releases of hazardous materials, and non-routine emergency events.

4.17.2.1 Accidents During Construction, Operation, and Decommissioning

The VOWTAP is dedicated to the concept that all accidents are preventable. No task is so important as to justify injuring employees, damaging property, or harming the environment. Employees, customers, and vendors engaging in work on the Project will be provided a work environment that will strive to eliminate all injuries and illnesses from recognized hazards through designing, planning, training, and executing safe work BMPs. Protection of people is a management responsibility and it is expected that all subcontractors will adopt Dominion's Incident Free Philosophy. Each contractor's management is responsible to ensure that their respective employers, subcontractors, and employees engaged on the Project comply with applicable regulatory requirements, as well as individual company and project-specific requirements.

Dominion will manage the overall health and safety of the Project under a Project-specific SMS developed in accordance with 30 CFR 585.810 § 585(627 (d), 614 (b) and 651. The overall goal of the SMS is to identify and mitigate hazards associated with the activities undertaken by employees on the Project that have the potential to affect human health or the environment.

More specifically, the SMS manages activities in respect to:

- Hazard identification;
- Risk management and control measures; and
- Protection of employees, contractors, and the public.

The SMS describes:

- Leadership commitment;
- Health and safety responsibilities of the Project employees; and
- Health and safety in Project execution.

This SMS is applicable to the activities performed in relation to:

- Project offices;
- Project travel; and
- Other work locations (vessels, ports, construction sites, etc.).

The Project will provide active leadership and support of safety, security, occupational health, environment, fire prevention, incident management, and other loss-related control activities. A draft of the proposed Project SMS is provided in Appendix S. This draft will be finalized prior to construction in consultation with relevant regulatory agencies, including but not limited to BOEM and the USCG.

4.17.2.2 Public Access

As described in Section 3.3.4, during offshore construction, Dominion will restrict temporary access along the proposed Inter-Array Cable and Export Cable construction right-of-ways, the work areas surrounding each WTG, and the Offshore HDD Work Area to minimize potential impacts to local mariners. All onshore work will be conducted within the boundaries of Camp Pendleton, and public access to work sites will be limited. To ensure protection of military personnel during construction, all equipment will be stored within the fenced Onshore HDD Work Area. In addition, no trenches or holes will be left open or unsecured overnight, and at no time will roadways be blocked to base vehicular traffic.

During operations, the WTG design provides a "haven of safe refuge" for boaters who may experience an emergency in the vicinity of the VOWTAP. The tower structure could serve as a mooring for a vessel in distress, and the platform on the WTG foundation can serve as a refuge while waiting for rescue. Access to the interior of the turbine will be restricted by the locked door at the base of the tower.

The Project's offshore and onshore cables (Inter-Array, Export Cable, Onshore Interconnection Cable and Fiber Optic Cable) will be buried to sufficient depths to prevent public access. The onshore Switch Cabinet and Interconnection Station will be located within the boundary of Camp Pendleton. The Interconnection Station will be surrounded by a fence and locked to prevent public access.

4.17.2.3 Accidental Release of Hazardous Materials

Construction and operation of the Project will involve the use of small amounts of hazardous materials, including hydraulic fluids, glycol, synthetic ester liquid, and diesel fuel. These materials may present a danger to public health if they are improperly managed or released into the environment. Potential impacts depend on the quantity, concentration, and characteristics of the hazardous material.

As standard practice, marine vessels involved in construction and operation of the Project will operate under oil spill prevention and response plans that comply with USCG requirements relating to prevention and control of oil spills and the discharge of wastes. Secondary containment will be utilized for oils and greases in accordance with all state and federal regulations. A spill response kit will be present on site at the Construction Port. Following construction, vessel operations will include work boats transporting Project personnel, tools, and materials to and from the WTGs for ongoing maintenance and response to WTG problems or failures. Maintenance vessels may transport hazardous materials, including primarily lubricants, hydraulic oil, and coolant; these materials will be transported in water-tight containers to prevent accidental spills.

During operation of the Project, the WTGs will contain small amount of oils, fuel, and other hazardous materials as described in Section 3.2.1 The design of the WTGs includes secondary containment designed to contain potential spills of these materials.

At the Construction Port, Base Port, and O&M facility, secondary containment and a spill response kit will be provided for oils and other hazardous materials in accordance with applicable state and federal regulations. The Project will minimize potential impacts through appropriate construction BMPs and compliance with the Project Spill Prevention, Control, and Countermeasures Plan and Oil Spill Response Plan that will be provided for agency review and approval prior to construction.

The Export Cable will not contain or be composed of any hazardous materials.

The Project Interconnection Station equipment, including the transformer and shunt reactor, will contain a total of approximately 2,246 gallons (8,500 liters) of oil. As described in Section 3.2.5, each of these pieces of equipment will include secondary containment, as required, in accordance with applicable regulations.

4.17.2.4 Electric and Magnetic Fields (EMF)

As discussed in Appendix K, the electric fields associated with the Project cables will be effectively blocked by the ground and will present no risk to human health or safety.

4.17.2.5 Non-Routine Events

Non-routine events may include foundation or WTG failure, response to extreme weather events, lightning strike, and fires.

Foundation or WTG failure is extremely unlikely. In the event that a component of the WTG collapses, there are no permanent structures or facilities near the WTGs that would be affected, and the likelihood of a vessel transiting underneath a WTG at the time of collapse is extremely low.

In accordance with engineering standards for offshore wind turbines (IEC 61400-1/3), the WTGs will shut down in extreme environmental conditions. Standard environmental operating conditions include cut-out wind speed greater than 56 mph (25 m/s) and air temperature greater than 14°F (-10°C) and less than 104°F (40°C). The WTGs have been designed following Class I-B specifications of the standards IEC-61400-1/IEC-61400-3. The design is specifically suited for offshore wind sites with referenced wind speeds of 50 m/s (112 mph over a 10 minute average) and 50-year extreme gusts of 70 m/s (157 mph over a 3 sec average) and air temperature greater than -4°F (-20°C) and less than 122°F (50°C). In the event of unsafe conditions for the turbines, including temperature, wind speed, or shaking, the WTG would be shut down by the SCADA system. The SCADA system has been designed to meet the standard IEC61400-25, "Communications for Monitoring and Control of Wind Power Plants."

A lightning protection system will be present on each WTG. The combination of external and internal protection reduces the potential damage to people and materials. The external protection will be designed to handle direct lightning strikes and to conduct the lightning peak current down into the grounding system at the bottom of the tower foundation. The internal system minimizes damage and interference by using equipotential bonding, overvoltage protection, and electromagnetic coordination. The blades will be protected by a receptor at their tip and a conductive cable system leading to the tower and then down to the earth.

The Haliade 150 WTG also has multiple layers of safety provisions to control rotor speed and safely stop operation of the WTG when necessary. To ensure the chances of rotor overspeed from an extreme event (e.g., extreme winds or equipment malfunction) are minimized to the maximum extent possible,the WTG controls are validated in a lab prior to installation using real control hardware and an environment simulator to confirm controller stability and rotor speed command (i.e., hardware in the loop procedure).

Additional operational safety systems on each WTG include a back-up power generator, FAA and USCG-compliant aviation and navigation obstruction lighting, fire suppression, and first aid and survival equipment. Protective relays and fusing for the onshore electrical facilities have been designed to quickly de-energize equipment under fault conditions, thereby minimizing associated electric shock and fire hazard.

4.18 Summary of Mitigation and Monitoring

Dominion considered avoidance and minimization of environmental impacts throughout the site selection and design processes. These location and design measures have been incorporated into the current project. In addition, Dominion will carry out the protective measures and BMPs described throughout Section 4, and summarized in this section.

4.18.1 Physical and Oceanographic Conditions

<u>Offshore:</u>

- Dominion has prepared a construction schedule that takes into consideration both weather and environmental conditions in the Project Area.
- Dominion has selected minimum target depths of burial of 3.3 ft (1 m) along the Inter-Array Cable route and 6.6 ft (2 m) along the Export Cable route to ensure protection from external egression. In areas where the minimal target depth of burial cannot be achieved, Dominion may also apply additional cable protection measures such as concrete mattresses or rock berms.
- Where the Export Cable crosses the DNODS, and within a 100-ft (30.5-m) perimeter upon entering and exiting the DNODS, Dominion will bury the cable not less than 6 ft (1.8 m) below the existing bottom,
- Dominion has avoided man-made hazards to the extent possible. Along portions of the of the Export Cable route that cross the live fire/danger zone and/or dredge disposal site, Dominion may increase the cable burial depth of the Export Cable up to 15 ft (4.5 m) to ensure protection. Additional surveys specifically designed for MEC detection and evaluation will also be conducted, as necessary, within the military practice areas prior to cable installation. These surveys will be performed in close coordination with applicable military stakeholders.
- Prior to installation, Dominion will complete route clearance and pre-lay grapnel activities to identify potential obstructions along the proposed cable routes and within the WTG and Offshore HDD Work Areas. Any obstructions identified during these activities will be removed or moved, as appropriate.
- Dominion will conduct regular monitoring for scour along the offshore cable routes. The IBGS foundations will also be monitored after major storm events. In the event scour is detected, additional monitoring and/or mitigation (such as infilling of the scour hole with an appropriate crushed rock fill, or the use of frond mats or other proven systems) will be applied, in consultation with applicable jurisdictional agencies.

<u>Onshore:</u>

- In areas were existing utilities or other constraints are encountered, Dominion will increase the burial depth of the cables, if necessary, in consultation with both BOEM and the USACE.
- Dominion will implement a Stormwater Management Plan pursuant to VAR10 General Permit, 9 VAC25-880 and an ESC Plan and associated BMPs in accordance with 9VAC25-840 to avoid or minimize potential erosion and/or stormwater runoff impacts from onshore construction activities. These plans will be provided to relevant agencies for review and approval prior to construction.

4.18.2 Water Quality

<u>Offshore:</u>

- During Export Cable HDD activities, Dominion will return the drilling fluid to a mud pond located within the HDD Work Area where it will be collected for reuse after cleaning.
- Dominion will develop an HDD Contingency Plan to address the inadvertent release of drilling fluid.

- All VOWTAP vessels will operate in accordance with the Oil Pollution Act of 1990 (OPA-90) and the international treaty, MARPOL 73/78, including a requirement to prepare a vessel response plan approved by the USCG. In addition, all VOWTAP vessels will be required to comply with the applicable USCG pollution prevention requirements regarding at-sea discharges of vessel-generated waste, issued under the authority of the Act to Prevent Pollution from Ships, as well as EPA BMPs under Small Vessel General Permits for vessels less than 79 ft (24.1 m).
- Dominion will employ spill containment measures at each WTG that will comprise leakage-free joints, high pressure and oil leakage sensors as well as two oil spill containment tanks at the base of each WTG. Dominion will develop and submit for agency review and approval an Oil Spill Response Plan to manage any inadvertent spill, or releases of oil or other hazardous materials during operations.

Onshore:

- Dominion will implement a Stormwater Management Plan pursuant to VAR10 General Permit, 9 VAC25-880 and an ESC Plan and associated BMPs in accordance with 9VAC25-840 to avoid or minimize potential erosion and/or stormwater runoff impacts from all onshore construction activities. These plans will be provided to relevant agencies for review and approval prior to implementation and construction.
- The shunt reactor and transformer associated with the Interconnection Station will be mounted on a concrete foundation with associated oil containment pits, to avoid an inadvertent release of mineral insulating transformer oil to nearby surface water resources.
- Dominion will conduct and assessment of the depth of the water table and tidal influence along the onshore portion of the route. This will be completed prior to final engineering design at locations such as the cable splice pits.

4.18.3 Marine Biological Resources

- Dominion will implement soft-start procedures during impact pile driving activities, to minimize potential impacts on fish and other marine species from underwater noise.
- Dominion has selected an offshore construction window outside of the known peak migration period for the North Atlantic right whale.
- Dominion will comply with the NOAA speed restrictions within the Mid-Atlantic Special Management Area of 10 knots for vessels 65 ft (19.8 m) or greater during the period of November 1 through April 30. Dominion will also follow NOAA's Operational Guidelines When in Sight of Whales (NOAA Fisheries & NOS 2013), unless doing so would compromise human or environmental health and safety and/or the integrity of the Project.
- Personnel onboard construction, operation, and/or decommissioning vessels will receive training on marine mammal sighting and reporting that will stress individual responsibility for marine mammal awareness and protection. Personnel will also undergo marine debris awareness training.
- During impact pile driving and cable laying activities, Dominion will implement the following to mitigate and/or avoid potential impacts from underwater noise:
  - Establish underwater noise exclusion and monitoring zones;
  - Conduct field verification of exclusion and monitoring zones;

  - Employ PSOs;
  - Implement ramp-up and soft-start procedures;
  - Implement shut-down procedures;
  - Apply time of day restrictions on impact pile driving activities; and
  - Conduct species observation reporting;
- To better understand the operational noise associated with the WTGs, Dominion will monitor and observe underwater noise for a period of at least 2 weeks during operations to collect data on the full range of wind turbine operational conditions.

4.18.4 Terrestrial Biological Resources

- Dominion will return areas disturbed during construction to pre-construction conditions once Project installation activities have been completed.
- Dominion will implement a Stormwater Management Plan pursuant to VAR10 General Permit, 9 VAC25-880 and an ESC Plan and associated BMPs in accordance with 9VAC25-840 to avoid or minimize potential impacts on surrounding habitats. These plans will be provided to relevant agencies for review and approval prior to implementation and construction.

4.18.5 Avian and Bat Species

- Dominion will use flashing aviation safety lights on the WTG nacelles, and will investigate the possibility of using down shielded lights (aka hooded lights), where possible, on construction vessels, to reduce the potential that Project lights would attract birds.
- Dominion will install anti-perching devices on the IBGS foundations to avoid attracting birds to the WTGs, which could further reduce the potential for collisions.
- Dominion will implement a post-construction monitoring program during operation of the Project to evaluate actual impacts from the WTGs. Details of the post-construction monitoring plan will be developed in coordination with applicable state and federal agencies.

4.18.6 Threatened and Endangered Species or Other Species of Special Concern

To minimize and/or avoid potential impacts to threatened and endangered species or other species of special concern, Dominion will implement the same actions as described in Sections 4.18.3 through 4.18.5. In addition, for threatened and endangered nesting sea turtles that have been known to occur at the proposed Export Cable landfall, Dominion will not conduct any construction activities at the site between the dates of May 1 through August 31, in accordance with VDGIF requirements. Dominion has also committed to landing the Export Cable onshore via HDD to avoid impact to the beach and dune, and to ensure no potential sea turtle nesting habitat is disturbed.

4.18.7 Essential Fish Habitat

To minimize and/or avoid potential impacts to EFH and associated EFH Species, Dominion will implement the same actions as described for Sections 4.18.3.

4.18.8 Wetlands and Other Jurisdictional Waterbodies

- Dominion will implement a Stormwater Management Plan pursuant to VAR10 General Permit, 9 VAC25-880 and an ESC Plan and associated BMPs in accordance with 9VAC25-840 to avoid or minimize potential erosion and/or stormwater runoff impacts from all onshore construction activities. These plans will be provided to relevant agencies for review and approval prior to implementation and construction.

4.18.9 Cultural Resources

- Dominion will implement an Onshore and Offshore Unanticipated Discoveries Plan, including archeological resource identification training, in consultation with the VDHR and BOEM in support of VOWTAP construction activities.
- Dominion will consult with the VDHR to determine if additional testing should be performed at various locations along the onshore portions of the Project Area prior to construction.

4.18.10 Visual Resources

- Dominion will select colors for the Switch Cabinet and structures within the Interconnection Station that will reduce visual contrast by blending the structures into the surrounding environment. In addition, Dominion will further screen the Interconnection Station by planting vegetation, as needed.
- During construction, Dominion will incorporate the following mitigation measures to minimize potential visual impacts for the onshore Project Area:
  - Implementation of a Fugitive Dust Control Plan to minimize dust during onshore construction activities; and
  - Maintenance of onshore construction areas to remove trash and debris.

4.18.11 Socioeconomic Resources

- Dominion will hire local workers, where possible, to meet labor needs for Project construction, operation, and decommissioning.
- To ensure the safety of commercial and recreational mariners:
  - Dominion will establish a Project-specific website to share information about VOWTAP construction progress with the community, and to give guidance on the daily construction activities and how they may affect marine traffic in the area. Dominion will also issue specific local notices to mariners in coordination with the USCG throughout the construction period.
  - Dominion will establish and temporarily restrict vessel access within the temporary WTG Work Areas, the offshore HDD Work Area, and along the Export and Inter-Array Cable right-of-ways during construction. As appropriate, these areas will also be marked and lit in accordance with USCG requirements and monitored by a security boat that will be available to assist local mariners. Project construction vessels anchoring in the area will use buoys with navigation lights to indicate the position of the anchor. In addition, if the construction vessels have to leave the WTG Work Area before installation of an IBGS foundation or WTG is

completed (e.g., in case of adverse weather), temporary USCG-approved navigational aids will be placed on the structures.
  - During cable installation, Dominion may deploy additional buoys with lights to indicate the location of the cable as it is being installed.
  - During operation, Dominion will light, individually mark, and maintain PATON per USCG ATON requirements.
  - Dominion will place a radar beacon (RACON; radar responder) at the WTG site.

- To minimize potential impacts to recreational users at the Camp Pendleton Beach cable landfall site, Dominion plans to complete onshore construction activities prior to the start of the summer tourist season (May 31).

4.18.12 Military Maritime Uses

- Dominion will coordinate all Project construction, operation, and decommissioning activities closely with the Fleet Area Control and Surveillance Facility, VA Capes and the Fleet Forces Atlantic Exercise Coordination Center at Naval Air Station Oceana.
- At Camp Pendleton, Dominion will stage work in a manner that will minimize potential impacts on training and daily activities. No trenches or holes will be left open or unsecured overnight, and roadways will not be blocked to base traffic.

4.18.13 Land Use

- Dominion will comply with the P-1 and I-2 zoning requirements for Category I screening at public utility installations, which apply to the Switch Cabinet and Interconnection Station.

4.18.14 Transportation

- Dominion will establish a Project-specific website to share information about VOWTAP construction progress with the community, and to give guidance on the daily construction activities and how they may affect marine traffic in the area. Dominion will also issue specific local notices to mariners in coordination with the USCG throughout the construction period.
- Dominion will establish and temporarily restrict vessel access within the temporary WTG Work Areas, the offshore HDD Work Area, and along the Export and Inter-Array Cable right-of-ways during construction. As appropriate, these areas will also be marked and lit in accordance with USCG requirements and monitored by a security boat that will be available to assist local mariners. Project construction vessels anchoring in the area will use buoys with navigation lights to indicate the position of the anchor. In addition, if the construction vessels have to leave the WTG Work Area before installation of an IBGS foundation or WTG is completed (e.g., in case of adverse weather), temporary USCG-approved navigational aids will be placed on the structures.
- During cable installation, Dominion may elect to deploy additional buoys with lights to indicate the location of the cable as it is being installed.
- During operation, Dominion will light, individually mark, and maintain PATON per USCG ATON requirements.
- Dominion will place a RACON (radar responder) at the WTG site.

- During construction at Camp Pendleton, Dominion will not block roadways to base vehicular traffic for long periods.
- Dominion will comply with requests from the FAA's Norfolk ATCT/ TRACON and the Navy's FACSFAC VACAPES for notification of the start of Project construction, in order to make necessary charting revisions.
- Dominion will request that the FAA issue a NOTAM indicating the location and height of the WTGs prior to the start of construction.
- Dominion will employ nighttime lighting on each WTG consistent with standard FAA requirements, with one L-864 medium intensity aeronautical light with a flash rate of 20 FPM atop each WTG nacelle. Aeronautical lights will be synchronized and arranged so as to not be visible below the horizontal plane.

4.18.15 Acoustic Environment

- Dominion will not conduct onshore construction activities between 7:00 p.m. and 7:00 a.m. on weekdays or Saturday, or at any time on Sunday;
- Dominion will establish and enforce construction site and access road speed limits during the construction period;
- Dominion will utilize electrically-powered equipment instead of pneumatic or internal combustion powered equipment where feasible;
- Dominion will locate material stockpiles and mobile equipment staging, parking, and maintenance areas as far as practicable from NSRs at the HDD Work Area;
- Dominion will only use noise-producing signals, such as horns, whistles, alarms, and bells, for safety warning purposes;
- Dominion will not make Project-related public addresses or allow on-site music systems to be audible at adjacent receptors; and
- Dominion will ensure all noise-producing construction equipment and vehicles with internal combustion engines are equipped with mufflers, air-inlet silencers, where appropriate, and any other shrouds, shields, or other noise-reducing features in good operating condition that meet or exceed original factory specification. Mobile or fixed "package" equipment (e.g., arc-welders, air compressors) will also be equipped with shrouds and noise control features that are readily available for that type of equipment.
- During impact pile driving and cable laying activities, Dominion will implement the following to mitigate and/or avoid potential impacts from underwater noise:
  - Establish both underwater noise exclusion and monitoring zones;
  - Conduct field verification of exclusion and monitoring zones;
  - Employ PSOs;
  - Implement ramp-up/soft-start procedures;
  - Implement shut-down procedures;
  - Apply time of day restrictions on impact pile driving activities; and
  - Conduct species observation reporting.

- Dominion will monitor and observe underwater noise real-time for a period of at least 2 weeks during operations to collect data on the full range of wind turbine operational conditions.

4.18.16 Air Quality

- Vessels providing construction or maintenance services for the Project will use low-sulfur fuel in compliance with EPA's June 1, 2012 sulfur limit on diesel fuel sold in the United States.
- Vessels constructed on or after January 1, 2016 will meet Tier III NO_X requirements when operating within ECAs.
- Dominion will require its equipment and fuel suppliers to provide equipment and fuels for the Project that have been certified to be in compliance with the applicable EPA or equivalent emission standards.
- Marine engines with a model year of 2007 or later and non-road engines complying with the Tier 2 standards (in 40 CFR 89 or 1039) or better will satisfy BACT.
- Dominion will meet BACT standards for the SF_6 insulated circuit breakers by installing the circuit breakers with a low pressure alarm and a low pressure lockout.

4.18.17 Public Health and Safety

- Dominion will manage the overall health and safety of the Project under a Project-specific SMS.
- Dominion will limit public access to work sites during construction and will ensure all equipment is stored within the fenced HDD Work Area. During operation, the Interconnection Station will be surrounded by a fence and locked to prevent access.
- During operation, the IBGS foundations could provide mooring for a vessel in distress, and the platforms on the foundations could serve as a refuge while waiting for rescue. To ensure safety, access to the interior of the turbine will be restricted by the locked door at the base of the tower.
- At the Construction Port, Base Port, and O&M facility, secondary containment equipment and a spill response kit will be provided for oils and other hazardous materials, in accordance with applicable state and federal regulations.
- Dominion will equip each WTG with a lightning protection system. The combination of external and internal protection reduces the damage potential to people and materials.
- Dominion will employ additional operational safety systems on each WTG, including a back-up power generator, fire suppression, and first aid and survival equipment. The onshore electrical facilities have also been designed with appropriate fire protection systems.

5 CUMULATIVE EFFECTS

5.1 Introduction

This section presents a discussion of the potential cumulative effects associated with the Project. Cumulative effects are defined in the CEQ regulations as "the impact on the environment which results from the incremental impact of the action when added to other past, present, and reasonably foreseeable future actions regardless of what agency (Federal or non-Federal) or person undertakes such other actions. Cumulative effects can result from individually minor but collectively significant actions taking place over a period of time" [40 CFR 1508.7].

This evaluation of potential cumulative effects from the Project is consistent with the following regulations and guidance:

- CEQ's Regulations for Implementing the Procedural Provisions of the National Environmental Policy Act (40 CFR Part 1500-1508, 1970 as amended)
- EPA Procedures for Implementing the Requirements of the Council on Environmental Quality on the National Environmental Policy Act (40 CFR Part 6 [2009])
- Considering Cumulative Effects under the National Environmental Policy Act (CEQ 1997)
- Consideration of Cumulative Effects in EPA Review of NEPA Documents, EPA 315-R-99-002 (EPA 1999)
- Guidance on Past and Present Actions (CEQ 2005)

Cumulative effects are identified and evaluated using the following general approach:

1. Identify the appropriate level and scope of analysis for each resource.
2. Review the assessment of potential impact producing factors for specific resources related to construction, operation, and decommissioning of the Project, including the potential direct and indirect effects.
3. Identify resources for which no effects are expected from the Project. These resources will not be considered further for cumulative effects.
4. Identify the resources for which potential Project effects might contribute to cumulative effects.
5. Identify past, present, and reasonably foreseeable future actions that could affect these resources.
6. Analyze the potential cumulative effects, based on the overlap and potential interaction among Project effects and the effects of the other identified actions that are pertinent to the analysis.

In accordance with CEQ guidance (CEQ 2005), the cumulative effects analysis focuses on effects that are "truly meaningful." The level of analysis for each resource is commensurate with the intensity of the effects identified in Section 4.

5.2 Identification of Resources Not Carried Forward for Cumulative Effects Analysis

Resources that do not have a direct or indirect impact associated with the VOWTAP are not analyzed for their contribution to cumulative effects. Additionally, for a resource to be carried forward for analysis, both the Project and the reasonably foreseeable future actions must result in an impact to the resource that would occur within roughly the same geographic and temporal range. Based on the information presented in Section 4, the resources that will not be analyzed for cumulative effects are identified as follows:

- Physical and Oceanographic Conditions. The assessment documented in Section 4.1 indicates that the Project would not affect meteorological or oceanographic conditions in or near the Project Area. The Project would cause highly localized and short-term changes to the distribution of seafloor sediments and terrestrial soils that would not have the potential for meaningful direct or indirect impacts on these resources.
- Terrestrial Biological Resources. The assessment documented in Section 4.4 indicates that the Project facilities would be located in previously disturbed areas and would avoid new disturbance of terrestrial wildlife habitat and, therefore, would not have the potential for meaningful direct or indirect impacts on these resources.
- Wetlands and other Jurisdictional Waters. The assessment documented in Section 4.8 indicates that the Project facilities would be located to avoid wetlands and other jurisdictional waters and, therefore, would not have the potential for meaningful direct or indirect impacts on these resources.
- Cultural Resources. The assessment documented in Section 4.9 indicates that the Project would not be likely to have the potential for meaningful direct or indirect impacts on marine, terrestrial archaeological resources or historic properties.
- Socioeconomic Resources. The assessment documented in Section 4.11 indicates that the Project would not have the potential for meaningful direct or indirect impacts on the local population and economy, housing conditions, public services, or commercial or recreational fishing.
- Military Maritime Uses. The information presented in Section 4.12 indicates that military maritime uses might present some scheduling constraints for the Project, but the Project would not interfere with such uses.
- Land Use. The information presented in Section 4.13 indicates that the Project would be compatible with existing land uses and consistent with applicable land use plans and regulations.
- Public Health and Safety. The assessment documented in Section 4.17 indicates that the Project would not have the potential for meaningful direct or indirect impacts on public health and safety.

Based on the review of potential impact producing factors, the specific resources that warrant consideration for potential cumulative effects are identified as follows:

- Water Quality
- Marine Biological Resources
- Avian and Bat Species
- Threatened and Endangered Species and other Species of Special Concern
- Essential Fish Habitat
- Visual Resources
- Transportation
- Acoustic Environment
- Air Quality

Consideration of potential cumulative effects related to these resources is addressed in Section 5.4.

5.3 Past, Present, and Reasonably Foreseeable Future Actions

5.3.1 Past and Present Actions

Past and present actions are not identified individually; rather this analysis relies on current environmental conditions as a proxy for the effects of past actions. This is because existing conditions reflect the aggregate impact of all prior human actions and natural events that have affected the environment and might contribute to cumulative effects. Consequently, the cumulative effects analysis for the Project does not attempt to quantify the effects of past human actions by adding up all prior actions on an action-by-action basis. Current conditions have been affected by innumerable actions over the last several centuries, and trying to isolate individual actions that continue to have residual effects would be nearly impossible. The CEQ issued an interpretive memorandum on June 24, 2005, regarding analysis of past actions, which states, "agencies can conduct an adequate cumulative effects analysis by focusing on the current aggregate effects of past actions without delving into the historical details of individual past actions" (CEQ 2005). Past actions are reflected in the baseline information presented in Section 4, which provides context for the cumulative effects analysis.

5.3.2 Reasonably Foreseeable Future Actions

This section discusses the reasonably foreseeable future actions that have the potential to overlap spatially and temporally with the VOWTAP. As described by the CEQ (2005), "It is not practical to analyze how the cumulative effects of an action interact with the universe; the analysis of environmental effects must focus on the aggregate effects of past, present, and reasonably foreseeable future actions that are truly meaningful."

Identified future actions were reviewed to determine if they should be considered further in the cumulative effects analysis. Factors considered when identifying future actions to be included in the cumulative effects analysis included the following:

- Whether the other action is likely or probable (i.e., reasonably foreseeable), rather than merely possible or speculative.
- The timing and location of the other action in relationship to the proposed Project.
- Whether the other action and the Project would affect the same resources.
- The current conditions, trends, and vulnerability of resources affected by the other actions.
- The duration and intensity of the effects of the other actions.
- Whether the effects have been truly meaningful, historically significant, or identified previously as a cumulative impact concern.

Reasonably foreseeable future actions considered for the VOWTAP are discussed in the following sections.

5.3.2.1 Commercial Development of the Virginia WEA

In September 2013, Dominion was awarded the lease in an auction conducted by BOEM for 112,800 ac (45,648.6 ha) of federal land off the coast of Virginia to develop an offshore commercial-scale wind turbine farm capable of generating up to 2,000 MW of electricity, enough for 600,000 homes. Dominion officially executed the Lease for the Virginia WEA with BOEM on October 22, 2013, with an effective date of

November 1, 2013. BOEM requires that a Construction and Operation Plan (COP) be submitted by Dominion within 5 years of executing the Lease.

During the next 5 years, activities associated with the Virginia WEA Lease Area will primarily consist of site characterization and assessment. Potential effects during this phase could include:

- Intermittent underwater noise associated with geophysical surveys, subbottom sampling, and installation of meteorological equipment;
- Increased vessel traffic associated with the site characterization and assessment activities; and
- Restrictions on areas available for marine uses, including commercial and recreational fishing.

All activities associated with site characterization and assessment would be confined to the Virginia WEA and a narrow corridor running between the WEA and shore that will serve as the right-of-way for the future export cable for the commercial project. In accordance with the Lease, all geophysical and subbottom sampling surveys must be completed by November 1, 2016. All remaining offshore site characterization activities must be completed on or before November 2018.

The operational life of the commercial project after the approval of the COP by BOEM is 33 years.

As noted previously, the VOWTAP Project Area is located immediately adjacent to the Virginia WEA. Potential effects associated with the development of the WEA would be similar in type to those discussed for the Project in Section 4, although larger in scale given the much larger size of the commercial wind power development.

5.3.2.2 Dam Neck Naval Annex Coastal Restoration

In July 2013, BOEM and the U.S. Navy signed a Memorandum of Agreement for oceanfront and dune system stabilization and restoration at the Dam Neck Annex at Naval Air Station Oceana, located adjacent to Camp Pendleton in Virginia Beach, Virginia. This agreement will allow for the use of up to 700,000 yd^3 (535,188.4 m^3) of sand from the OCS to stabilize and restore the Dam Neck Annex oceanfront and dune system. BOEM manages non-energy minerals obtained from the OCS, including sand, gravel and shell resources for coastal restoration and protection. The restored sand dune will be 5,282 ft (1,610 m) long, 20 ft (6.1 m) high, and 50 ft (15.2 m) wide. The beach renourishment portion of the project is 2 mi (3.2 km) long, including the approximately 1 mi (1.6 km) area in front of the dune system (BOEM 2013). The sediment will be sourced from Sandbridge Shoal Borrow Areas A and B, which lie approximately 3 to 4 mi (4.8 to 6.4 km) offshore.

The restoration project represents the third construction cycle for beach nourishment at the Dam Neck Annex, and is intended to fully replenish the beach and reshape the constructed dune system to 1996 dimensions. The project will help reduce erosion and will enable the dune system to continue providing storm protection along the Naval Station Oceana, Dam Neck Annex.

Potential effects of this project could include:

- Increased marine traffic between the borrow areas and the site of the restoration project at the Dam Neck Annex;
- Increased traffic from heavy equipment on roads within and around Dam Neck Annex during the period of construction;

- Short-term sediment disturbance at the borrow areas, and
- Increased coastal and dune habitat for terrestrial wildlife in the area.

The area of impact associated with this project would include the borrow areas at Sandbridge Shoal, the beach and dune area at the Dam Neck Annex, the marine transit corridor between the borrow sites and the oceanfront at Dam Neck Annex, and the roadways leading into and within the Dam Neck Annex.

Work on the project is expected to begin between fiscal year (FY) 2013 and FY 2016, and is expected to take approximately 3 months to complete construction (BOEM 2013).

5.3.2.3 Atlantic Wind Connection Project

In March 2011, BOEM received an unsolicited ROW Grant application from Atlantic Grid Holdings, LLC (AGH) for a subsea backbone transmission system (referred to as the Atlantic Wind Connection project) in state waters and on the OCS offshore the states of New York, New Jersey, Delaware, Maryland, and Virginia. The purpose of the project is to transmit electricity generated by future offshore commercial wind facilities to onshore markets. The project is proposed to be built in three phases: the New Jersey link, the Delmarva link, and the Bay link (which connects the previous two links into a continuous north-south connection) (AGH 2013). The Delmarva link will be built after the New Jersey link, and will be completed in two phases. The first phase will connect Delaware to Maryland with two offshore hubs serving the WEAs off the coasts of both states. The second phase connects the first phase to Virginia and adds an offshore hub serving the WEA off the coast of Virginia. AGH estimates construction of the three phases would occur over approximately a 10-year timeframe. Phase One (New Jersey) of the project could be operational in early 2017, and the Delmarva line would be one of the last phases built. Subject to acquisition of permits and availability of materials, components, and equipment, the entire system could be in operation by 2021 (AWC 2013).

Potential effects of this project could include:

- Increased vessel traffic associated with survey activities during site characterization for the potential cable route;
- Intermittent underwater noise associated with site characterization activities and construction, and
- Temporary disturbance of benthic habitat from cable installation.

The Delmarva link would be built 10 mi to 12 mi (16.1 km to 19.3 km) off of the coasts of Delaware, Maryland, and Virginia, connecting the future offshore wind farms that will be built in the WEAs to the terrestrial transmission grid. The specific locations and time frames for the Delmarva link have not yet been identified beyond potential connection to the WEA; however, it can be assumed that existing ports in the Virginia Beach area would be utilized for construction vessels transiting to and from this project.

5.3.2.4 Other Potential Actions

In 2011, WASACE Cable Company Worldwide Holdings announced plans to build a system of submarine communication cables linking North America, Europe, South America, and Africa. One of the cable landing points announced was Virginia Beach, Virginia. Original projections were that the project would be completed by 2014, and a May 2012 news report stated that WASCE Cable Company had begun the procurement process to select a cable system supplier for the project, and that the Africa cable system was scheduled to be in service by the first quarter of 2014. (BusinessTech 2012). The current status of the project is not clear.

Due to the lack of available information and the highly speculative nature of the WASACE project, this project was not considered a reasonably foreseeable future action and, as such, was not included in the cumulative impact analysis.

5.4 Resource-Specific Cumulative Effects

For a cumulative effect to occur, direct and indirect effects from the VOWTAP would need to overlap in time and space with effects from one or more of the reasonably foreseeable future actions that were identified, and would need to represent an incremental change to environmental conditions that would interact with the effects of other actions in a meaningful way. As discussed in Section 5.2, no cumulative impact would occur to resources where the Project would not itself result in direct or indirect impacts. Similarly, no cumulative effect would occur to resources where the Project would result in an impact, but where this impact would not occur in approximately the same time and place as effects from identified reasonably foreseeable future actions. Finally, no cumulative effect would occur if an identifiable Project effect would overlap in time and space with effects from reasonably foreseeable future actions, but the interaction among the effects would not cause an incremental or meaningful change in future environmental conditions for the applicable resource. The following sections summarize the assessment of cumulative affects by resource area.

5.4.1 Water Quality

As indicated in Section 4.2, marine water quality could be affected by localized increases in TSS during VOWTAP construction and decommissioning activities, and/or by accidental spills or releases (e.g., oil, lubricants, etc.) during construction, operation, or decommissioning.

The only reasonably foreseeable future action that could conceivably overlap both spatially and temporally with the construction of the VOWTAP is the Atlantic Wind Connection Project. However, as discussed in Section 4.2, elevated TSS levels from VOWTAP construction will be limited to the immediate vicinity of the Inter-Array and Export Cable routes and the WTG sites, and will be of low intensity and short duration. Therefore, it is highly unlikely that the VOWTAP and the Atlantic Wind Connection would increase TSS levels at approximately the same time or to a degree that would have a meaningful cumulative effect on marine water quality.

Spills and releases during VOWTAP construction, operation, or decommissioning are unlikely. As discussed in Section 3.2, all Project facilities (both onshore and offshore) have been designed with appropriate spill containment systems. In addition, all Project activities will be implemented under a series of storm water management, erosion control, oil spill response, and marine trash and debris plans. Therefore, the potential for a meaningful cumulative effect on water quality from an accidental spill or release is very low.

5.4.2 Marine Biological Resources

Project construction disturbance could cause the loss of benthic and epibenthic species within a limited and localized area, and would displace a small area of benthic habitat at the site of the IBGS foundations.

Development of the adjacent WEA could lead to similar effects on the resource, which would occur in essentially similar and contiguous habitat. Benthic habitat disturbed by Project construction will recover long before development of the WEA, however, and the disturbance effects would not overlap in time. The amount of benthic habitat removed by the Project would represent an extremely small increment to overall benthic habitat loss when combined with the development of the WEA, and would also be separated in time from the development of the WEA by a number of years.

With regard to demersal and pelagic fish, although the Project would cause minor, localized, and temporary effects on these species as a result of increased TSS and noise during construction and decommissioning; these effects would not overlap spatially or temporally with similar effects from development of any of the reasonably foreseeable future actions and, therefore, would not represent a meaningful cumulative effect.

The Project could cause minor, localized, and temporary disturbance effects to marine mammals and sea turtles during construction as a result of noise, increased TSS, or vessel traffic. These effects might overlap in time with site characterization activities for WEA development or vessel traffic from the Dam Neck Restoration Project, and there could be some degree of spatial overlap for vessel traffic changes. Because the effects for each project would be limited in duration and extent, and would be mitigated through implementation of environmental protection measures and BMPs such as those discussed in Section 4.3, the potential for these combined effects to interact in a meaningful way is low.

5.4.3 Avian and Bat Species

The Project could cause minor and temporary effects to non-listed avian species as a result of various types of disturbances during construction; however, these would not overlap spatially and temporally with similar effects from development of any of the reasonably foreseeable future actions. During Project operation, the VOWTAP WTGs would not create a barrier effect for birds and, based on use patterns observed during avian surveys, would pose a very low risk of collision for birds. While the development of the WEA a number of years in the future may result in higher levels of potential effects on avian species, the incremental impact of the VOWTAP relative to the WEA development would be negligible.

5.4.4 Threatened and Endangered Species and Other Species of Special Concern

Consideration of the potential for cumulative effects to threatened and endangered species and other species of special concern involves the same factors and determinations as described in Sections 5.4.2 and 5.4.3, and in Section 5.2 with respect to terrestrial biological resources.

5.4.5 Essential Fish Habitat

Consideration of the potential for cumulative effects to EHF and associated EFH species involves the same factors and determinations as described in Sections 5.4.2.

5.4.6 Visual Resources

As documented in Section 4.10, the Project WTGs would not be noticeable to casual observers at viewing locations on the shore, and the onshore facilities would create limited change to existing visual conditions. These minor potential visual effects would not overlap spatially or temporally with the reasonably foreseeable future actions, with the exception of commercial development of the WEA. At some point in the future, the Project WTGs would be seen along with turbines in the WEA by recreational and other viewers on vessels within viewing range. It is also possible that the aggregation of WTGs within the WEA would be noticed by viewers on shore. In either context, however, the incremental contribution of the VOWTAP to the overall cumulative effect would be minimal.

5.4.7 Transportation

Construction of the onshore Project facilities could create minor and short-term effects on surface transportation within affected portions of Camp Pendleton. It is possible that traffic associated with the Dam Neck Coastal Restoration project could overlap in time with VOWTAP construction. If so, the Dam Neck traffic would likely use routes located to the south of Camp Pendleton and any interaction effects would be unlikely. The onshore Project activity would not overlap spatially or temporally with development of any of the other identified reasonably foreseeable future actions.

Short-term increases to vessel traffic associated with construction or decommissioning of the VOWTAP could overlap in time with similar actions associated with the WEA, the Dam Neck Restoration Project, or the Atlantic Wind Connection Project, and there could be some degree of spatial overlap. To the extent that such changes occurred in combination, the effects for all of the projects would be limited in duration and minor in relation to the baseline level of vessel activity in the area. Based on the intensity and duration of the effects, the potential for meaningful cumulative effects on marine transportation is very low.

As discussed in Section 4.14.3, the proposed WTGs are located inside the boundaries of multiple ORF ASR-9 MVA sectors. ATCT/TRACON has requested notification of the start of WTG construction so appropriate charting changes can be made. This minor potential effect would not overlap spatially or temporally with the reasonably foreseeable future actions, with the exception of commercial development of the WEA. However, because the new adjusted altitude of the MVA would still be below the floor of controlled airspace and only used in emergency situations, the incremental contribution from VOWTAP to the overall cumulative effect would be negligible.

5.4.8 Acoustic Environment

As documented in Section 4.15, in-air noise generated by onshore Project construction, operation, or decommissioning would not result in direct or indirect effects for NSRs. Short-term increases in underwater noise associated with offshore construction or decommissioning of the VOWTAP could overlap in time with similar actions associated with the WEA site characterization and assessment activities, the Dam Neck Restoration Project, or the Atlantic Wind Connection Project, and there could be some degree of spatial overlap. The receptors for underwater noise are fish and marine mammals, and the consideration of potential cumulative effects is addressed by the discussion in Section 5.4.2.

5.4.9 Air Quality

The Project would create minor short-term air emissions associated with construction and decommissioning activities. These effects would not overlap spatially or temporally with similar effects from development of any of the identified foreseeable actions, and would not create the potential for meaningful cumulative effects.

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Gravender, David – Technical Editor

- Ph.D., English (Candidate), 1997, University of Toronto
- M.A., English, 1991, University of Toronto

- B.A., English, 1990, University of Washington

Haugh, Sarah – Terrestrial Archaeology Lead

- M.A., American and New England Studies, (In Progress), University of Southern Maine
- B.A., Geography-Anthropology/Archaeology, 2003, University of Southern Maine.

Hobson, Joanna – Senior Geologist

- M.A., Geological Sciences, 1998, University of California, Santa Barbara
- B.A., Environmental Studies, 1991, University of California, Santa Cruz

Jackson, Shawn – Visualization Specialist

- B.S. (Bachelor of Science), Landscape Architecture, 2001, Colorado State University
- A.S., Geography, 1997, Colorado State University

Jodziewicz, Laurie – Offshore Wind Consultant

- B.A., International Politics, 1997, The George Washington University

Kalapinski, Erik – Acoustic Resource Lead

- B.S., Civil and Environmental Engineering, 1994, University of Massachusetts

Kennedy, Keith – Air Quality Lead

- M.S., Civil and Environmental Engineering, 1977, Northeastern University
- B.S., Civil and Environmental Engineering, 1974, Cornell University

Lavallee, Janelle – Deputy Project Manager

- B.A., Geography and Anthropology, 2000, University of Southern Maine

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- MPhil., Anthropology, 1975, Columbia University
- M.A., Anthropology, 1974, Columbia University
- B.A., Anthropology, 1972, The American University

Pellerin, Tricia – In-Air Noise Lead

- M.E.Sc. (Master of Engineering), Chemical and Biochemical Engineering, 2005, University of Western Ontario
- B.E.Sc., Chemical and Biochemical Engineering, 2002, University of Western Ontario

Scales, William – GIS Analyst

- Various Coursework, Environmental Management I & II, Ocean Environments, 2003, Harvard University Extension School

- BS (Bachelor of Science), English (Minor: Biology), 1999, Lehigh University

Schils, Natalie – Environmental Scientist

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Sexton, James –Historic Properties Lead

- Ph.D., History of Art, 1999, Yale University
- M.A., History of Art, 1999, Yale University
- B.A., History of Art, 1988, Yale University

Svedlow, Aaron – Avian and Terrestrial Wildlife Resource Lead

- M.S., Biology, In Progress, University of Southern Maine
- B.S., Environmental Science and Wildlife Management, 2004, University of New Hampshire

Varnik, Kristjan – Underwater Acoustic Engineer

- M.E., Mechanical Engineering, Tufts University, 2012
- B.A., Computer Science, New York University, 1999

Welz, Nick – Marine Biologist

- M.S., Marine Fisheries Science, 2007, University of Rhode Island
- B.S., Business Management/Environmental Studies, 2000, Skidmore College

7.1.3 Tetra Tech Subconsultants

7.1.3.1 Capitol Airspace Group

Doyle, Ben – President, Aviation Lead

- A.A., History, 1996, Cochise College

Morgan, Ron – Senior Aviation Consultant

- A.A., Aerospace Technology, Glendale College

7.1.3.2 C&H Global Security, LLC

Holt, William (Biff) Captain, USCG (ret.)– Navigation Risk Assessment Lead

- Master of Science, Natural Resources, 1978, University of Michigan
- Bachelor of Science, Management, 1968, United States Coast Guard Academy

Morrissey, Sean – Senior Navigation Risk Consultant

- BS, Marine Transportation Operations, 2002, Maine Maritime Academy
- USCG Licensed Master of Steam or Motor Vessels of Any Gross Tons Upon Oceans

- First Class Pilot of Vessels of Any Gross Tons for Port Canaveral, FL

7.1.3.3 Exponent

Bailey, Bill – Electromagnetic Field (EMF) Lead

- Ph.D., Neuropsychology, 1975, City University of New York
- M.B.A., Business Administration, 1969, University of Chicago
- B.A., 1966, Dartmouth College

Benjamin Cotts – Electromagnetic Field (EMF) Analysis

- Ph.D., Electrical Engineering, 2011, Stanford University
- M.S., Electrical Engineering, 2004, Stanford University
- B.S., Electrical Engineering, 2004, University of Portland

7.1.3.4 R.C. Goodwin & Associates

McCullough, David – Nautical Archaeologist

- Ph.D., Maritime Archaeology, 2000, University of Glasgow, Scotland
- B.A., Archaeology, 1992, University of Utah

Ryberg, Kathryn – Nautical Archaeologist

- M.S., Archaeological Computing, 2002, University of Southampton, England
- B.A., Anthropology, 1999, University of Wisconsin

Schmidt, Steve – Marine Cultural Resources Lead

- M.A., Maritime History and Underwater Research, 1991, East Carolina University
- B.A., Archaeology, 1986, Towson State University

7.1.3.5 Woods Hole Group

Buck, Mitchell – Sediment Transport Analyst

- M.C.E., Civil Engineering, 2007, University of Delaware
- B.S., Environmental Engineering, 2005, Johns Hopkins University

Hamilton, Bob – Vice President/Coastal Engineer, Sediment Transport Lead

- M.C.E., Civil Engineering, 1994, University of Delaware
- B.S., Civil Engineering, 1992, Lehigh University

7.1.4 VOWTAP Partners

7.1.4.1 Alstom

Arora, Dhiraj - Wind Innovation Manager

- Ph.D., Mechanical Engineering/Biomedical Engineering, 2005, University of Utah
- B.Eng., Mechanical Engineering, 1997, Delhi College of Engineering

Fisas, Albert – Innovation Director/Co-Principal Investigator

- M.S., Mechanical Engineering, 1998, Catalonia Polytechnic University, Spain

7.1.4.2 Kellogg, Brown & Root (KBR)

Cox, Harry – Civil Engineer

- B.Eng., Civil Engineering, 2010, Birmingham University

London, Gary – Engineering Director

- B.Sc., Civil Engineering, 1988, Surrey University

Oakley, Gary - Project Manager

- M.Sc, Water Resources, 1977, Birmingham University, England
- B.Sc., Civil Engineering, 1975, Birmingham University

7.1.4.3 Keystone Engineering Inc. (Keystone)

Mechling, Hiram – Civil/Structural Engineer

- M.S., Wind Energy, 2010, technical University of Denmark
- M.S., Civil and Structural Engineering, 2010, University of Washington
- B.S., Civil Engineering, 2005, Tulane University
- B.S., Physics, 2004, Loyola University

7.1.4.4 National Renewable Energy Laboratory (NREL)

Musial, Walter – Manager, Offshore Wind and Ocean Power Systems/Co-Principal Investigator

- M.S., Mechanical Engineering, 1983, University of Massachusetts-Amherst
- B.S., Mechanical Engineering, 1980, University of Massachusetts-Amherst

7.1.4.5 Newport News Shipbuilding

Natterer, John – Engineering Manager

- M.B.A., Business, 1995, College of William and Mary
- B.S., Marine Engineering Systems, 1986, U.S. Merchant Marine Academy

7.1.4.6 Virginia Coastal Energy Research Consortium (VCERC)

Hagerman, George – Virginia Tech Advanced Research Institute/Co-Principal Investigator

- M.S., Marine Sciences, 1980, University of North Carolina
- B.S., Zoology, 1976, University of North Carolina

Sorlie, Sue – Virginia Tech Advanced Research Institute

- M.S., Geography/Climatology, 1990, University of Delaware
- B.A., Physical Geography, 1984, San Diego State University

7.1.4.7 Virginia Department of Mines, Minerals and Energy (DMME)

Christopher, Al –Director, Division of Energy

- M.B.A., Business Administration, 2000, Virginia Commonwealth University
- B.S., Mass Communication, 1975, Virginia Commonwealth University

7.2 December 2013 Preparers

7.2.1 Dominion

Chapman, Guy – Director, Renewable Energy Research and Program Development/ Principal Investigator

- B.S., Computer Science, 1986, DePaul University

Goodin, Salud –Business Development Manager

- M.S., Environmental Science and Engineering, 1992, Virginia Polytechnic Institute and State University
- B.S., Chemistry, 1985, College of William and Mary

Lanterman, Kimberly – Environmental Manager

- M.S., Environmental Engineering, 1996, Georgia Institute of Technology
- B.S., Industrial Engineering, 1988, North Carolina State University

Larson, John –Director, Alternative Energy Generation Technologies/Designated Project Operator

- B.S., Chemical Engineering, 1985, North Carolina State University

McConvey, Paul – Customer Relations for Electric Interconnect and distribution

- Bachelor of Commerce, 1976, University of Windsor (Ontario, Canada)

Pietryk, Steve – Generation Construction Project Manager

- B.S., Mechanical Engineering, 1982, Worcester Polytechnic Institute

Plautz, Molly – Project Supervisor

- M.S., Environmental Studies, 2012, Virginia Commonwealth University
- B.S., Environmental Policy and Planning, 2006, Virginia Polytechnic Institute and State University

Trivette, Joel – Generation Construction Electric Interconnect Project Manager

- B.S., Electrical Engineering, 1985, Ohio State University

7.2.2 Tetra Tech

Andrake, TR – Air Quality Resource Specialist

- MS, Civil/Environmental Engineering, 1999, University of Delaware
- BS, Environmental Engineering, 1992, Wilkes University

Campo, Joe – Senior Wetland Scientist

- Ph.D., Wildlife Ecology, 1983,Texas A&M University
- M.S., Wildlife Ecology, 1980, Mississippi State University
- B.S., Forestry, 1978, Louisiana State University

Daniels, Jennifer – Director of Offshore Energy - Project Manager

- M.S., Business Administration, 2006, University of Massachusetts
- B.S., Marine Resource Development and Aquatic Technologies, 1999, University of Rhode Island

Davidson, Lori –Visual Resources Lead

- M.S., Landscape Architecture, University of Michigan, 2005
- B.S., Environmental Studies & Application, Michigan State University, 1998

Dresser, Brian – Benthic Resource Lead

- M.S., Ecology, University of Georgia, Odum School of Ecology, 2003
- B.S., Biology, Plymouth State University, 1996

Farmer, Chris – Senior Avian Ecologist

- Ph.D., Ecology, 2002, State University of New York College of Environmental Science and Forestry
- M.S., Science Education, 1987, State University of New York Albany
- B.S., Biology, 1986, State University of New York Albany

Feehan, Tim – Marine Species and Fisheries Resource Lead

- B.S., Zoology, 1995, University of Rhode Island

Feldpausch, Bob – Geophysical and Shallow Geotechnical Lead

- B.S., Environmental Studies and Policy, 1998, Michigan State University
- A.S., Geographic Resources and Environmental Technology, 1996, Lansing Community College

Fischl, Joe –Wetlands Lead

- M.S., Ecology, 1983, Rutgers University
- B.S., Wildlife Biology, 1976, Rutgers University

Gay, Marybeth – Marine Biologist

- M.S., Marine Fish Ecology, Cranfield University, 2012
- B.S., Marine Biology, Texas A&M University, 2007

Gorini, Jennifer – Environmental Planner, Marine Spatial Planning

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