Appendix R – Navigational Risk Assessment

Virginia Offshore Wind Technology Advancement Project (VOWTAP)

Navigational Risk Assessment

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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), a 12-megawatt (MW) offshore wind technology testing facility located approximately 24 nautical miles (nm) or 43 kilometers (km) east of Virginia Beach, Virginia. The Project is proposed to demonstrate the viability of offshore wind generators and provide information important to offshore wind research and development. The Project will consist of two, 6-megawatt wind turbine generators (WTGs) connected by a 34.5-kilovolt (kV) submarine cable (the Inter-Array Cable), and a 34.5-kV submarine transmission cable (Export Cable) from the WTGs to a shore terminus at Camp Pendleton, VA south of Cape Henry.

Construction of the VOWTAP Project will occur generally during spring and summer months to avoid adverse weather conditions. Components of the WTG's IBGS foundation structures and cables will be transported directly from selected load-out ports in Europe or the Gulf of Mexico to the Project Site. A variety of construction vessels will be employed in the construction of VOWTAP, including a jack-up vessel, heavy lift vessel, and cable-laying vessel. Support vessels, such as crew boats and tugs, will be located in a Construction Port within Chesapeake Bay and will be required to make transits of the inshore channels of Chesapeake Bay to the Project Site. Cable laying will occur 24 hours a day, while pile driving will occur only during daylight hours.

Part of the permitting process for Offshore Renewable Energy Installations (OREI), such as VOWTAP, involves the completion of a Navigational Risk Assessment (NRA) that comports with guidance provided by the U.S. Coast Guard (USCG). The USCG reviews the NRA to assist with its jurisdictional responsibilities of ensuring maritime safety and allows the USCG to advise the Approving Authority for an OREI project, in this case the Bureau of Offshore Energy Management (BOEM), on the suitability of the project from its jurisdictional perspective. BOEM requires the completion of an NRA in accordance with 30 CFR § 585.627.

Risk, in the context of the VOWTAP NRA, is the combination of the frequency and the severity of the consequence of a specific accident. A risk assessment is the process for identifying hazards that may result in an accident and for determining the risk (frequency and consequence) posed by those hazards.

The objectives of the VOWTAP NRA are as follows:

- Describe the Project and its elements.
- Establish a "Base Case" or "Current Situation" without the Project by:
  - Describing the waterway characteristics and the marine environment in the vicinity of the Project Area and construction routes
  - Analyzing marine traffic in the vicinity of the Project Area, including construction routes

        - Examining previous significant casualties in the vicinity of the Project Area
    - Identify hazards and navigational issues that may exist as a result of the construction, operation, and maintenance of the Project
    - Assess the risk (frequency and consequence) of those identified hazards and determine what, if any, appropriate risk mitigation measures need to be implemented to manage the risk to an acceptable level

The VOWTAP NRA is a qualitative risk assessment using "Change Analysis," one of the methods of risk assessment accepted by the USCG for use in Risk-based Decision Making (USCG RBDM Guidelines, 2013). A Change Analysis establishes the Base Case or Current Situation without the Project, and then evaluates whether there are new risks brought about by the presence of the Project. The potential hazards identified for further consideration as to their frequency and consequence are then qualitatively measured against the Base Case and compared to the situation with the Project.

The Ports of Virginia and the Port of Baltimore are among the busiest in the United States. A 2011 report by the U.S. Maritime Administration (MARAD) indicated that the Port of Virginia was fourth in the nation in terms of vessel calls by Container Ships and third in the nation in terms of vessel calls by Dry Bulk Carriers. Similarly, the Port of Baltimore was first in the nation in vessel calls by Roll-on/Roll-off (Ro-Ro) Ships and sixth in the nation in vessels calls by Container Ships.

A Traffic Separation Scheme (TSS) at the entrance to Chesapeake Bay provides separated traffic lanes in this congested waterway. In addition, the TSS for Chesapeake Bay directs vessel traffic away from the designated Danger Zones south of the TSS[1] and the Restricted Area north of the TSS that may otherwise represent hazards for vessel traffic. The TSS comprises a Northeast Approach and a Southeast Approach, which includes a deep water channel between an inbound and outbound lane that is used by large, deep-draft ships, including aircraft carriers. Commercial, charter, and recreational fishing also occur in areas near VOWTAP.

Farther offshore and more proximate to the VOWTAP project site, Automated Identification System (AIS) data show that vessels follow track-lines that typically fall on either side of the VOWTAP site, although some are recorded as passing through the site. A natural deep-draft channel running from the northeast to the southwest outside the TSS encourages larger ships to avoid other areas that may encroach on the VOWTAP site.

In addition to the considerable volume of vessel traffic into and out of Chesapeake Bay, there is a significant military presence. The U.S. Navy homeports numerous ships and provides training, testing, and exercise opportunities in areas near the VOWTAP project and, specifically, in an area that will be crossed by the Export Cable.

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[1] The Danger Zone includes the military practice area/live fire danger zone associated with the Dam Neck facility (referred to as W-50-A), the Camp Pendleton live fire area, (referred to as R-6606).

Weather in the vicinity is generally moderate; however, hurricanes have passed through the area in the past. The mean wind speed in the vicinity is about 12 knots (6 m/s). During winter months, storms moving up the Atlantic coast may generate northeasterly winds with speeds reaching 30 to 50 knots (15.4 m/s to 25.7 m/s).

A variety of issues were examined for the VOWTAP NRA to determine what hazards may be present as a result of the construction and operation of VOWTAP. These included the following:

- Weather constraints during construction and operations
- Potential effects of VOWTAP on navigation
- Risk of collision and allision due to the presence of VOWTAP
- Disruption of normal traffic patterns caused by the presence of VOWTAP
- Sound generated during construction
- Potential impact on USCG missions
- Potential effects of VOWTAP on communications systems
- Potential effects of VOWTAP on radar
- Potential effects of VOWTAP on positioning systems
- Potential effects of VOWTAP on Chesapeake Light and other Aids to Navigation in the area.

There were no indications of a hazard event exhibiting a significant Risk Differential between the Base Case and the case with VOWTAP that would cause a "no go" decision. All the hazards identified showed modest risk differentials between the base case and the case with VOWTAP, with some indicating the need for mitigating measures. Figure ES-1 summarizes the hazards identified as requiring some risk control or mitigation measure.

Figure ES-1 Identified Hazards Requiring Mitigation

Hazard Identification	Discussion
Collision	
Commercial vessel navigating near a WTG collides with another vessel navigating around a WTG.	Presence of WTGs potentially increases risk of collision absent other risk control mechanisms.
Naval vessel navigating near a WTG collides with another vessel navigating around a WTG.	Presence of WTGs potentially increases risk of collision absent other risk control mechanisms.
Presence of fishing vessels causes collision between other navigating vessels.	Presence of WTGs may increase presence of fishing vessels that would not otherwise operate in the area.
Recreational vessel collides with another vessel navigating near, around, or through a WTG.	Presence of WTGs potentially increases risk of collision absent other risk control mechanisms.
Vessels engaged in constructing WTG causes collision between other navigating vessels.	Additional vessels operating in the area of the WTGs causes increased risk of collision between vessels. Lack of maneuverability of vessels engaged in construction increases risk of collision.
Vessels engaged in servicing a wind turbine collide with another navigating vessel navigating near, around, or through a WTG.	Additional vessels operating in the area of the WTGs causes increased risk of collision between vessels.

Hazard Identification	Discussion
Collision	
Presence of vessels engaged in servicing a wind turbine causes collision between other navigating vessels	Additional vessels operating in the area of the WTGs causes increased risk of collision between vessels. However, sufficient sea room exists for maneuvering.
Vessels towing WTG components collide with a navigating vessel (construction phase only)	Towing and service vessels during construction will be limited in maneuverability.
Allision with Structure or Blade	
Commercial or Naval vessel under control makes contact with a WTG blade.	Air gap of blades less than air draft of most commercial vessels. Vessel encountering blades will sustain damage.
Recreational vessel under control makes contact with a wind turbine blade.	Air gap of blades greater than over 90% of recreational vessels. However, if a maxi-sized yacht encounters a blade, it will sustain damage.
Fishing vessel under control makes contact with a wind turbine blade.	Air gap of blades is greater than air draft of most fishing vessels. However, if a large fishing vessel with a significant air draft encounters a blade, it will sustain damage.
Recreational vessel not under command makes contact with a wind turbine blade.	Air gap of blades greater than over 90% of recreational vessels. However, if a maxi-sized yacht encounters a blade, it will sustain damage.
Fishing vessel not under command makes contact with a WTG blade.	Air gap of blades is greater than air draft of most fishing vessels. However, if a large, drifting fishing vessel with a significant air draft encounters a blade, it will sustain damage.
Vessel servicing the WTGs not under command makes contact with a WTG blade.	Blades will be secured while WTG is undergoing servicing.
Foundering and Capsizing	
Submarine cable is snagged by fishing equipment heeling vessel and causing it to founder or capsize.	The Inter-Array Cable will be buried to target depth of 1 m and the Export Cable will be buried to a target depth of 2 m.
A collapsed WTG is snagged by fishing equipment heeling the vessel and causing it to founder or capsize.	The likelihood of collapse of a WTG structure is low. However, special notification will be required to vessels if it should occur.
Submarine cable is snagged by an anchor heeling the vessel and causing it to founder or capsize.	The Inter-Array Cable will be buried to target depth of 1 m and the Export Cable will be buried to a target depth of 2 m.
A collapsed WTG is snagged by an anchor heeling the vessel and causing it to founder or capsize.	The likelihood of collapse of a WTG structure is low. However, special notification will be required to vessels if it should occur.
Electrocution	
Helicopter servicing the WTGs or Search and Rescue (SAR) causes an electric discharge between the helicopter and the wind turbine.	Dominion will monitor WTGs from its O&M Facility during SAR or servicing. An Emergency Response Plan will address procedures for both emergency shut-down and communications with response personnel during such events.
Search and Rescue	
Presence of the WTGs increases the risk of an accident (e.g. collision, contact, stranding, or grounding) and also inhibits search and rescue.	An incident requiring Search and Rescue assets around WTGs would require securing turbine blades during incident response and monitoring WTGs during a SAR incident.
Emergency Response	
Presence of the WTGs increases need for emergency response from a vessel involved in a collision, grounding, stranding, foundering, or capsizing,	Risk would be from hull rupture in the event of a collision between two vessels.

Based on the nature of VOWTAP, it has been assumed that the risk control and risk mitigation measures fall into 4 broad categories: Design, Operations and Emergency Plans, Public Notification, and Regulatory. Within each of these categories, risk control and mitigation measures were determined as follows:

- Design
    - Lighting and Marking
    - Radar Beacon (RACON) installation
- Operations and Emergency Plans
    - Control Center
    - Servicing Vessel Procedures
    - Communications Plan
    - Emergency Response Plans
- Public Notification
    - Notices to Mariners
    - Chart Modification/Marking
    - Public Outreach to Marinas and Professional Associations
- Regulatory
    - Safety Zones
    - Buoys

Standard marine navigational practices and application of the Rules of the Road will serve to minimize the risks identified by the construction and operation of VOWTAP. Additionally, applying the risk mitigation measures identified for each hazard (Table 7.6) will result in reducing the risk to a level that is broadly tolerable or "as low as reasonably practicable" (ALARP).

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Abbreviations and Acronyms

AIRSTA	U.S. Coast Guard or U.S. Navy Air Station
AIS	Automated Identification System
ALARP	As Low as Reasonably Practicable
ATBA	Area to be Avoided
ATON	Aids to Navigation
BOEM	Bureau of Ocean Energy Management
CCTV	Closed-Circuit Television
CFR	Code of Federal Regulations
COLREGS	International Regulations for Preventing Collisions at Sea
COTP	Captain of the Port
DoD	Department of Defense
EPIRB	Emergency Position Indicating Radio Beacon
FAA	Federal Aviation Administration
FACSFAC VA Capes	Fleet Area Control and Surveillance Facility, VA Capes
FPM	Flashes per minute
GPS	Global Positioning System
GRT	Gross Tons
HAT	Highest astronomical tide
Km or KM	Kilometer
LOA	Length overall
LNG	Liquefied natural gas
LPG	Liquefied petroleum gas
M or M	Meter
Mi or MI	Statute mile
MLW	Mean low water
MLLW	Mean lower low water
MW	Megawatt
M/V	Motor vessel
NEPA	National Environmental Policy Act
Nm or NM	Nautical mile
NOAA	National Oceanic and Atmospheric Administration
NRA	Navigational Risk Assessment
NTM	Notices to Mariners
OCS	Outer Continental Shelf
OREI	Offshore Renewable Energy Installation
PATON	Private aids to navigation
Project	Virginia Offshore Wind Technology Advancement Project
RACON	Radar beacon
RAP	Research Activities Plan
RBDM	Risk Based Decision Making
RNA	Regulated Navigation Area
Ro-Ro	Roll-on/Roll-off
ROV	remotely operated vehicle
SAR	Search and Rescue
TSS	Traffic Separation Scheme
UKC	Under Keel Clearance
ULSD	Ultra-Low Sulfur Diesel

USACE	United States Army Corps of Engineers
USC	United States Code
USCG	U.S. Coast Guard
VHF	Very High Frequency
WTG	Wind Turbine Generator

1 Introduction

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 24 nm (43 km) east of Virginia Beach, Virginia. The project is proposed to demonstrate the viability of offshore wind generators and provide information important to offshore wind research and development. The demonstration project will consist of two, 6 MW wind turbine generators (WTGs) connected by a 34.5-kilovolt (kV) submarine cable (the Inter-Array Cable between the WTGs, and a 34.5-kV transmission cable (Export Cable) from the WTGs to a shore terminus in Virginia Beach, Virginia.

Construction and operation of the VOWTAP requires an Outer Continental Shelf (OCS) Renewable Energy Research Lease. An Easement from the Bureau of Ocean Energy Management (BOEM) is also 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 U.S. Coast Guard (USCG) recommends that a Navigational Risk Assessment (NRA) be performed as part of the approval process following the guidance provided in (NVIC 02-07). The purpose of the NRA is to determine the potential risk to navigation as a result of the construction, operation, and maintenance of the WTGs and associated submarine cables. Similarly, BOEM regulations for offshore energy leases similarly require a number of plans and assessments as part of the lease application process (30 CFR 585). BOEM and USCG entered into a Memorandum of Agreement (MOA) to coordinate jurisdiction between the two agencies to ensure the safe construction and operation of Offshore Renewable Energy Installations (OREI) on the U.S. Outer Continental Shelf (BOEMRE/USCG MOA: OSC-06).

This NRA is intended to meet the recommendations of NVIC 02-7 as part of the overall BOEM approval process for VOWTAP.

1.1. Stakeholder Interaction

Since 2011, Dominion has engaged in a significant outreach program to stakeholders that may be affected by the contraction or operation of VOWTAP. The following is a list of entities involved in the stakeholder engagement process:

- Navy Fleet Forces Command Virginia Capes;
- U.S. Army Corps Of Engineers (USACE);
- Virginia Maritime Association;
- Virginia Pilot Association;
- American Waterways Operators;

- U.S. Coast Guard (USCG);
- Department of Defense (DoD Siting Clearinghouse);
- Navy Seafloor Protection Office; and
- State Military Reservation Camp Pendleton.

This early interaction has resulted in changes that have satisfied those stakeholders with whom engagement has occurred.

The issues raised by stakeholders included:

- Consideration for moving the VOWTAP site from an original location based on Automated Information System (AIS) data, which indicated less vessel traffic than an original site.
- The need to maintain the natural deep-water channel running southwesterly to the approach to the Traffic Separation Scheme (TSS) at the entrance to Chesapeake Bay clear and free of obstacles (see Figure 2.1).
- The desire to keep the Project as close to the commercial Virginia Wind Energy Area (WEA) as possible to minimize the impact on tug and barge coastwise traffic traveling on north-south tracks.
- The need to consider future commercial wind farm development of the Virginia WEA and the potential impact on future vessel traffic into and out of the Chesapeake Bay.

Discussions during the stakeholder engagement process led to the selection of the proposed VOWTAP Research Lease Area (see Figure 2.1). This area avoids the noted maritime stakeholder concerns.

Additional discussion of these stakeholder issues and others that were identified during the NRA process, including mitigation measures to reduce risk to an acceptable level, is found in Section 7.

1.2. NRA Objectives

As a result of stakeholder interaction early in the planning process for VOWTAP, the NRA has been undertaken to determine the potential risk to navigation from the construction and operation of VOWTAP, as well as the means to mitigate or control any significant risks to an acceptable level. The NRA is based on USCG guidance for OREI contained in NVIC 02-07. Additional guidance on the conduct of the NRA has been informed by newer material published by the United Kingdom Department of Trade and Industry, "Methodology for Assessing the Marine Navigational Safety Risks of Offshore Wind Farms."

The objectives of this NRA are as follows:

- Describe the Project and its elements

- Describe the characteristics of the waterways and marine environment in the vicinity of the Project Area and construction routes
- Characterize marine traffic in the vicinity of the Research Lease Area (inclusive of the Inter-Array and WTGs), the Export Cable corridor, and vessel construction routes
- Examine previous significant casualties in the area of the Project.
- Identify hazards and navigation issues which may exist as a result of the construction, operation, and maintenance of the Project
- Assess the potential risk (frequency and consequence) of those identified hazards and determine what, if any, appropriate risk mitigation measures need to be implemented to manage the risk to an acceptable level

1.3. NRA Description

The NRA is a qualitative risk assessment using "Change Analysis," one of the methods of risk assessment accepted by the USCG for use in Risk-based Decision Making (USCG RBDM Guidelines, 2013). A Change Analysis establishes a Base Case, (i.e., current conditions absent the Project), and then evaluates whether there are new risks brought about by the presence of the Project. The potential hazards identified for further consideration as to their frequency and consequence are then qualitatively measured against the Base Case and compared to the situation with the Project.

NVIC 02-07 establishes the need to determine the risk associated with a number of activities and conditions to provide a complete understanding of a Project and its implications for navigation safety and USCG mission performance.

The methodology for conducting the Change Analysis is based on the procedures established by the United Kingdom Department of Trade and Industry (DTI) for offshore wind installations (UK Department of Trade and Industry, 2013) which, in turn is based on the Formal Safety Assessment Process prescribed by the International Maritime Organization (IMO). The DTI methodology is a systematic means of identifying hazards that may exist as a result of the construction, operation, or maintenance of an OREI; an assessment of the likelihood of an event occurring relating to these hazards; an assessment of the consequences of such an event; and the identification of risk control measures that may be used to reduce or manage the risk for events that pose high levels of risk. Throughout the process, there is interaction between the assessment of the risk and the control measures to ultimately achieve a risk that is "as low as reasonably practicable" or ALARP (UK Department of Trade and Industry, 2013).

In the course of analyzing the risk of various hazards potentially associated with VOWTAP, a "What If" analysis was used informally to determine the relative consequence of an event. "What If" analysis is a widely accepted problem-solving approach for use in Risk-based Decision Making. It is a process for posing questions that may suggest situations that result in accidents or system performance problems and the potential consequences of those situations (USCG RBDM Guidelines, 2013). For example, even though historical data may not support the possibility of a particular type of incident, such as an allision between a vessel and a structure, such an event may be possible. A "What If" analysis of such an event allows the qualitative determination of the relative consequences of the event and provides additional detail for the overall risk assessment. The results of these "What If" Analyses for various conditions and situations are included in Section 7 of this NRA.

1.4. NRA Sources of Information

Information for the NRA has been drawn from numerous sources, including literature review of papers, data, and results of modeling conducted for other wind farms or projects that provide transferrable information applicable to the VOWTAP. Databases from a variety of sources have been compiled in order to create some quantitative basis for the conclusions reached in the NRA. Personal interviews have been conducted with stakeholders and subject matter experts in their particular field. Finally, the expert opinion of the staff of C&H Global Security has been used to determine the appropriateness of the conclusions. Each of these sources of information is noted in the appropriate location to ensure that the information may be replicated at a later time. Section 9 documents in detail the sources of information used for this NRA.

1.5. Assumptions and Limitations

The NRA is based on conditions known at the time of the study, including projected changes in future shipping activities, such as current expansion of the Panama Canal and the subsequent increase in size of certain vessels, and known plans for offshore development, such as the possible commercial development of the Virginia WEA during the life of the Project.

The NRA was prepared based on direction provided by the USCG in NVIC 02-07. No modeling or simulations of future conditions with the Project were undertaken for this NRA. Instead, this NRA relies on published models, reports, and findings developed for other offshore wind projects around the world, particularly in Europe, to the extent that the information and data appeared relevant to VOWTAP.

1.6. Uncertainty

Uncertainty is inherent in all risk assessment, even quantitative risk assessment, and the degree of uncertainty can influence decisions and future states. The degree of uncertainty is generally based on the quality of data and its applicability to the risks being assessed. For example, the probability of vessel collisions may be calculated using historical data and quantitative analysis, but variables in the chain of events that led to a particular collision or a series of collisions may not exist in the future such that similar events elude prediction. Similarly, the dearth of incidents may make quantitative analysis unreliable. Tests, trials, and models may not successfully capture the totality of variables that may lead to an event based on a particular hazard and the results of such are also, therefore, subject to uncertainty.

The degree of uncertainty of evidence used in a risk assessment may be determined qualitatively and relatively using a taxonomy developed by the UK Department of Trade and Industry, as depicted in Table 1.1.

The "Current Situation," which provides the least uncertainty for determining risk, such as AIS data, widely used to determine the density of vessel traffic in a particular area, still contains elements of uncertainty. AIS has been shown to overstate traffic density in some instances and understate it in others (Barco, et al., 2009). In other words, uncertainty will exist even in an analysis based on the highest orders of evidence.

Table 1.1 Quality of Evidence and Level of Uncertainty

Current Situation	Least Uncertainty
Trials	↑
Validated Modeling	
Quantitative Analysis	
Qualitative Analysis	
Expert Opinion: Written	
Expert Opinion: Verbal	
No Evidence	Highest Uncertainty

The levels of uncertainty associated with various factors examined for this NRA are addressed in Section 7 of this report. Expert opinion, both written and verbal, and qualitative analysis was extensively used in determining risk associated with the VOWTAP.

1.7. Document Structure

The VOWTAP NRA consolidates guidance from both USCG NVIC 02-07 and the UK DTI guidance for offshore wind installations. The organizational structure is consistent with that provided for in the UK DTI guidance, but it contains the elements recommended in USCG NVIC 02-07.

In order to assure that the provisions of USCG NVIC 02-07 are addressed, a "cross walk" between the requirements of NVIC 02-07 and this NRA is provided in Table 1.2.

Table 1.2 Crosswalk between NVIC 02-07 and VOWTAP NRA

NVIC Section	Specific Requirement	VOWTAP NRA Section
Visual Navigation and Collision Avoidance	Structures could block or hinder view of other vessels underway	Section 6.2.4
	Structures could block or hinder the view of coastline or other navigational feature, such as AtoN	Section 6.2.4

NVIC Section	Specific Requirement	VOWTAP NRA Section
	Structures and locations could limit the ability of vessels to maneuver to avoid collision	Section 6.2.3
Comms, Radar and Positioning Systems	Can Structures produce radio Interference	Section 6.2.4
	Can structures produce radar reflections, blind spots, shadow areas	Section 6.2.4
	Vessel to vessel	Section 6.2.4
	Vessel to shore	Section 6.2.4
	VTS radar to vessel	Section 6.2.4
	RACONS to/from vessel	Section 6.2.4
	Aircraft or Air Traffic Control	Section 6.2.4
	Comply with current recommendations concerning electromagnetic interference	Section 6.1.2
	Can structures and generators produce sonar interference affecting fishing, military or industrial	Section 6.1.5
	Acoustic noise that might Interfere with sound signals from other vessels or AtoN	Section 6.1.5
	Structures, generators, and cabling produce electro-magnetic fields affecting compasses or other nav. systems	Section 6.1.5
	Will power or noise generated above or below water create physical risks	Section 6.1.5
Navigational Marking	Site marking day and night	Section 2.1.3 and Attachment IV
	Individual structures marked	Section 2.1.3 and Attachment IV
	RACON or AIS transceiver	Section 2.1.3
	Sound signal characteristics	Section 2.1.3
	Compliance of markings with USCG requirements or IALA recommendations	Section 2.1.3
	Maintenance of AtoN	Section 2.5
	Procedures to respond to and correct ATON casualties	Section 2.5
	Impact of marking structures on existing AtoN	Section 2.1.3
Standards and Procedures for Shutdown	Design Requirements	
	WTGs marked with unique identification characters	Section 2.1.3
	WTGs controlled from operations center	Section 6.2.4
	Safe shutdown processes coordinated with USCG	Section 6.2.4
	WTG control mechanism fix and maintain blade position from ops center	Section 6.2.4
	Nacelle hatches capable of opening from outside	Section 2.1.2
	Access ladders	Section 2.1.2
	Operational Requirements	
	Ops Center manned 24 hours per day	Section 6.2.4

NVIC Section	Specific Requirement	VOWTAP NRA Section
	Chart with GPS position and identifying marks	Section 6.2.4
	USCG command center with contact number for ops center	Section 6.2.4
	USCG command center with chart showing GPS position and identifying marks	Section 6.2.4
	Operational Procedures	
	USCG command center will ID any WTGs in vicinity of distressed vessel	USCG
	USCG command center will pass info to ops center	USCG
	Ops center will initiate shutdown and maintain until notified	Section 6.2.4
	Comms and shutdown procedures tested 2x per year	Section 6.2.4
	After allision, report WTG structural integrity IAW marine casualty regs.	Section 6.2.4
Effects of Tides, Tidal Streams and Currents		Section 3.12 and Section 6.1.1
Weather		Section 3.11, Section 6.1.3, and Section 6.2.1
Ice		Section 3.14, Section 6.1.1, Section 6.2.1
Traffic Survey		Section 4.3
Risk of Collision, Allision, or Grounding	Collision Frequency, consequences, location, type, vessel type	Section 6.1.3 and Section 6.2.2
	Allision Frequency, consequences, location, vessel type	Section 6.1.3 and Section 6.2.2
	Grounding Frequency, consequences, location, vessel type	Section 6.1.3 and Section 6.2.2
Structures	Do features of the WTGs and cables pose difficulty to vessels underway, normal ops or anchoring	Section 6.2.2
	Do features of WTGs pose problems to emergency rescue services	Section 6.2.5
	Noise or vibrations above or below water impact nav. Safety or other USCG missions	Section 6.2.5
	Ability of WTG to withstand damage from vessels without toppling for range of vessel types, speeds and sizes	Section 6.1.3
Assessment of Access to and Navigation within or close to WTGs	Extent to which navigation within the site is safe or should be prohibited or recommended to be avoided	Section 2.3
	Does exclusion from the site cause navigational, safety, or transiting problems for vessels in the area	N/A
USCG Mission Considerations	SAR	Section 6.2.5
	MEP/Response	Section 6.2.5

2 Project Description

The VOWTAP is a collaborative research and development effort undertaken by several governmental and private-sector entities. The VOWTAP Team members are Dominion, the Virginia Department of Mines, Minerals and Energy (DMME), the National Renewable Energy Laboratory (NREL), the Virginia Coastal Energy Research Consortium (VCERC), Alstom (the turbine manufacturer), Keystone Engineering Inc. (Keystone), as the foundation design firm, Kellogg, Brown & Root (KBR, the marine engineering contractor), and Newport News Shipbuilding. In December 2012, VOWTAP was selected by the DOE for federal funding assistance to support initial engineering design and permitting for offshore wind demonstration projects. On May 8, 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.

Section 2 describes the characteristics of the Project that are directly applicable to the NRA. The information provided here is based on the VOWTAP Research Activities Plan (RAP) unless otherwise noted.

2.1. Wind Turbine Generators

2.1.1. Location

The proposed Lease Area is located in Federal waters east of the entrance to the Chesapeake Bay in OCS Lease Block 6111, Aliquot H (Figure 2.1). The WTG site lays approximately 17 nm (31.5 km) east-southeast of the inbound Northern Approach in the Traffic Separation Scheme (TSS) and approximately 15 nm (27.8 km) east-northeast of the Southeast Approach to the TSS. The WTGs will be installed approximately 3,445 ft (1,050 m) apart, in the following positions:

Turbine 1: 75° 29’ 29.88” W 36° 53’ 46.63” N

Turbine 2: 75° 29’ 29.66” W 36° 53’ 12.6” N

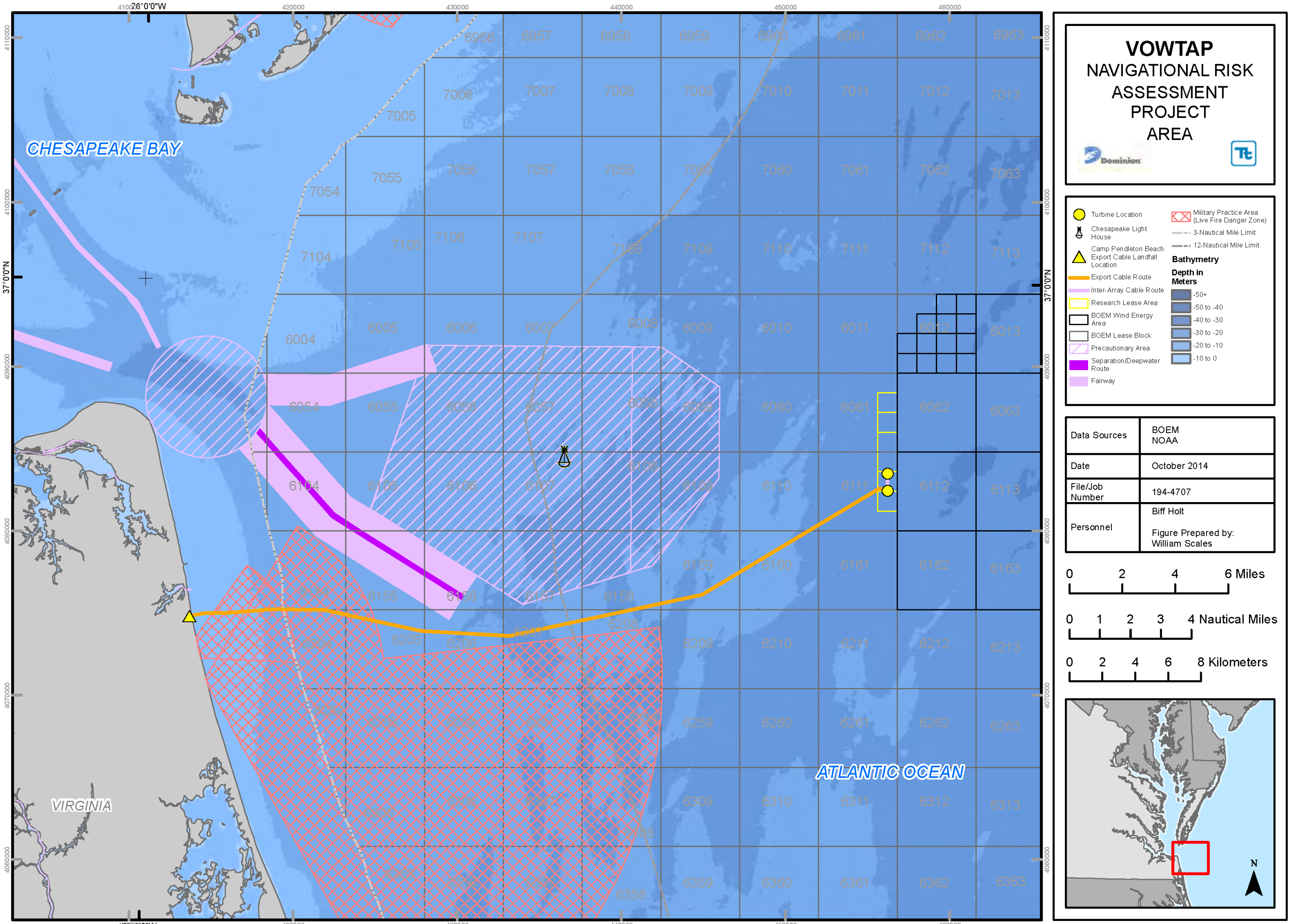


Figure 2.1 VOWTAP Project Area

2.1.2. WTG Design Specifications

The Project will consist of two 6 MW "Alstom Haliade 150" WTGs, each comprised of a tower, nacelle, and rotor with three blades (see Figure 2.2). Each tower will be constructed and mounted atop a Keystone "Inward Battered Guide Structure" (IBGS) with a draft of 87 ft (26m) to 89 ft (27m) that is fixed to the seafloor. The WTG tower base diameter is approximately 19.7 ft (6m) and will sit atop a transition piece mounted to the IBGS foundation.

The nacelle and hub located atop the tower will be 25.3 ft (7.7m) wide, 64.3 ft (19.8m) long, and 26.9 ft (8.9m) high. Rotor blades mounted to the nacelle will be 241 ft (73.5m) long and 10.5 ft (3.2m) wide with a total "rotor swept zone" of 495 ft (151m). Once mounted, the total height of the turbine (from MSL) will be 584 ft (178m). The blade clearance above the water surface (air gap) at MSL will be 89 ft (27m) and at Highest Astronomical Tide (HAT) 82.4 ft (25.1m). The rotor on each WTG rotates into the wind to optimize efficiency of the WTGs.

The rotor speed will be 4 revolutions per minute (rpm) to 11.5 rpm with an operational cut-in wind speed of 5.8 knots (3 m/s) and a cut-out wind speed of 48.6 knots (25 m/s). The WTGs are designed to operate in air temperatures between 14°F (-10°C) and 104°F (40° C). If wind speeds exceed 48.6 knots (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. The WTG is designed to withstand wind speeds of 97 knots (50 m/s) over a 10-minute average and 50-year extreme gusts of 136 knots (70 m/s) over a 3-sec average.

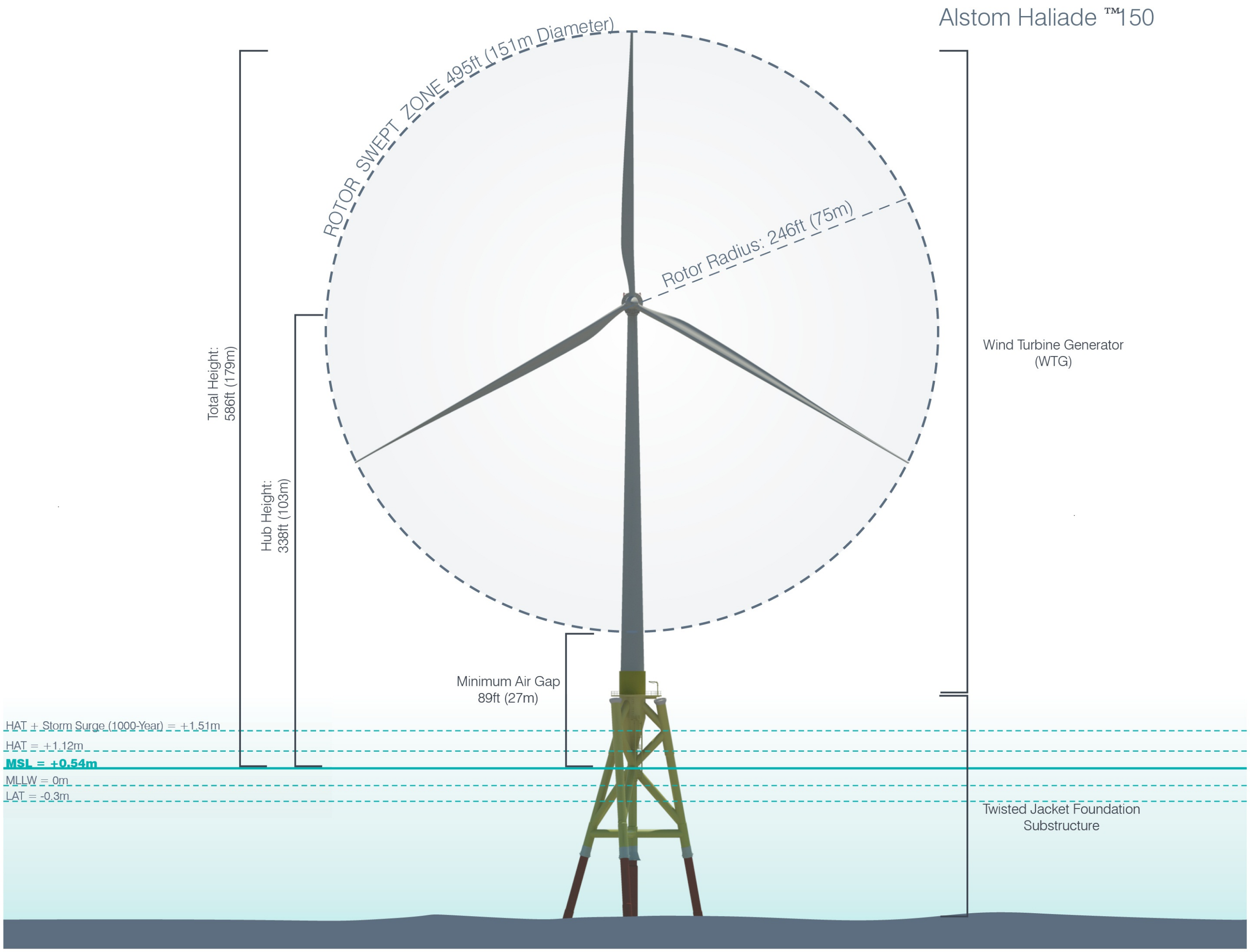


Figure 2.2 Representative VOWTAP WTG Diagram

2.1.3. Lighting and Marking of VOWTAP and Aids to Navigation

Dominion has developed a lighting and marking scheme for the VOWTAP WTGs. The plan is based on USCG regulations (33 CFR 66 and 67), guidance (USCG ATON Manual, 2005), determinations for other proposed offshore wind energy projects (USCG Salerno Letter, 2008) and international recommendations (IALA, 2008). Attachment V describes the proposed marine navigation lighting and marking for each turbine.

The lighting and marking plan for the VOWTAP WTGs will be subject to approval by the Commander, USCG District Five. Dominion will submit an application for private aids to navigation in accordance with Title 33 Code of Federal Regulations Part 66 in such time as to allow careful review and approval by the District Commander.

During construction, and as appropriate otherwise, the offshore work 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 are completed (e.g., in case of adverse weather), temporary USCG-approved navigational aids will be placed on the structures.

During the operation of the WTGs, lighting for each WTG will consist of 2 yellow (or amber) lights on the same horizontal plane at a height of not more than 50 ft (15m) above HAT or at the level of the platform, whichever is greater. Lights will be programmed to activate one-half hour before sunset and to deactivate one-half hour after sunrise.

A RACON is proposed to be installed on one of the WTGs, subject to USCG approval.

Aeronautical lighting for each turbine is described in other documents associated with the permitting process for VOWTAP and is not discussed here.

The following marking is proposed to enhance the navigational safety of VOWTAP:

- The jacket portion of the foundation of each WTG will be painted yellow all around from the level of HAT to 50 ft (15 m) or at least to the bottom of the transition deck, whichever is greater.
- Above the yellow demarcation line, each WTG will be painted bright white or slightly off-white color (less than 5 percent grey tone).
- Each WTG will have a unique alphanumeric identifier. The letters will be black, retro reflective material, at least 15 ft (4.6 m) in

height, located 120° apart with the letters mounted vertically from a point 10 ft (3 m) above the platform.
  - Each WTG will be marked by two yellow bands of retro reflective material each 6 ft (2 m) high and separated by 6 ft (2 m), which will be situated around the tower above the alphanumeric identifier of each WTG.

2.2. Submarine Export and Inter-Array Cables

The 34.5-kV Export Cable will be installed below the seabed between the onshore landing point at Camp Pendleton, VA (south of Cape Henry) and the southerly WTG, a distance of approximately 25 nm (45 km). This cable will be laid in one continuous run to avoid the need for offshore splicing of the cable. An Inter-Array Cable will join the two WTGs.

A fiber optic cable will also be incorporated into the Export Cable and will be used to transmit data from each of the VOWTAP WTGs to the Supervisory Control and Data Acquisition (SCADA) system.

The submarine cables will be installed using a towed jet plow or remotely operated vehicle (ROV) jet trencher that utilizes high-pressure water from vessel-mounted pumps that are injected into the sediments through nozzles distributed along the front of the plow. 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 (1m) 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. At a distance of approximately 656.2 ft (200m) from each IBGS foundation, a ROV jet trencher will be used to jet the cables into the seabed and support final installation of the cables into the central caisson of the IBGS.

The cables will be buried to a target depth of 3.3 ft (1 m) along the Inter-Array Cable and 6.6 ft (2 m) along the Export Cable, in accordance with recommendations for mitigating threat to submarine cables, and as a result of expected soil conditions along the cable routes. At high-risk areas identified along the route, such as the military practice area/live fire danger zones and the dredge material placement area, Export Cable depth may be increased up to 15 ft (4.5m). Dominion has identified five areas along the route where the presence of mobile sand waves may require additional measures to ensure the protection of the cable. At the five identified 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.

The jet plow and/or ROV jet trencher will be towed from a cable-laying vessel equipped with dynamic positioning (DP) to ensure the accuracy and speed of cable installation. The rate of cable-laying is estimated at approximately 0.11 knots (0.2

km/hour). At this rate and without interruptions, Export Cable installation is expected to be completed in 4 weeks. An additional 11 weeks is expected to be required for completing Export Cable landfall on shore and interconnection with the WTG, as well as laying the Inter-Array cable. The results of the cable-laying operation will be assessed via a ROV or a Burial Assessment Sled from the cable-laying vessel upon completion of installation activities.

2.3. Project Construction Methods and Schedule

A Construction Port at an existing waterfront industrial or commercial site in either Virginia Beach, Norfolk, and/or Newport News will be established to support construction and operations and maintenance (O&M). Waterway characteristics applicable to the proposed Construction Port are described in Section 3.

The WTG and foundation components will be assembled offshore at the VOWTAP site. Construction plans call for a work barge to be anchored at the site for use as a temporary working platform for storage of materials, equipment, and components. This vessel will also be used for any diving, future scour protection installation, if needed, and grouting spread operations. Offshore assembly will include the use of vessels equipped with dynamic positioning and heavy lift capabilities necessary for hoisting and installing the substructure, tower, nacelle, rotor, and blades. Transportation of equipment and/or components from the Construction Port will be aboard U.S. flagged vessels operating in accordance with rules and regulations governing the waterways, as described in Section 3.

Offshore construction will require approximately 12 weeks and is anticipated to take place during the months of May through July. Cable laying will occur 24 hours a day, while pile driving will occur only during daylight hours. The offshore construction period has been defined to take advantage of favorable weather conditions and avoid periods when activity needs to be restricted, based on Project related metocean studies and environmental constraints. Historical weather and metocean data analysis conducted as part of this assessment is described in Section 3. Offshore construction activities will be temporarily suspended in response to defined adverse weather constraints, including winds in excess of 20 knots (10.3 m/s) and/or wave heights greater than 3.3 ft (1m). Table 2.1 graphically displays the proposed project schedule for construction of VOWTAP.

Table 2.1 Construction Window

Activity	Anticipated Timeframe
Interconnection Station Installation	April through June
Onshore Interconnection Cable and Switch Cabinet installation	February through April
Export Cable Landfall Construction (including Offshore HDD)	March through April
IBGS Foundation installation and pile driving	May
Export Cable Installation	May through June
Inter-Array Cable Installation	June
WTG installation	June through July
Commissioning	August through September

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. 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 construction corridor along the routes of the Export Cable and Inter-Array Cable. 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.

A variety of vessels will be required to support the offshore construction activities. Table 2.2 is a preliminary list of the vessel types expected to be used to support the project, their anticipated movements, and activities, as described in the RAP.

Table 2.2 Potential Construction Phase Equipment and Materials

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, 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 (5.4m) 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 tugboat. Used to transport substructure from fabrication yard to the construction area.
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 tugboat. Used to support installation activities as required.
Tug Boats	180 x 45 x 40 (20)	Ocean class tug with large hp and high bollard pull. Assists barge and other vessel repositioning as required.

Vessel	Approximate Size (ft) Length x Width x Depth (Draft)	Description / Equipment
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)	Support jack-up barge.
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.

Upon final determination of the Construction Port, those vessels transiting to and from the Project Area may be subject to pilotage and other requirements as described in Section 3. For instance, foreign vessels must take a State pilot when in State waters and those vessels with a draft of less than 25 ft (7.62m) and tows must use the Auxiliary Channels when navigating Thimble Shoal Channel.

In addition to lighting used for collision avoidance by vessels engaged in construction and support activities, work lighting will be provided to ensure safe operations.

2.4. Component Transportation and Storage

The various VOWTAP components and equipment will be fabricated in ports other than the Project Area. The cables and most of the major components for the WTGs will be transported directly to the Project Area for construction and positioning, largely eliminating the need for storage of components. Unless unforeseen circumstances and conditions require it (such as *force majeure*[2]), the vessels transporting components and the cable-laying vessel are not expected to call at any U.S. port.

Ancillary operations, such as site preparation and construction support and monitoring, will likely be staged at the Construction Port and transported to the Project Area, as necessary, aboard U.S. flagged barges, tugs, crew boats, and other ancillary installation vessels.

2.5. Operations and Maintenance

The VOWTAP has been designed to operate remotely with minimal day-to-day supervision throughout its 20-year life. However, standard operational monitoring and

[2] Force Majeure is a traditional concept in maritime law that a vessel in distress may approach a beach, coastline, port or harbor in order to secure life and property aboard the vessel.

preventative maintenance will be required necessitating the use of support or service vessels throughout the life of the Project. O&M activities are summarized as follows:

- The IBGS foundations will be inspected on an annual basis, using the Project's dedicated service vessel. A scour survey will also be conducted at intervals of 1 year, 2 years, 5 years, and 10 years after commissioning or after a major storm event.

- The WTGs will be inspected and maintained according to a specified plan, which will require multiple trips per year by the Project's dedicated service vessel.

- The Inter-Array Cable and Export Cable will not require maintenance unless a fault or failure occurs.

- Sonar surveys of the cable routes will be conducted 6 months and 1 year after installation. Subsequent surveys will occur at regular 2-year intervals thereafter, or after a major storm event.

2.6. Decommissioning

At the end of the Project's 20-year operational life, the Project will be decommissioned in accordance with a detailed Project decommissioning plan that will be developed in accordance with applicable laws, regulations, and best marine practices at the time. In preparation for decommissioning activities, Dominion will conduct a bathymetric survey to define the datum to which the foundations will be removed below the seabed. 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 or ROV jet trencher technique used for installation and re-used or cut below the seabed and left in place.

3 Waterways Characteristics

The proposed VOWTAP Project Area is located offshore from the Virginia coast and the entrance to the Chesapeake Bay, which provides water access to several major ports and many lesser ports (NOAA Coast Pilot, 2013). The waters surrounding the Project Area serve as a vital conduit for maritime commerce in the Mid-Atlantic region. These waters are routinely navigated by the commercial shipping traffic, military vessels, fishing vessels, and recreational craft. This Section documents the characteristics of the waterways that are important to the NRA.

3.1. Aids to Navigation

The waters surrounding the Project Area are marked with both Federal and private aids to navigation (ATON). A fixed beacon, the Chesapeake Light, is located 14 nm (26 km) eastward of Cape Henry and about 11 nm (20.5 km) west-northwest of the Project Area. The beacon is a white light that is housed 117 ft (35.7m) above the water within a white superstructure atop a blue tower. The light flashes twice in a 15-second period and has a nominal range (the maximum distance the light can be seen in clear weather) of 19 nm (35.2km), making it a prominent ATON for vessels bound to or from Chesapeake Bay (USCG Light List, 2013). In addition to the light, the aid is equipped with a sound signal and RACON.

Other prominent ATON include two fixed beacons, Cape Charles Light and Cape Henry Light, located on the north and south capes, respectively, that make up the entrance to the Bay. Cape Charles Light has a height of eye of 180 ft (54.9m) and a nominal range of 18 nm (33.3km). Cape Henry Light has a height of eye of 164 ft (50m) and a nominal range of 17 nm (31.5km). Both lights are shown from fixed octagonal black and white towers. Cape Henry Light is also equipped with a red sector covering and warning mariners of the shoals outside Cape Charles. Together with Chesapeake Light, these ATON are important for mariners in part because of the great distance with which their lights can be seen (NOAA Coast Pilot, 2013). Other important ATON with lesser ranges include the RW "CB" buoy (CB buoy), a "safewater" mark indicating the seaward entrance to the Southeast Approach traffic lanes, and the yellow "NCA" buoy, a special mark indicating the seaward entrance to the Northeast Approach traffic lane. Various other private aids and non-lateral aids are also found near the TSS (Figure 3.1).

3.2. Traffic Separation Schemes / Precautionary Areas

A TSS has been established in the approaches to Chesapeake Bay between Fisherman's Island on the north and Cape Henry on the South (Figure 3.1). The TSS includes the Northeast Approach, Southeast Approach, Southeast Deep-Water Route, and a 2-mile (3.2 km) radius Precautionary Area centered on Chesapeake Bay Entrance Lighted Whistle Buoy CH. The VOWTAP site is more than 17 nm (31.5km) from the Northeast Approach and 15 nm (27.8km) from the Southeast Approach.

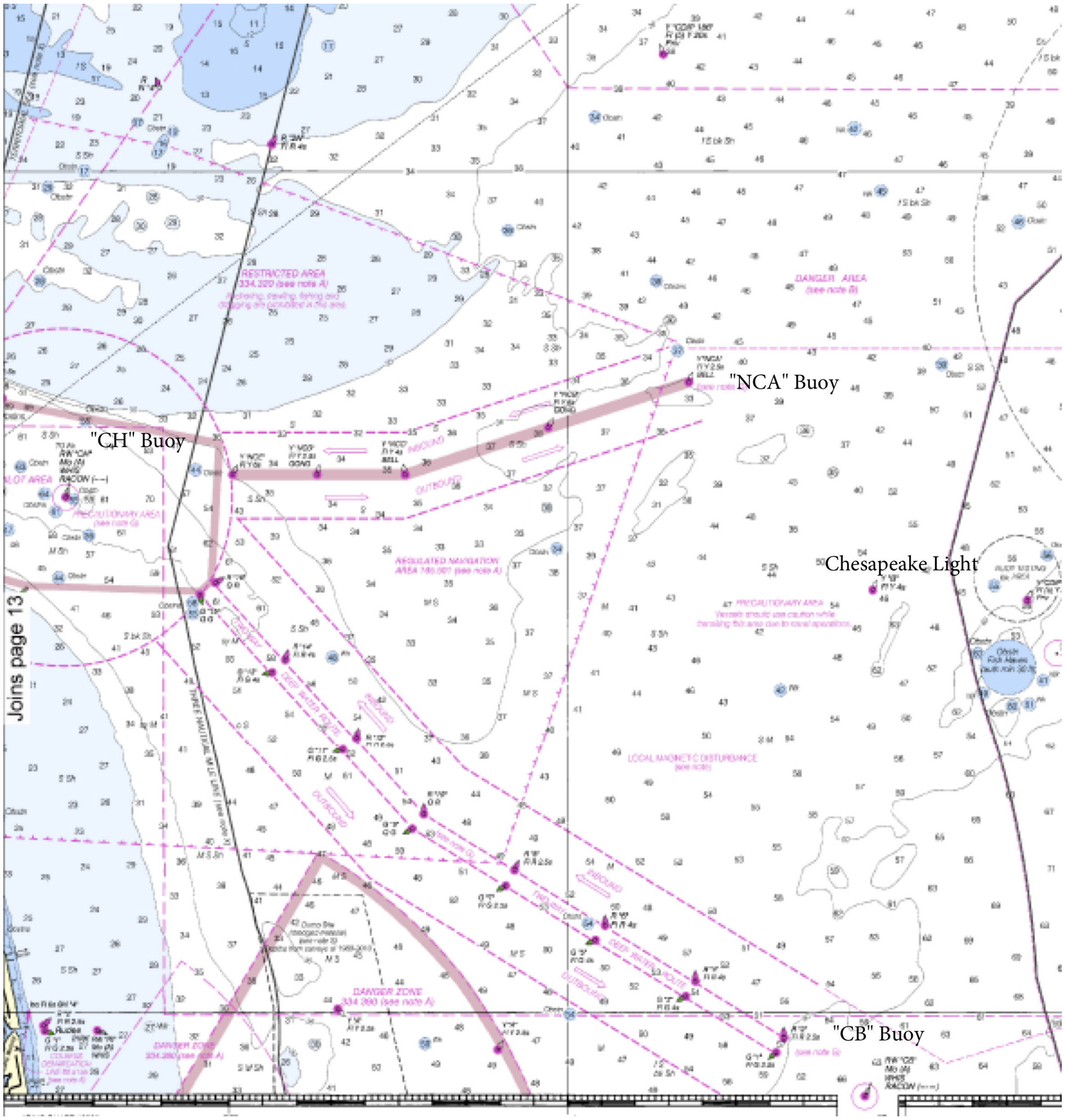


Figure 3.1 Chesapeake Traffic Separation Scheme and Aids to Navigation

The TSS is designed to aid in the prevention of collisions by providing separated traffic lanes in a congested waterway. In addition, the TSS for Chesapeake Bay directs vessel traffic away from the charted Danger Zone and Restricted Area that may otherwise represent hazards for vessel traffic. Use is recommended, but not required, for vessels approaching or departing Chesapeake Bay and it does not supersede or alter the applicable Rules of the Road (NOAA Coast Pilot, 2013).

The Northeast Approach consists of both inbound and outbound traffic lanes separated by a separation zone and 5 yellow fairway buoys. All buoys are both lighted and equipped with sound signaling appliances. The depth of water through the Northeast Approach is mostly less than 36 feet (11 m) at MLLW (NOAA Chart 12221, 2013). Coastwise vessels approaching from the north will typically use the Northeast Approach if their draft is sufficiently shallow and minimum underkeel clearance (UKC) can be maintained.

The Southeast Approach is situated in deeper water and runs from the CB buoy to the CH buoy. A Deep-Water Route between the two lanes separates the inbound and outbound traffic 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 (Coast Pilot, 2013). The Deep-Water Route provides depths in excess of 50 feet (15.8 m) to and from the Bay. A Federal navigation project maintains channels with depths of 50 feet (15.8 m) to Baltimore and 55 feet (17 m) to Hampton Roads.

Depending on the location of the arrival or departure port, a Virginia Pilot or Maryland Pilot normally embarks and disembarks vessels within the precautionary area surrounding the CH Buoy. Vessels using the TSS inbound for the pilot boarding area are encouraged by the USCG to make a security broadcast on VHF-FM channel 13. If transiting the Deep-Water Route, vessels are advised to communicate those intentions on VHF-FM channel 16 prior to entering the waterway at the CH buoy if outbound or the CB buoy if inbound. Pilotage is compulsory for all foreign vessels and U.S. vessels under register when operating in State waters; however, State pilotage is optional for U.S. vessels under enrollment engaged in the coastwise trade so long as a Federal pilot is aboard and properly licensed (NOAA Coast Pilot 2013). Pilotage is not required in the waters surrounding the VOWTAP Project Area or the adjacent Virginia WEA.

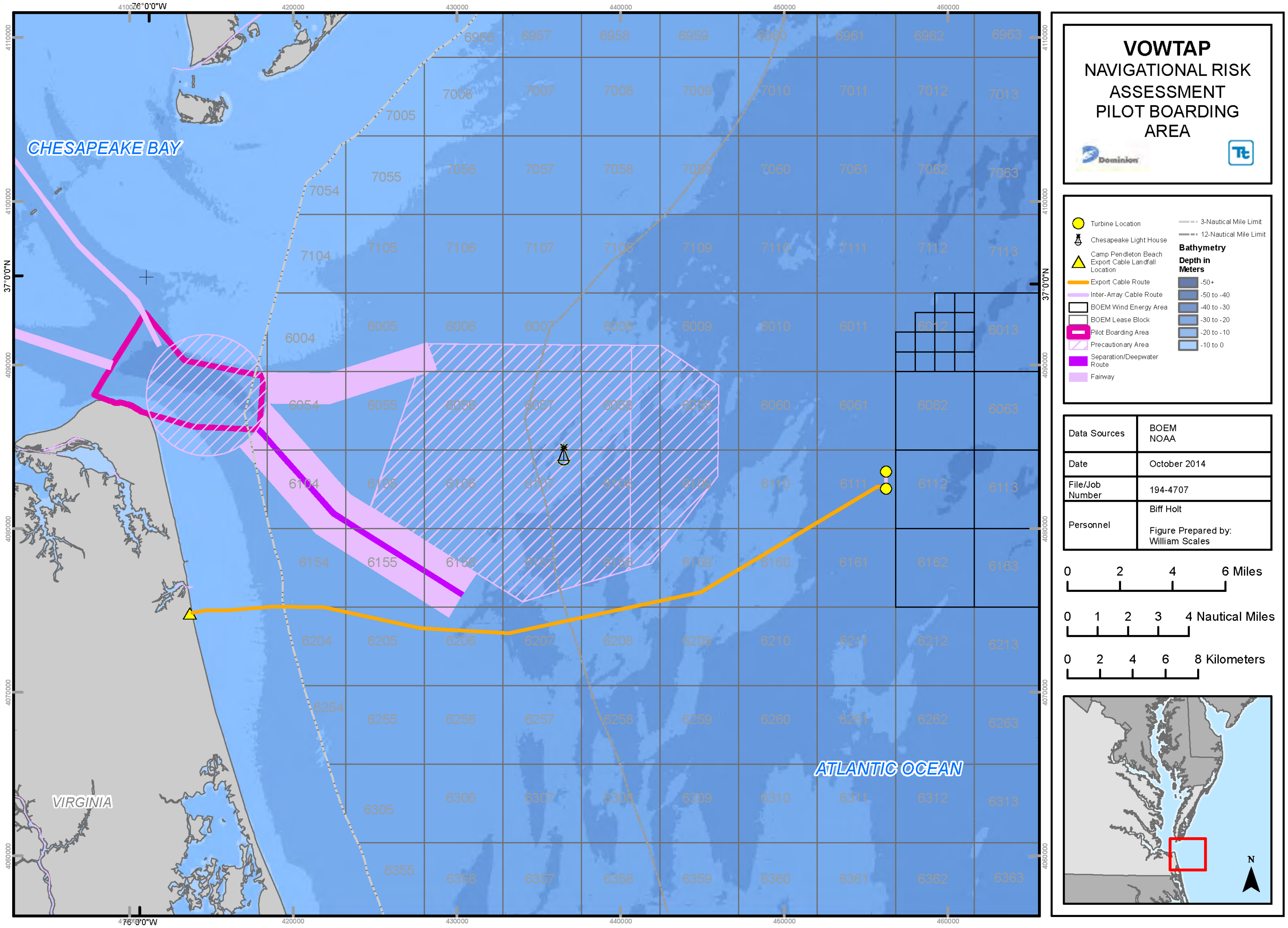


Figure 3.2 Pilot Station

3.3. Special Operating Areas

The VOWTAP Project Area lies near the Mid-Atlantic Seasonal Management Area (SMA) designated by the U.S. National Marine Fisheries Service for the protection of Northern Right Whales (Figure 3.3). From November 1 through April 30 each year, all vessels greater than or equal to 65 ft (19.8m) in overall length and subject to the jurisdiction of the United States must slow to speeds of 10 knots or less when transiting the SMA (50 CFR 224). As such, vessels will generally be increasing or decreasing speed, in accordance with the regulations for operating within the SMA, when operating near the Lease Area. Vessels clearing the SMA will generally increase speed once outside the SMA's 20-mile (32-km) radius, whereas vessels approaching the TSS for entry into the bay will be slowing down in order to comply with the 10-knot speed limit.

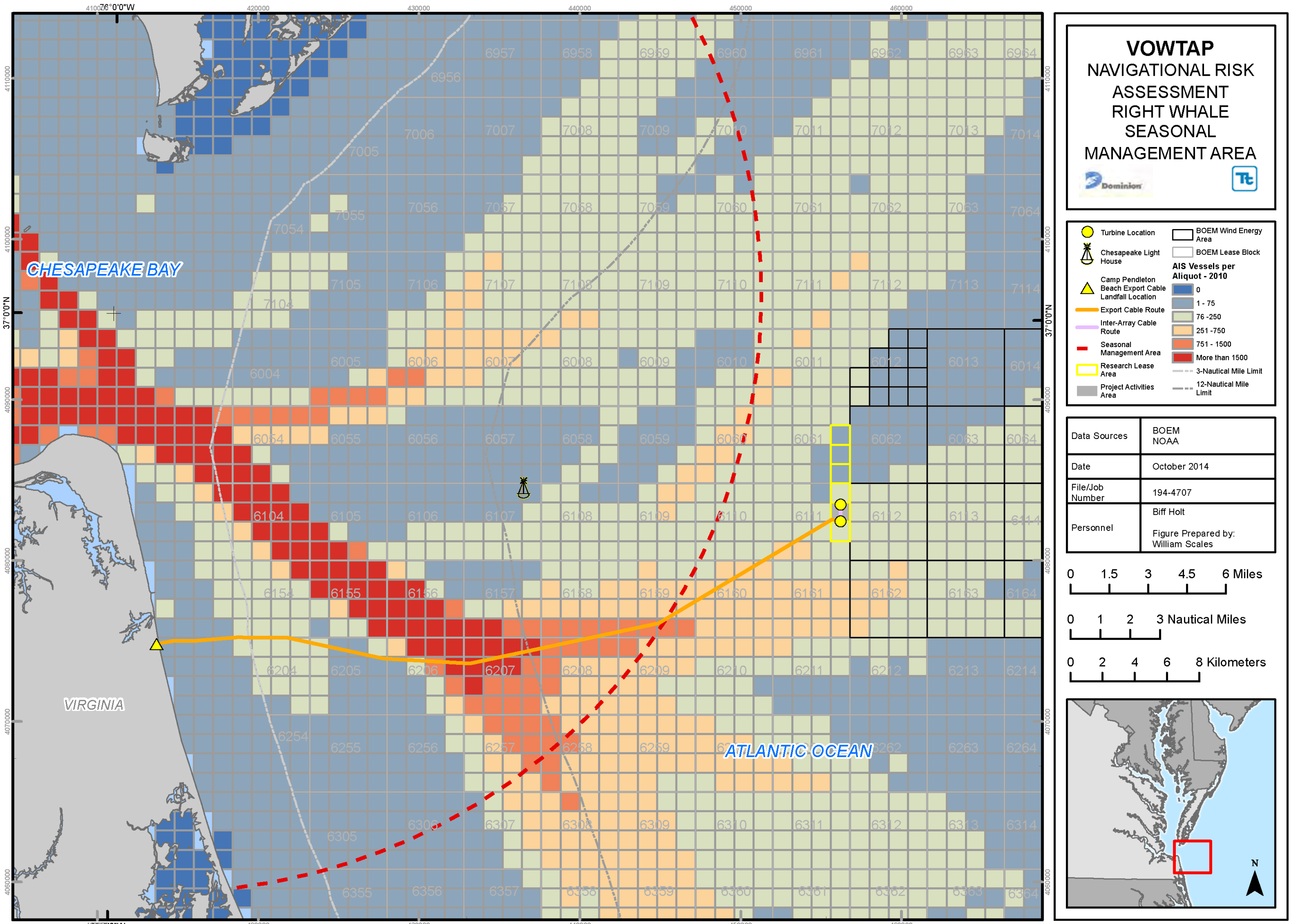


Figure 3.3 Right Whale SMA Proximity to VOWTAP

3.4. Disposal Sites / Dumping Grounds

Dumping grounds or disposal sites are areas within the territorial waters of the United States used for the placement of dredged material, spoils, and other wastes. These areas are typically identified on navigation charts and may require or suggest avoidance by vessel traffic, based on the potential for uncharted or unreliable depth soundings and/or the existence of hazardous material occupying the site. No identified dumping grounds are located within the Project Area.

An active dumpsite for dredge spoils is located 5.6 nm (10.4 km) northeast of the Chesapeake Light and approximately 4 nm (2.4 km) from the Lease Area (Figure 2.1). Charted depths within the dumpsite are based on surveys from 1980-2006 and as a result, may be unreliable. Vessels proceeding to or from the Southeast Approach generally maintain clearance from the dumpsite by operating south of a yellow special ATON, buoy “A” (Morrissey, 2013).

An additional active dumpsite known as the Dam Neck Ocean Disposal Site (DNODS) is located shoreward of the Southeast Approach traffic lanes, approximately 2.5 nm (4.6km) off the coast of Virginia Beach. Depths shown on NOAA Chart 12207 are a result of surveys carried out between 2005 and 2011. This site is generally clear of all commercial traffic, although VOWTAP support and construction vessels may pass through this area during installation and maintenance of the Export Cable. The proposed cable route traverses DNODS Zones 2 and 5, which have been earmarked to receive fine sediment not used for beach replenishment activities.

3.5. Marine Protected Areas

Marine Protected Areas (MPAs) are defined areas where natural and/or cultural resources are given greater protection than the surrounding waters. These areas are reserved by federal, state, territorial, tribal, or local regulations to provide lasting protection for part or all of the natural and cultural resources therein (NOAA MPA Center, 2013).

The MPA closest to the Project Area is False Cape State Park located approximately 22 nm (40.7km) from the Project Area, and 10 nm (18.5km) from the proposed landfall site at Camp Pendleton.

3.6. Danger Zones and Restricted Areas

The VOWTAP WTGs are well clear of offshore restricted areas and designated danger zones. The Export Cable route to the landfall site near Camp Pendleton, however, passes through the northern boundaries of a danger zone located offshore of Virginia Beach. The Dam Neck Live Fire Danger Zone extends seaward 15 nm (27.8km) from shore and closely borders the Southeast Approach traffic lanes (Chart 12207, 2013). Vessels proceeding through the area are advised to do so with caution and to remain within the area no longer than necessary for purposes of transit (33 CFR 334.390). 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 the regulation (33 CFR 334.380).

Figure 3.4 depicts the location of the designated danger zone and the proposed Export Cable route.

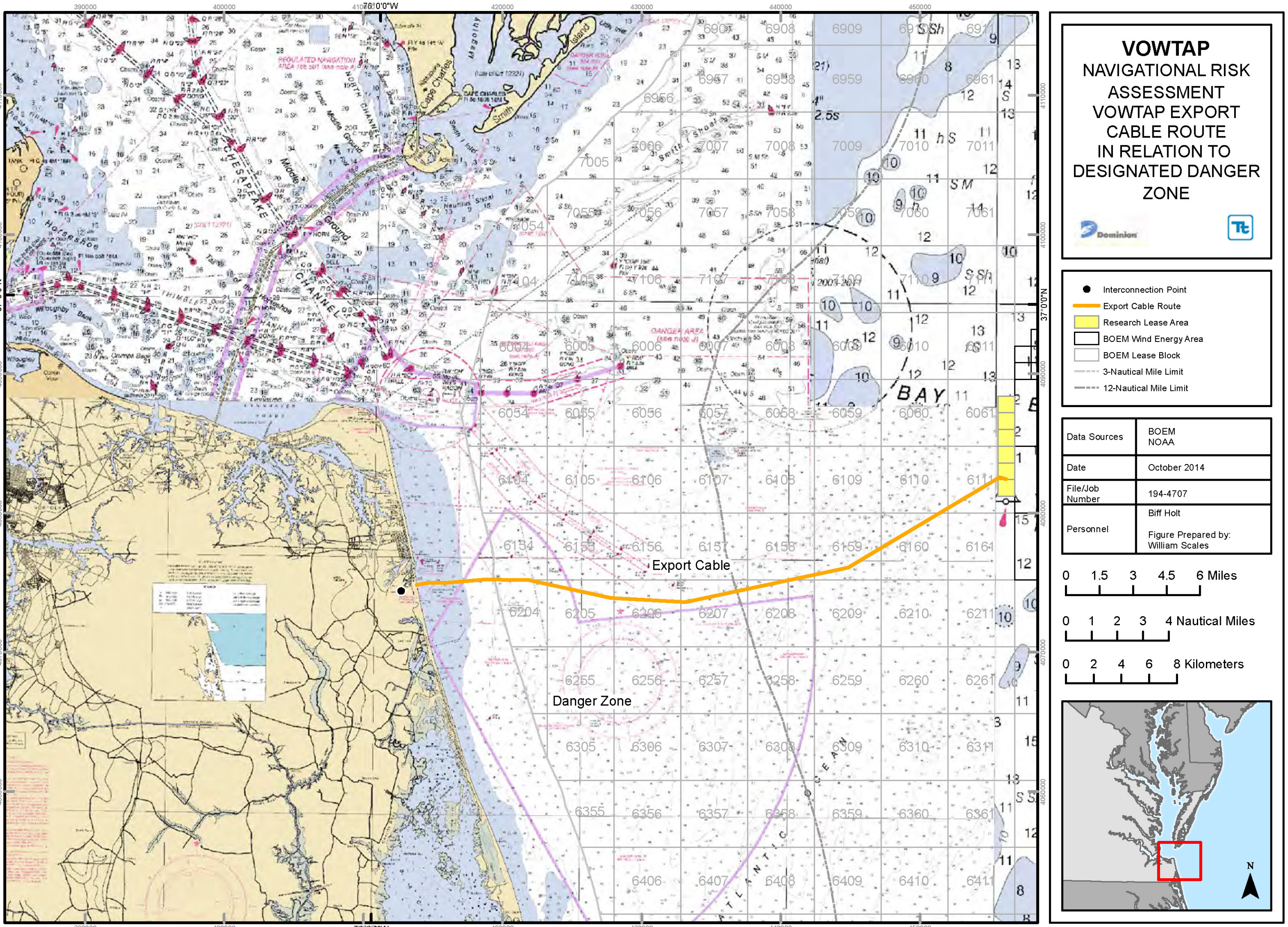


Figure 3.4 VOWTAP Export Cable Route in Relation to Designated Danger Zone

An area running from inside Cape Henry to Virginia Beach and encompassing the TSS precautionary area, most of the Northeast Approach, and portions of the Southeast Approach is designated by the Army Corps of Engineers as a "Naval Restricted Area". Anchoring, trawling, crabbing, fishing, and dragging are prohibited within this area, and no object attached to a vessel may be placed near the bottom (33 CFR 334.320).

The waters inside a line drawn across the entrance to Chesapeake Bay between Wise Point, Cape Charles Light, and Cape Henry Light have been designated by the USCG as a Regulated Navigation Area (RNA). Any vessels over 65 feet (19.8m) in length may not anchor within the RNA except within a designated anchorage area unless in an emergency or with the prior approval of the Captain of the Port (COTP) (33 CFR 165.501). Therefore, any anchoring outside of the designated anchorages (See Section 3.8) is subject to this RNA.

Within Chesapeake Bay and Hampton Roads are numerous other restricted areas, danger zones, and tunnel areas that impose restrictions on vessel navigation in the area. An emergency restricted area surrounds the Chesapeake Bay Bridge Tunnel (CBBT) complex in an effort to mitigate the risk of damage to the bridge tunnel from vessels, which has occurred on several occasions (NOAA Coast Pilot, 2013). The lower bay is quite often subject to sudden and violent weather deterioration, which can pose extreme hazards to vessels operating or anchoring in close proximity. The emergency restricted area discourages maneuvering near the bridge complex and requires engines to be readied on short notice for vessels anchored nearby.

Near the entrance to Hampton Roads, a 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 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). Within the restricted area, anchoring, fishing and dragging are prohibited and no object or appendages from vessels will be placed on or near the bottom (33 CFR 360).

Additionally, the Norfolk Naval Base lies on Sewell's Point on the southeast end of Hampton Roads. As such, a restricted area encompasses all waterside access to the base running from its border with Norfolk International Terminals to its boundaries inside Willoughby Bay. No vessels or persons may enter this area unless the Commander, Navy Region, Mid-Atlantic or their designee, grants permission (33 CFR 334.300).

A security zone has also been established in the waters of the James River along the Newport News Shipbuilding and Dry Dock Company shipyard in Newport News. The security zone has been established by the COTP and although certain exemptions apply, including those for public vessels and vessels performing work at the yard, access must be granted by the COTP Hampton Roads, Virginia (33 CFR 165.504). The security zone includes the waterside boundaries of the shipyard extending between property lines.

3.7. Military Operating Areas

3.7.1. Virginia Capes (VACAPES) Operating Area (OPAREA)

The Virginia Capes Operating Area (VACAPES OPAREA) is a set of defined ocean surface and subsurface operating areas used by the U.S. Navy for various exercises and training. The OPAREA is located in the coastal and offshore waters of the western North Atlantic Ocean adjacent to Delaware, Maryland, Virginia, and North Carolina, covering some 27,661 square nm of surface waters (U.S. Navy Fleet Forces Command, 2008). Figure 3.5 shows extent of the VACAPES OPAREA.

Training activities occurring in the VACAPES OPAREA include various types of Surface Warfare (SUW) exercises involving the use of explosive ordnance, including air-to-surface Missile Exercises, surface-to-surface Bombing Exercises, and Mine Warfare/Mine Exercises (MIW) using shapes to emulate mines (no explosives are used); Amphibious Warfare (AMW) exercises involving firing from ships to targets on shore; and Strike Warfare (STW) involving firing air-to-surface missiles (U.S. Navy Fleet Forces Command, 2008).

Most exercises in the VACAPES OPAREA involve vessel movements, and there may be as many as 10 ships operating in the OPAREA at any one time. Operations involve vessels ranging in size from 362 ft (110m) for a nuclear-powered attack submarine (SSN) to 1,092 feet (333 m) for a nuclear-powered aircraft carrier (CVN). They occur intermittently with substantial variability in duration, ranging from a few hours up to 2 weeks. Operations are widely dispersed throughout the VACAPES and typically result in about 1,400 total vessel days per year (U.S. Navy Fleet Forces Command, 2008). Vessels are monitored and controlled during training and exercises by FACSFAC VA Capes in Virginia Beach (Casey, 2013).

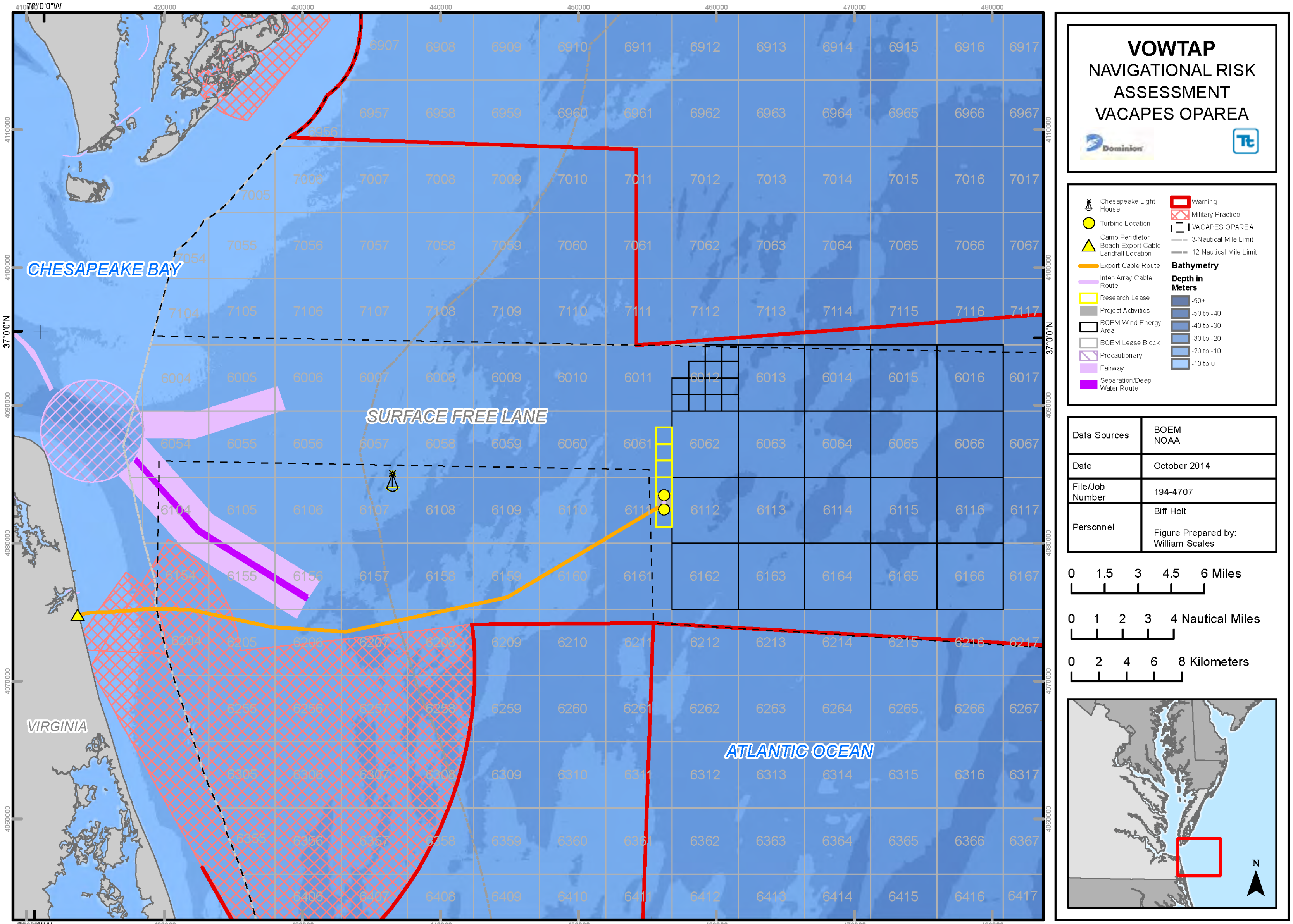


Figure 3.5 VACAPES Operating Area

3.7.2. Shipboard Electronic Systems Evaluation Facility (SESEF)

The Navy's SESEF range provides electromagnetic system test and evaluation services to both the Navy and USCG commands (Casey, 2013). The SESEF range is located between 8 nm (14.8km) and 18 nm (33.3km) offshore from the entrance to Chesapeake Bay (*see* Figure 3.6) and is supported by the Joint Expeditionary Base Little Creek/Fort Story, Virginia. The facility is one of only two sites on the east coast and Gulf of Mexico (Jacksonville, FL is the other site) that provides electromagnetic test, evaluation, and certification for Fleet units.

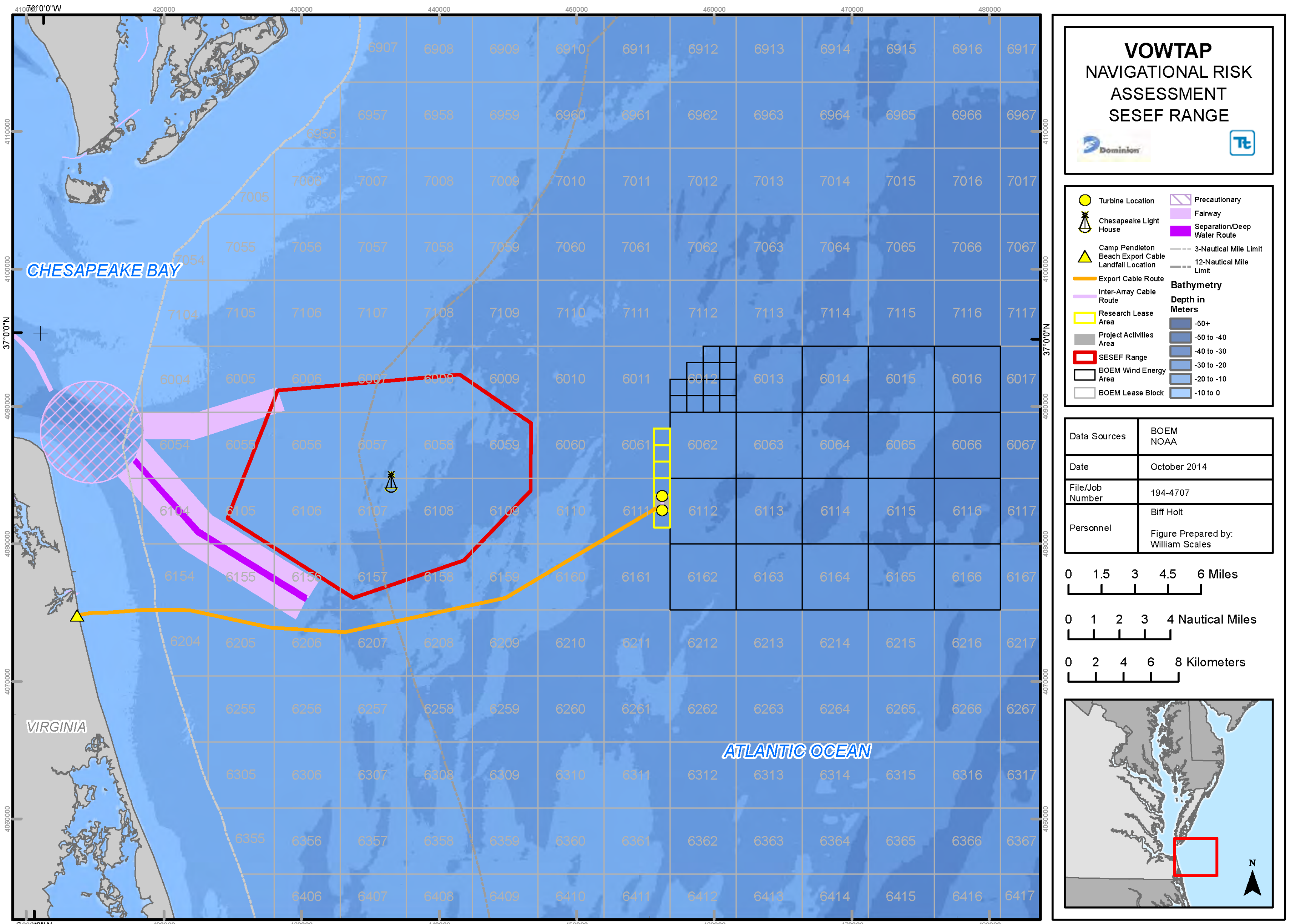


Figure 3.6 U.S. Navy SESEF Range

On average, 300 major test and evaluation events occur at the facility annually (Casey, 2013). These tests require long periods of dedicated testing and specific, rigid ship maneuvering orders. Navy vessels performing the tests must avoid buoys and ship traffic to safely and accurately complete each test. Non-Navy vessels transiting the SESEF range could potentially disrupt Navy testing and create unsafe surface navigation conditions that could lead to risk of collision.

3.8. Anchorages

There are no designated anchorages near the VOWTAP Project Area, however, the presence of anchorages within Chesapeake Bay may impact the movement of support vessels for VOWTAP.

Numerous designated anchorages are located in the area from the TSS precautionary area at the entrance to Chesapeake Bay to the waters near Hampton Roads, Newport News, and Norfolk, Virginia. Anchoring outside of designated anchorages in the Port of Virginia is discouraged and subject to the COTP and/or the International Regulations for Preventing Collisions at Sea (COLREGS). Anchorages are listed below in Table 3.4. Specific regulations are in place for Naval Anchorages A, B, C, and D (33 CFR 110.168). With the exception of naval or military support vessels, no vessels may anchor without the permission of the COTP in consultation with the Commander, Naval Amphibious Base Little Creek except in an emergency situation. Anchorages A and B can accommodate deeper vessels as soundings at MLLW range from 24 to 57 feet (NOAA Chart 12222). Anchorages C and D are shallower and also lay within a restricted area as described in Section 3.6. All persons and vessels are prohibited from approaching any naval vessel within 300 yards or within 600 yards of any vessel displaying the red "baker" burgee (33CFR110.168, 2013).

Table 3.1 Anchorages in Chesapeake Bay & Port of Virginia

Anchorage	Description	Location
A	Naval Anchorage	South of Thimble Shoal Channel offshore Cape Henry
Thimble Shoals Channel Anchorages		
B	Naval Anchorage	Lynnhaven Roads, Buoy "3" to the CBBT
C	Naval Anchorage	South of channel, adjacent to Buoy "9" and "11"
D	Naval Anchorage	South of channel and Anchorage "C"
E	Commercial Explosives Anchorage	South of channel, adjacent to Buoy "13" and "15" and includes Explosives Handling Berth E-1
Hampton Roads Anchorages		
F	Hampton Bar	Adjacent to Norfolk Harbor Entrance Reach and includes Anchorage Berth F-1
G	Hampton Flats Naval Explosives Anchorage	Adjacent to Norfolk Harbor Entrance Reach and Newport News Channel, includes Explosives Handling Berths G-1, 2, 3, and 4
H	Newport News Bar	Adjacent to Newport News Channel
James River Anchorages		
I	Newport News	Adjacent to Newport News, includes Anchorage Berths I-1, and I-2
J	Newport News Middle	South of Newport News Channel and the shallow draft

Anchorage	Description	Location
	Ground	vessel fairway
K	Newport News Middle Ground	South of Newport News Channel and includes Anchorage Berths K-1 and K-2
L	Craney Island Flats	Adjacent to Norfolk Harbor Reach

Anchorage E is a commercial explosives anchorage and, as such, commercial vessels are generally given priority over naval and public vessels. Within the anchorage lies an explosives handling berth for vessels carrying dangerous cargos. When occupied, other vessels may not anchor within 500 yards of the anchorage berth. Anchorage F is a deepwater anchorage in Hampton Roads restricted to vessels having a draft deeper than 45 feet. Vessels expecting to remain at anchor for more than 72 hours, as well as those with a draft lighter than 45 feet, must obtain permission from the COTP. Anchorage G is designated as an explosives handling area for naval vessels; all other vessels must obtain permission from the COTP. Vessels handling explosives or other Class 1 materials may not do so within 400 yards of Norfolk Harbor Entrance Reach. In addition, the transfer of explosives within 850 yards of another anchored vessel or Anchorages F or H is also prohibited. Anchorages I and K, adjacent to Newport News, are intended for vessels over 500 feet and/or drawing more than 30 feet. Any smaller vessels or those with lighter drafts must obtain permission from the COTP before anchoring in either berth in both anchorages. Other anchorage restrictions within the Port of Virginia limit Anchorage O to recreational vessels and designate portions of Anchorage N for marine event purposes (33CFR110.168).

USCG District 5 is considering designation of a new offshore anchorage, tentatively to be located to the northeast and adjacent to the Inbound Traffic Lane of the Southeastern Approach to Chesapeake Bay. The area being considered is 1 nm (1.9km) wide by approximately 7 nm (13km) long, extending from the terminus of the Inbound Traffic Lane to the turn (Walters, 2013). The distance to VOWTAP of this new anchorage is approximately 15 nm (27.8km).

3.9. Submarine Cables

There are no known or documented submerged cables or pipelines in the vicinity of the Project Area. Consultations with the U.S. Navy Seafloor Office of Cable Protection confirmed that no military seabed assets exist within the VOWTAP Project Area.

3.10. Navigation Routes

3.10.1. Offshore Routes

Commercial vessels approaching the Chesapeake Bay entrance from either the northeast or southeast are guided by ATON and the TSS along routes that allow for safe navigation. Vessels seaward of the TSS and ATON are free to take any track that the Master of the vessel deems prudent but, generally within 12 nm (2.2km) of the entrance to Chesapeake Bay, they take advantage of a naturally deep channel that runs in a southwesterly direction south of Chesapeake Light (see Figure 2.1).

Vessels departing Chesapeake Bay for points south, all deep-draft vessels (including aircraft carriers), and some other vessels heading across the Atlantic or for northern ports will depart via the Southeast Approach. Once clear of the TSS, southerly heading vessels normally alter course to a heading toward Cape Hatteras. This track will keep vessels well clear of the Project Area. Departing vessels bound for points north or a great circle route or rhumb line track across the Atlantic have the potential to pass relatively near the VOWTAP offshore facilities. For instance, vessels with a deep draft are likely to use the Southeast Approach or the Southeast Deep-Water Route. Once clear of the TSS, these vessels are likely to round the CB buoy for a northeasterly heading. Deeper-draft vessels will generally keep Chesapeake Light close to port in an effort to avoid water depths of less than 10 fathoms, as shown in Figure 3.5 (Gill, 2013).

It is estimated that the Closest Point of Approach (CPA) to the VOWTAP Research Lease Area for vessels departing the Southeast Approach for points north or a great circle or rhumb line track across the Atlantic will be 3 nm (5.6km) to 10 nm (18.5km).

Lighter-draft vessels may navigate the Northeast Approach upon departure from the Chesapeake Bay. Once clear of the TSS, these vessels generally will alter course to a more northerly heading while vessels intending a transatlantic voyage will generally assume a northeasterly heading (Gill, 2013).

Vessels bound for Chesapeake Bay from points south will generally make for the Southeast Approach, as it provides the shortest and deepest route to the pilot boarding area for both Virginia and Maryland ports (Gill, 2013). As shown in Figure 3.7, this track will keep vessels well clear of the VOWTAP site. Vessels arriving from points north or from a transatlantic crossing may use either TSS approach. For instance, vessels arriving from New York may opt for the Northeast Approach, since it is the shortest route to the pilot boarding area. However, depending on vessel draft and UKC requirements, the same vessel may opt for the Southeast Approach for entry to the Bay.

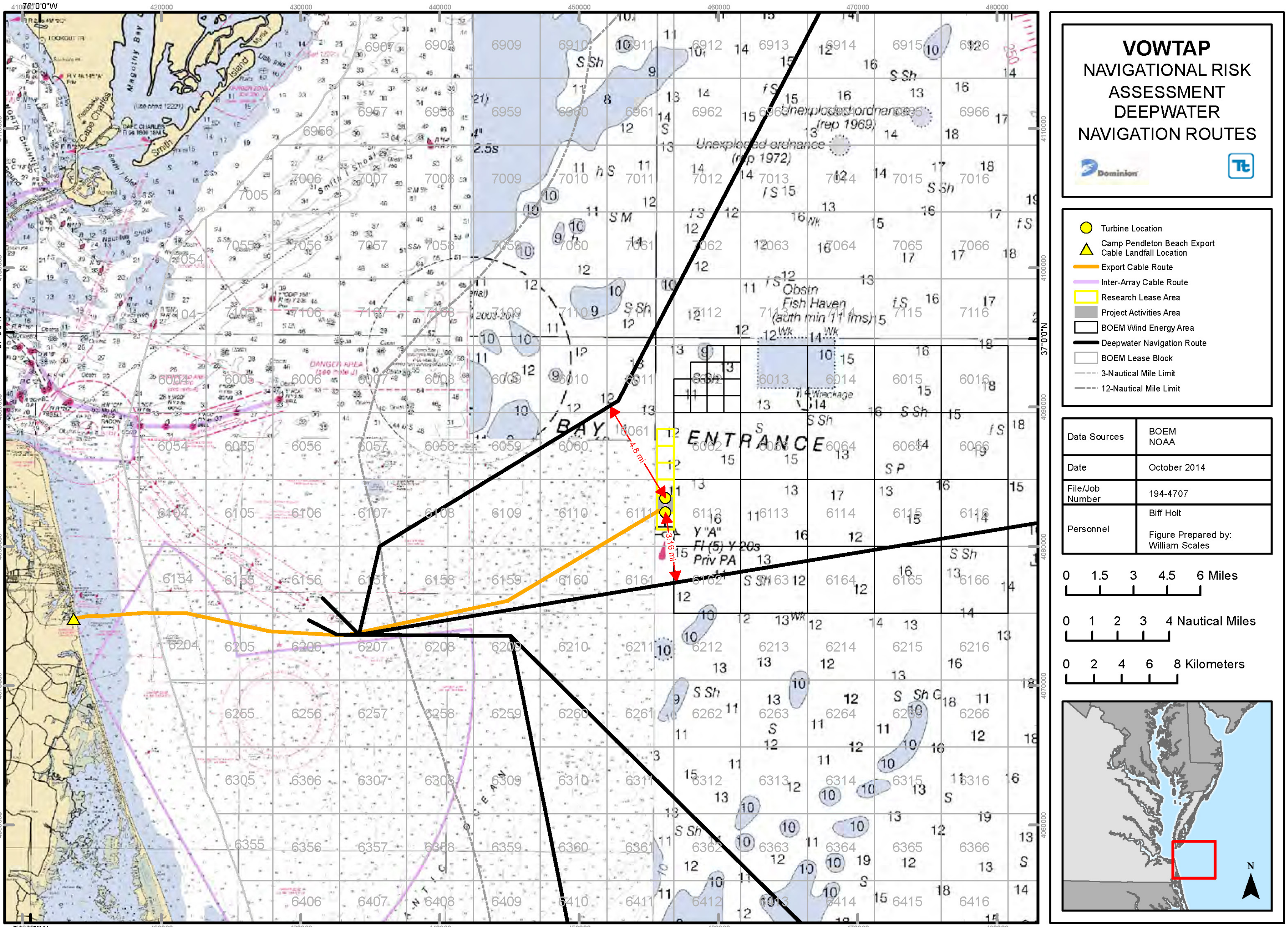


Figure 3.7 Deepwater Approaches to the TSS

These vessel tracks are consistent with the Automated Information System (AIS) data for the area (Figure 3.8). Vessel traffic is heaviest within the Southeast Approach traffic lanes, as indicated by the dark red shading of these aliquots with a substantial amount of vessel traffic from the north utilizing the natural deepwater channel approaching the Southeast Approach. The Northern Approach yielded less traffic, with between 751 and 1,500 vessels counted in 2010 as indicated in Figure 3.8.

Coastwise deep-draft commercial vessels proceeding north and south along the Atlantic coast generally operate east of the Project Area. These vessels have either rounded Cape Hatteras for northern ports or are likely bound for Cape Hatteras. The towing industry is greatly influenced by the sea conditions, however, and tow vessels are likely to operate closer to shore during adverse weather conditions. Towline units are likely to navigate west of the VOWTAP Project Area and seaward of the TSS (Parker, 2013).

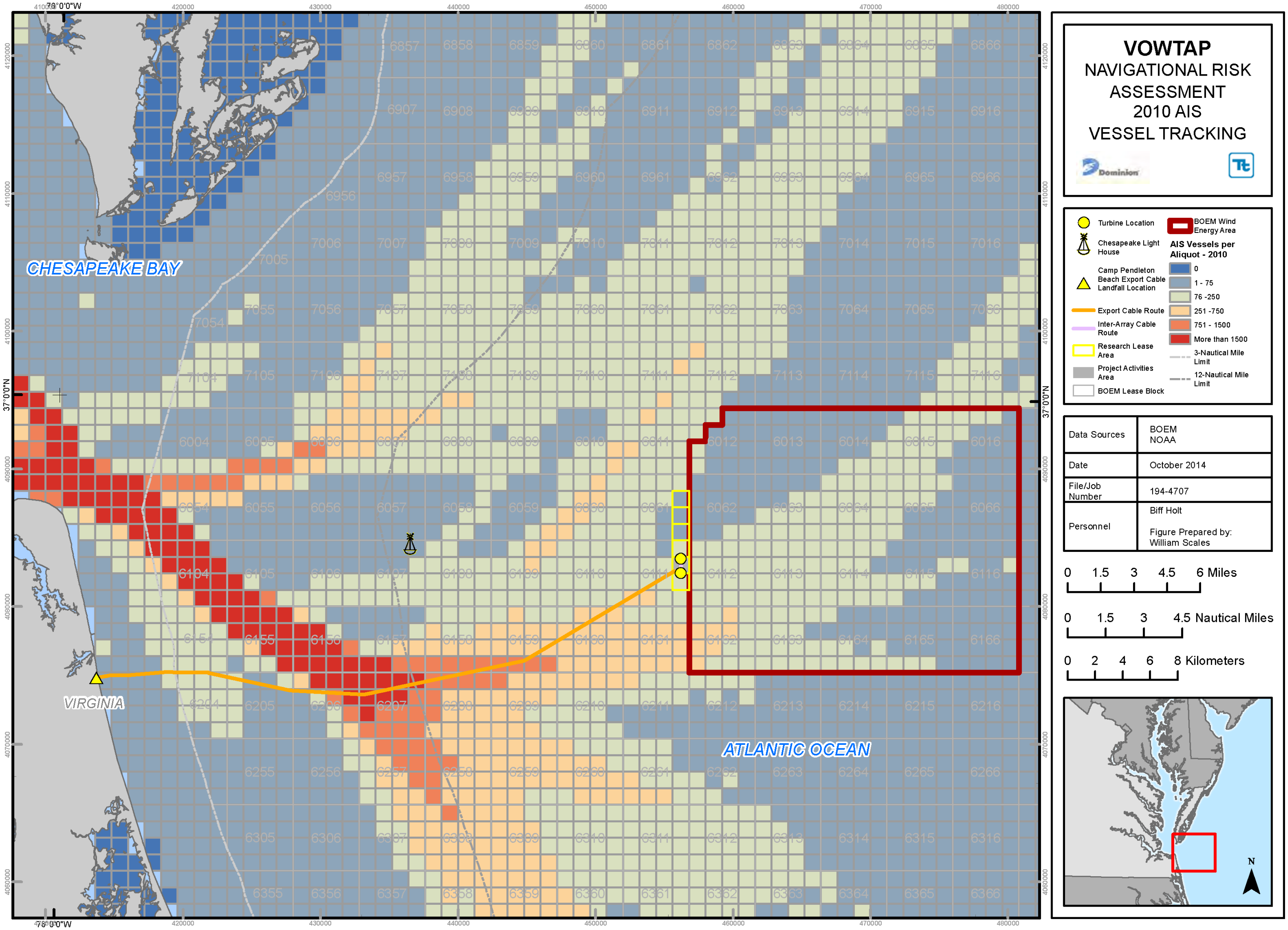


Figure 3.8 All Vessel Traffic near the Virginia WEA, 2010

3.10.2. Inshore Routes

Vessels used for VOWTAP construction and O&M activities will be situated at the Construction Port (see Section 2.3) in the Hampton Roads area and would make routine transits through Hampton Roads to the Project Area. Vessels outbound will follow the Newport News Channel and Norfolk Harbor Entrance Reach through Hampton Roads before entering Thimble Shoal Channel leading towards the entrance to the TSS precautionary area (NOAA Chart 12222). These waters are likely to be heavily trafficked based on the volume of vessels calling at Virginia ports and the Port of Baltimore (see Section 4). Most of these commercial vessels are subject to either State or Federal pilotage, as discussed in Section 3.2. Figure 3.9 shows the channels that comprise the inshore routes through lower Chesapeake Bay.

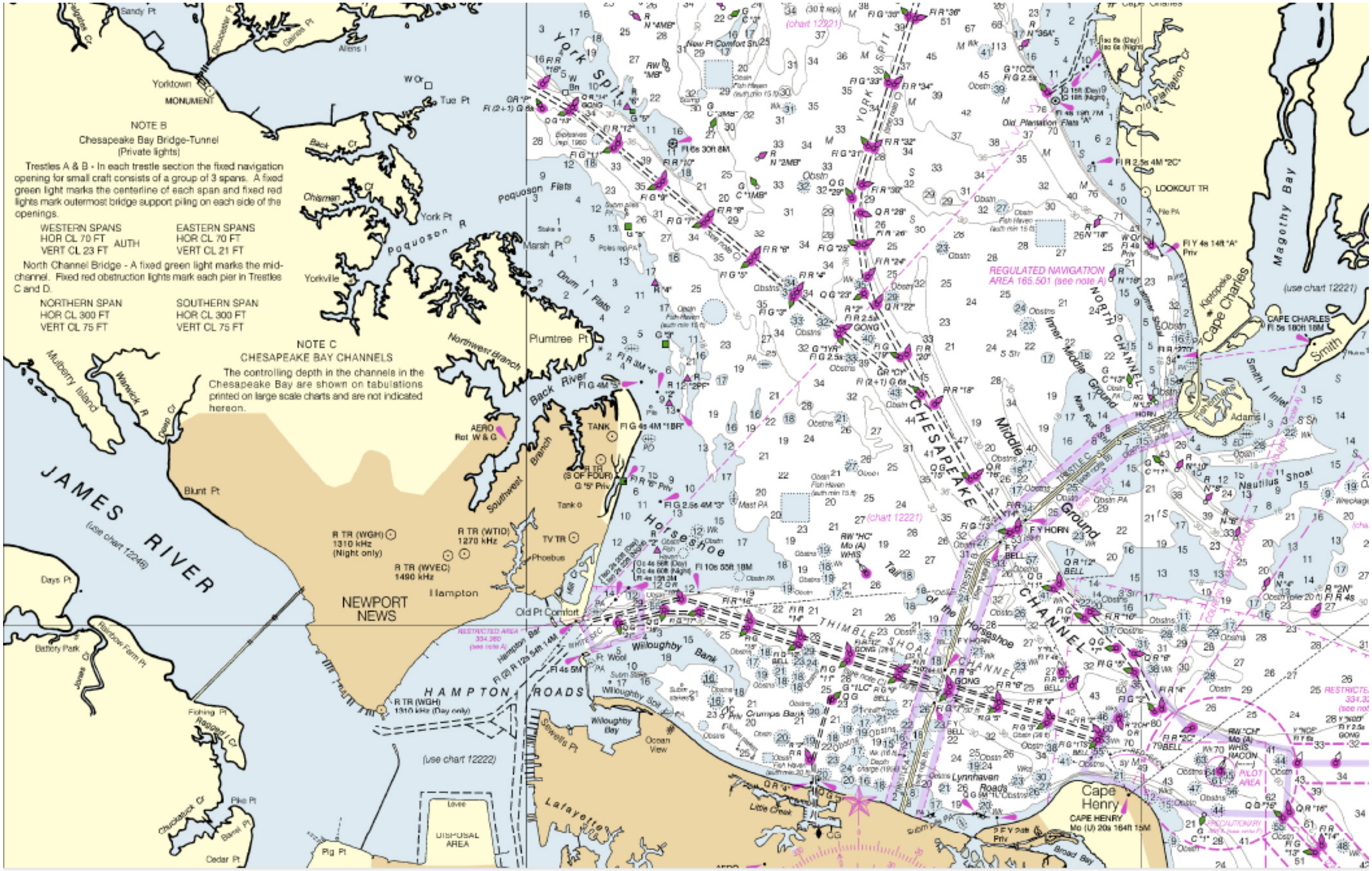


Figure 3.9 Inshore Channels through Lower Chesapeake Bay

3.11. Weather Conditions

The VOWTAP Project Area is located in a temperate climate with seasonal variations in temperature that are greatly influenced by the surrounding ocean and prevailing winds. Temperatures average 61.6° F annually, with the highest mean monthly temperature of 79.1° F experienced in July. January and February yield the lowest mean temperatures during the year at 41.8° F and 42.9° F, respectively. Late summer and early fall are generally associated with good weather, whereas the potential for severe weather increases from late fall through spring. The mean sea temperature recorded over a 9-year period ranges from 39.9°F (4.4°C) to 73.4°F (23.0°C). Similar to the mean air temperatures, the lowest average monthly mean sea temperature occurs in February and the highest in July (NOAA Coast Pilot, 2013). Weather conditions that can adversely affect navigation are summarized in this section.

3.11.1. Fog

Poor visibility can also be problematic for mariners operating in the area off Chesapeake Bay. There typically are 30 to 40 dense fog days each year, with most occurring between January and April. Dense fog is more common offshore, especially on unusually, warm, humid winter and spring days when warm moist air moves across the cold waters offshore Virginia (NOAA Coast Pilot, 2013). Fog days with winds less than 10 knots have also been known to drop visibility to near zero. Figure 3.10 depicts the frequency of occurrence for visibility to be restricted to less than 2 nm (3.7 km) offshore coastal Virginia (NOAA Coast Pilot, 2103).

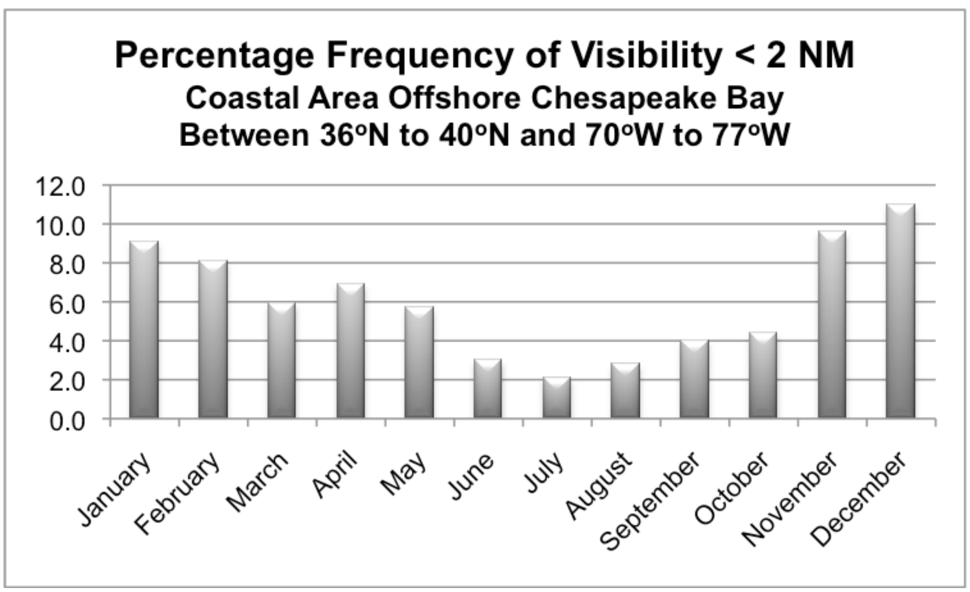


Figure 3.10 Frequency of Visibility Less Than 2 NM

In addition to fog, visibility can also be obstructed during winter months by snow and other precipitation. As indicated, the fall and winter months typically yield the most frequent occurrence of fog, while the summer months have highest instances of visibility greater than 2 nm (3.7 km).

Closer to shore and inside Chesapeake Bay, the total number of fog days has averaged 155 per year over the last 50 years. According to the National Climactic Data Center (NCDC), the month of August typically yields the most mean fog days, averaging 16 per month, whereas the month of April yields the least average days at 11. The data from the NCDC do not distinguish between dense fog days or light fog days (NOAA Coast Pilot, 2013).

3.11.2. Winds

The prevailing winds for areas off Chesapeake Bay vary seasonally. Northerly winds prevail during the fall and winter months, from September through March, while southerly winds are more common during the spring and summer. Mean wind speeds during the fall and winter are generally higher than in the summer, with the highest mean average recorded in January. Table 3.2 shows the mean and maximum winds throughout the year during the period from 1980 to 2005 (Dominion, 2013a). Mean and maximum wind speeds are observations are based on 1-hour periods and measured at 10 meters above sea level.

Table 3.2 Omni-Directional Month Mean and Maximum Wind Speed Excluding Hurricanes (m/s)

COMBINED PERIOD (1980 to 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	SW
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

Significant weather systems predominantly occur during the fall and winter, from November through April, with gales occurring as early as September (NOAA Coast Pilot, 2013). During these months, storms moving up the Atlantic coast may generate northeasterly winds with speeds reaching 30 to 50 knots (15.4 m/s to 25.7 m/s). Several days of strong and gusty winds may follow the passage of a storm. During the spring and early summer, thunderstorms approaching from the northwest can also move quickly offshore. However, winds typically moderate once these weather systems clear the area.

By mid-summer, milder weather prevails and the frequency of thunderstorms is reduced, with air masses yielding bad weather generally moving at 10-20 knots (5.1 m/s to 10.2 m/s). Figure 3.11 depicts the percentage frequency of occurrence of winds in excess of 33 knots near the Project Area (NOAA Coast Pilot, 2013).

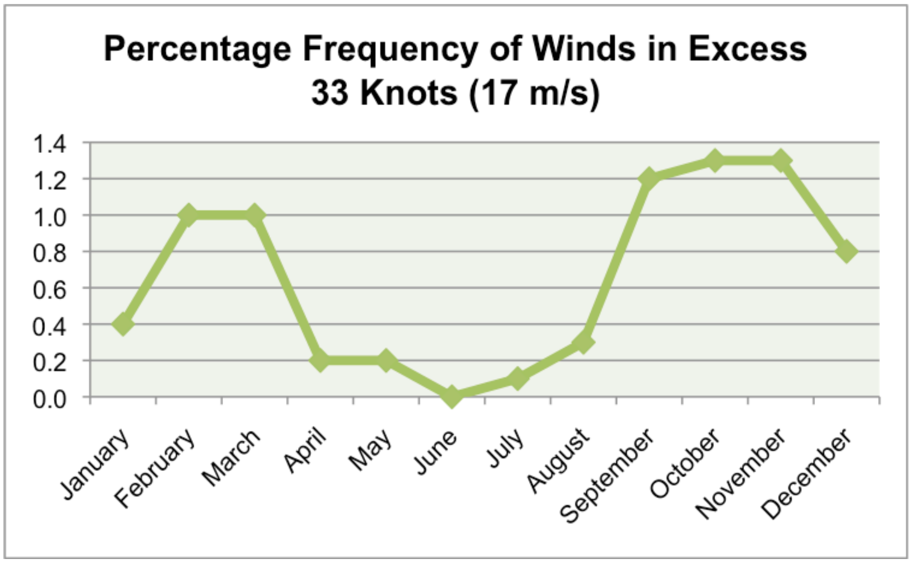


Figure 3.11 Percentage Frequency of Winds in Excess of 33 Knots (17 m/s) Coastal Waters Off Chesapeake Bay Between 36°N to 40°N and 70°W to 77°W

The mid-Atlantic region of the United States is also subject to threat from tropical weather systems that can significantly impact the weather experienced during the summer and fall. The east coast of the United States represents the western boundary of the Atlantic hurricane basin, and as such will always be at some risk for hurricane activity. The Atlantic hurricane season runs from June 1st through November 30 each year, and significant storms have historically impacted the area surrounding the Virginia WEA. Tropical systems are classified using the Saffir-Simpson Hurricane Wind Scale shown in the Table 3.3 (NOAA, National Hurricane Center, 2013). These systems are associated with high winds, heavy storm surge, rain, and potentially tornadic activity. Category 4 and 5 storms are considered major hurricanes and generate the highest winds and storm surges.

Table 3.3 Saffir-Simpson Hurricane Wind Scale

Category	Sustained Winds	Damage
1	64-82 kts	Some
2	83-95 kts	Extensive
3	96-112 kts	Devastating
4	113-136 kts	Catastrophic
5	137 kts or greater	Catastrophic

Since 1769, more than 30 severe tropical systems have impacted coastal Virginia and its offshore waters (NOAA NHC, 1999). In addition to those storms making landfall, some severe storms (such as Hurricane Earl in 2010, a category 4 storm at its peak) have skirted the coast and followed the Gulf Stream current away from land. Although never making landfall, the severe weather and surge have inflicted serious damage to the coastal areas along the eastern seaboard.

The National Hurricane Center (NHC) has developed a computerized model for assessing the long-term vulnerability of coastal areas to tropical cyclone events. The NHC Risk Analysis Program (HURISK) uses data beginning with the year 1886 and is updated on an annual basis. The model produces charts and diagrams depicting tropical cyclone tracks, motion, intensities, and return periods for coastal areas along the Atlantic tropical cyclone basin (NOAA NHC, 2013). A hurricane return period is the frequency at which a certain intensity of hurricane can be expected. The HURISK program was used to generate the estimated return periods for both Category 1 and 2 hurricanes passing within 50 nm (92.6 km) of the U.S. Coast (Figure 3.12). The HURISK data indicate the Project Area is subject to longer return periods (12-16 years) for hurricanes with wind speeds equal to or in excess of 64 knots, than Cape Hatteras (5-7 years), which lies approximately 100 mi (161 km) due south. Similarly, the return period for hurricanes with wind speeds equal to or in excess of 96 knots is substantially longer for the Project Area (53-120 years) than for Cape Hatteras (14 to 22 years).

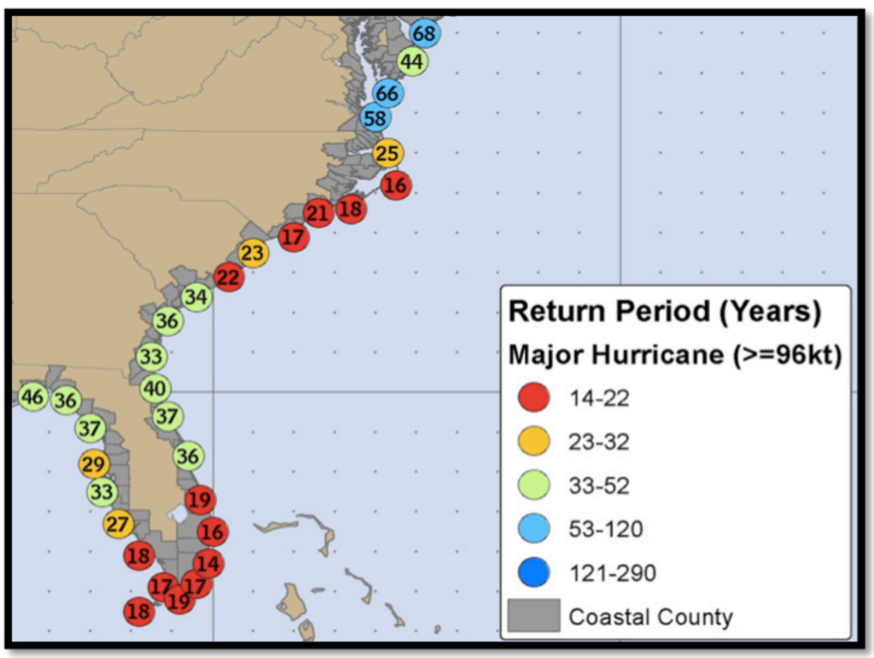


Figure 3.12 NHC HURISK Return Period for Hurricanes (NHC)

Wind direction and strength during a storm vary with the path of the storm. Winds during storms generally rotate counterclockwise resulting in winds stronger on the right side of the storm system due to the relative motion of the advancing storm system plus the wind speed of the storm system itself (NOAA NHC, 1999). Figure 3.13 shows the storm tracks interacting with coastal Virginia since 1940.

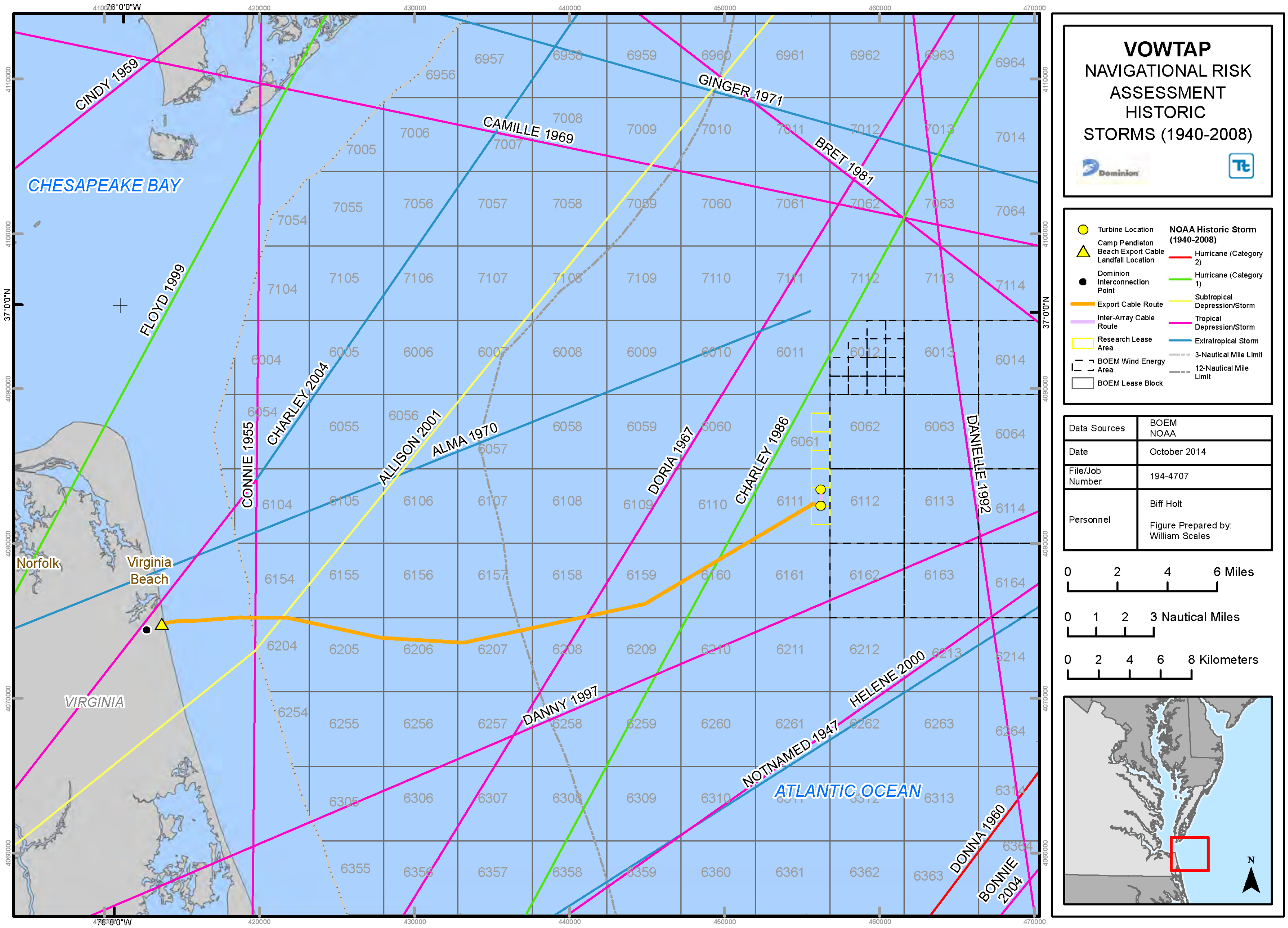


Figure 3.13 Historical Storm Tracks (1940-2008)

3.11.3. Wave Heights

Similar to the lighter winds experienced, summer months are also typically associated with smaller wave heights. The mean significant wave height often experienced during June and July is approximately 3 ft (1 m). As a result of the higher winds, mean wave heights generally experienced during the fall and winter can be 6.5 ft (2 m) or greater. Significant wave height is equivalent to the mean height, from crest to trough, of the highest one-third of the waves in a sea state (NOAA National Weather Service, 2013). As a general rule, the largest individual wave encountered may be as much as two times the significant wave height. Significant wave height measurements from National Data Buoy Center (NDBC) Station 44099, a Scripps Institution of Oceanography wave rider buoy located approximately 13 nm (24 km) east of Cape Henry, Virginia and 11 nm (20.4 km) west of the Project Area, are depicted in Figure 3.14 (Scripps, 2013).

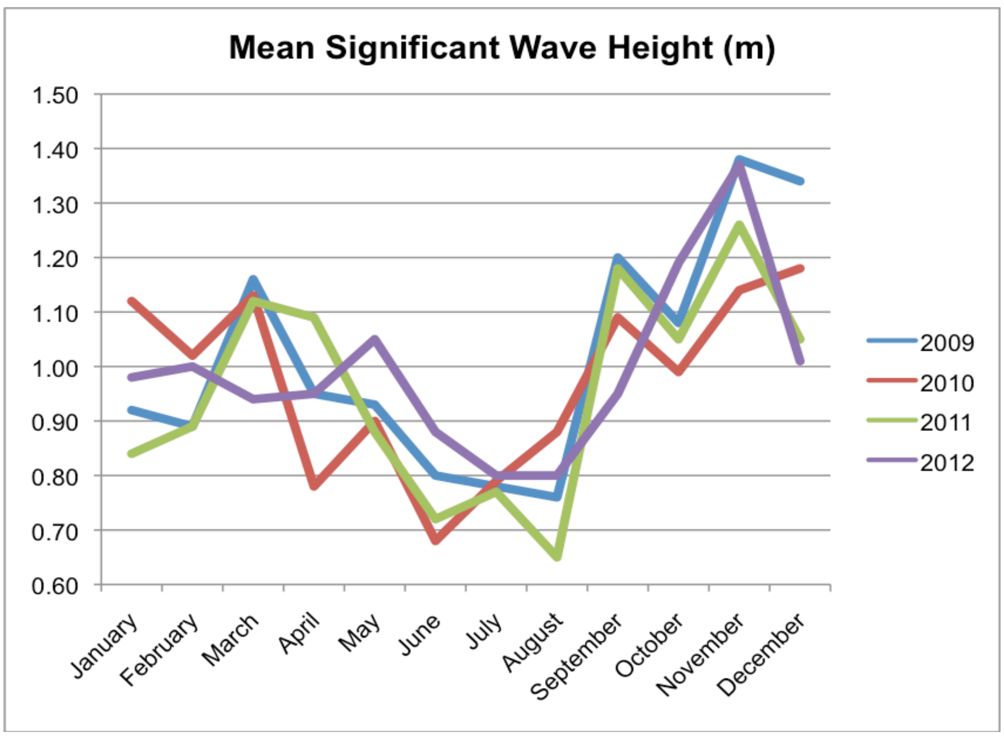


Figure 3.14 Station 44099 Significant Wave Heights (2009-2012)

Increased wave heights can occur as a result of seasonal weather variations, especially during winter or tropical storms. Figure 3.15 depicts the percentage frequency of significant wave heights in excess of 9 feet (2.7 m) offshore coastal Virginia. Similar to the mean significant wave heights measured at Station 44099, slight peaks are apparent during peak hurricane season in September and October, and during the winter. The maximum frequency for wave heights greater than 9 feet (2.7 m) was 1 percent, which was recorded for April.

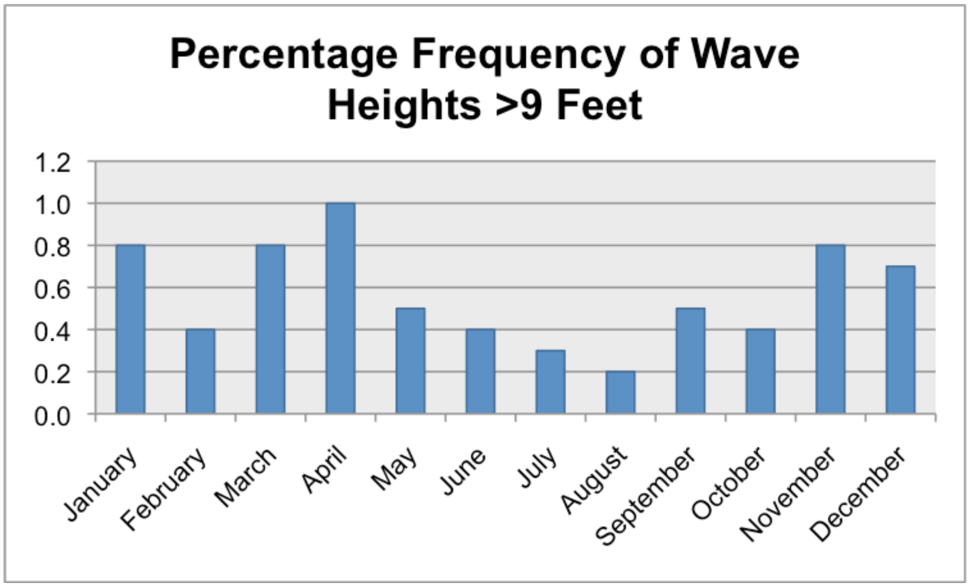


Figure 3.15 Coastal Waters Off Chesapeake Bay Between 36°N to 40°N and 70°W to 77°W

In addition to wind speed, wind fetch can influence the wave heights in the Project Area. Fetch is defined as the unobstructed distance that wind can travel over water in a constant direction (Bowditch, 1977). A longer fetch generally results in larger wind-generated waves. Given the planned location of the Project Area, the greatest potential occurrence for large wind-generated waves exists from easterly and southeasterly winds.

3.12. Tides, Tidal Streams, and Currents

The Chesapeake Bay is a unique waterway, as the bay is long enough to contain one complete wavelength of the dominant semi-diurnal tide. The mean range of tide at Cape Henry is 3.12 ft (1 m) and tidal currents at the entrance can range from 1.0 knot on the flood and 1.5 knots on the ebb (NOAA Coast Pilot, 2013). Tidal current conditions are expected to be similar near the VOWTAP site, although during a 1-year return period there is potential for extreme surface currents to exceed 2 knots (Dominion, 2013a).

Currents within Hampton Roads and the Elizabeth River can be influenced considerably by the winds. At times, currents may even exceed the tabulated values in the Tidal Current Tables. Current velocity, however, is about 1.0 knot in the Hampton Roads waterway and averages about 0.6 knot in the Elizabeth River (Coast Pilot Ch. 9, 2013)

Other than the effect of storm surge, the highest level a tide can be predicted to attain is called the Highest Astronomical Tide (HAT), which most commonly occurs during the spring tide when the moon is in perigee, or closest to the Earth (Woods Hole, 2013). HAT is an important consideration for determining the air gap, which is the minimum clearance between the bottom sweep of the rotors and the surface of the water.

Using a Tidal Model Driver (TMD), it has been determined that HAT at the VOWTAP site is 4.3 ft (1.3m) above Mean Lower Low Water (MLLW) and 2.6 ft (0.79m) above Mean Sea Level (MSL). The air gap is 89 ft (27 m) at MSL and is reduced to 82.4 ft (25.1m) at HAT. Extreme storm surge has also been calculated using a TMD and winter storm and hurricane ocean weather data. Over a 1-year return period, positive surge has been calculated to exceed 1.44 ft (0.44m) for winter storms and 0.79 ft (0.24m) for hurricanes above datum.

3.13. Magnetic Compass Anomalies

Local magnetic compass anomalies have been identified in the waters near the Project Area. Differences of as much as 6 degrees of variation (Bowditch, 1977), the angle between the geographic and magnetic meridians, have been observed anywhere from 3 to 17 nm offshore from Cape Henry south to Currituck Beach Light. The combination of variation and deviation are used to correct a ship's compass; therefore, prudent seamanship for vessels operating within this area to would normally include monitoring the magnetic compass closely for potential anomalies. Self-propelled vessels of 1600 Gross Tons (GRT) or more are required to have a gyrocompass aboard (33 CFR 164.35), thus the magnetic anomalies should not impact most commercial vessels that typically call on Chesapeake Bay ports. However, the potential for greater compass error in this location should be noted for vessels less than 1600 GRT, which would include vessels associated with the construction and operation of VOWTAP.

3.14. Ice

Sea ice is generally not an issue within the Project Area. Within the Chesapeake Bay, and specifically Hampton Roads, icing is also not a problem as the waters are generally free of ice (NOAA Coast Pilot, 2013).

The potential exists for superstructure icing on the WTGs when conditions are such that temperatures are below 28^{o} F (-2.2^{o} C) and winds are blowing in excess of 13 knots. These conditions primarily occur from November through March and are most common in January and February, when they are present roughly 3% of the time.

Ice that does accrete on the WTGs may be shed or cast from the turbine by the mechanical forces of the rotating blades and by gravity. A report by GE Energy for land-based wind farms indicates that a safe distance from a WTG to any occupied structure, road, or public use area is represented by the following formula (Wahl and Giguere, 2006):

Safe Distance = 1.5 x (hub height + rotor diameter).

In the case of the VOWTAP WTGs, an extremely conservative "safe" distance would be 1,250 ft (381 m) for a vessel operating in the area of the WTGs during periods of ice accumulation, using maximum WTG dimensions at MSL.

Additionally, a Finnish study theorized that the risk of being struck by ice cast from a turbine is diminishingly small at distances greater than approximately 820.2 ft (250m) from the turbine in a climate where moderate icing occurs (Morgan, et al., 1998).

4 Maritime Traffic and Vessel Characteristics

The waterways surrounding the Project Area and the nearby Chesapeake Bay are traversed by a large variety of commercial, military, and recreational vessels. Commercial and military traffic operates continuously throughout the year, while recreational vessels are influenced by season and variations in the weather. Larger commercial vessels bound to and from ports in Chesapeake Bay can be expected to follow the TSS described in Section 3.1; however, recreational vessels and smaller commercial vessels, such as charter boats, towing vessels, and fishing boats are not limited to the TSS.

The Port of Virginia and the Port of Baltimore are among the busiest in the United States. A 2011 report by the U.S. Maritime Administration (MARAD) indicated that the Port of Virginia was fourth in the nation in terms of vessel calls by Container Ships and third in the nation in terms of vessel calls by Dry Bulk Carriers. Similarly, the Port of Baltimore was first in the nation in vessel calls by Roll-on/Roll-off (Ro-Ro) Ships and sixth in the nation in vessels calls by Container Ships (US DOT MARAD, 2013).

Both the Port of Virginia and the Port of Baltimore are currently the only two Post-Panamax Ready (PPR) east coast ports (Conway, 2012)[3]. Channel depths in excess of 50 feet and cranes capable of offloading ships more than 22 containers wide will open these two Chesapeake Bay ports to increased traffic by larger vessels, specifically, container vessels with capacities anticipated to reach 12,500 Twenty-foot Equivalent Units (TEUs) once the Panama Canal expansion project is completed in early 2015 (Conway, 2012).

The deepest route to and from the Bay is south of Chesapeake Light and through the buoyed Deep-Water Route within the Southeast Approach. Most commercial vessels, using this approach are required to be equipped with navigation position fixing equipment specified by the International Convention on the Safety of Life at Sea (SOLAS), Chapter 5 Safety of Navigation, as well as the US Navigation Safety Regulations under 33 CFR 164. Additionally, those vessels approaching the Bay are generally operating at a heightened state of alert and at slower maneuvering speeds as required under the COLREGS Rule 6, Safe Speed. A State Pilot is required for all foreign vessels entering the Bay and for U.S. vessels under register when operating within Chesapeake Bay (U.S. Coast Pilot, Volume 3). The use of a pilot is not required for vessels operating in the waters outside of the entrance to the Chesapeake Bay, eastward of a line between Cape Henry and Cape Charles. Vessels that take on a pilot prior to entering Chesapeake Bay must undertake a series of pre-arrival checks, including the testing of the engine(s) astern prior to arriving at the Bay entrance (33 CFR 164.25).

[3] "Post-Panamax Ships" are those that exceed the dimensions of the Panama Canal lock chambers and are greater than 289.56 meters long with a beam of 32.31 meters and a draft of 12.04 (Marine Insight, 2013).

This section of the NRA describes the types of vessels routinely operating in the Chesapeake Bay entrance and waters directly offshore in the vicinity of the Project Area, and the marine traffic patterns associated with those vessels. As applicable, the information is related to the Project Area location and the anticipated route for Project construction and support vessels. The information in this section has been gathered from multiple sources, as indicated, and has been used to inform conclusions provided in Sections 6 and 7 regarding the potential navigational risks associated with the VOWTAP.

4.1. Commercial Vessel Traffic Summary

The traffic lanes and precautionary area making up the Chesapeake Bay entrance TSS serve as both safe and recommended access to the Port of Virginia and the Port of Baltimore, the 7th and 16th busiest ports in the U.S. in terms of total cargo volume, respectively (AAPA, 2011). The Port of Virginia[4] is 3rd in the nation in terms of containership cargo, handling over 2 million TEUs in 2012 (Virginia Port Authority, 2103).

The U.S. Maritime Administration (MARAD) maintains annual records of port calls by commercial vessels. The data apply to oceangoing, self-propelled vessels of 10,000 DWT or greater and account for 98% of the capacity of commercial vessels calling at U.S. ports (USDOT MARAD, 2013). Data for the Port of Virginia and Baltimore have been analyzed to determine the numbers and types of commercial vessels that may navigate in the vicinity of the Project Area.

4.1.1. Port of Virginia Commercial Vessel Traffic

From 2005 to 2011, annual port calls to the Port of Virginia ranged from approximately 2,700 (in 2009) to nearly 3,700 (2011) and averaged 2,839 (Figure 4.1).

[4] The Port of Virginia comprises Norfolk International Terminals, APMT Terminals, Portsmouth Marine Terminal, Newport News Marine Terminal, the Virginia Inland Port, and the Port of Richmond.

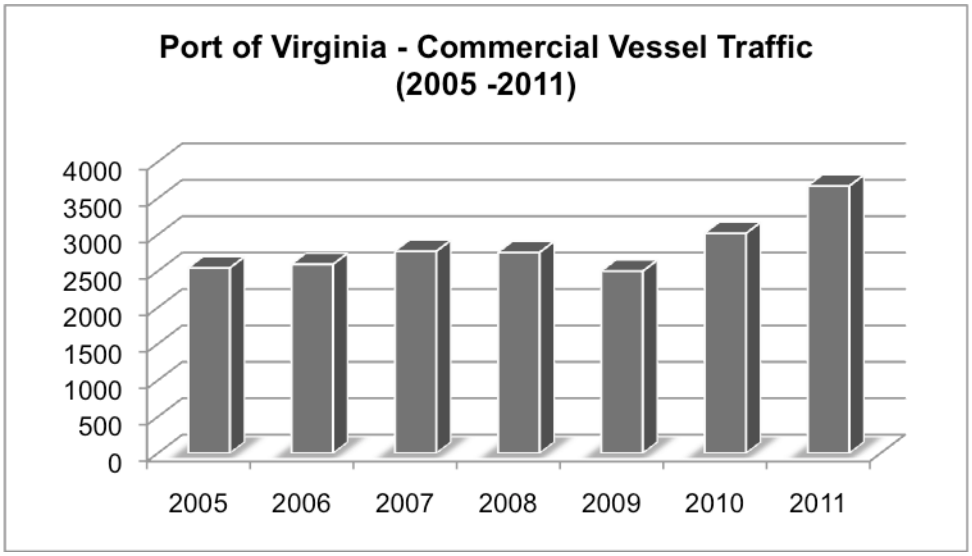


Figure 4.1 Self-Propelled, Oceangoing Vessels 10,000 DWT or Greater Calling at the Port of Virginia (USDOT MARAD, 2013)

Container ship calls on the Port of Virginia are more than double the number of calls for any other type vessel (VPA 2040 Master Plan, 2013) (*see* Figure 4.2). Container ships represent some of the largest vessels in operation and require some of the deepest natural and dredged channels to access America's ports (Virginia Mariner, 2013). For example, the MSC Bruxelles, which first called on the Port of Virginia in 2011, is 337 meters long and has a beam of 46 meters.

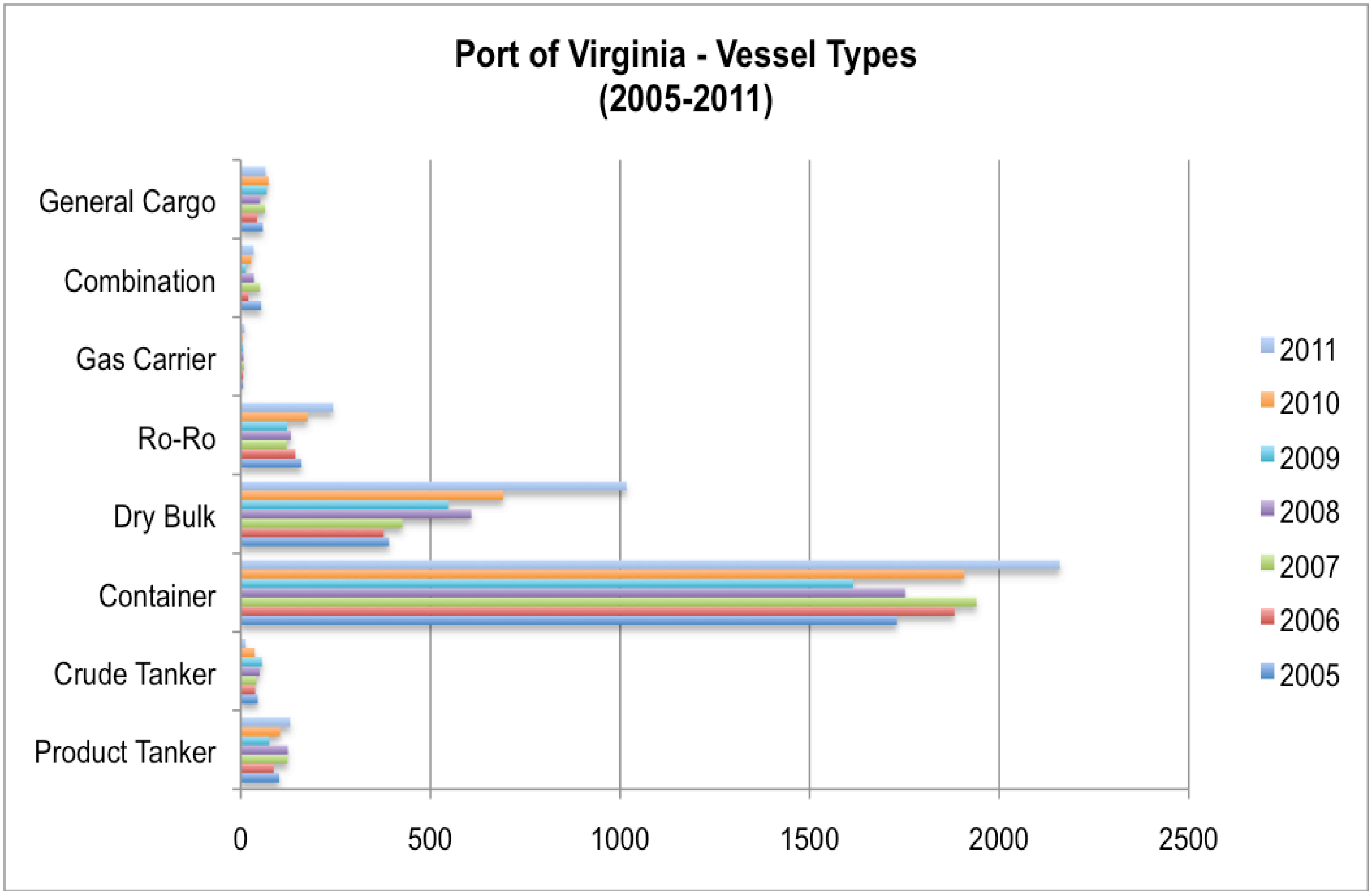


Figure 4.2 Number of Self-Propelled, Oceangoing Vessels 10,000 DWT or Greater Calling at the Port of Virginia by Type

4.1.2. Port of Baltimore Commercial Vessel Traffic

Although the Port of Baltimore moves less cargo tonnage annually than the Port of Virginia, it is the busiest port in the country for shipping and receiving Roll-on/Roll-off (Ro-Ro) cargo ships (Thompson, 2013). Baltimore also receives more dry bulk ships than the Port of Virginia. Access to the Port of Baltimore is primarily through the Chesapeake Bay, although 40% of vessels arriving and departing use the Chesapeake and Delaware (C&D) Canal as an alternative access (State of Maryland, 2013). The Federal navigation project for the C&D Canal provides for a channel 35 feet deep and 400 feet wide, thereby limiting the size of ships that can use the canal (NOAA Coast Pilot, 2013). The C&D Canal is not expected to be increased in size to accommodate larger ships. Annual calls to the Port of Baltimore over the 2005 to 2011 period ranged from approximately 1,500 in 2009 to 2,100 in 2011, as shown in Figure 4.3.

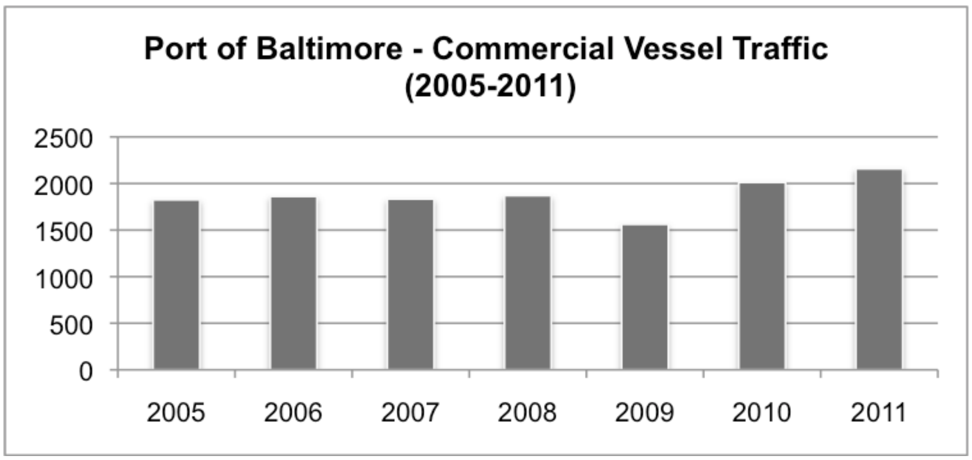


Figure 4.3, Self-Propelled, Oceangoing Vessels 10,000 DWT or Greater Calling at the Port of Baltimore (USDOT MARAD, 2013)

Ro-Ro vessels, with an average of almost 780 calls annually, account for the largest share of vessel traffic at the Port of Baltimore (see Figure 4.4). The port also receives container ships, dry bulk vessels, and tankers. Larger vessels with a draft deeper than the 35-ft controlling depth in the C&D canal are limited to access via the Chesapeake Bay entrance. As a result, Baltimore-bound vessels arriving at Cape Henry will have followed the same traffic patterns to the Chesapeake Bay entrance as vessels bound for the Port of Virginia.

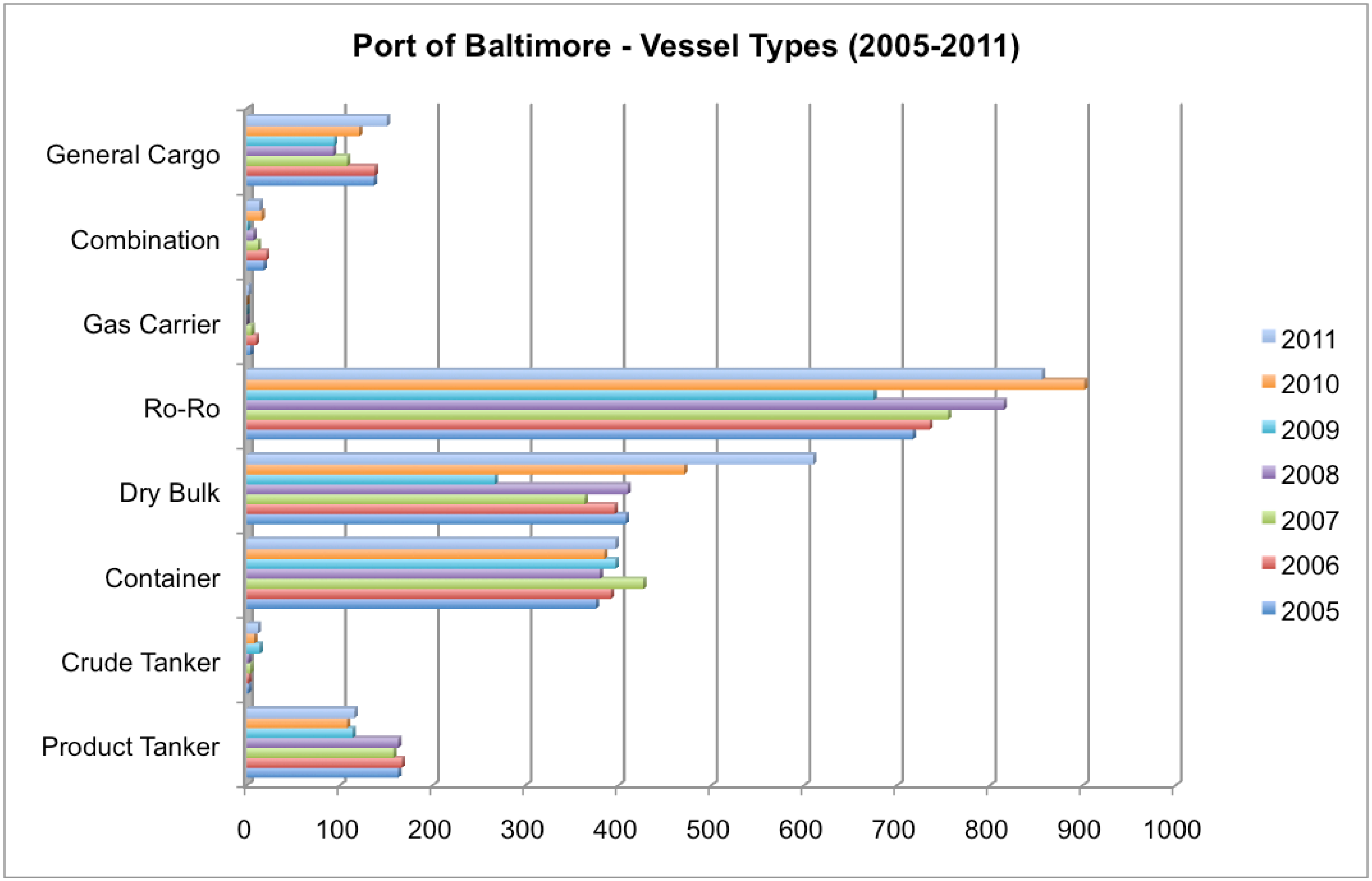


Figure 4.4 Number of Self-Propelled, Oceangoing Vessels 10,000 DWT or Greater Calling at the Port of Baltimore by Type

4.2. Vessel Types and Characteristics

4.2.1. Passenger Vessels

The Port of Virginia and Baltimore serve as departure and arrival ports for large passenger vessels, such as those owned and operated by Royal Caribbean International (RCI) and Carnival Cruise Lines (CCL). RCI has 40 cruises scheduled to depart from Baltimore in 2013, whereas CCL has 52 scheduled sailings (State of Maryland, Department of Transportation, 2013). Most of the RCI cruises sailing from Baltimore in 2013 were aboard the Grandeur of the Seas, a 74,000 GT vessel measuring 915 ft (279 m) in length with an average draft of 26 ft (7.8 m) (Royal Caribbean, 2013). The Carnival Pride, an 88,500 GT vessel measuring 963 ft (294 m) with an average draft of 26 ft (8.0 m), accounted for most of the CCL vessel sailings from Baltimore in 2013 (Carnival, 2013). Cruise passenger traffic is not as busy in the Port of Virginia, where the Carnival Glory had only 9 scheduled sailings in 2013 (Cruise Norfolk, 2013).

On average, one cruise ship passes through the Virginia Capes entrance to Chesapeake Bay every 3 days during the year. Departures are normally Saturday or Sunday, with the number of sailings per month fairly evenly distributed throughout the year (State of Maryland, Department of Transportation, 2013).

Passenger vessels traversing Chesapeake Bay are designed with extremely high sides and superstructure rising more than 100 ft above the waterline. This extremely high freeboard creates a large "sail area" that causes these vessels to be more susceptible to influence from the wind. The Carnival Pride and the Grandeur of the Seas have an air draft greater than the minimum air gap presented in Figure 2.2, the representative WTG design. At a draft of 26 ft (8.0 m) the Carnival Pride has an air draft of 171 ft (52.09 m), whereas the Grandeur of the Seas has an air draft of 162 ft (49.3 m) (Grimison, 2013).

4.2.2. Dry Cargo Vessels

Dry cargo vessels include general cargo ships, Ro-Ro cargo ships, dry bulk ships, and container ships (Figures 4.2 and 4.4). Container ships are easily identifiable from the containers on deck, although containers (or "boxes") are carried both above and below deck. Bulk carriers, Ro-Ros, and automobile carriers are typically recognizable from the extremely high freeboard and superstructure. With the exception of Ro-Ros, most modern dry cargo vessels are designed with a superstructure aft. As noted previously, the expansion of the Panama Canal and the fact the controlling depths for the ports of Baltimore and Virginia are in excess of 50 feet allows for receiving larger cargo vessels. However, while the displacement of modern ships is increasing, their horsepower and handling characteristics are not increasing proportionally (MacElrevey, 2008).

Container ships are generally the most maneuverable among the dry cargo vessel types, with the capability of operating at high speeds because of a lower block coefficient (the ratio of the vessel's hull volume to the length times the breadth times the depth of the hull) and higher horsepower. Conversely, bulk vessels are mostly underpowered, with a high block coefficient and less maneuverability. Container ships and Ro-Ro vessels are also high-sided, with freeboards typically in excess of 75 feet. This makes them more susceptible to the wind when compared to bulk carriers, which tend to have a freeboard of less than 30 feet in the loaded condition (MacElrevey, 2008).

4.2.3. Liquid and Gas Tank Vessels

Liquid tank vessels have characteristics similar to bulk carriers described above. These vessels typically have the superstructure located aft, have a large block coefficient, and carry minimal freeboard in the loaded condition. Tankers represent a much smaller percentage of vessel calls than dry cargo ships for both the Ports of Baltimore and Virginia (MARAD). Regulations for tankers arriving and departing U.S ports are generally more stringent than for cargo ships; 33 CFR 164.13 prescribes special navigation rules for tankers. Each tanker is required to navigate with at least two deck officers on the bridge; where a pilot is required, one of those officers may serve as pilot if their license is properly endorsed. Use of approved autopilot systems within a TSS, such as the scheme for entry and departure from Chesapeake Bay, is acceptable as long as a qualified helmsman is standing by at all times. Within any waters within 0.5 nm of any U.S. shore, however, the vessel must be in hand steering.

Gas tank vessels have called on Chesapeake Bay ports in the past, specifically at the Dominion Cove Point LNG Terminal. Cove Point has been receiving shipments of Liquefied Natural Gas (LNG) since 1978, although it has imported minimal LNG recently (Dominion, 2013b). Chesapeake Bay could see an increase in LNG vessel traffic if the planned construction of liquefaction facilities for exporting LNG occurs in 2017 (Dominion, 2013b).

Similar to other high-sided vessels, LNG ships generally have a freeboard of 75 ft or greater (MacElrevey). These ships are more maneuverable than conventional tankers carrying liquid bulk cargo and have a block coefficient similar to container ships. Their construction and operation is highly regulated (International Maritime Organization IGC Code). They are equipped with sophisticated leak detection technology, emergency shutdown systems, advanced radar and positioning systems, and numerous other technologies to enhance safety (Center for Liquefied Natural Gas, 2013). In addition, under its authority in 33 CFR 165.503 the USCG has in the past instituted a temporary moving security zone around LNG ships transiting Chesapeake Bay.

The Port of Virginia also handles Liquefied Petroleum Gas (LPG) cargo through the DCP Midstream, LLC terminal located at the confluence of the St. Julian's Creek and the southern branch of the Elizabeth River. Terminal capacity is 240,000 barrels, and LPG cargos received at the terminal include propane and butane. LPG vessels calling at the DCP Midstream terminal in Virginia are limited by a controlling air draft of 135 ft at MHW and a maximum draft of 35 ft at MLW (Virginia Maritime Association, 2013).

Similar to LNG vessels, LPG ships are also highly regulated and are required to adhere to the IGC Code and other USCG regulations. Additionally, the USCG and local law enforcement implement a security zone around LPG vessels transiting or moored upon the navigable waters of the Hampton Roads COTP zone. The security zone requires vessels to keep clear of vessels carrying certain dangerous cargo (CDC) and passenger vessels (33 CFR 165.503).

4.2.4. Commercial Fishing Vessels

The waters of the Chesapeake Bay and the coastal and offshore waters of Virginia support a varied commercial fishing industry. Prominent commercial species in these waters include blue crab, menhaden, scallops, croaker, striped bass, flounder, quahog, spiny dogfish, and oysters (U.S. Department of the Interior BOEM, 2012).

Along the mid-Atlantic coast, the majority of the commercial harvest of Atlantic menhaden occurs within Virginia waters. Menhaden leave Chesapeake Bay in late fall and migrate south towards the North Carolina capes until March and early April, when they return to the bay. In the commercial fishery, menhaden are primarily caught via purse seine (NOAA Chesapeake Bay Office, 2013). Purse seine fishing generally occurs in coastal waters less than 50 ft (15m) deep. Once fish are located, two small purse boats are launched from a carrier vessel, each carrying half of the seine, and encircle the school and tighten the purse line, which envelops the school (Smith, 1991). Currently, there are 10 boats operated by Omega Protein out of Reedville, Virginia ranging in size from 166 ft (51m) to 200 ft (61m) in length that engage in the menhaden commercial fishery (South Atlantic Fishery Management Council, 2013).

Blue crab is another major fishery in the mid-Atlantic region, although the fishery is mostly limited to waters inside Chesapeake Bay. Females spawn near the mouth, where higher salinity water is more prevalent. Once hatched, larvae migrate into the Bay where they grow and mature in the submerged aquatic vegetation (NOAA CB, 2013)).

4.2.5. Charter Fishing and Recreational Vessels

Sport fishing activities in the vicinity of the Project Area are concentrated along the Virginia coast and offshore in the temperate waters of the Gulf Stream. Fishing takes place year round, however, targeted species can be seasonal and dictate what grounds are fished. For instance, species like billfish are found far offshore, while mackerel or cobia are found in coastal waters. As a result, most charter fishing excursions are broken down into three categories: offshore trips, nearshore trips, and inshore trips. Offshore trips generally cover the most ground, as boats go more than 45 miles offshore. Nearshore trips may run as far as 20 miles and may include trips to the Chesapeake Light Tower or down the coast towards North Carolina. Inshore trips stay close to Rudee Inlet and no more than 3 miles offshore (Virginia Beach Fishing, 2013).

Charter vessels vary in shape and size, as some are tailored more for coastal fishing grounds instead of offshore waters. A survey of fishing boats in the area, most operating from Rudee Inlet, indicates the largest vessels exceed 90 ft in length and carry upwards of 140 passengers. Smaller charter vessels range in size from 20 ft to over 60 ft may carry as few as 6 passengers. Many charter vessels are not limited to fishing use and frequently advertise other offshore activities, including sunset cruises and whale watching.

Recreational or privately owned vessels not for hire are widespread throughout coastal and inland Virginia. In 2010, 245,940 boats were registered in the Commonwealth, of which 237,023 were traditional powerboats, sailboats with auxiliary engines, or personal watercraft (USDOT, Research and Innovative Technology Administration, 2010). Boaters in Virginia registering boats with an engine greater than 10 horsepower and personal watercraft are required to complete a boating safety education course as part of the initial registration. The law has been in place since 2007, and was instituted after a study concluded more than 700 boating accidents resulted in nearly 100 fatalities in the 5 prior years (Commonwealth of Virginia, Department of Game and Inland Fisheries, 2013). Comparatively, 95 boating accidents with 14 fatalities were recorded in the State of Virginia in 2012 (Commonwealth of Virginia DGIF, 2013). The Virginia Department of Game and Inland Fisheries (DGIF) 2012 Recreational Boating Incident Summary also revealed most of the 2012 boating accidents and related fatalities occurred in lakes and rivers, whereas only 3 accidents and no fatalities occurred in the Atlantic Ocean (DGIF 2012).

Recreational boating activities are likely to be centered on local marinas and inlets feeding the lower Chesapeake Bay and Atlantic Ocean. A survey of marinas closest to the Export Cable landfall site in the Virginia Beach area reveals more than 700 slips available at marinas in Rudee Inlet, Lynnhaven Inlet, and Little Neck Creek. These slips can accommodate boats up to 200 ft in length, and transient slips are available. Smaller boats may also be kept in dry storage; Marina Shores Marina near Lynnhaven Inlet can accommodate up to 420 boats (Marina Shores Marina, 2013).

4.2.6. Military Vessels

Norfolk, Virginia is home to the U.S. Navy's Atlantic Fleet, which includes more than 75 ships. These vessels include aircraft carriers, cruisers, destroyers, large amphibious ships, submarines, and supply ships staffed by military sailors and civilian mariners. The largest of these vessels are the Nimitz-class aircraft carriers, which displace more than 97,000 tons and measure 1,092 ft long. Table 4.1 describes the classes of U.S. Navy ships that are most commonly found operating in and out of Norfolk Naval Base (US Navy, 2013).

Table 4.1 Naval Vessel Characteristics – Homeport Norfolk and Little Creek, VA

U.S. Naval Vessel Characteristics				
Type	Length (ft.)	Breadth (ft.)	Draft (ft.)	Displacement
Aircraft Carrier (Nimitz Class)	1,092	252	38	97,000
Destroyer (Arleigh Burke Class)	505	66	31	8,300
Cruiser (Ticonderoga Class)	567	55	34	9,600
Amphibious Assault (Wasp Class)	844	106	27	40,650
Frigate (Perry Class)	445	45	25	4,100
Landing Ship Dock (Whidbey Island Class)	610	84	21	16,883 (full)
Patrol (Coastal) Craft (Cyclone Class)	174	25	7.5	331 (full)

Naval vessels are staffed in greater numbers than merchant ships and carry similar navigation equipment, although in most instances the equipment is more sophisticated and is continuously staffed in a navigation center. These vessels are also bound by the COLREGs, unless under direction of the Secretary of the Navy and/or during times of war.

4.2.7. USCG Vessels

Hampton Roads is homeport to a number of vessels that support USCG missions. Vessel types include medium endurance cutters, patrol boats, buoy tenders, and other small boats. Table 4.2 lists types and dimensions for USCG vessels currently homeported in the Hampton Roads area (US USCG Datasheet 2013).

Table 4.2 USCG Vessels Homeported in the Hampton Roads Area

Class	Length Overall (feet)	Beam (feet)	Draft (feet)	Displacement (long tons)
Famous Class Medium Endurance Cutter (WMEC)	270	38	14’ 5”	1790
Inland Construction Tender (WLIC)	160	32	5	
Protector Class Coastal Patrol Boat (WPB)	87	19	5’ 7”	91
Small Harbor Tug (WYTL)	65	17	6’11”	72
Inland Buoy Tender (WLI)	65	17	4	50

In addition to vessels stationed in Chesapeake Bay, cutters from other locations could pass near the Project Area enroute to operations or to facilities in Chesapeake Bay. In most instances, these cutters would not exceed the dimensions of the *Famous* class cutter.

4.3. Marine Traffic Survey

Vessel traffic through the Virginia WEA is relatively high in comparison with other WEAs on the Atlantic Coast (see Attachment II, Vessel and Traffic Data). This is consistent with the waterway characteristics described in Section 3.

4.4. Traffic Patterns Relative to the Project Area

Marine traffic routes as they pertain to commercial vessel traffic operating in and around the Project Area are fairly straightforward. Large commercial vessels are typically approaching or departing from either the Northern Approach or Southeast Approach traffic lanes making up the TSS, with commercial and military deep draft vessels taking the Southeast Approach. The volume of commercial traffic is shown in Figure 4.6. The data is taken from an AIS plot for 2010 created by the USCG in support of the Atlantic Coast Port Access Route Study (ACPARS) (See Attachment II). The vessels captured on this plot are those required to carry an AIS installation as described in 33 CFR 164.46. They include self-propelled vessels, other than fishing or passenger vessels, 65 ft (19.8 m) or more in length engaged in commercial service on an international voyage, tankers and passenger vessels of 150 GT or more, and towing vessels 26 feet or greater in length and over 600 horsepower.

This pattern is consistent with the data from the USACE presented in Figure 4.5 showing the percentage of vessels calling on the Port of Virginia and their representative drafts (USACE, Navigation Data Center, 2013).

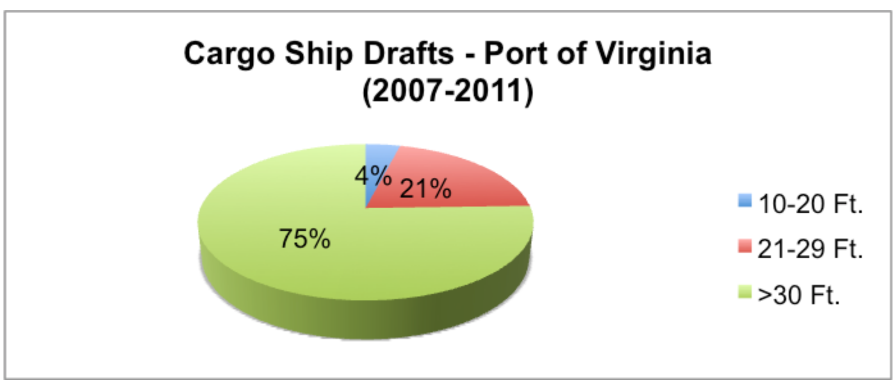


Figure 4.5 Cargo Ship Calls by Deep Draft – Port of Virginia

As Figure 4.5 indicates, 75% of commercial vessels have a draft greater than 30 ft (9.1 m). Soundings as low as 34 feet can be found within the Northern Approach, whereas soundings around 50 feet are more common within the Southeast Approach. The Deep-water Route between the inbound and outbound traffic lanes in the Southeast Approach Channel additionally provides depths in excess of 55 feet (NOAA Chart 12221). Ships generally steer better in shallow water, as full shallow water effect is felt in water depths 1.2 times the vessel's draft; however, in shallow water a ship's turning radius increases and can be as much as double that experienced at sea (MacElrevey, 2008). Other factors driving vessels to use the Southeast Approach include maintaining the desired minimum UKC and the potential for “squat” in shallow water, the tendency of large vessels operating at high speeds in shallow water to lose underkeel clearance. These concerns subside seaward of the TSS, as deeper water prevails.

In relation to the Project Area, the heaviest volumes of approaching or departing traffic pass east of Chesapeake Light, mostly clear or through the middle of the WEA on a northeasterly or southwesterly heading.

The vessel traffic data reveal different patterns when comparing cargo ships, tankers, and towing vessel traffic. Cargo ships generally follow the same traffic pattern. By comparison, towing vessel traffic appears to follow the Northern Approach traffic lane in much greater numbers than the Southeast Approach. In addition, towing vessel counts in 2010 adjacent to and within the Virginia WEA number less than 20 in all aliquots (see Attachment II).

The AIS figures shown in Attachment II and in Figure 3.7 also break down the traffic patterns of tank vessel traffic both arriving and departing the Chesapeake Bay entrance. As with cargo vessels, the heaviest volumes of tank vessels entering Chesapeake Bay utilize the Southeast Approach traffic lane due to their deeper draft. Tank vessel counts within the greater Virginia WEA and Project Area are generally low, and number less than 20 in most aliquots. Traffic patterns at the seaward entrance of the Southeast Approach lane show a clear distinction for vessels moving east and west, in addition to southeast and northwest. These tracks indicate tank vessel traffic tends to keep clear of the Project Area.

Passenger vessels, as described in Section 4.3, account for a small percentage of vessel traffic arriving and departing the Chesapeake Bay. According to the 2010 AIS traffic data analyzed, most of the passenger vessels utilize the Southeast Approach traffic lanes and are headed for points south. This track keeps the vessels well clear of the Project Area and is consistent with data from RCI and CCL, which indicates most cruises departing the ports of Baltimore and Virginia are bound for Caribbean ports.

Military exercises take place in the VACAPES OPAREA. Included in this area is a “Live Fire Area” designated as a “Dangerous Zone” on nautical charts. Navy operations for training exercises in this area are controlled through FACSFAC VA Capes in Virginia Beach. They schedule and monitor all offshore training, and notify both the FAA and USCG when training exercises are scheduled for Notices to Airmen (NOTAM) and Notices to Mariners to be published (Casey, 2013).

The Navy also operates the Shipboard Electronic Systems Evaluation Facility (SESEF), which provides electromagnetic system test and evaluation services to both Navy and USCG commands. The Norfolk at-sea SESEF range is located between 8 and18 nm offshore from the entrance to Chesapeake Bay and is supported by the Joint Expeditionary Base Little Creek/Fort Story, Virginia. The facility is one of only two sites on the east coast and Gulf of Mexico (Jacksonville, FL is the other site) that provides electromagnetic test, evaluation, and certification for Fleet units. In addition, the Norfolk SESEF range enables the development and evaluation of new and upgraded systems. On average, 300 major test and evaluation events occur at the facility annually (U.S. Navy, Fleet Forces Command, 2012).

4.4.1. Seasonal Traffic Variations

According to a study carried out from 2005 to 2009, AIS and radar data indicate the fewest vessel transits occur during the winter season. Transits during the spring, summer, and fall are fairly similar in volume, with the most vessel transits occurring during the spring and summer months (Barco, et al., 2009). This is consistent with the vessel tracks by month taken from AIS data for 2010, as shown in Attachment II.

4.4.2. Marine Events

The location of the Project Area is far enough offshore that it has little or no relation to traffic for sailing events. Most races occur within Chesapeake Bay or less than 3 nm (5.56km) offshore. Examples include the annual Neptune Atlantic Regatta in September, which normally includes 15-30 boats and runs from Cape Henry to Rudee Inlet. There are a few races occurring further offshore, including the Bi-Annual Annapolis to Newport event in June and the annual “Carib 1500” in November.

The Annapolis to Newport race departs from Annapolis, MD as racers sail down the bay and exit the Chesapeake Bay entrance. Boats head offshore and round the Chesapeake Light Tower before heading northeasterly towards Block Island and the finish line at Newport, RI. This race normally includes around 50 boats. A few boats exceed 80 ft (24.3m) in length with masts reaching 120 feet, however, most of the boats are smaller and have a mast height less than the 89 ft (27 m) VOWTAP air gap at MSL for (Schaumloffel, 2013). After rounding Chesapeake Light and heading northeast, these vessels generally pass well clear of the Project Area. Figure 4.6 is a “screen shot” of the tracks of the vessels during the most recent June 2013 race (Annapolis Yacht Club, 2013).

The “Carib 1500” race also originates inside Chesapeake Bay at Portsmouth, VA. Upon exiting the bay entrance, racers head southeast toward Bermuda and ultimately finish in the Caribbean at Tortola, British Virgin Islands (Schaumloffel, 2013). This track keeps the vessels well clear of the Project Area. This race normally includes vessels less than 50 feet in length.

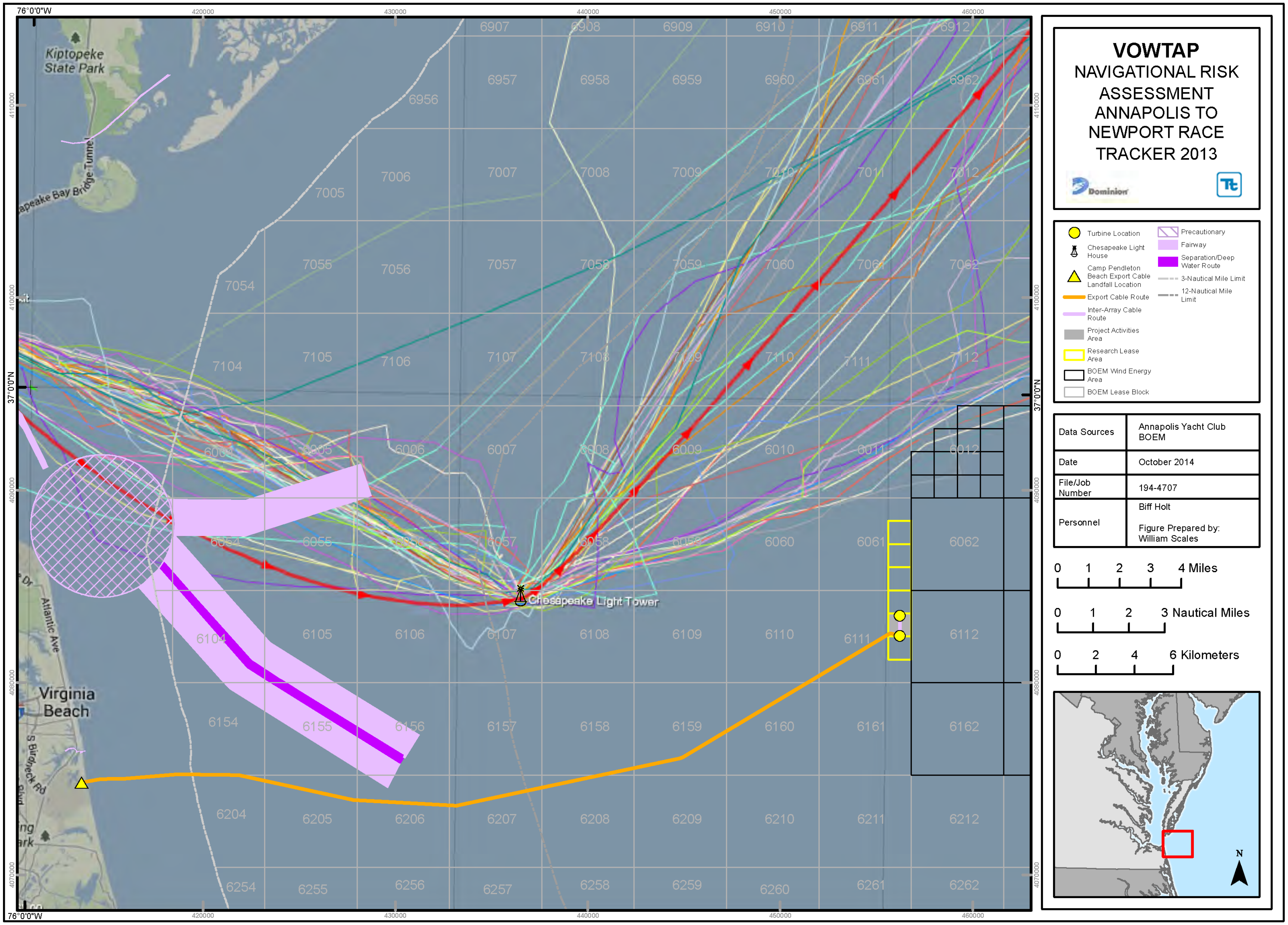


Figure 4.6 Annapolis to Newport 2013 Race Tracker

5 Historical Casualty Data for the Area

Casualty data for the Project Area and environs was extracted from a USCG database of reportable marine casualties and pollution incidents from vessels from 1982 to 2012 for the waters of the U.S. The data examined were incidents that occurred between 2003 and 2013 in Chesapeake Bay and its tributaries south of the entrance to the James River to the Chesapeake Bay Bridge Tunnel (CBBT) and offshore from the CBBT to the Project Area and beyond at a radius of approximately 20 nm from the WTGs. The data created from the USCG database is found in Attachment IV to this NRA.

The area within Chesapeake Bay was selected for its proximity to a potential Construction Port for VOWTAP and the route that would be taken by VOWTAP construction and support vessels.

The area surrounding VOWTAP was selected for its proximity to VOWTAP and the assumption that casualties occurring in that area might be expected to impact VOWTAP or to be affected by the presence of the WTGs.

The casualties and pollution incidents examined were those that are operational in nature, that is, the vessel or vessels involved were underway or in an operational status at the time of the incident, particularly foundering or capsizing; fire and explosion; grounding (both powered and drifting); collision between two vessels; and allision between a vessel and a structure.

Regulations from the U.S. Coast Guard (46 CFR 4.03) require notification of a marine casualty in U.S. waters that meets certain criteria, including loss of life and any occurrence involving a vessel that results in:

- Grounding
- Stranding
- Foundering
- Flooding
- Collision
- Allision
- Explosion
- Fire
- Reduction or loss of a vessel's electrical power, propulsion, or steering capabilities
- Failures or occurrences, regardless of cause, which impair any aspect of a vessel's operation, components, or cargo
- Any other circumstance that might affect or impair a vessel's seaworthiness, efficiency, or fitness for service or route
- Any incident involving significant harm to the environment

Of the reportable marine casualties that were examined for this analysis, there were 21 in the past 10 years that occurred in the area within Chesapeake Bay of relevance to VOWTAP: 5 allisions, 4 collisions, 4 groundings, and 8 categorized as equipment failures, generally loss of propulsion. None of the incidents resulted in serious damage to the environment or to other vessels or structures (see Attachment IV). None of the incidents would have seriously impeded construction or O&M activities associated with VOWTAP associated vessels operating from the Construction Port to the Project area nor is it likely that the presence of the vessels associated with VOWTAP would have caused similar casualties.

There were 17 marine casualties reported in the offshore area described above in the past 10 years: 1 allision by a fishing vessel with Chesapeake Bay Light, 1 collision between 2 fishing vessels, 1 fire aboard a recreational vessel, 2 groundings of freight ships in the vicinity of the TSS, and 11 equipment failures. None of the incidents resulted in serious damage to the environment or to other vessels or structures (see Attachment IV). None of these incidents would have significantly impacted the Project area or WTGs nor is it likely that the presence of the WTGs would have contributed to these incidents.

One incident that occurred prior to 2003 and was not included in the data examined was a collision between a Ro-Ro vessel, the *Saudi Riyadh*, and the *Arthur W. Radford*, a U.S. Navy Spruance-class Destroyer. In 1999, the *Radford* was conducting tests around a special purpose buoy approximately 17 miles off the coast of Virginia. The *Saudi Riyadh* was making for Chesapeake Bay from New York enroute to Baltimore. The *Saudi Riyadh* struck the starboard side of the *Radford* penetrating nearly 25 feet (8 m) into the main deck.[5] The incident occurred approximately 7 nm from the Project Area. This incident is not considered significant to VOWTAP.

[5] In Re National Shipping Company of Saudi Arabia, U.S. District Court, Eastern District of Virginia, June 21, 2000, 14 F. Supp. 2d 425 (2000). Available online at: http://www.leagle.com/decision/2000572147FSupp2d425_1535. (accessed 16 December 2013).

6 Potential Effects of the Project on Safe Navigation

6.1. Construction Phase

VOWTAP offshore construction activities are scheduled to commence in May for anticipated completion before the end of September (see Table 2.1).

Cable laying will occur 24 hours a day, while pile driving will occur only during daylight hours. Task lighting, in compliance with local and federal health and safety regulations, will be in place for activities during nighttime operations.

Vessels of various size and type will participate in the VOWTAP construction and will be situated in the Construction Port in the Hampton Roads area (see Section 2.3). Specific vessel types and activities are described in Table 2.2. Vessel registry will comply with Jones Act requirements when transporting cargo and equipment between U.S. ports and as otherwise required. Large components will be transported from Europe directly to the Project Area without calling at an intermediate U.S. port. The transport of smaller components, equipment, and personnel will be carried out by the smaller tug/barge combinations, supply boats, and passenger crew boats from the selected Construction Port in the Hampton Roads area. It is anticipated that these vessels will be operating between the Construction Port and the Project Area continuously during the development phase. All movements will be in accordance with regulations governing the prescribed waterways, as described in Section 3.

Specific vessel details, such as fuel types and capacities, will become available as vessel contracts are awarded. However, it is generally assumed that construction vessels, such as the Jack-up vessel and Cable-lay vessel, will carry between 600 and 1000 tons of fuel oil and 12 to 15 tons of lube oil, which is typical for vessels of comparable type and size. All fuels will be stored within designated tanks located within the vessel hulls. Smaller vessels, such as workboats, will carry between 2 and 20 tons of fuel. Lube oil will be stored in sealed containers on deck.

6.1.1. Weather Constraints on Construction

Wind speed and wave height restrictions for setting of the jacket, piles, and turbines is limited to 20 knots (10.3 m/s) and 3.3 ft (1m), respectively as stated in the RAP. In addition, emergency procedures will be developed for hurricane events, storms, and other inclement weather, including fog and other periods of restricted visibility that may necessitate a work stoppage. Construction plans call for offshore construction and turbine commissioning to be carried out prior to the start of hurricane season and continue through the early months of the season. 97% of tropical activity generally occurs between June and December with a peak of activity occurring in September. Even though the potential for a hurricane event is minimal, a hurricane preparedness plan will be developed, consistent with the Port of Hampton Roads Maritime Severe Weather Contingency Plan, and will guide the evacuation of all personnel and vessels associated with construction activities (USCG Sector Hampton Roads, 2010).

Weather constraints will also include stand-by limits where construction vessels and personnel may remain on scene during periods of work stoppage. In the event stand-by limits are exceeded, construction vessels and personnel will be evacuated and moved off site to a safe mooring location.

As described in Section 3, there is a small potential for icing of offshore structures during the winter months, however, icing is not anticipated to impact construction activities given the construction schedule.

6.1.2. Effects of VOWTAP Construction on Navigation

During the construction phase, there is the potential for interaction with vessels bound to or from the Southeast Traffic lanes for entry into the Chesapeake Bay, based on an evaluation of AIS data for the area (see Figure 3.8). Under Rule 3, General Definitions of the Navigation Rules, vessels laying cable are restricted in their ability to maneuver due to the nature of their work and, as a result, additional responsibilities with navigating vessels apply in accordance with Rule 18 (US USCG COLREGS, 2013). The 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. Additional mitigating factors to reduce the risk of collision should include security broadcasts over VHF radio, as well as broadcast notices to mariners and coordination with USCG Sector Hampton Roads.

Temporary private ATON will be established during construction, subject to USCG approval, to indicate construction activities and alert mariners of potential danger. The perimeter of the Project Area will be identified by the use of buoys with navigation lights. Vessels anchoring in the area will also use buoys with navigation lights to indicate the position of the anchor. During the cable-laying phase of construction, additional buoys with lights will be used to indicate the location of the cable as it is being installed. All ATON will meet USCG requirements and is subject to a separate lighting and marking plan under development.

A Temporary Safety Zone of 820 ft (250 m) radius will be requested to surround each temporary work area noted in Section 2.3. Notices to Mariners will be issued to advise mariners of the Temporary Safety Zones, and the areas will be marked and lighted in accordance with USCG requirements. The Temporary Safety Zones will be proposed to be in place for the duration of construction activities.

All vessels engaged in the construction of the VOWTAP will be marked, lighted, and employ sound signals, as prescribed in accordance with the applicable navigation rules for the location and activity in which a vessel is engaged. The structures will be lighted and marked in accordance with the lighting and marking plan for the operational phase not later than the time of departure of the last construction vessel. If the construction vessels have to leave a structure before it is completed (e.g., in case of adverse weather), temporary navigational aids will be placed on the structures. Such temporary aids will be subject to approval of the Commander, Sector Hampton Roads.

6.1.3. Risk of Collision and Allision

An allision between a vessel and a WTG is possible but highly unlikely in either the construction or the operations phase. Studies conducted by Germanischer Lloyd (GL) and Hamburg University of Technology (TUHH) modeled allisions by, among other vessel types, a 50,000 DWT cargo ship and a 30,000 DWT Tank ship (Biehl, 2010). These ship types are comparable to those that might operate in the vicinity of VOWTAP. The allision occurred at 4 knots with a WTG of comparable design to VOWTAP (Biehl, 2010). The study concluded that collapse of the WTG is unlikely to occur in such a scenario. In the case of a powered allision, the WTG structure may be expected to collapse especially if the hull of the vessel is penetrated (Biehl, 2010).

Adherence to the COLREGS by all mariners should serve to mitigate risk posed to safe navigation by the construction and general operation of the VOWTAP and any support vessels. Notwithstanding the importance of all of the rules, the "Rule of Good Seamanship" is arguably the most paramount. Rule 2(a), Responsibility, states:

"Nothing in these rules shall exonerate any vessel, or the owner, master or crew thereof, from the consequences of nay neglect to comply with these Rules or of the neglect of any precaution which may be required by the ordinary practice of seaman, or by the special circumstances of the case (COLREGS, 2013)."

This Rule applies when others fail and is fundamental to the safe operation of vessels. In addition to the rule of good seamanship, Rule 2(b) states:

"In construing and complying with these Rules due regard shall be had to all dangers of navigation and collision and to any special circumstances, including the limitations of the vessels involved, which may make a departure from these Rules necessary to avoid immediate danger (COLREGS, 2013)."

Commonly referred to as the "General Prudential Rule," this rule states that a departure from the Rules may at times be necessary in extreme cases, or in the event a situation develops that is not clearly defined in the COLREGS.

Notwithstanding the provisions of Rule 2 or any special circumstances, the Steering and Sailing Rules provide the mariner with a road map to operating safely, regardless of the conditions. Included in this section is Rule 5, Lookout, which applies in any condition of visibility and states:

"Every vessel shall at all times maintain a proper look-out by sight and hearing as well as by all available means appropriate in the prevailing circumstances and conditions so as to make a full appraisal of the situation and of the risk of collision (COLREGS, 2013)."

A scenario whereby a navigator approaching coastal waters, in close proximity to the VOWTAP, sets the autopilot and goes below is not only a violation of Rule 5, but also the rule of good seamanship. Maintaining a proper lookout, combined with Rule 6, Safe Speed, is of the utmost importance in allowing enough time to determine that a potential risk of collision exists and to take actions to avoid collision.

In addition to the rules described above and other rules in the COLREGS, the marking of the VOWTAP WTGs on charts, using Broadcast Notices to Mariners during construction, and adherence to the approved marking and lighting plan will serve to mitigate the potential risk of collision that exists between vessels and the risk of allision with VOWTAP structures and support craft.

6.1.4. Disruption of Normal Traffic Patterns

No significant disruption of normal traffic patterns is anticipated within the Project Area, nor the adjacent waters of the Chesapeake Bay entrance TSS and precautionary area. An increase in vessel traffic may be noticeable as support vessels operate from the designated Construction Port. As a result, coordination between vessels associated with the VOWTAP construction activities and the Virginia Pilots, USCG, and other relevant parties will contribute to safe operations and minimize any potential for traffic disruptions.

6.1.5. Sound Generated During Construction

Sound generation during construction may impact sonar of passing vessels and, potentially, naval vessels operating in the area. It is generally assumed the greatest sound generated will result from use of the hydraulic hammer for pile driving, which will be intermittent. The average pile driving time per WTG is estimated to take a total of 7days with an average of 6,500 blows per WTG required to drive piles to the prescribed depth.

6.1.6. Potential Impact on USCG Missions

There is no indication of impact on USCG missions during the construction phase of VOWTAP. Vessels engaged in construction activities will be available for support and assistance in the event of a Search and Rescue event or emergency response to an oil spill.

Vessels engaged in construction activities will meet requirements for Emergency Response Plans in the event of a spill.

Communications Plans, under development, will address the means of communicating between construction contractors, Dominion, and USCG emergency responders.

6.2. Operational Phase

6.2.1. Weather Constraints during Operations

Compared to the historical wind speeds experienced in the area (see Section 3.11), the operational parameters of the WTGs (see Section 2.1) are sufficient to enable operation of VOWTAP in excess of 98% of the time without complication. Wind speeds in excess of 33 knots (17 m/s) have been found to occur less than 1.4% of the time in the area, usually in October (Figure 3.7), while the WTG is designed to withstand wind speeds of 97 knots (50 m/s) over a 10-minute average and 50-year extreme gusts of 136 knots (70 m/s) over a 3-sec average).

Similarly, historical storm tracks have passed south and east of the Project Area, placing the WTGs in the left, or "safe", quadrant of these storms (see Figure 3.9). A storm passing just west of the Project Area is likely to impose the highest risk to VOWTAP WTGs based on the highest wind potential in the right quadrant of storms.

Given the analysis presented, the potential for icing on the WTG rotors is most likely during the months of January and February when recreational boating is extremely limited. The tracks of most commercial vessels transiting the Project Area are outside the calculated "safe" area (see Section 3.14). If ice were to accrete on turbine blades, the greatest potential for risk from ice dropped or cast appears to be to fishermen who may be fishing within the bounds of the "safe" area during an extremely cold winter.

6.2.2. Effects of VOWTAP on Navigation

The United Kingdom Maritime and Coastguard Agency has developed a template for use by "Offshore Renewable Energy Installations" in determining the level of risk and tolerability for wind farms and their relationship to shipping lanes (UK Maritime and Coastguard Agency, 2013). Table 6.1 shows the distance from a shipping lane that a proposed wind farm is situated, criteria that determine the level of risk, the risk determination, and the level of tolerability.

Table 6.1 Wind Farm: "Shipping Route" Template

Distance of WTG Boundary from Shipping Route	Factors	Risk	Tolerability
< 0.25 nm (<500m)	500m inter-turbine spacing = small craft only recommended	VERY HIGH	Intolerable
0.25 nm (500m)	X band radar interference	VERY HIGH	
0.45 nm (800m)	Vessels may generate multiple echoes on shore based radars	VERY HIGH	
0.5 nm (962m)	Mariners' high traffic density domain	HIGH	Tolerable if ALARP
0.8 nm (1481m)	Mariners' ship domain	HIGH	
1 nm (2778m)	Minimum distance to parallel boundary of TSS	MEDIUM	
1.5 nm (2778m)	S band radar interference ARPA affected	MEDIUM	
2 nm (3704m)	Compliance with COLREGS becomes less challenging	MEDIUM	
>2 nm (3704m)	But not near TSS	LOW	
3.5 nm (6482m)	Minimum separation distance between turbines opposite sides of a route	LOW	
5 nm (9260m)	Adjacent wind farm introduces cumulative effect Distance from TSS entry/exit	VERY LOW	Broadly Acceptable
10 nm (1988520m)	No other wind farms	VERY LOW	

In the context of this NRA, the term "tolerable" does not necessarily mean "acceptable." Using the definition provided by the Government of the United Kingdom's Health and Safety Executive, it refers instead to a willingness by society as a whole to live with a risk so as to secure certain benefits in the confidence that the risk is one that is worth taking and that it is being properly controlled. It does not imply, however, that the risk will be acceptable to everyone, i.e. that everyone would agree without reservation to take the risk or have it imposed on him or her (UK HSE, 2001).

Using the taxonomy of distance from a wind farm to shipping routes, it is then possible to prioritize the level of risk to shipping for the determination of risk mitigation or risk control measures.

As noted in Section 2.1, the distance from VOWTAP to the TSS is about 14 nm (26 km). Additionally as noted in Section 3.11, the CPA of a vessel using an assumed shipping route from the end of the TSS, past Chesapeake Light, and thence either north or transatlantic is 3 nm (5.6 km) to 10 nm (18.5 km). The general risk of the presence of VOWTAP on shipping then is rated as "low" to "very low."

Qualitatively, VOWTAP does minimally increase the risk of collision between vessels transiting the area enroute to or from the Chesapeake Bay TSS due to its presence (something is there that was not previously there). However, because there is no channel constriction caused by the presence of the WTGs or other factors that would limit the navigability of vessels, the risk is very low (See Section 7).

VOWTAP does also create a minimal risk of allision by a vessel with one of the WTGs, due to the same reasoning (something is there that was not previously there). However, the radar image of the WTGs and mitigation measures, such as chart corrections and other notices to mariners, as well as appropriate lighting, marking, and sound signaling in accordance with an approved lighting and marking plan, should minimize this risk. In fact, by virtue of their fixed position, the WTGs present attractive position fixing landmarks for mariners.

For recreational vessels, an issue of concern is the air gap of the WTGs compared to masthead height of a sailboat if it ventures too closely to a WTG. The air gap for VOWTAP WTGs is a minimum of 89 ft (27m) at MSL and 82.4 ft (25.1 m) at HAT. U.S. Sailing, the governing body for the sport of sailboat racing in the U.S., was queried as to data regarding mast heights for vessels rated with U.S. Sailing. Large sailboats that may participate in offshore point-to-point races, such as the Annapolis to Newport race, are of particular interest. Figure 4.5 is a chart showing data regarding masthead heights of sailboats registered with US Sailing. The data show that 94% of IRC rated boats have a masthead height less than 89 ft (27 m) and 92% of IRC rated boats have a masthead height less than 82 ft (25 m). (US Sailing, 2013)

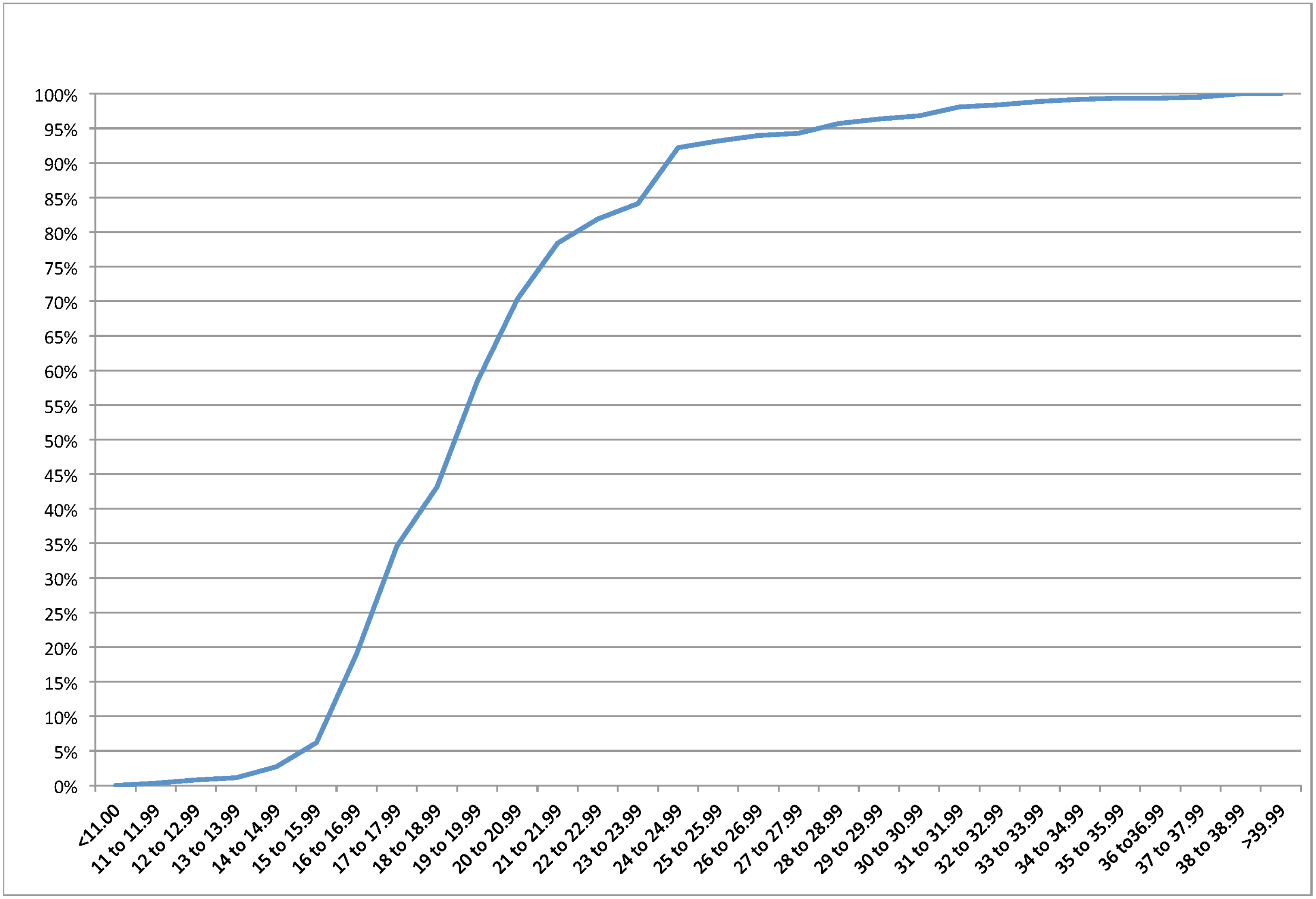


Figure 6.1 Masthead Heights of US Sail IRC Rated Boats in the U.S. (m)

At 27 miles offshore, there is potential for charter or commercial fishing vessels bound for offshore waters to pass through or near the Project Area while enroute to the fishing grounds. These vessels may also use the area around the WTGs to take advantage of marine species that congregate around fixed structures.

The normal operation of VOWTAP and supporting activities are not anticipated to impact the traffic patterns of commercial, recreational, or fishing traffic in the area. As described in Section 4, the siting of the Project Area offshore the Chesapeake Bay entrance is far enough offshore that recreational vessel traffic will be limited. The offshore structures are likely to create an underwater habitat attracting fish and other wildlife and subsequently sport fisherman.

6.2.3. Disruption of Normal Traffic Patterns

Commercial traffic patterns, as noted in Section 3.10, indicate that the highest concentration of commercial vessels is clear of the Project Area, however, vessels arriving or departing the Southeast Approach to the TSS from the east will need to exercise caution when in the vicinity of the WTGs. The siting of the WTGs may impact coastwise towing vessels, specifically smaller tugs and tows using wire gear operating closer to shore in inclement weather. However, industry professionals, including those from the American Waterways Operators (AWO), have been consulted in ultimately deciding the specific location of the WTGs (Section 1.1 and Parker, 2013).

6.2.4. Potential Effects on Electronic Navigational Aids and Communications

Studies of the potential effects on electronic navigation and communication systems typically used by mariners operating in the vicinity of VOWTAP have been reviewed as part of this analysis.

Communications

VHF Radio. The primary means of communication for vessels operating in the vicinity of VOWTAP is Very High Frequency (VHF) radio. Recreational vessels less than 65.6 ft (20 m) are not required to carry VHF radio, but it is not uncommon for most vessels that would be operating as far out as VOWTAP to be equipped with such radios. VHF radio provides users with line-of-sight communications capability with typical ranges of 20 nm (37 KM) -25 nm (46 km). The effective range could vary, however, depending on weather factors, antenna height, and transmitter power.

A study was conducted in 2004 by the United Kingdom Department of Transportation, Maritime and Coastguard Agency at the North Hoyle wind farm comprising 30 WTGs in a grid pattern. In this study, both a handheld VHF radio operated on a WTG within the farm and a small radio installation aboard a vessel in close proximity on the opposite side of the farm were tested. There were no noticeable effects on voice communications recorded, and multiple shore installations nearby received all transmissions (UK Department of Transportation, 2004).

Automated Identification System (AIS). AIS is a maritime navigation safety communications system required on board certain vessels that provides vessel information, including vessel identity, type, position, course, speed, navigational status and other safety-related information automatically to appropriately equipped shore stations, other ships, and aircraft. Such information from similarly fitted ships is also automatically received and displayed facilitating communications and navigation safety. AIS is also used in vessel traffic safety systems to monitor and track ships equipped with AIS and to allow exchange data between AIS-equipped ships and shore-based facilities.

Vessels required to carry AIS generally include self-propelled vessels greater than 65 feet in length in commercial service on an international voyage, all tank vessels, passenger vessels of 150 gross tons or more, and towing vessels in commercial service 26 feet or longer or propelled by more than 600 horsepower (33 CFR 164.01).

Fishing vessels that do not otherwise meet the regulatory standards are not required to carry AIS nor are recreational vessels. However, a growing proportion of fishing and recreational vessels carry AIS voluntarily to increase their visibility to other shipping.

The North Hoyle Report (UK Department of Transportation, 2004) evaluated the impact of the WTGs on AIS, and concluded that there were no adverse effects caused by the WTGs on AIS operations.

Other Means of Communications. The North Hoyle Report (UK Department of Transportation, 2004) also provided the results of tests on other means of communications used at sea: mobile telephones and Digital Selective Calling, an important component of the Global Maritime Distress and Safety System (GMDSS).

These tests also showed that WTGs did not interfere with these types of communications.

Radar

Marine radar is widely used by commercial vessels, and many fishing vessels and large recreational vessels are also equipped with marine radar. Concern has been raised in the past that wind farms, especially large wind farms comprising numerous WTGs, may produce unwanted effects on the display of marine radar, including:

- Indirect or false echoes;
- Multiple echoes;
- Linear, small and large sector reflections; and
- Other phenomena associated with interference such as masking.

A study conducted by Marico Marine (UK) on behalf of the British Wind Energy Association (BWEA) of the effect of the wind farm on ships' radar, including the ability to determine the presence of small craft within the array of WTG (Kentish Flats project), found that there was no impact for ships operating in the shipping channel; that ships were able to identify the WTGs, to identify other ships both within the wind farm and on the other side of it, and that small craft within the wind farm were detectable (Marico Marine, 2007). The study did note, however, that the return signal from a small craft operating near a WTG or passing close aboard a WTG would be indistinguishable from that of a WTG until the small craft was clear of the turbine. In this instance, the study involved the Kentish Flat Offshore Wind Farm, in operation since 2005, comprising 30 WTGs about 6 miles offshore near the Thames shipping channel. The platform bases are of monopile construction and the height of the hub of each WTG is 70 m. There is 700 m between each WTG (Lindoe Offshore Renewables Center, 2013).

A similar study conducted by Marico for the Cape Wind Offshore Wind Farm in Nantucket Sound off the coast of Massachusetts came to a similar conclusion; negligible impacts on vessel radars within or outside the wind farm. Cape Wind is a 130 WTG array covering 24 square miles. The WTGs are 84.5 meters high (above MSL) with a separation distance between WTGs ranging from 600 m to 1,000 m (U.S. Department of the Interior MMS, 2012). However, this study was challenged by opponents of the project who commissioned a study that showed deleterious impacts on marine radar by the presence of the wind farm.

As a result, the USCG commissioned a study to resolve the opposing conclusions. The USCG concluded from this study that there were "moderate" effects to marine radar as a result of the Cape Wind Offshore Wind Farm:

- That the presence of the wind farm would not adversely impact the ability of a vessel outside the wind farm to detect another vessel outside the wind farm, even if portions of the wind farm are between the 2 vessels.
- That the presence of the wind farm would not adversely impact the ability of a vessel's radar inside the wind farm from detecting a vessel outside the wind farm.
- That the presence of the wind farm would affect the ability of a vessel outside the wind farm to detect a vessel operating within the wind farm. The USCG found that vessels operating within the wind farm are detectable, but special attention is required by the radar operator to detect false radar signals from valid radar signals.
- That the presence of the wind farm would affect the ability of a vessel inside the wind farm to detect another vessel operating within the wind farm. The USCG again found that vessels operating within the wind farm are detectable, but special attention is required by the radar operator to detect false radar signals from valid radar signals.

The USCG additionally proposed that appropriate mitigation measures be undertaken to minimize the impact of these findings on marine radar (USCG Salerno Letter, 2009).

Given that the VOWTAP project is substantially smaller (two WTGs) than either the Kentish Flats Wind Farm (30 WTGs) or the proposed Cape Wind Offshore Wind Farm (130 WTGs), we would not expect there to be the same degree of signal reverberation between WTGs. There is no indication then, based on these studies and an extrapolation of the results, that the VOWTAP WTGs would impede the ability of vessels' marine radar from identifying other vessels either within or on the opposite side of the VOWTAP Project.

VOWTAP will consist of two WTGs spaced 3,445 feet (1,050 m) apart. The findings of the studies analyzed and reviewed as part of this assessment show that there is limited discernible impact on marine radar by WTGs, and that mitigation measures may be employed to reduce the impact even more in cases of large numbers of WTGs. This assessment concludes that there will be no adverse impact on marine radar by VOWTAP on either navigation or collision avoidance.

Positioning Systems

Global Positioning System. The Global Positioning System (GPS) is becoming increasingly used in marine applications, including recreational boating (USCG NAVCEN 2012). GPS includes 24 satellites transmitting signal information by Ultra High Frequency (UHF) radio waves received by individual units that use the signals from multiple satellites to triangulate and calculate the user's position. The signal transmitted by the satellites travels by line of sight unless obstructed by solid objects, such as buildings.

In the event a marine GPS unit on board a ship loses signal information from satellites, it sounds an alarm and calculates the most recent course and speed to provide a dead reckoning position for the user until the signal is re-acquired.

The North Hoyle report (UK Department of Transportation, 2004) by the UK Department of Transportation studied the potential impact of WTGs on GPS and concluded that there was no interference.

Magnetic Compasses. Magnetic compasses are widely used by recreational vessels for navigation and steering. They are also used as secondary, or backup, navigational equipment for similar purposes by fishing and commercial vessels.

The North Hoyle study (UK Department of Transportation, 2004) examined the potential effect of the WTG structures on magnetic compasses and concluded that there was no adverse impact. It also found, however, that due to the large amount of ferrous material in WTG structures, hand bearing and small compasses found on smaller recreational vessels, such as sail boats, may be affected if the vessel sails too close to a WTG.

This assessment concludes that there will be no adverse effect from the VOWTAP on positioning systems, except for magnetic compasses on small boats. However, marking and lighting the WTGs will provide sufficient mitigation to reduce the impact of this effect. The fixed construction of the individual WTGs also provides mariners with a suitable means of determining position either visually or with radar.

Chesapeake Light

Chesapeake Light is a major fixed Aid to Navigation maintained by the USCG to assist mariners approaching or departing Chesapeake Bay. It is situated approximately 10 nm (18.5 km) east southeast of the entrance to the Bay and approximately 12 nm (22 km) west of VOWTAP. It is 117 feet (35.7m) high and is equipped with a light with a nominal range of 19 nm (35 km), a sound signal, and a RACON with a nominal range of 15 nm (28 km).

VOWTAP will have some potential impact on the visibility of Chesapeake Light from vessels approaching Chesapeake Bay from the east, particularly larger vessels transiting east of VOWTAP making for the deepwater channel. An "Area of Potential Interference" is created by the presence of the WTGs and the turbine blades that may alter the observed characteristic of Chesapeake Light periodically while a vessel is in that zone out to the nominal range of the primary light. The primary sound signal would not be affected due to the distance of VOWTAP from the Light nor would the RACON.

Figure 6.3 is a graphical depiction of the Area of Potential Interference caused by the turbine blades. Due to the significant spread between the individual WTGs and the relatively slow rotation of the rotors, the calculation of this Area of Potential Interference represents a worst-case situation. In most cases, no interference with the light characteristics or sound signal will occur. However, any interference with the light characteristics that may occur will be minimal and of short duration.

There are no other visibility implications to the VOWTAP WTG due to the narrow diameter of the towers and the spacing of the WTGs (see Section 2.1).

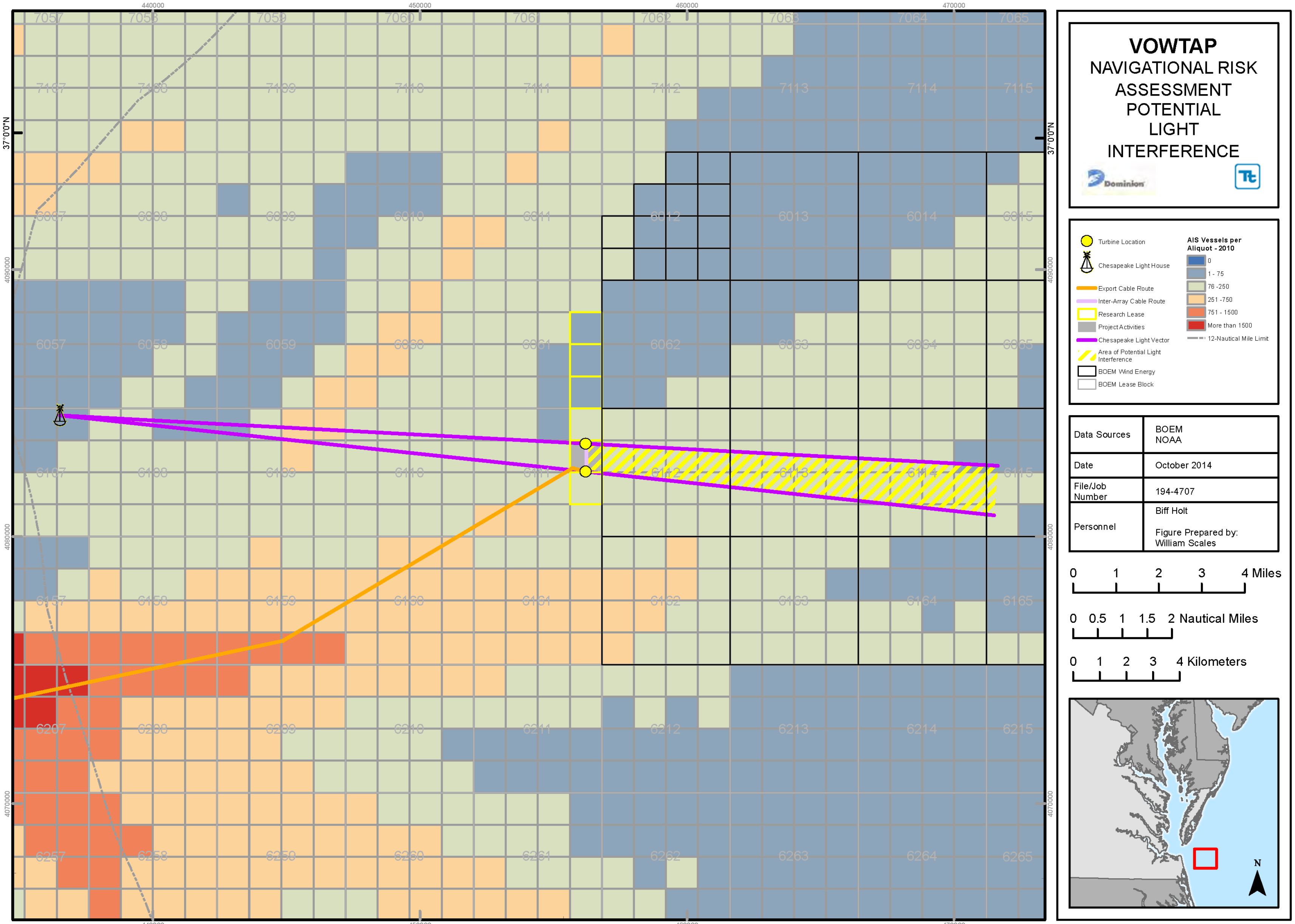


Figure 6.2 Area of Potential Interference of Chesapeake Light Caused by VOWTAP WTGs

6.2.5. Potential Impact on USCG Missions

Air assets in support of USCG missions, such as helicopters and fixed wing aircraft, are deployed from USCG Air Station Elizabeth City, North Carolina.

USCG aviation assets may be affected if a Search and Rescue (SAR) case occurs near VOWTAP such that the aircraft would maneuver near one of the WTGs. In that instance, USCG Sector Hampton Roads would contact the Dominion Operations Center with a request that the turbine blades be remotely secured.

USCG surface assets would be impacted if the air draft of a cutter exceeded the air gap of the WTGs' blades, such as the case potential for a WMEC or larger vessel. The air gap is sufficient for other USCG surface assets. However, in the interest of safety, it would be prudent to request securing the blades for a SAR case in the vicinity of VOWTAP in which any USCG surface asset is anticipated to be used.

The USCG's Marine Environmental Response (MER) mission would similarly be affected if response assets needed to operate in the vicinity of VOWTAP. In those instances, a request should be made by USCG Sector Hampton Roads to Dominion to secure the turbine blades for the duration of response operations in that area.

Contingency Plans for Non-routine Events

Shutdown procedures for the VOWTAP will be contained in an Emergency Response Plan still under development. However, once operations commence, VOWTAP will be monitored using the SCADA system in the export cable (see Section 2.2) by a 24-hour staffed control room outfitted with the capability to shutdown turbine operation remotely in the event of an emergency. The operations control room, in addition to equipment for monitoring turbine operation, will be equipped with communications capabilities for coordination with the USCG, police, and other relevant authorities that may respond to a threat or emergency. The plan will cover emergency signals, muster responsibilities, training, drills, reporting, and recording. The plan will also cover response actions for specific emergencies. In addition, Dominion intends to collaborate with the USCG and relevant authorities in carrying out emergency drills, training, and exercises in accordance with the established regulations.

In the event a shutdown of VOWTAP infrastructure is initiated due to an allision or casualty that may impair the structural integrity of the WTGs, Dominion will inspect and verify the condition of any affected WTG in accordance with company procedures.

6.3. Decommissioning

The VOWTAP demonstration turbines will have a design life of 20 years. At the end of their operational life, the wind turbines will be decommissioned and deconstructed in the reverse sequence that they are constructed. This will require the use of heavy lift vessels similar to those involved in the wind turbine construction process. The structure and equipment will be removed and transported to shore using either a transportation barge or the heavy lifting vessel. Specific vessel characteristics will be determined prior to the decommissioning process.

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. At this stage, decommissioning methodology cannot be finalized as it is recognized that industry technology and best practices are likely to change over the operational life of the VOWTAP facilities. The VOWTAP decommissioning application will be coordinated with applicable local, state, and federal governments and will meet all BOEM decommissioning requirements.

7 Navigational Risk Assessment

7.1. Formal Safety Assessment Process

The Formal Safety Assessment Process (FSA) follows that developed by the International Maritime Organization (IMO) and prescribed by the United Kingdom Department of Trade and Industry for assessing the navigational risks of offshore wind farms (UK Department of Trade and Industry 2013). The process involves identifying hazards that may be associated with a project, assessing the risk of those hazards, and determining appropriate risk control measures. Figure 7.1 depicts the FSA process used for the VOWTAP NRA.

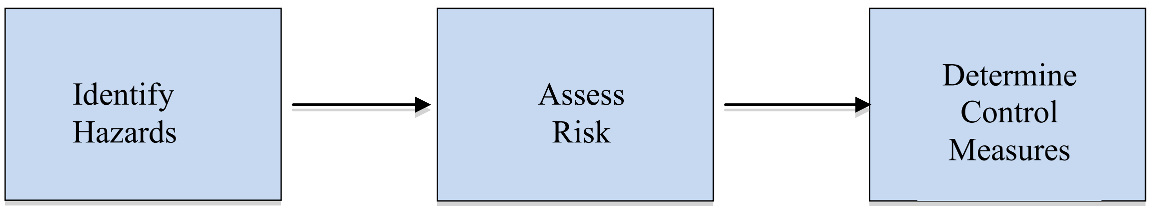


Figure 7.1 Formal Safety Assessment Process

7.2. VOWTAP Navigational Risk Assessment

This Risk Assessment used a Change Analysis as the means of determining the relative size of risk associated with VOWTAP, as noted in Section 1.3. A Change Analysis establishes a Base Case, (i.e. current conditions absent the project), and then evaluates whether there are new risks brought about by the presence of VOWTAP. The potential hazards identified for further consideration as to their frequency and consequence were qualitatively measured for the Base Case and then compared to the situation with VOWTAP.

Potential navigational hazards associated with VOWTAP were identified during the risk assessment process and a Hazard Log established and maintained. The Hazard Log consists of a list of identified hazards, their frequency and severity without the presence of VOWTAP, their frequency and severity with VOWTAP, and the differences between the two states.

Sources of information for the FSA included the following:

- Historical Data
- Available Studies
- Expert Opinion
- Professional Opinion
- Other reference sources such as the U.S. Coast Pilot and navigational charts.

The NRA for VOWTAP principally used Expert Opinion and Qualitative Analysis for determining the frequency and consequence of a hazard as noted in Section 1. However, where possible Historical Data was used and some quantification of risk determined in order to provide less uncertainty as indicated in Table 1.1. The Hazard Log indicates the sources of the evidence used in making a risk determination.

The process for assessing the risks of identified hazards created as a result of VOWTAP was largely qualitative. The frequency of hazards associated with the current situation without VOWTAP was assumed to be low in spite of the level of vessel traffic entering and departing Chesapeake Bay. Table 7.1 is the Frequency Matrix that was developed to assist in the qualitative determination of the frequency with which an event may occur.

Table 7.1 Frequency Matrix

Frequency	Frequent	Likely to happen yearly or more frequently
	Reasonably Probable	Likely to happen during the licensing period of a wind farm (nominally 20 years)
	Remote	Unlikely (but not exceptional) to happen during the licensing period
	Extremely Remote	Only likely to happen in exceptional circumstances

Similarly, the consequence of an event was evaluated qualitatively using the UK DTI example, which is based on the IMO model. The consequences were assumed to be relative to the type of incident that may occur using the information in Table 7.2. Both consequences to humans as well as materiel consequences of an event were evaluated using the standards in Table 7.2.

Table 7.2 Consequence Matrix

		Human Consequence	Materiel Consequence
Consequence	Catastrophic	Loss of more than 4 vessel crew members, loss of more than 4 maintenance crew, multiple fatalities ashore	Total loss of WTG installation, total loss of vessel
	Major	Loss of vessel crew members (1-4), loss of maintenance crew (1-4), fatalities ashore (1-4)	Loss of WTG installation, major damage to vessel or shore facility
	Minor	Injury to vessels crew, injury to maintenance crew, injury ashore	Damage to WTG installation rendering it unusable for a time, reportable damage to a vessel, minor damage to a shore facility
	Insignificant	No significant harm	No significant harm

Following the determination of the Frequency that an event may occur and an evaluation of the consequences of that event, a "Criticality" Score was developed with a score assigned to each hazard event. A "Red-Yellow Green" (R-Y-G) methodology was used to indicate the criticality of each identified hazard event. Table 7.3 shows the Criticality methodology used for this assessment.

Table 7.3 Criticality Score

Frequency	Frequent	4	5	6	7
	Reasonably Probable	3	4	5	6
	Remote	2	3	4	5
	Extremely Remote	1	2	3	4
		Insignificant	Minor	Major	Catastrophic
	Consequence				

The Criticality Score shown in Table 7.3 is based on the level of tolerability for the hazard event identified. For example, a Criticality Score of 1 is considered to be "broadly acceptable" and no mitigating action or control measure would be required. Conversely, a "Criticality Score" of 7 is "unacceptable" without significant design or engineering control to reduce the criticality to a more tolerable level. Table 7.4 is the explanation of the numbering system used to express the Criticality Score.

Table 7.4 Determination of Criticality Score

Criticality Score	Level of Tolerance	Explanation
1	**Broadly Acceptable**	No further action is necessary
2	**Broadly Acceptable**	No further action is necessary
3	**Tolerable with Monitoring**	Risk must be mitigated with engineering and/or administrative controls.
4	**Tolerable with Additional Controls**	Risk must be mitigated with design modification, engineering and/or administrative control to reduce to Criticality Score 3 or below before operations
5	**Tolerable with Modifications**	Risk must be mitigated with design modification, engineering and/or administrative control to reduce to Criticality Score 4 or below before construction
6	**Unacceptable**	Risk must be mitigated with design modification and/or engineering control to reduce to Criticality Score 5 or below before permitting
7	**Unacceptable**	Risk must be mitigated with design modification and/or engineering control to reduce to Criticality Score 5 or below before permitting

The difference between the Criticality Score for the Base Case without VOWTAP and the Criticality Score for VOWTAP was calculated. A "Red-Yellow Green" (R-Y-G) methodology was used to indicate the difference in conditions. The intent is to focus mitigation measures or "go-no go" decisions on the risk differences that are significant with a special focus on the following:

- High Risks- situations that exhibit high riskiness taking into consideration both the potential frequency and consequence of an event.
- High Probability Events- situations that show a propensity to occur frequently.
- High Consequence Events- situations that have a high level of severity.
- Low Confidence- situations in which the confidence in the evidence is low or non-existent.

There were no indications of a hazard event exhibiting a significant Risk Differential between the Base Case and the case with VOWTAP that would cause a "no go" decision. All the hazards identified showed modest risk differentials with some indicating the need for mitigating measures. Table 7.5 provides a summary of hazard events that indicated a positive differential from the Base Case (Criticality Score of 3 or Greater) and will require mitigation measures. The complete Hazard Log showing the totality of events and the differential between the Base Case and the case with VOWTAP is provided in Attachment I.

Table 7.5 Hazards Identified as Requiring Mitigation

Hazard Identification	Discussion
Collision	
Commercial vessel navigating near a WTG collides with another vessel navigating around a wind farm.	Presence of WTGs potentially increases risk of collision absent other risk control mechanisms
Naval vessel navigating near a WTG collides with another vessel navigating around a WTG.	Presence of WTGs potentially increases risk of collision absent other risk control mechanisms
Presence of fishing vessels causes collision between other navigating vessels.	Presence of WTGs may increase presence of fishing vessels that would not otherwise operate in the area.
Recreational vessel collides with another vessel navigating near, around or through a WTG.	Presence of WTGs potentially increases risk of collision absent other risk control mechanisms
Vessels engaged in constructing WTGs cause collision between other navigating vessels	Additional vessels operating in the area of the WTGs causes increase risk of collision between vessels. Lack of maneuverability of vessels engaged in construction increases risk of collision.
Vessels engaged in servicing a wind turbine collide with another navigating vessel navigating near, around or through a WTG.	Additional vessels operating in the area of the WTGs causes increase risk of collision between vessels
Presence of vessels engaged in servicing a wind turbine causes collision between other navigating vessels	Additional vessels operating in the area of the WTGs causes increase risk of collision between vessels. However, sufficient sea room exists for maneuvering.
Vessels towing WTG components collide with a navigating vessel (construction phase only)	Towing and service vessels during construction will be limited in maneuverability
Allision with Structure or Blade	
Commercial or Naval vessel under control makes contact with a wind turbine blade.	Air gap of blades less than air draft of most commercial vessels. Vessel encountering blades will sustain damage.
Recreational vessel under control makes contact with a wind turbine blade.	Air gap of blades greater than over 90% of recreational vessels. However, if a maxi-sized yacht encounters a blade, consequence will be major.
Fishing vessel under control makes contact with a wind turbine blade.	Air gap of blades is greater than air draft of most fishing vessels. However, if a large fishing vessel with a significant air draft encounters a blade, consequence will be major.
Recreational vessel not under command makes contact with a wind turbine blade.	Air gap of blades greater than over 90% of recreational vessels. However, if a maxi-sized yacht encounters a blade, consequence will be major.
Fishing vessel not under command makes contact with a wind turbine blade.	Air gap of blades is greater than air draft of most fishing vessels. However, if a large, drifting fishing vessel with a significant air draft encounters a blade, consequence will be minor.
Vessel servicing WTG not under command contact with a wind turbine blade.	Blades will be secured while WTG is undergoing servicing.
Foundering and Capsizing	
Subsea cable snags fishing equipment heeling vessel and causing it to founder or capsize.	The Inter-Array Cable will be buried to a target depth of 1 m and the Export Cable will be buried to a target depth of 2 m.
Subsea fallen over turbine snags fishing equipment heeling vessel and causing it to founder or capsize.	Little likelihood of collapse of WTG structure. However, special notification will be required to vessels if it occurs.
Subsea cable snags anchor heeling vessel and causing it to founder or capsize.	The Inter-Array Cable will be buried to a target depth of 1 m and the Export Cable will be buried to a target depth of 2 m.
Subsea fallen over turbine snags anchor heeling vessel and causing it to founder or capsize.	Little likelihood of collapse of WTG structure. However, special notification will be required to vessels if it occurs.
Electrocution	
Helicopter servicing the WTGs or Search and Rescue [SAR]) causes an electric discharge between the helicopter and the wind turbine.	Dominion will monitor WTGs from its O&M Facility during SAR or servicing. An Emergency Response Plan will address procedures for both emergency shut-down and communications with response personnel during such events.

Hazard Identification	Discussion
Search and Rescue	
Presence of the WTGs increases the risk of an accident (e.g. collision, contact, stranding or grounding) and also inhibits search and rescue.	An incident requiring Search and Rescue assets around WTGs would require securing turbine blades during incident response.
Emergency Response	
Presence of the WTGs increases need for emergency response from a vessel involved in a collision, grounding, stranding, foundering, or capsizing,	Risk would be from hull rupture in the event of a collision between 2 vessels.

Risk Control or Mitigation Measures

With the identification of those potential hazards requiring mitigation, the next step in the process was to identify risk control or mitigation measures that would reduce the risk (frequency and consequence) to a risk "as low as reasonably practicable" (ALARP). ALARP is measure of risk tolerance using the general criteria of "Broadly Acceptable" or that risks after applying a risk control or mitigation measure are not unduly high (UK HSE, 2001). ALARP assumes that the nature and level of risk has been properly assessed based on best available evidence and that the results have been used properly to determine risk control or mitigation measures.

Based on the nature of VOWTAP, it has been assumed that the risk control and risk mitigation measures fall into 4 broad categories: Design, Operations and Emergency Plans, Public Notification, Regulatory. Within each of those categories, risk control and mitigation measures were determined as follows:

- Design
  - Lighting and Marking
  - RACON
- Operations and Emergency Plans
  - Control Center
  - Servicing Vessel Procedures
  - Communications Plan
  - Emergency Response Plans
- Public Notification
  - Notices to Mariners
  - Chart Modification/Marking
  - Public Outreach to Marinas and Professional Associations
- Regulatory
  - Safety Zones
  - Buoys

After identifying the hazards that require risk control or mitigation measures, these 4 categories were applied to define the most appropriate measure given the risk profile of the hazard.

Table 7.6 is a summary of the risk control or risk mitigation measures applied to those identified hazards that posed the highest risk (see Table 7.5) to reduce the risk to a tolerable or ALARP level. The complete Hazard Log showing the totality of events and the risk mitigation or control measure to be applied is provided in Attachment I.

Table 7.6 Risk Mitigation Measures

Description	Mitigation Measure			
	Design	Operations and Emergency Plans	Public Notification	Regulatory
Collision				
Commercial vessel navigating near a WTG collides with another vessel navigating around a WTG.	Lighting and marking IAW approved plan.		Notice to Mariners regarding placement of WTGs and need to be vigilant around WTGs. Mark VOWTAP on charts.	
Naval vessel navigating near a WTG collides with another vessel navigating around a WTG.	Lighting and marking IAW approved plan.		Notice to Mariners regarding placement of WTGs and need to be vigilant around WTGs. Mark VOWTAP on charts.	
Presence of fishing vessels causes collision between other navigating vessels.			Notice to Mariners regarding placement of WTGs and outreach to fishing community regarding need to be vigilant around WTGs. Mark VOWTAP on charts.	
Recreational vessel collides with another vessel navigating near, around or through a WTG.	Lighting and marking IAW approved plan.		Notice to Mariners regarding placement of WTGs and outreach to recreational boating community regarding need to be vigilant around WTGs. Mark VOWTAP charts.	
Vessels engaged in constructing WTGa causes collision between other navigating vessels	Lighting and marking IAW approved plan.	Ensure procedures in place for construction vessels to maintain continual lookout. Operations orders to towing vessels regarding communications with other vessels during construction.	Notice to Mariners regarding placement of WTGs. Broadcast NtoM during construction phase. Mark VOWTAP on charts.	Establish temporary work areas during construction phase and mark with buoys. Illuminate construction vessels during construction phase.
Vessels engaged in servicing a wind turbine collide with another navigating vessel navigating near, around or through WTGs	Lighting and marking IAW Approved plan.	Operations orders to service vessels regarding communications with other vessels during operations and need to maintain lookout.	Notice to Mariners regarding placement of WTGs and need to be vigilant around WTGs. Mark VOWTAP on charts. Broadcast NtoM when servicing is planned.	

Description	Mitigation Measure			
	Design	Operations and Emergency Plans	Public Notification	Regulatory
Presence of vessels engaged in servicing a wind turbine causes collision between other navigating vessels	Lighting and marking IAW approved plan.	Operations orders to service vessels regarding communications with other vessels during operations and need to maintain lookout.	Notice to Mariners regarding placement of WTGs and need to be vigilant around WTGs. Mark VOWTAP on charts. Broadcast NtoM when servicing is planned.	
Vessels towing WTG components collide with a navigating vessel (construction phase only)		Ensure procedures in place for construction vessels to maintain continual lookout. Operations orders to towing vessels regarding communications with other vessels during construction.	Notice to Mariners during construction phase regarding towing components. Broadcast NtoM when towing operations are planned.	
Allision with Structure or Blade				
Commercial or Naval vessel under control makes contact with a WTG blade.	Lighting and marking IAW approved plan.	Monitor WTGs and implement emergency shutdown and communications procedures.	Notice to Mariners regarding placement of WTGs, blade air gap and need to be vigilant around WTGs. Mark VOWTAP on charts.	
Recreational vessel under control makes contact with a WTG blade.	Lighting and marking IAW approved plan.	Monitor WTGs and implement emergency shutdown and communications procedures.	Notice to Mariners regarding placement of WTGs and blade air gap. Outreach to marinas and race organizers regarding air gap. Mark VOWTAP on charts.	
Fishing vessel under control makes contact with a WTG blade.	Lighting and marking IAW approved plan.	Monitor WTGs and implement emergency shutdown and communications procedures.	Notice to Mariners regarding placement of WTGs and blade air gap. Outreach to fishing community regarding air gap. Mark VOWTAP on charts.	
Recreational vessel not under command makes contact with a WTG blade.		Monitor WTGs and implement emergency shutdown and communications procedures.		
Fishing vessel not under command makes contact with a WTG blade.		Monitor WTGs and implement emergency shutdown and communications procedures.		
Vessel servicing WTG not under command contact with a WTG blade.		Monitor WTGs and implement emergency shutdown and communications procedures.		

Foundering and Capsizing				
Fishing equipment snags on subsea cable, heeling vessel and causing it to founder or capsize.	Ensure Inter-Array and Export Cable are properly buried or covered.	Monitor WTGs and implement emergency shutdown procedures.	Notice to Mariners regarding placement of WTGs and cables. Mark cables on charts.	
Subsea fallen over turbine snags fishing equipment heeling vessel and causing it to founder or capsize.		Monitor WTGs and implement emergency shutdown and communications procedures.	Request emergency Notice to Mariners if WTG structure collapses.	
Subsea cable snags anchor heeling vessel and causing it to founder or capsize.	Ensure Inter-Array and Export Cable are properly buried or covered.	Monitor WTGs and implement emergency shutdown procedures.	Notice to Mariners regarding placement of WTGs and cables. Mark cables on charts.	
Subsea fallen over turbine snags anchor heeling vessel and causing it to founder or capsize.		Monitor WTGs and implement emergency shutdown and communications procedures.	Request emergency Notice to Mariners if WTG structure collapses.	
Electrocution				
Helicopter servicing the WTGs (or Search and Rescue [SAR)) causes an electric discharge between the helicopter and the wind turbine.	Secure turbine blades in the event of SAR operations in vicinity of WTGs.	Monitor WTGs during SAR ops in the vicinity of WTGs or during servicing. Implement emergency response and communications plan as required.	Ensure servicing helicopters are briefed on danger of electric discharge.	Ensure SAR helicopters are briefed on danger of electric discharge.
Search and Rescue				
Presence of the WTGa increases the risk of an accident (e.g., collision, contact, stranding or grounding) and also inhibits search and rescue.	Secure turbine blades in the event of SAR operations in vicinity of WTGs.	Monitor WTGs during SAR ops in the vicinity of WTGs. Implement emergency response and communications plan as required.		
Emergency Response				
Presence of the WTGs increases need for emergency response from a vessel involved in a collision, grounding, stranding, foundering, or capsizing.	Secure turbine blades in the event of SAR operations in vicinity of WTGs.	Monitor WTGs during emergency response in the vicinity of WTGs. Implement emergency response and communications plan as required.		

8 Conclusions

The findings of the VOWTAP NRA support the conclusion that there are minimal adverse impacts from the construction and operation of the VOWTAP project. The findings further support the conclusion that those impacts can be mitigated by control measures that reduce the already low potential for occurrence.

Standard marine navigational practices and application of the Rules of the Road will serve to minimize the risks identified by the construction and operation of VOWTAP. Additionally, applying the risk mitigation measures identified for each hazard (Table 7.6) will result in reducing the risk to a level that is broadly tolerable or "as low as reasonably practicable" (ALARP).

8.1. ALARP Determination

Assuming that Dominion will apply the mitigation or risk control measure identified for each hazard situation, or request that those mitigation or risk control measures beyond their authority (e.g., Broadcast Notices to Mariners) be implemented, VOWTAP achieves ALARP for the construction and operation of the WTGs, Inter-Array cable, and Export Cable for VOWTAP.

9 References

ACPARS Workgroup, "Atlantic Coast Port Access Route Study, Interim Report, Docket Number USCH-2011-0351," July 13, 2012. Available online at: http://www.uscg.mil/lantarea/acpars/docs/ACPARS_Interim_Report-Final_09AUG.pdf (accessed 13 September 2013).

Alstom Group. "HaliadeTM 150-6MW Offshore Wind Turbine Technical Overview," 2012.

———. "Loads Design Basis of Haliade 150, Technical Report INF-13572," 2013.

AAPA (American Association of Ports Authority). "U.S. Port Ranking by Cargo Tonnage 2011." Available online at: http://aapa.files.cms-plus.com/PDFs/2011%20U%20S%20%20PORT%20RANKINGS%20BY%20CARGO%20TONNAGE.pdf (accessed September 9, 2013).

Annapolis Yacht Club, Race Tracker, "Annapolis to Newport," available online at: http://http://www.race.annapolisyc.org/DesktopDefault.aspx?tabid=151 (accessed 20 September 2013).

Barco, S.G., G.G.Lockhart, K.M., Lagueux, A.R. Knowlton and W.M. Swingle. "Characterizing Large Vessel Traffic in the Chesapeake Bay Ocean Approach Using AIS and Radar. Final Report for NFWF Award #2006-0093-009 and VDGIF Contract #2007-10280. VAQF Scientific Report 2009-05." Virginia Beach, VA.

Benard, Emile ACPARS Project Manager, U. S. USCG Atlantic Area (LANT-54), Personal Communication, September 6, 2013.

Biehl, Florian and Peter Dalhoff. "Ship Collision, Risk Analysis – Emergency Systems – Collision Dynamics." Germanischer Lloyd WindEnergie GmbH and Hamburg University of Technology, Germany. 2010. Available online at: http://www.gl-group.com/pdf/ship_collision_dal.pdf (accessed 20 September 2013).

Bowditch, Nathaniel. American Practical Navigator, Volume I, 1977 ed., s.v. "Variation."

Carnival Cruise Lines, Cruise Ships, "Carnival Pride." Available online at: http://www.carnival.com/cruise-ships/carnival-pride.aspx (accessed August 31, 2013).

Casey, James. U.S. Navy, U.S. Fleet Forces Command, Compatibility & Readiness Sustainment, Personal Communication, 25 October 2013.

Center for Liquefied Natural Gas, LNG Safety/Security. Available online at: http://www.lngfacts.org/about-lng/safetysecurity (accessed 26 September 2013).

Conway, K.C. Counselors of Real Estate (CRE), Real Estate Issues, *"North American Port Analysis: Beyond Post-Panamax Basics to Logistics."* Available online at: http://www.cre.org/memberdata/pdfs/North_American_Port_Analysis.pdf (Accessed September 10, 2013).

Cruise Norfolk, "Cruise Schedule." Available online at: http://www.cruisenorfolk.org/schedule.php (accessed August 31, 2013).

DGIF (Commonwealth of Virginia, Department of Game and Inland Fisheries), "Virginia Boating Safety Education Compliance Requirement." Available online at: www.dgif.virginia.gov/boating/education/faq.asp (accessed 18 Sep. 2013).

———, "2012 Recreational Boating Incident Summary." Available online at: www.dgif.virginia.gov/boating/2012-accident-report.pdf (accessed 18 September 2013)

Dominion Resources Services, Inc., "Dominion Proposes to Construct Liquefaction Facilities for Exporting LNG." Available online at: http://www.dom.com/business/gas-transmission/cove-point (accessed September 20, 2013) (Dominion, 2013a)

———, "Metocean Criteria for Virginia Offshore Wind Technology Advancement Project (VOWTAP), Report Number C56462/7907/R3," August 28, 2013. (Dominion, 2013b)

Gill, Captain Trevor, U.S. Licensed Merchant Master Mariner, Personal Communication, November 22, 2013.

Grimison, Capt. Richard, Florida State Pilot, Personal Communication, 20 September 20, 2013.

IALA (International Association of Marine Aids to Navigation and Lighthouse Authorities), "IALA Recommendation O-139 On the Marking of Man-Made Offshore Structures," Edition I, December 2008. Available online at: http://www.iala-aism.org/publications/1507091219/marking-of-man-made-offshore-structures-139 (accessed September 25, 2013).

International Maritime Organization, "Guidelines for Formal Safety Assessment (FSA) for use in the IMO Rulemaking Process," Maritime Safety Committee (MSC) Circular 1023. Available online at: http://www.imo.org/OurWork/HumanElement/VisionPrinciplesGoals/Documents/1023-MEPC392.pdf (accessed 10 September 2013).

———, International Code for the Construction and Equipment of Ships Carrying Liquefied Gases in Bulk (IGC Code). Available for purchase at: https://shop.imo.org/b2c_shop/app/displayApp/(layout=7.0-7_1_66_61_69_6_9&uiarea=3&carea=0000000057&citem=00000000570000000154)/.do?rf=y.

Lindoe Offshore Renewables Center. Kentish Flats 1 Offshore Wind Farm, General Information. Available online at: http://www.lorc.dk/offshore-wind-farms-map/kentish-flats-1 (accessed October 7, 2013).

MacElrevey, Daniel H., *Shiphandling for the Mariner*, 4th ed. (Centerville, MD: Cornell Maritime Press, 2008).

Marico Marine (UK), "Investigation of Technical and Operational Effects on Marine Radar Close to Kentish Flats Offshore Wind Farm." Available online at: http://www.dft.gov.uk/mca/kentish_flats_radar.pdf (accessed September 11, 2013).

Marina Shores Marina, "Dry Storage." Available online at: http://www.marinashoresmarina.com (accessed 17 September 2013).

Marine Insight, "The Ultimate Guide to Ship Sizes." Available online at: http://www.marineinsight.com/marine/marine-news/headline/the-ultimate-guide-to-ship-sizes/ (accessed October 10, 2013).

Morgan, Colin, Bossanyi, Seifert, and Henry, "*Assessment of Safety Risks Arising from Wind Turbine Icing."* Paper presented at the Boreas IV Programme of Cold Weather Climate Conference, Hetta, Finland, 31 March – 02 April 1998. Available online at: http://www.windaction.org/posts/53-assessment-of-safety-risks-arising-from-wind-turbine-icing#.UnLJrZFR_34 (accessed on 15 August 2013).

Morrissey, Captain Sean. U.S. Licensed Merchant Master Mariner, Personal Communication, September 20, 2013.

Parker, Jeff. Port Captain Kirby Offshore Marine, Personal Communication, October 1, 2013.

Polmar, Norman. The Naval Institute Guide to Ships and Aircraft of the U.S. Fleet, Eighteenth Edition. U.S. Naval Institute, Annapolis, MD, 2005.

Royal Caribbean International (RCI), Our Fleet, "Vision Class." Available online at: http://www.royalcaribbean.com/findacruise/ships/home.do (accessed August 31, 2013).

Schaumloffel, Christian. Member, Board of Directors, Cruising Club of Virginia, Inc. Personal Communication, 20 September 2013.

Scripps Institution of Oceanography. Coastal Data Information Program (CDIP), Integrative Oceanography Division, *"NBDC Station 44099 Historic Data."* Available online at: http://cdip.ucsd.edu/?nav=historic&sub=data&stn=147&stream=p1 (accessed September 15, 2013).

Smith, Joseph W., "The Atlantic and Gulf Menhaden Purse Seine Fisheries: Origins, Harvesting Technologies, Biostatistical Monitoring, Recent Trends in Fisheries Statistics, and Forecasting," *Marine Fisheries Review* 53, no. 4 (1991), 28. Available online at: http://aquaticcommons.org/9912/1/mfr5344.pdf (accessed September 18, 2013).

South Atlantic Fishery Management Council (SAFMC), Ecosystem-Based Management, Volume III, Human and Institutional Environment. Available online at: http://safmc.net/Library/EcosystemLibrary (accessed September 18, 2013).

State of Maryland, Maryland at a Glance, Waterways. "Chesapeake & Delaware (C&D Canal)." Available online at: http://www.msa.maryland.gov/msa/mdmanual/01glance/html/canals.html (accessed August 31, 2013).

State of Maryland, Department of Transportation (MDOT), Port Administration, "Cruise Schedule," http://www.cruise.maryland.gov/content/cruise-schedule (Accessed August 31, 2013).

Thomson, Candy. "Port of Baltimore led nation in two cargo categories in 2012," The Baltimore Sun, February 27, 2013. Available online at: http://articles.baltimoresun.com/2013-02-27/business/bs-bz-port-cargo-0228-20130227_1_cargo-categories-public-terminals-general-cargo (accessed September 19, 2013).

United Kingdom Department of Trade and Energy, "Guidance on the Assessment of the Impact of Offshore Winds Farms: Methodology for Assessing the Impact of Wind Farms. Available online at: http://webarchive.nationalarchives.gov.uk/+/http://www.berr.gov.uk/files/file22888.pdf (accessed August 29, 2013).

United Kingdom Department of Transportation, Maritime and Coastguard Agency, "Results of the electromagnetic investigations and assessments of marine radar, communications and positioning systems undertaken at the North Hoyle wind farm by QinetiQ and the Maritime and Coastguard Agency." Available online at: http://www.dft.gov.uk/mca/effects_of_offshore_wind_farms_on_marine_systems-2.pdf (accessed September 10, 2013).

United Kingdom Health and Safety Executive, "Reducing Risks Protecting People, HSE's Decision-Making Process." Available online at: http://www.hse.gov.uk/risk/theory/r2p2.pdf (accessed 15 October 2013).

United Kingdom Maritime and Coastguard Agency, "Offshore Renewable Energy Installations (OREIs) - Guidance on UK Navigational Practice, Safety and Emergency Response Issues." Marine Guidance Note (MGN 371). Available online at http://www.dft.gov.uk/mca/mgn371.pdf (accessed 31 October 2013).

U.S. Army Corps of Engineers, Navigation Data Center (NDC), "Waterborne Commerce of the United States, Part 1 – Waterways and Harbors, Atlantic Coast, 2007-2011." Available online at: http://www.navigationdatacenter.us/wcsc/ (accessed 15 Aug. 2013).

U.S. Bureau of Ocean Energy Management, Regulation and Enforcement- U.S. Department of the Interior and the U.S. USCG- U.S. Department of Homeland Security, "Memorandum of Agreement- Offshore Renewable Energy Installations on the Outer Continental Shelf, BOEMRE/USCG MOA: OCS-06," July 27, 2011.

USCG (United States Coast Guard), "Aids to Navigation Manual, Administration (ATON Manual)," Commandant Instruction M16500.7A, March 2, 2005. Available online at: http://uscg.mil/directives/cim/16000-16999/CIM_16500_7A.pdf (accessed September 10, 2013).

———, "Assessment of the Potential Impacts to Navigation Safety of the Nantucket Sound Wind Farm as Proposed by Cape Wind LLC," Enclosure 1 to letter from RADM Brian Salerno, Assistant Commandant for Safety, Security, and Stewardship to Dr. Walter Cruickshank, Deputy Director, Minerals Management Service dated 14 November 2008. Available online at: http://energy.gov/sites/prod/files/EIS-0470-FEIS-Attachment_B-Agency_Correspondence.pdf (accessed September 10, 2013).

———, "Assessment of Potential Impacts to Marine Radar as it Relates to Marine Navigation from the Nantucket Sound Wind Farm as Proposed by Cape Wind LLC," Enclosure (1) to letter from RADM Brian Salerno, Assistant Commandant for Safety, Security, and Stewardship to Dr. Walter Cruickshank, Deputy Director, Minerals Management Service dated 13 January 2009. Available online at: http://www.boem.gov/Renewable-Energy-Program/Studies/USCGRADARfindingsandrecommendationsFINAL.aspx (accessed September 10, 2013).

———, Datasheet, "Aircraft, Boats, and Cutters." Available online at: http://www.uscg.mil/datasheet/#cutters (accessed 2 November 2013).

———. Light List, Volume 2: Atlantic Coast from Shrewsbury River, New Jersey to Little River, South Carolina (COMDTPUB P16502.2), 2013 edition. Available online at: http://www.navcen.uscg.gov/pdf/lightLists/LightList%20V2.pdf (accessed August 4, 2013).

———, Navigation and Vessel Inspection (NVIC) Circular No. 02-07, "Guidance on the USCG's Roles and Responsibilities for Offshore Renewable Energy Installations (OREI), Commandant Publication (COMDTPUB) P16700.4," March 9, 2007.

———, "Navigation Rules International – Inland (COLREGS), Commandant Instruction (COMDTINST) M16672.2D," Corrected thru Oct. 2013.

———, "Risk-based Decision Making Guidelines, Chapter 6," last modified 6/23/10. Available online at: http://www.uscg.mil/hq/cg5/cg5211/Volumes%201-2.asp (accessed October 11, 2013).

——— Sector Hampton Roads, "Port of Hampton Roads Maritime Severe Weather Contingency Plan." Available online at: https://homeport.uscg.mil/mycg/portal/ep/portDirectory.do?tabId=1&cotpId=26 (accessed October 7, 2013).

U.S. CFR (U.S. Code of Federal Regulations), Navigation and Navigable Waterways, Anchorage Regulations. "Hampton Roads, Virginia and Adjacent Waters (33CFR110.168)," 2013. Available online at: http://www.gpo.gov (accessed September 27, 2013).

———, Navigation and Navigable Waterways, Danger Zone and Restricted Area Regulations. "Atlantic Ocean south of entrance to Chesapeake Bay; firing range (33 CFR 334.390)," 2013, http://www.gpo.gov (accessed September 27, 2013).

———, Navigation and Navigable Waterways, Danger Zone and Restricted Area Regulations. "Atlantic Ocean south of entrance to Chesapeake Bay; firing range (33 CFR 334.390)," 2013, http://www.gpo.gov (accessed September 27, 2013).

——— Navigation and Navigable Waterways, Danger Zone and Restricted Area Regulations. "Atlantic Ocean South of Entrance to Chesapeake Bay off Dam Neck, Virginia; Naval Firing Range (33 CFR 334.380)," 2013, http://www.gpo.gov (accessed September 27, 2013).

———, Navigation and Navigable Waterways, Danger Zone and Restricted Area Regulations. "Chesapeake Bay Entrance, Naval Restricted Area (33 CFR 334.320)" 2013. Available online at: http://www.gpo.gov (accessed September 27, 2013).

———, Navigation and Navigable Waterways, Danger Zone and Restricted Area Regulations."Chesapeake Bay off Fort Monroe, VA; firing range danger zone (33

CFR 334.350),” 2013. Available online at: http://www.gpo.gov/fdsys/pkg/CFR-2012-title33-vol3/xml/CFR-2012-title33-vol3-sec334-350.xml (accessed September 30, 2013).

———, Navigation and Navigable Waterways, Danger Zone and Restricted Area Regulations. “Chesapeake Bay off Fort Monroe, VA; restricted area, U.S. Naval Base and Naval Surface Weapon Center (33 CFR 334.360),” 2013. Available online at: http://www.ecfr.gov/cgi-bin/text-idx?SID=34b8a1d559815b7b0512a8c46addc0ad&tpl=/ecfrbrowse/Title33/33cfr334_main_02.tpl (accessed September 30, 2013).

———, Navigation and Navigable Waterways, Danger Zone and Restricted Area Regulations. “Hampton Roads and Willoughby Bay, Norfolk Naval Base, Naval Restricted Area, Norfolk, VA (33 CFR 334.300),” 2013. Available online at: http://www.gpo.gov/fdsys/pkg/CFR-2012-title33-vol3/pdf/CFR-2012-title33-vol3-sec334-300.pdf (accessed September 30, 2013).

———, Navigation and Navigable Waterways, Navigation Safety Regulations. “Equipment: All Vessels (33 CFR 164.35),” 2013. Available online at: http://http://www.ecfr.gov/cgi-bin/text-idx?c=ecfr&tpl=/ecfrbrowse/Title33/33cfr164_main_02.tpl (Accessed September 12, 2013).

———, Navigation and Navigable Waterways, Navigation Safety Regulations, “Tests before entering or getting underway (Title 33 Part 164.25),” 2013. Available online at: http://www.ecfr.gov/cgi-bin/text-idx?c=ecfr&tpl=/ecfrbrowse/Title33/33cfr164_main_02.tpl (accessed September 20, 2013).

———, Navigation and Navigable Waters, Regulated Navigation Areas and Limited Access Areas. “Newport News Shipbuilding and Drydock Company Shipyard, James River, Newport News, VA (33CFR165.504),” 2013. Available online at: http://www.gpo.gov/fdsys/pkg/CFR-2012-title33-vol2/pdf/CFR-2012-title33-vol2-sec165-504.pdf (accessed September 30, 2013).

———, Navigation and Navigable Waterways, Regulated Navigation Areas and Limited Access Areas. “Chesapeake Bay Entrance and Hampton Roads, VA and Adjacent Waters – Regulated Navigation Area (33CFR165.501),” 2013. Available online at: http://www.gpo.gov (Accessed 27 Sep. 2013).

———, Wildlife and Fisheries, Endangered Marine and Anadromous Species. “Speed Restrictions to Protect North Atlantic Right Whales,” (50 CFR 224.105). Available online at: http://www.gpo.gov/fdsys/pkg/CFR-2011-title50-vol9/pdf/CFR-2011-title50-vol9-sec224-105.pdf (accessed September 2, 2013).

USDOC NOAA (U.S. Department of Commerce, National Oceanic and Atmospheric Administration). Nautical Chart 12207, "Cape Henry to Currituck Beach Light," 23rd ed., February 2013 (Corrected thru 28 Sep. 2013).

———. Nautical Chart 12221, "Chesapeake Bay Entrance," 81st ed., April 2011 (Corrected thru NTM 28 Sep. 2013).

———. Nautical Chart 12222, "Cape Charles to Norfolk Harbor," 54th ed., April 2013 (Corrected thru 28 Sep. 2013).

———. Nautical Chart 12245, "Hampton Roads," 68th ed., May 2013 (Corrected through October 5, 2013).

———. Nautical Chart 12253, "Norfolk Harbor and Elizabeth River," 47th ed., April 2012 (Corrected thru September 28, 2013).

———. United States Coast Pilot 3 Atlantic Coast: Sandy Hook to Cape Henry, "Appendix B, Meteorological Data," 46th ed., 2013. Available online at: http://www.nauticalcharts.noaa.gov/nsd/coastpilot/files/cp3/CPB3_E46_Appendix B_20130929_0002_WEB.pdf (accessed September 5, 2013).

———. "United States Coast Pilot 3 Atlantic Coast: Sandy Hook to Cape Henry, Ch. 9 Chesapeake Bay Entrance," 46th ed., 2013. Available online at: http://www.nauticalcharts.noaa.gov/nsd/coastpilot/files/cp3/CPB3_E46_C09_20130922_0003_WEB.pdf (accessed August 15, 2013).

———. National Hurricane Center. "Saffir-Simpson Hurricane Wind Scale." Available online at: http://www.nhc.noaa.gov/aboutsshws.php (accessed September 2, 2013).

———. National Hurricane Center. "Hurricane Basics." May 1999. Available online at: http://hurricanes.noaa.gov/pdf/hurricanebook.pdf (accessed October 2, 2013).

———. National Marine Protected Areas Center. "The Marine Protected Areas Inventory." Available online at: http://marineprotectedareas.noaa.gov/dataanalysis/mpainventory/ (accessed September 12, 2013).

———. Technical Memorandum NWS NHC 38, "The National Hurricane Center Risk Analysis Program (HURISK)," 1991. Available online at: http://www.nhc.noaa.gov/pdf/NWS-NHC-1987-38.pdf (accessed October 1, 2013).

———. U.S. National Weather Service. Significant Wave Height. Available online at: http://www.srh.noaa.gov/key/?n=marine_sigwave (accessed October 2, 2013).

———. Chesapeake Bay (CB) Office. "Menhaden." Available online at: http://chesapeakebay.noaa.gov/fish-facts/menhaden (accessed September 17, 2013).

U.S. Department of the Interior, Bureau of Ocean Energy and Management. "Commercial Wind Lease Issuance and Site Assessment Activities on the Atlantic Outer Continental Shelf Offshore New Jersey, Delaware, Maryland, and Virginia Final Environmental Assessment, OCS EIS/EA BOEM 2012-003." Available online at: http://www.boem.gov/uploadedFiles/BOEM/Renewable_Energy_Program/Smart_from_the_Start/Mid-Atlantic_Final_EA_012012.pdf (accessed 17 September 2013).

U.S. Department of the Interior, Minerals Management Service, "Environmental Impact Statement for the Proposed Cape Wind Energy Project, Nantucket Sound, Offshore Massachusetts," Appendix M, Final Environmental Impact Statement. Available online at: http://energy.gov/sites/prod/files/DOE-EIS-0470-Cape_Wind_FEIS_2012.pdf (accessed 7 October 2013).

U.S. Department of Transportation, Maritime Administration. "Vessel Calls, Snapshot, 2011," March 2013. Available online at: http://www.marad.dot.gov/documents/Vessel_Calls_at_US_Ports_Snapshot.pdf (accessed September 16, 2013).

U.S. Department of Transportation, Maritime Administration. "Vessel Calls at U.S. Ports (2005-2011)." Available online at: http://www.marad.dot.gov/library_landing_page/data_and_statistics/Data_and_Statistics.htm (accessed August 17, 2013).

U.S. Department of Transportation, Research and Innovative Technology Administration. "Recreational Boat Registrations by Propulsion Type: 2010." Available online at: http://www.rita.dot.gov/bts/sites/rita.dot.gov.bts/files/publications/state_transportation_statistics/state_transportation_statistics_2011/index.html (accessed 31 August 2013).

U.S. Navy, "U.S. Navy List of Ships." Available online at: http://www.navy.mil/navydata/ships/lists/shipalpha.asp (accessed 17 Sep. 2013).

U.S. Navy Fleet Forces Command. "USFF Port Access Route Study (PARS) Input – (USCG-2011-0351)." 3 February 2012.

———, Letter to the Office of Protected Resources, National Marine Fisheries Service, "Request for Letter of Authorization for the Incidental Harassment of Marine Mammals Resulting from Navy Training Operations Conducted Within the VACAPES Range Complex," April 2008.

United States Sailing Association. About US Sailing.org, Available online at http://about.ussailing.org/About_Us.htm, (accessed 15 October 2013).

———, Masthead Heights of IRC rates sailboats from 2010 to 2013, provided by U.S. Sailing October via email 15, 2013.

Virginia Beach Fishing, "Charter Trip Info." Available online at: http://www.virginiafishing.com/chartertripinfo.htm (accessed September 17, 2013).

Virginia Maritime Association, Port of Virginia Annual 2013, "Port Facilities. Available online at: http://c.ymcdn.com/sites/www.vamaritime.com/resource/resmgr/pa2013/pa2013_port_facilities.pdf (accessed October 16, 2013).

Virginia Maritimer, "Record Setting Vessel calls Virginia," September – October 2011. Available online at: http://viewer.zmags.com/publication/946ae6ea#/946ae6ea/1 (accessed September 5, 2013).

Virginia Port Authority, "2040 Master Plan, Executive Summary," May 2013. Available online at: http://www.portofvirginia.com/media/11163/vpamasterplan052113.pdf (accessed September 3, 2013).

———. "Port of Virginia Key Performance Indicators." Available online at: http://www.portofvirginia.com/development/port-stats.aspx (accessed 24 September 2013).

Wahl, David and Giguere, Philippe. General Electric Energy, Wind Application Engineering (GER-4262), *"Ice Shedding and Ice Throw – Risk and Mitigation,"* April 2006. Available online at: http://site.ge-energy.com/prod_serv/products/tech_docs/en/downloads/ger4262.pdf (accessed 15 August 2013.

Walters, John, Chief, Waterways Management, USCG Fifth District (dpw), Personal Communication, 29 October 2013.

Woods Hole Oceanographic Institution (WHOI). Perigean Spring Tides. Available online at: http://www.whoi.edu/page/live.do?pid=52235&tid=282&cid=88649 (accessed September 15, 2013).

VOWTAP Navigational Risk Assessment

Attachments

C&H Global Security, LLC

Attachment I Hazard Log Change Analysis

Reference		Hazard Identification (Accident Sequence)	Without Wind Farm			With Wind Farm				
			Frequency	Consequence	Criticality	Frequency	Consequence	Criticality	Difference	Risk Reduction Action Required
1		**Collision**								
	a	Commercial vessel navigating near a WTG collides with another vessel navigating around a WTG.	N/A	N/A	N/A	Extremely Remote	Major	3	3	Yes
	b	Naval vessel navigating near a WTG collides with another vessel navigating around a WTG.	N/A	N/A	N/A	Extremely Remote	Major	3	3	Yes
	c	Increased size of vessels operating in the area increases the risk of collision	Extremely Remote	Major	3	Extremely Remote	Major	3	0	No
	d	Presence of fishing vessels causes collision between other navigating vessels.	N/A	N/A	3	Extremely Remote	Major	3	3	Yes

Reference		Hazard Identification (Accident Sequence)	Without Wind Farm			With Wind Farm				Risk Reduction Action Required
			Frequency	Consequence	Criticality	Frequency	Consequence	Criticality	Difference	
	e	Recreational vessel collides with another vessel navigating near or around a WTG.	N/A	N/A	N/A	Extremely Remote	Major	3	3	Yes
	f	Presence of recreational vessels causes collision between other navigating vessels.	Extremely Remote	Major	3	Extremely Remote	Major	3	0	No
	g	Navigating vessel navigating near or around a WTG collides with anchored vessel.	Extremely Remote	Major	3	Extremely Remote	Major	3	0	No
	h	Presence of anchored vessels causes collision between other navigating vessels.	Extremely Remote	Major	3	Extremely Remote	Major	3	0	No

Reference		Hazard Identification (Accident Sequence)	Without Wind Farm			With Wind Farm				
			Frequency	Consequence	Criticality	Frequency	Consequence	Criticality	Difference	Risk Reduction Action Required
	i	Vessels engaged in servicing a wind turbine collide with each other.	N/A	N/A	N/A	Extremely Remote	Minor	2	2	No
	j	Vessels engaged in constructing WTGs causes collision between other navigating vessels	N/A	N/A	N/A	Extremely Remote	Major	3	3	Yes
	k	Vessels engaged in servicing a wind turbine collide with another navigating vessel navigating near or around a WTG.	N/A	N/A	N/A	Extremely Remote	Major	3	3	Yes
	l	Presence of vessels engaged in servicing a wind turbine causes collision between other navigating vessels	N/A	N/A	N/A	Extremely Remote	Major	3	3	Yes

Reference		Hazard Identification (Accident Sequence)	Without Wind Farm			With Wind Farm				
			Frequency	Consequence	Criticality	Frequency	Consequence	Criticality	Difference	Risk Reduction Action Required
	m	Vessels towing WTG components collide with a navigating vessel (construction phase only)	N/A	N/A	N/A	Extremely Remote	Major	3	3	Yes
2		**Allision with Structure or Blade**								
	a	Commercial or Naval vessel under control makes contact with WTG structure.	N/A	N/A	N/A	Extremely Remote	Minor	2	2	No
	b	Recreational vessel under control makes contact with WTG structure.	N/A	N/A	N/A	Extremely Remote	Minor	2	2	No
	c	Fishing vessel under control makes contact with WTG structure.	N/A	N/A	N/A	Extremely Remote	Minor	2	2	No

Reference		Hazard Identification (Accident Sequence)	Without Wind Farm			With Wind Farm				Risk Reduction Action Required
			Frequency	Consequence	Criticality	Frequency	Consequence	Criticality	Difference	
	d	Vessel servicing a WTG makes contact with structure.	N/A	N/A	N/A	Extremely Remote	Minor	2	2	No
	e	Commercial vessel not under command makes contact with structure.	N/A	N/A	N/A	Extremely Remote	Insignificant	1	1	No
	f	Recreational vessel not under command makes contact with structure.	N/A	N/A	N/A	Extremely Remote	Insignificant	1	1	No
	g	Fishing vessel not under command makes contact with structure.	N/A	N/A	N/A	Extremely Remote	Insignificant	1	1	No
	h	Commercial or Naval vessel under control makes contact with a wind turbine blade.	N/A	N/A	N/A	Extremely Remote	Major	3	3	Yes

Reference		Hazard Identification (Accident Sequence)	Without Wind Farm			With Wind Farm				Risk Reduction Action Required
			Frequency	Consequence	Criticality	Frequency	Consequence	Criticality	Difference	
	i	Recreational vessel under control makes contact with a wind turbine blade.	N/A	N/A	N/A	Extremely Remote	Major	3	3	Yes
	j	Fishing vessel under control makes contact with a wind turbine blade.	N/A	N/A	N/A	Extremely Remote	Major	3	3	Yes
	k	Vessel servicing WTG makes contact with a wind turbine blade.	N/A	N/A	N/A	Extremely Remote	Minor	2	2	No
	l	Commercial vessel not under command makes contact with a wind turbine blade.	N/A	N/A	N/A	Extremely Remote	Minor	2	2	No

Reference		Hazard Identification (Accident Sequence)	Without Wind Farm			With Wind Farm				
			Frequency	Consequence	Criticality	Frequency	Consequence	Criticality	Difference	Risk Reduction Action Required
	m	Recreational vessel not under command makes contact with a wind turbine blade.	N/A	N/A	N/A	Extremely Remote	Major	3	3	Yes
	n	Fishing vessel not under command makes contact with a wind turbine blade.	N/A	N/A	N/A	Extremely Remote	Major	3	3	Yes
	o	Vessel servicing WTG not under command contact with a wind turbine blade.	N/A	N/A	N/A	Extremely Remote	Major	3	3	Yes
3		**Grounding and Stranding**								
	a	Vessel under control grounds or becomes stranded on a foundation structure.	N/A	N/A	N/A	N/A	N/A	N/A	N/A	No

Reference		Hazard Identification (Accident Sequence)	Without Wind Farm			With Wind Farm				Risk Reduction Action Required
			Frequency	Consequence	Criticality	Frequency	Consequence	Criticality	Difference	
	b	Vessel servicing a wind turbine grounds on a foundation structure.	N/A	N/A	N/A	N/A	N/A	N/A	N/A	No
	c	Vessel under control grounds or becomes stranded on a collapsed wind turbine.	N/A	N/A	N/A	Extremely Remote	Minor	2	2	No
	d	Vessel not under command grounds or becomes stranded on a foundation structure	N/A	N/A	N/A	Extremely Remote	Insignificant	1	1	No
	e	Due to restricted maneuvering a vessel navigating near a WTG grounds.	N/A	N/A	N/A	N/A	N/A	N/A	N/A	No

			Without Wind Farm			With Wind Farm				
Reference		Hazard Identification (Accident Sequence)	Frequency	Consequence	Criticality	Frequency	Consequence	Criticality	Difference	Risk Reduction Action Required
	f	Due to restricted maneuvering a vessel navigating around WTGs grounds.	N/A	N/A	N/A	N/A	N/A	N/A	N/A	No
4		**Foundering and Capsizing**								
	a	Subsea obstacle snags fishing equipment heeling vessel and causing it to founder or capsize.	N/A	N/A	N/A	Extremely Remote	Major	3	0	No
	b	Subsea cable snags fishing equipment heeling vessel and causing it to founder or capsize.	N/A	N/A	N/A	Extremely Remote	Major	3	3	Yes

Reference		Hazard Identification (Accident Sequence)	Without Wind Farm			With Wind Farm				
			Frequency	Consequence	Criticality	Frequency	Consequence	Criticality	Difference	Risk Reduction Action Required
	c	Subsea fallen over turbine snags fishing equipment heeling vessel and causing it to founder or capsize.	N/A	N/A	N/A	Extremely Remote	Major	3	3	Yes
	d	Subsea obstacle snags anchor heeling vessel and causing it to founder or capsize.	N/A	N/A	N/A	Extremely Remote	Major	3	0	No
	e	Subsea cable snags anchor heeling vessel and causing it to founder or capsize.	N/A	N/A	N/A	Extremely Remote	Major	3	3	Yes

Reference		Hazard Identification (Accident Sequence)	Without Wind Farm			With Wind Farm				
			Frequency	Consequence	Criticality	Frequency	Consequence	Criticality	Difference	Risk Reduction Action Required
	f	Subsea fallen over turbine snags anchor heeling vessel and causing it to founder or capsize.	N/A	N/A	N/A	Extremely Remote	Major	3	3	Yes
5		**Fire**								
	a	*No reasonably foreseeable accident has been identified where WTGs can cause a fire on a vessel (or vice versa) other than a consequence of a collision, contact, or grounding.*	N/A	N/A	N/A	N/A	N/A	N/A	N/A	No

Reference		Hazard Identification (Accident Sequence)	Without Wind Farm			With Wind Farm				
			Frequency	Consequence	Criticality	Frequency	Consequence	Criticality	Difference	Risk Reduction Action Required
		Explosion								
	a	*No reasonably foreseeable accident has been identified where WTGs can cause an explosion on a vessel other than as a consequence of a collision, contact, or grounding.*	N/A	N/A	N/A	N/A	N/A	N/A	N/A	No
7		**Loss of Hull Integrity**								
	a	*No reasonably foreseeable accident has been identified where WTGs can cause a loss of hull integrity on a vessel (or vice versa) other than as a consequence of a collision, contact, or grounding.*	N/A	N/A	N/A	N/A	N/A	N/A	N/A	No

Reference		Hazard Identification (Accident Sequence)	Without Wind Farm			With Wind Farm				
			Frequency	Consequence	Criticality	Frequency	Consequence	Criticality	Difference	Risk Reduction Action Required
8		**Flooding**								
	a	*No reasonably foreseeable accident has been identified where WTGs can cause flooding on a vessel (or vice versa) other than as a consequence of a collision, contact, or grounding.*	N/A	N/A	N/A	N/A	N/A	N/A	N/A	No
9		**Machinery Related Accidents**								
	a	Wind turbine machinery accident requires emergency rescue of servicing staff.	N/A	N/A	N/A	Extremely Remote	Insignificant	1	1	No
	b	Blade failure results in the blade (or parts of the blade) hitting a navigating vessel or a person on the vessel.	N/A	N/A	N/A	Extremely Remote	Minor	2	2	No

Reference		Hazard Identification (Accident Sequence)	Without Wind Farm			With Wind Farm				Risk Reduction Action Required
			Frequency	Consequence	Criticality	Frequency	Consequence	Criticality	Difference	
	c	Ice on blade comes off hitting a navigating vessel or a person on the vessel.	N/A	N/A	N/A	Extremely Remote	Minor	2	2	No
	d	Blade failure results in a floating blade entering the seaways.	N/A	N/A	N/A	Extremely Remote	Minor	2	2	No
	e	Turbine control failure results in a failure of turbine navigation aids (e.g. lighting) resulting in non detection of WTGs and increase risk of powered contact.	N/A	N/A	N/A	Extremely Remote	Minor	2	2	No

Reference		Hazard Identification (Accident Sequence)	Without Wind Farm			With Wind Farm				
			Frequency	Consequence	Criticality	Frequency	Consequence	Criticality	Difference	Risk Reduction Action Required
10		**Payload Related Accidents**								
	a	*No reasonably foreseeable accident has been identified where WTGs can cause a machinery related accident on a vessel other than as a consequence of a collision, contact, or grounding.*	N/A	N/A	N/A	N/A	N/A	N/A	N/A	No

Reference		Hazard Identification (Accident Sequence)	Without Wind Farm			With Wind Farm				
			Frequency	Consequence	Criticality	Frequency	Consequence	Criticality	Difference	Risk Reduction Action Required
11		**Hazardous Substance Accident**								
	a	*No reasonably foreseeable accident has been identified where WTGs can cause a machinery related accident on a vessel other than as a consequence of a collision, contact, or grounding.*	N/A	N/A	N/A	N/A	N/A	N/A	N/A	No

Reference		Hazard Identification (Accident Sequence)	Without Wind Farm			With Wind Farm				Risk Reduction Action Required
			Frequency	Consequence	Criticality	Frequency	Consequence	Criticality	Difference	
12		**Accidents to Personnel**								
	a	Accidents caused by Transfer to/from servicing vessel (or helicopter) to a wind turbine.	N/A	N/A	N/A	Extremely Remote	Minor	2	2	No
	b	Accidents caused by Transfer between servicing vessels.	N/A	N/A	N/A	Extremely Remote	Minor	2	2	No
	e	Person in water from servicing vessel or wind turbine (unaided, in floatation device, life raft or life boat) requires rescue.	N/A	N/A	N/A	Extremely Remote	Minor	2	2	No
	f	Bad weather (or other event) preventing egress from a wind turbine resulting in marooning and requiring rescue.	N/A	N/A	N/A	Extremely Remote	Minor	2	2	No

Reference		Hazard Identification (Accident Sequence)	Without Wind Farm			With Wind Farm				
			Frequency	Consequence	Criticality	Frequency	Consequence	Criticality	Difference	Risk Reduction Action Required
13		**Accidents to the General Public**								
	a	*No reasonably foreseeable accident has been identified where WTGs can cause an accident to the general public other than as a consequence of a collision, contact, or grounding.*	N/A	N/A	N/A	N/A	N/A	N/A	N/A	
14		**Electrocution**								
	a	Vessel hits turbine structure sufficiently hard to breach cable insulation.	N/A	N/A	N/A	Extremely Remote	Minor	2	2	No
	b	Anchoring vessel drags up export cable and shorts cable to the anchor.	N/A	N/A	N/A	Extremely Remote	Minor	2	2	No

Reference		Hazard Identification (Accident Sequence)	Without Wind Farm			With Wind Farm				
			Frequency	Consequence	Criticality	Frequency	Consequence	Criticality	Difference	Risk Reduction Action Required
	c	Servicing (or SAR) helicopter operations cause an electric discharge between the helicopter and the wind turbine.	N/A	N/A	N/A	Extremely Remote	Major	3	3	Yes
15		**High Severity Outcomes**								
	a	A major incident with a large Cruise Vessel or Passenger Ferry leading to a major search and rescue event.	Extremely Remote	Catastrophic	4	Extremely Remote	Catastrophic	4	0	No
	b	Emergency response operations following a major incident with a large oil tanker leading to large scale pollution.	Extremely Remote	Major	3	Extremely Remote	Major	3	0	No

Reference		Hazard Identification (Accident Sequence)	Without Wind Farm			With Wind Farm				
			Frequency	Consequence	Criticality	Frequency	Consequence	Criticality	Difference	Risk Reduction Action Required
	c	Emergency response operations following a major incident with a Liquefied Gas Tanker close to a major center of population resulting in a large scale explosion risk.	Extremely Remote	Majo r	3	Extremely Remote	Major	3	0	No
16		**Search and Rescue**								
	a	Presence of WTGs increases the risk of an accident (e.g. collision, contact, stranding or grounding) and also inhibits search and rescue.	N/A	N/A	N/A	Extremely Remote	Major	3	3	Yes
	b	Person or vessel requiring search and rescue drifts into the area of WTGs and the presence of WTGs inhibits search and rescue.	N/A	N/A	N/A	Extremely Remote	Minor	2	2	No

Reference		Hazard Identification (Accident Sequence)	Without Wind Farm			With Wind Farm				
			Frequency	Consequence	Criticality	Frequency	Consequence	Criticality	Difference	Risk Reduction Action Required
	c	Activities around WTGs both generate an increased need for search and rescue and the presence of WTGs inhibits search and rescue.	N/A	N/A	N/A	Extremely Remote	Minor	2	2	No
	d	Activities around WTGs generate an increased need for search and rescue in the area.	N/A	N/A	N/A	N/A	N/A	N/A	N/A	No
	e	Person or vessel requiring search and rescue drifts through the area of WTGs and the presence of WTGs inhibits search and rescue during the transit stage.	N/A	N/A	N/A	Extremely Remote	Minor	2	2	No
	f	Search and Rescue operations following a major incident with a large Cruise Vessel or Passenger Ferry	Extremely Remote	Major	3	Extremely Remote	Major	3	0	No

Reference		Hazard Identification (Accident Sequence)	Without Wind Farm			With Wind Farm				
			Frequency	Consequence	Criticality	Frequency	Consequence	Criticality	Difference	Risk Reduction Action Required
17		**Emergency Response**								
	a	Presence of WTGs increases need for emergency response from foundering, capsizing, collision, or grounding.	N/A	N/A	N/A	Extremely Remote	Major	3	3	Yes
	b	Presence of WTGs inhibits ability to provide emergency response.	N/A	N/A	N/A	Extremely Remote	Minor	2	2	No
	c	Pollution outside area of WTGs drifts into area of WTGs and presence of WTGs inhibits clean up.	N/A	N/A	N/A	Extremely Remote	Minor	2	2	No
	d	Activities in area of WTG both generate an increased risk of pollution and the presence of WTGs inhibits clean up.	N/A	N/A	N/A	Extremely Remote	Minor	2	2	No

Reference		Hazard Identification (Accident Sequence)	Without Wind Farm			With Wind Farm				
			Frequency	Consequence	Criticality	Frequency	Consequence	Criticality	Difference	Risk Reduction Action Required
	e	Routing of vessels (or post collision, contact or grounding incident) results in hazardous cargoes closer to areas of population.	Extremely Remote	Minor	2	Extremely Remote	Minor	2	0	No
	f	Emergency response operations following a major incident with a large oil tanker	Extremely Remote	Major	3	Extremely Remote	Major	3	0	No
	g	Emergency response operations following a major incident with a Liquefied Gas Tanker close to a major center of population.	Extremely Remote	Major	3	Extremely Remote	Major	3	0	No

Attachment II Hazard Log Mitigation Measures

Reference		Hazard Identification (Accident Sequence)	Actions to Reduce Risk Discussion	Quality of Evidence	Mitigation Measure Design	Operations and Emergency Plans	Public Notification	Regulatory
1		**Collision**						
	a	Commercial vessel navigating near a WTG collides with another vessel navigating around a WTG.	Presence of WTGs potentially increases risk of collision absent other risk control mechanisms	Qualitative Analysis	Lighting and marking IAW approved plan. Install RACON.	N/A	Notice to Mariners regarding placement of WTGs and need to be vigilant around WTGs. Mark VOWTAP on charts.	N/A
	b	Naval vessel navigating near a WTG collides with another vessel navigating around a WTG.	Presence of WTGs potentially increases risk of collision absent other risk control mechanisms	Qualitative Analysis	Lighting and marking IAW approved plan. Install RACON.	N/A	Notice to Mariners regarding placement of WTGs and need to be vigilant around WTGs. Mark VOWTAP on charts.	N/A
	c	Increased size of vessels operating in the area increases the risk of collision	Increased size of vessels will not increase risk of collision	Qualitative Analysis	N/A	N/A	N/A	N/A
	d	Presence of fishing vessels causes collision between other navigating vessels.	WTGs may increase presence of fishing vessels due to increased fish populations around WTGs.	Expert Opinion: Verbal	N/A	N/A	Notice to Mariners regarding placement of WTGs and outreach to fishing community regarding need to be vigilant around WTGs. Mark VOWTAP on charts.	N/A
	e	Recreational vessel collides with another vessel navigating near or around a WTG.	Presence of WTGs potentially increases risk of collision absent other risk control mechanisms	Expert Opinion: Verbal	Lighting and marking IAW approved plan. Install RACON.	N/A	Notice to Mariners regarding placement of WTGs and outreach to recreational boating community regarding need to be vigilant around WTGs. Mark VOWTAP charts.	N/A
	f	Presence of recreational vessels causes collision between other navigating vessels.	WTGs should not increase presence of recreational vessels to increase risk of collision between navigating vessels. Sufficient sea room exists for maneuvering.	Expert Opinion: Verbal	N/A	N/A	N/A	N/A
	g	Navigating vessel navigating near or around a WTG collides with anchored vessel.	Presence of WTGs should not change risk of collision with anchored vessel. Sufficient sea room exists for maneuvering.	Expert Opinion: Verbal	N/A	N/A	N/A	N/A
	h	Presence of anchored vessels causes collision between other navigating vessels.	Presence of WTGs should not change risk of collision with anchored vessel. Sufficient sea room exists for maneuvering.	Expert Opinion: Verbal	N/A	N/A	N/A	N/A
	i	Vessels engaged in servicing a wind turbine collide with each other.	Additional vessels operating in the area of the WTGs causes increase risk of collision between vessels. Lack of maneuverability of vessels engaged in construction increases risk of collision.	Expert Opinion: Verbal	N/A	N/A	N/A	N/A

			Actions to Reduce Risk		Mitigation Measure			
Reference		Hazard Identification (Accident Sequence)	Discussion	Quality of Evidence	Design	Operations and Emergency Plans	Public Notification	Regulatory
	j	Vessels engaged in constructing WTGs causes collision between other navigating vessels	Additional vessels operating in the area of the WTGs causes increase risk of collision between vessels. Lack of maneuverability of vessels engaged in construction increases risk of collision.	Expert Opinion: Verbal	Lighting and marking IAW approved plan. Install RACON.	Ensure procedures in place for construction vessels to maintain continual lookout. Operations orders to towing vessels regarding communications with other vessels during construction.	Notice to Mariners regarding placement of WTGs. Broadcast NtoM during construction phase. Mark VOWTAP on charts.	Establish safety zone during construction phase and mark with buoys. Illuminate construction vessels during construction phase.
	k	Vessels engaged in servicing a wind turbine collide with another navigating vessel navigating near or around a WTG.	Additional vessels operating in the area of the WTGs causes increase risk of collision between vessels	Qualitative Analysis	Lighting and marking IAW approved plan. Install RACON.	Operations orders to service vessels regarding communications with other vessels during operations and need to maintain lookout.	Notice to Mariners regarding placement of WTGs and need to be vigilant around WTGs. Mark VOWTAP on charts. Broadcast NtoM when servicing is planned.	N/A
	l	Presence of vessels engaged in servicing a wind turbine causes collision between other navigating vessels	Additional vessels operating in the area of the WTGs causes increase risk of collision between vessels. However, sufficient sea room exists for maneuvering.	Expert Opinion: Verbal	Lighting and marking IAW approved plan. Install RACON.	Operations orders to service vessels regarding communications with other vessels during operations and need to maintain lookout.	Notice to Mariners regarding placement of WTGs and need to be vigilant around WTGs. Mark VOWTAP on charts. Broadcast NtoM when servicing is planned.	N/A
	m	Vessels towing WTG components collide with a navigating vessel (construction phase only)	Towing and service vessels during construction will be limited in maneuverability	Expert Opinion: Verbal	N/A	Ensure procedures in place for construction vessels to maintain continual lookout. Operations orders to towing vessels regarding communications with other vessels during construction.	Notice to Mariners during construction phase regarding towing components. Broadcast NtoM when towing operations are planned.	N/A
2		**Allision with Structure or Blade**						
	a	Commercial or Naval vessel under control makes contact with WTG structure.	Presence of WTGs potentially increases risk of allision absent other risk control mechanisms	Qualitative Analysis	N/A	N/A	N/A	N/A
	b	Recreational vessel under control makes contact with WTG structure.	Presence of WTGs potentially increases risk of allision absent other risk control mechanisms	Qualitative Analysis	N/A	N/A	N/A	N/A
	c	Fishing vessel under control makes contact with WTG structure.	Presence of WTGs potentially increases risk of allision absent other risk control mechanisms	Qualitative Analysis	N/A	N/A	N/A	N/A
	d	Vessel servicing a WTG makes contact with structure.	Historical data of servicing vessels striking a WTG	Historical Record	N/A	N/A	N/A	N/A
	e	Commercial vessel not under command makes contact with structure.	Presence of WTGs potentially increases risk of allision absent other risk control mechanisms. Drifted allision will have limited consequences.	Qualitative Analysis	N/A	N/A	N/A	N/A

Reference		Hazard Identification (Accident Sequence)	Actions to Reduce Risk: Discussion	Quality of Evidence	Mitigation Measure: Design	Mitigation Measure: Operations and Emergency Plans	Mitigation Measure: Public Notification	Mitigation Measure: Regulatory
	f	Recreational vessel not under command makes contact with structure.	Presence of WTGs potentially increases risk of allision absent other risk control mechanisms. Drifted allision will have limited consequences.	Qualitative Analysis	N/A	N/A	N/A	N/A
	g	Fishing vessel not under command makes contact with structure.	Presence of WTGs potentially increases risk of allision absent other risk control mechanisms. Drifted allision will have limited consequences.	Qualitative Analysis	N/A	N/A	N/A	N/A
	h	Commercial or Naval vessel under control makes contact with a wind turbine blade.	Air gap of blades greater than air draft of most commercial vessels. Vessel encountering blades will sustain damage.	Qualitative Analysis	Lighting and marking IAW approved plan. Install RACON.	Monitor WTGs and implement emergency shutdown and communications procedures.	Notice to Mariners regarding placement of WTGs, blade air gap and need to be vigilant around WTGs. Mark VOWTAP on charts.	N/A
	i	Recreational vessel under control makes contact with a wind turbine blade.	Air gap of blades greater than over 90% of recreational vessels. However, if a maxi-sized yacht encounters a blade, consequence will be major.	Qualitative Analysis	Lighting and marking IAW approved plan. Install RACON.	Monitor WTGs and implement emergency shutdown and communications procedures.	Notice to Mariners regarding placement of WTGs and blade air gap. Outreach to marinas and race organizers regarding air gap. Mark VOWTAP on charts.	N/A
	j	Fishing vessel under control makes contact with a wind turbine blade.	Air gap of blades is less than air draft of most fishing vessels. However, if a large fishing vessel with a significant air draft encounters a blade, consequence will be major.	Expert Opinion: Verbal	Lighting and marking IAW approved plan. Install RACON.	Monitor WTGs and implement emergency shutdown and communications procedures.	Notice to Mariners regarding placement of WTGs and blade air gap. Outreach to fishing community regarding air gap. Mark VOWTAP on charts.	N/A
	k	Vessel servicing WTG makes contact with a wind turbine blade.	Blades will be secured while WTG is undergoing servicing.	Qualitative Analysis	N/A	N/A	N/A	N/A
	l	Commercial vessel not under command makes contact with a wind turbine blade.	Drifting vessel encountering blades will incur minor damage.	Qualitative Analysis	N/A	N/A	N/A	N/A
	m	Recreational vessel not under command makes contact with a wind turbine blade.	Air gap of blades greater than over 90% of recreational vessels. However, if a maxi-sized yacht encounters a blade, consequence will be major.	Qualitative Analysis	N/A	Monitor WTGs and implement emergency shutdown and communications procedures.	N/A	N/A
	n	Fishing vessel not under command makes contact with a wind turbine blade.	Air gap of blades is greater than air draft of most fishing vessels. However, if a large, drifting fishing vessel with a significant air draft encounters a blade, consequence will be minor.	Qualitative Analysis	N/A	Monitor WTGs and implement emergency shutdown and communications procedures.	N/A	N/A
	o	Vessel servicing WTG not under command contact with a wind turbine blade.	Blades will be secured while WTG is undergoing servicing.	Qualitative Analysis	N/A	Monitor WTGs and implement emergency shutdown and communications procedures.	N/A	N/A
3		**Grounding and Stranding**						
	a	Vessel under control grounds or becomes stranded on a foundation structure.	No shoal water in area of WTG structures	Qualitative Analysis	N/A	N/A	N/A	N/A

Reference		Hazard Identification (Accident Sequence)	Actions to Reduce Risk Discussion	Quality of Evidence	Mitigation Measure Design	Operations and Emergency Plans	Public Notification	Regulatory
	b	Vessel servicing a wind turbine grounds on a foundation structure.	No shoal water in area of WTG structures	Qualitative Analysis	N/A	N/A	N/A	N/A
	c	Vessel under control grounds or becomes stranded on a collapsed wind turbine.	Little likelihood of collapse of WTG structure. However, special notification will be required to vessels if it occurs.	Expert Opinion: Verbal	N/A	N/A	N/A	N/A
	d	Vessel not under command grounds or becomes stranded on a foundation structure	Little likelihood of collapse of WTG structure. However, special notification will be required to vessels if it occurs.	Qualitative Analysis	N/A	N/A	N/A	N/A
	e	Due to restricted maneuvering a vessel navigating near a WTG grounds.	No shoal water in area of WTG structures. No restricted navigation caused by the presence of VOWTAP	Qualitative Analysis	N/A	N/A	N/A	N/A
	f	Due to restricted maneuvering a vessel navigating around WTGs grounds.	No shoal water in area of WTG structures. No restricted navigation caused by the presence of VOWTAP	Qualitative Analysis	N/A	N/A	N/A	N/A
4		**Foundering and Capsizing**						
	a	Subsea obstacle snags fishing equipment heeling vessel and causing it to founder or capsize.	Design of WTG structure makes snagging extremely remote, however, damage would be substantial if it occurs and vessel founders or capsizes.	Expert Opinion: Verbal	N/A	N/A	N/A	N/A
	b	Subsea cable snags fishing equipment heeling vessel and causing it to founder or capsize.	Export cable will be buried to a depth of 2 m. Inter-Array Cable will be buried to a depth of 1 m.	Expert Opinion: Verbal	Ensure inter array and transmission cable are properly buried or covered.	Monitor WTGs and implement emergency shutdown procedures.	Notice to Mariners regarding placement of WTGs and cables. Mark cable crossings on charts.	N/A
	c	Subsea fallen over turbine snags fishing equipment heeling vessel and causing it to founder or capsize.	Little likelihood of collapse of WTG structure. However, special notification will be required to vessels if it occurs.	Expert Opinion: Verbal	N/A	Monitor WTGs and implement emergency shutdown and communications procedures.	Request emergency NtoM if WTG structure collapses.	N/A
	d	Subsea obstacle snags anchor heeling vessel and causing it to founder or capsize.	Design of WTG structure makes snagging extremely remote, however, damage would be substantial if it occurs and vessel founders or capsizes.	Expert Opinion: Verbal	N/A	N/A	N/A	N/A
	e	Subsea cable snags anchor heeling vessel and causing it to founder or capsize.	Export cable will be buried to a depth of 2 m. Inter-Array Cable will be buried to a depth of 1 m.	Expert Opinion: Verbal	Ensure inter array and transmission cable are properly buried or covered.	Monitor WTGs and implement emergency shutdown procedures.	Notice to Mariners regarding placement of WTGs and cables. Mark cable crossings on charts.	N/A
	f	Subsea fallen over turbine snags anchor heeling vessel and causing it to founder or capsize.	Little likelihood of collapse of WTG structure. However, special notification will be required to vessels if it occurs.	Expert Opinion: Verbal	N/A	Monitor WTGs and implement emergency shutdown and communications procedures.	Request emergency NtoM if WTG structure collapses.	N/A
5		**Fire**						
	a	*No reasonably foreseeable accident has been identified where WTGs can cause a fire on a vessel (or vice versa) other than a consequence of a collision, contact, or grounding.*	N/A	N/A	N/A	N/A	N/A	N/A
6		**Explosion**						

Reference		Hazard Identification (Accident Sequence)	Actions to Reduce Risk Discussion	Quality of Evidence	Mitigation Measure Design	Operations and Emergency Plans	Public Notification	Regulatory
	a	*No reasonably foreseeable accident has been identified where WTGs can cause an explosion on a vessel other than as a consequence of a collision, contact, or grounding.*	N/A	N/A	N/A	N/A	N/A	N/A
7		**Loss of Hull Integrity**						
	a	*No reasonably foreseeable accident has been identified where WTGs can cause a loss of hull integrity on a vessel (or vice versa) other than as a consequence of a collision, contact, or grounding.*	N/A	N/A	N/A	N/A	N/A	N/A
8		**Flooding**						
	a	*No reasonably foreseeable accident has been identified where WTGs can cause flooding on a vessel (or vice versa) other than as a consequence of a collision, contact, or grounding.*	N/A	N/A	N/A	N/A	N/A	N/A
9		**Machinery Related Accidents**						
	a	Wind turbine machinery accident requires emergency rescue of servicing staff.	Servicing vessels would provide emergency services unless the incident were beyond their capability.	Expert Opinion: Verbal	N/A	N/A	N/A	N/A
	b	Blade failure results in the blade (or parts of the blade) hitting a navigating vessel or a person on the vessel.	N/A	Expert Opinion: Verbal	N/A	N/A	N/A	N/A
	c	Ice on blade comes off hitting a navigating vessel or a person on the vessel.	Ice buildup and shedding is not an issue in this project area.	Expert Opinion: Written	N/A	N/A	N/A	N/A
	d	Blade failure results in a floating blade entering the seaways.	Blade failure is highly remote.	Expert Opinion: Verbal	N/A	N/A	N/A	N/A
	e	Turbine control failure results in a failure of turbine navigation aids (e.g. lighting) resulting in non detection of WTGs and increase risk of powered contact.	Radar would continue to detect WTGs. Monitoring WTGs would alert personnel to failure. Emergency procedures would be undertaken to replace lighting and repair WTG.	Expert Opinion: Verbal	N/A	N/A	N/A	N/A
10		**Payload Related Accidents**						
	a	*No reasonably foreseeable accident has been identified where WTGs can cause a machinery related accident on a vessel other than as a consequence of a collision, contact, or grounding.*	N/A	N/A	N/A	N/A	N/A	N/A

			Actions to Reduce Risk		Mitigation Measure			
Reference		Hazard Identification (Accident Sequence)	Discussion	Quality of Evidence	Design	Operations and Emergency Plans	Public Notification	Regulatory
11		**Hazardous Substance Accident**						
	a	*No reasonably foreseeable accident has been identified where WTGs can cause a machinery related accident on a vessel other than as a consequence of a collision, contact, or grounding.*	N/A	N/A	N/A	N/A	N/A	N/A
12		**Accidents to Personnel**						
	a	Accidents caused by Transfer to/from servicing vessel (or helicopter) to a wind turbine.	"Man overboard" procedures on board vessel would be invoked.	Expert Opinion: Verbal	N/A	N/A	N/A	N/A
	b	Accidents caused by Transfer between servicing vessels.	"Man overboard" procedures on board vessel would be invoked.	Expert Opinion: Verbal	N/A	N/A	N/A	N/A
	e	Person in water from servicing vessel or wind turbine (unaided, in floatation device, life raft or life boat) requires rescue.	"Man overboard" procedures on board vessel would be invoked.	Expert Opinion: Verbal	N/A	N/A	N/A	N/A
	f	Bad weather (or other event) preventing egress from a wind turbine resulting in marooning and requiring rescue.	Servicing will occur in favorable weather only.	Expert Opinion: Verbal	N/A	N/A	N/A	N/A
13		**Accidents to the General Public**						
	a	*No reasonably foreseeable accident has been identified where WTGs can cause an accident to the general public other than as a consequence of a collision, contact, or grounding.*	N/A	N/A	N/A	N/A	N/A	N/A
14		**Electrocution**						
	a	Vessel hits turbine structure sufficiently hard to pierce J tube and breach cable insulation.	Emergency shutdown procedures would be invoked.	Expert Opinion: Verbal	N/A	N/A	N/A	N/A
	b	Anchoring vessel drags up export cable and shorts cable to the anchor.	Emergency shutdown procedures would be invoked.	Expert Opinion: Verbal	N/A	N/A	N/A	N/A
	c	Servicing (or SAR) helicopter operations cause an electric discharge between the helicopter and the wind turbine.	Operations center will monitor WTGs during SAR or servicing. Emergency procedures will need to address communications with response personnel and emergency shutdown procedures.	Expert Opinion: Verbal	Secure turbine blades in the event of SAR operations in vicinity of WTGs.	Monitor WTGs during SAR ops in the vicinity of WTGs or during servicing. Implement emergency response and communications plan as required.	Ensure servicing helicopters are briefed on danger of electric discharge.	Ensure SAR helicopters are briefed on danger of electric discharge.

Reference		Hazard Identification (Accident Sequence)	Actions to Reduce Risk Discussion	Quality of Evidence	Mitigation Measure Design	Operations and Emergency Plans	Public Notification	Regulatory
15		**High Severity Outcomes**						
	a	A major incident with a large Cruise Vessel or Passenger Ferry leading to a major search and rescue event.	N/A	N/A	N/A	N/A	N/A	N/A
	b	Emergency response operations following a major incident with a large oil tanker leading to large scale pollution.	N/A	N/A	N/A	N/A	N/A	N/A
	c	Emergency response operations following a major incident with a Liquefied Gas Tanker close to a major center of population resulting in a large scale explosion risk.	N/A	N/A	N/A	N/A	N/A	N/A
16		**Search and Rescue**						
	a	Presence of WTGs increases the risk of an accident (e.g. collision, contact, stranding or grounding) and also inhibits search and rescue.	An incident requiring Search and Rescue assets around WTGs would require securing turbine blades during incident response.	N/A	Secure turbine blades in the event of SAR operations in vicinity of WTGs.	Monitor WTGs during SAR ops in the vicinity of WTGs. Implement emergency response and communications plan as required.	N/A	N/A
	b	Person or vessel requiring search and rescue drifts into the area of WTGs and the presence of WTGs inhibits search and rescue.	An incident requiring Search and Rescue assets around WTGs would require securing turbine blades during incident response.	N/A	N/A	N/A	N/A	N/A
	c	Activities around WTGs both generate an increased need for search and rescue and the presence of WTGs inhibits search and rescue.	SAR may be required if servicing vessel or personnel were damaged or injured. Securing turbine blades would be required during incident response.	N/A	N/A	N/A	N/A	N/A
	d	Activities around WTGs generate an increased need for search and rescue in the area.	Activities in VOWTAP would not generate SAR in surrounding area.	N/A	N/A	N/A	N/A	N/A
	e	Person or vessel requiring search and rescue drifts through the area of WTGs and the presence of WTGs inhibits search and rescue during the transit stage.	An incident requiring Search and Rescue assets around WTGs would require securing turbine blades during incident response.	N/A	N/A	N/A	N/A	N/A

Reference		Hazard Identification (Accident Sequence)	Actions to Reduce Risk Discussion	Quality of Evidence	Mitigation Measure Design	Operations and Emergency Plans	Public Notification	Regulatory
	f	Search and Rescue operations following a major incident with a large Cruise Vessel or Passenger Ferry	An incident requiring Search and Rescue assets around WTGs would require securing turbine blades during incident response.	N/A	N/A	N/A	N/A	N/A
17		**Emergency Response**						
	a	Presence of WTGs increases need for emergency response from foundering, capsizing, collision, or grounding.	Risk would be from hull rupture in the event of a collision between 2 vessels.	N/A	Secure turbine blades in the event of SAR operations in vicinity of WTGs.	Monitor WTGs during emergency response in the vicinity of WTGs. Implement emergency response and communications plan as required.	N/A	N/A
	b	Presence of WTGs inhibits ability to provide emergency response.	VOWTAP would not inhibit oil pollution response.	N/A	N/A	N/A	N/A	N/A
	c	Pollution outside area of WTGs drifts into area of WTGs and presence of WTGs inhibits clean up.	VOWTAP would not inhibit oil pollution response.	N/A	N/A	N/A	N/A	N/A
	d	Activities in area of WTG both generate an increased risk of pollution and the presence of WTGs inhibits clean up.	VOWTAP would not generate need for nor inhibit oil pollution response.	N/A	N/A	N/A	N/A	N/A
	e	Routing of vessels (or post collision, contact or grounding incident) results in hazardous cargoes closer to areas of population.	Vessel routing would not be affected by VOWTAP	N/A	N/A	N/A	N/A	N/A
	f	Emergency response operations following a major incident with a large oil tanker	Emergency response would not be inhibited by VOWTAP	N/A	N/A	N/A	N/A	N/A
	g	Emergency response operations following a major incident with a Liquefied Gas Tanker close to a major center of population.	Vessel routing would not be affected by VOWTAP	N/A	N/A	N/A	N/A	N/A

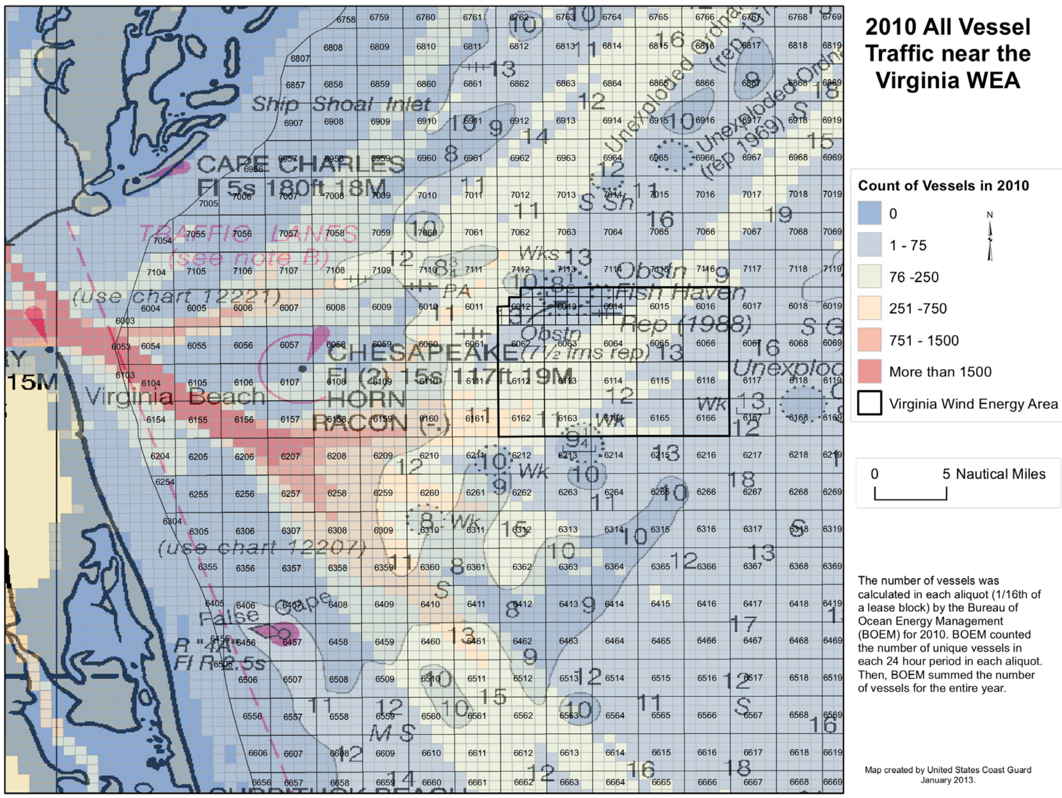
Attachment III Vessel and Traffic Data

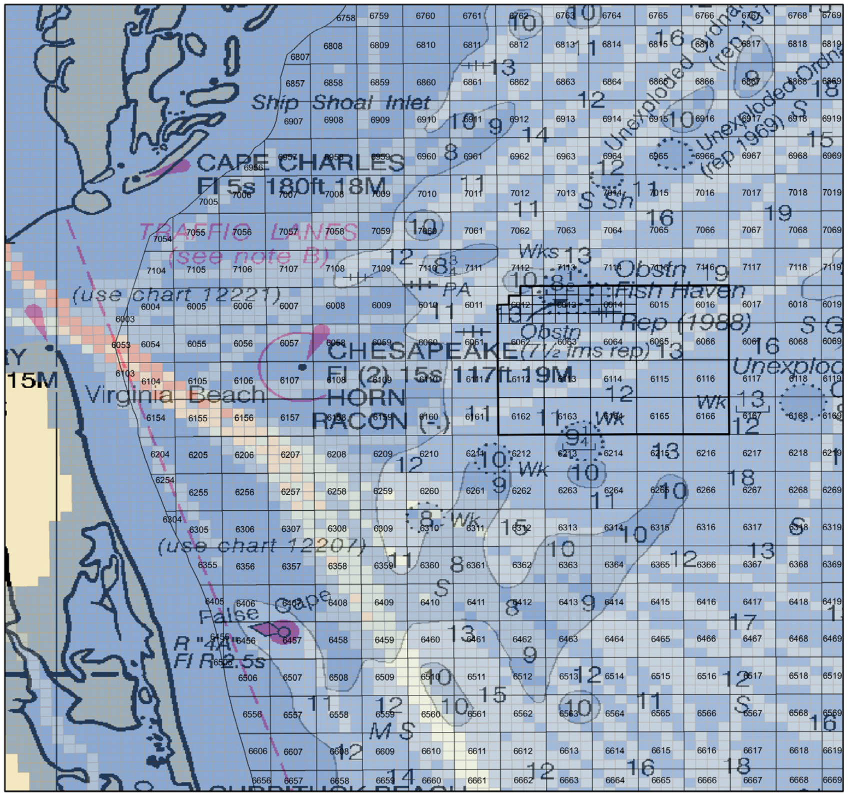
The following data were provided by the Virginia Maritime Authority. They represent vessel arrivals and departures by vessel type, both foreign and American, per month for the years 2005 through 2012.

Total Ship Calls for Virginia Ports by Container Ships (Does not include layberth)

	2005	2006	2007	2008	2009	2010	2011	2012
Jan	176	196	187	168	146	141	159	164
Feb	156	179	181	155	129	153	133	149
Mar	179	197	214	162	137	163	153	173
Apr	177	184	188	168	133	149	157	161
May	189	195	204	161	148	167	146	158
Jun	185	193	185	152	159	165	147	160
Jul	181	187	197	158	149	151	156	173
Aug	185	207	190	168	155	164	151	172
Sep	191	191	183	164	157	142	153	166
Oct	192	207	190	165	152	165	165	158
Nov	192	199	189	160	142	139	152	172
Dec	175	203	181	152	151	142	156	160
Total	**2,178**	**2,338**	**2,289**	**1,933**	**1,758**	**1,841**	**1,828**	**1,966**
% Change	3.5%	7.3%	-2.1%	-15.6%	-9.1%	4.7%	-0.7%	7.5%

The following Figures were provided by the ACPARS Project Manager of the Coast Guard's Atlantic Area (LANT-54). They depict vessel counts from AIS data for 2010 in the vicinity of the Virginia Wind Energy Area (WEA) for all vessels and then by vessel type.





2010 Passenger Vessel Traffic near the Virginia WEA

Count of Vessels in 2010

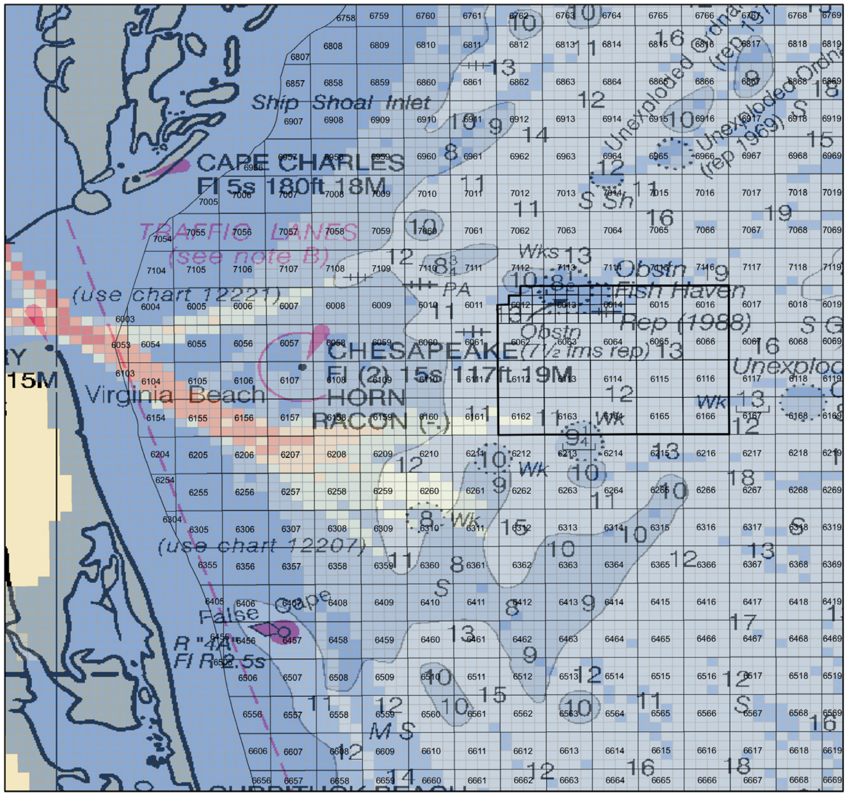
Passenger

- 0
- 1 - 20
- 21 - 50
- 51 - 100
- 101 - 250
- More than 250
- Virginia Wind Energy Area

0 5 Nautical Miles

The number of vessels was calculated in each aliquot (1/16th of a lease block) by the Bureau of Ocean Energy Management (BOEM) for 2010. BOEM counted the number of unique vessels in each 24 hour period in each aliquot. Then, BOEM summed the number of vessels for the entire year.

Map created by United States Coast Guard January 2013.



2010 Tanker Vessel Traffic near the Virginia WEA

Count of Vessels in 2010

Tankers

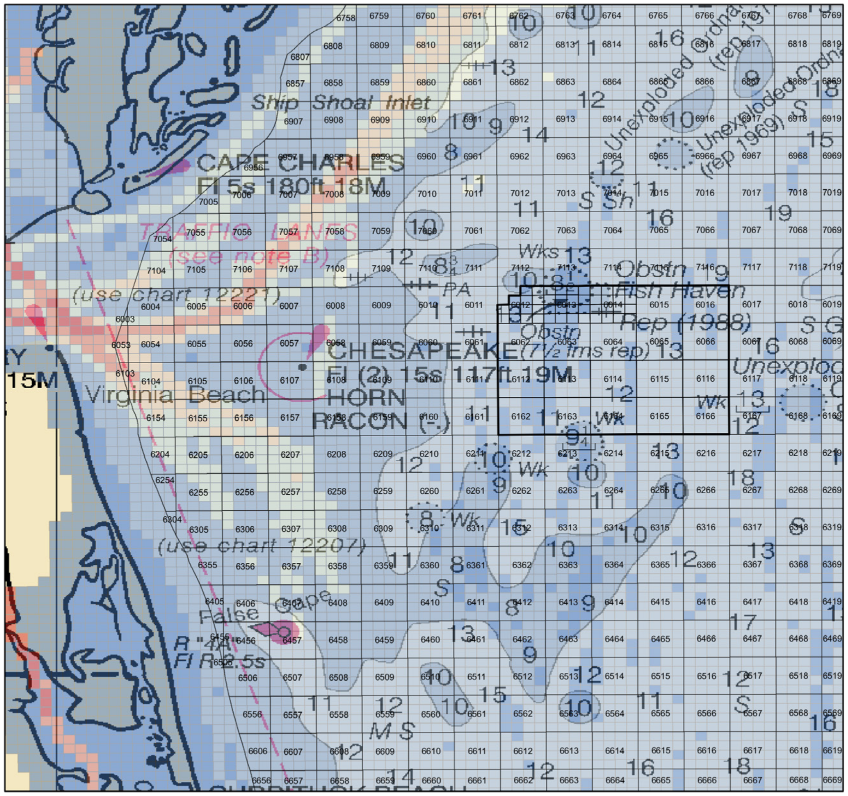
- 0
- 1 - 20
- 21 - 50
- 51 - 100
- 101 - 250
- More than 250
- Virginia Wind Energy Area

N

0 5 Nautical Miles

The number of vessels was calculated in each aliquot (1/16th of a lease block) by the Bureau of Ocean Energy Management (BOEM) for 2010. BOEM counted the number of unique vessels in each 24 hour period in each aliquot. Then, BOEM summed the number of vessels for the entire year.

Map created by United States Coast Guard January 2013.



2010 Tugs and Towing Vessel Traffic near the Virginia WEA

Count of Vessels in 2010

TugsTowing

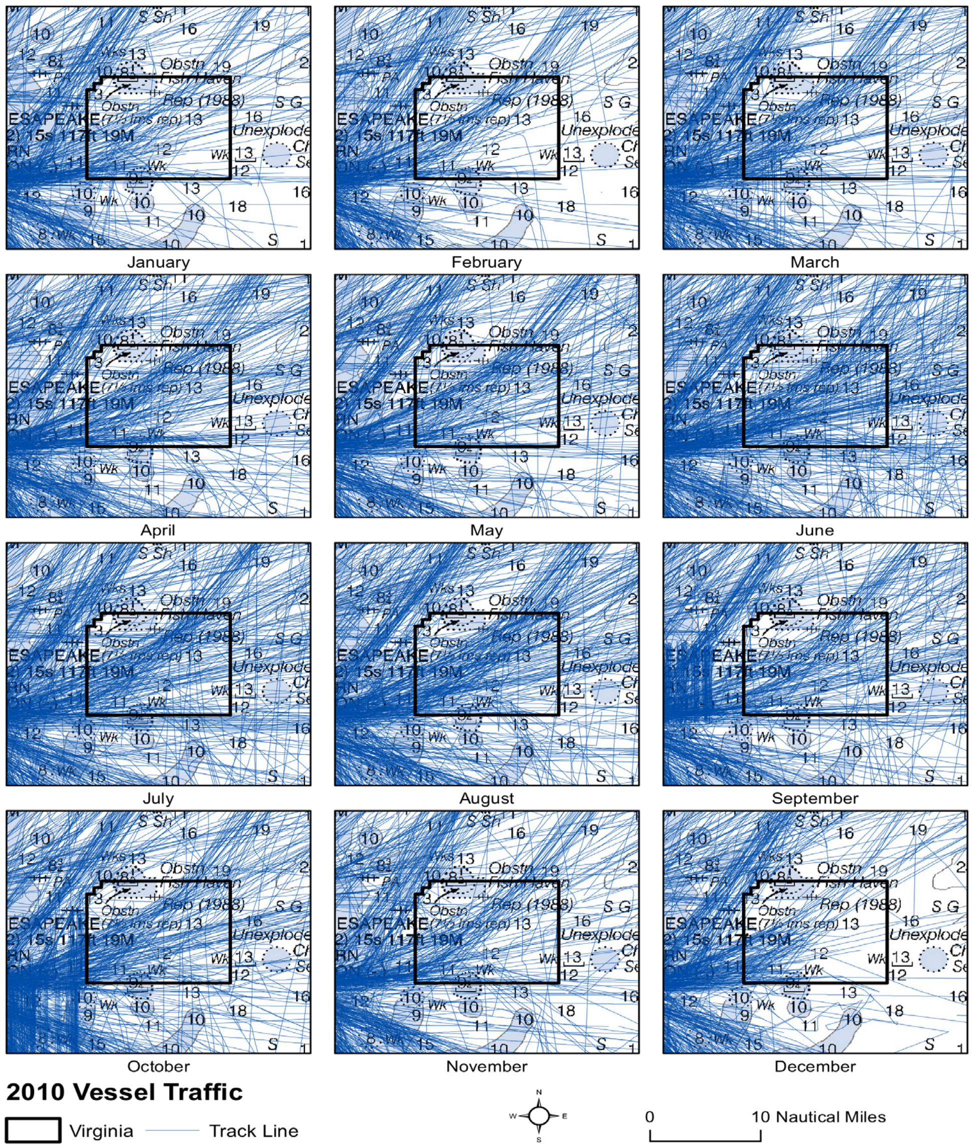
N

- 0
- 1 - 20
- 21 - 50
- 51 - 100
- 101 - 250
- More than 250
- Virginia Wind Energy Area

0 5 Nautical Miles

The number of vessels was calculated in each aliquot (1/16th of a lease block) by the Bureau of Ocean Energy Management (BOEM) for 2010. BOEM counted the number of unique vessels in each 24 hour period in each aliquot. Then, BOEM summed the number of vessels for the entire year.

Map created by United States Coast Guard January 2013.



Vessel traffic in 2010 by month through the Virginia WEA.

AIS DATA Legends

AIS Data Sheets Descriptions

Sheet	Description
1. Vessel Type Classifications for AIS Data	List of vessel type codes and their descriptions.
2. Quantity of Traffic by Wind Energy Area 2009	Number of unique Maritime Mobile Service Identification (MMSI) numbers and Transits for each WEA
3. Count of Unique Maritime Mobile Service Identification Number by Vessel Type, Virginia WEA 2009	Charts for number of unique MMSIs by vessel type in each WEA.
4. Unique Transits of Virginia WEA by Vessel Class, 2009	Charts for number of unique transits by vessel type in each WEA. This includes all vessel types.

1. Vessel Type Classifications for AIS Data

Code	Ship & Cargo Classification	Code	Ship & Cargo Classification
0	Unknown	60	Passenger, all ships of this type
20	Wing in ground (WIG), all ships of this type	61	Passenger, Hazardous category A
21	Wing in ground (WIG), Hazardous category A	62	Passenger, Hazardous category B
22	Wing in ground (WIG), Hazardous category B	63	Passenger, Hazardous category C
23	Wing in ground (WIG), Hazardous category C	64	Passenger, Hazardous category D
24	Wing in ground (WIG), Hazardous category D	65	Passenger, Reserved for future use
25	Wing in ground (WIG), Reserved for future use	66	Passenger, Reserved for future use
26	Wing in ground (WIG), Reserved for future use	67	Passenger, Reserved for future use
27	Wing in ground (WIG), Reserved for future use	68	Passenger, Reserved for future use
28	Wing in ground (WIG), Reserved for future use	69	Passenger, No additional information
29	Wing in ground (WIG), Reserved for future use	70	Cargo, all ships of this type
30	Fishing	71	Cargo, Hazardous category A
31	Towing	72	Cargo, Hazardous category B
32	Towing: length exceeds 200m or breadth exceeds 25m	73	Cargo, Hazardous category C
33	Dredging or underwater ops	74	Cargo, Hazardous category D
34	Diving ops	75	Cargo, Reserved for future use
35	Military Ops	76	Cargo, Reserved for future use
36	Sailing	77	Cargo, Reserved for future use
37	Pleasure Craft	78	Cargo, Reserved for future use
38	Reserved	79	Cargo, No additional information
39	Reserved	80	Tanker, all ships of this type
40	High speed craft (HSC), all ships of this type	81	Tanker, Hazardous category A
41	High speed craft (HSC), Hazardous category A	82	Tanker, Hazardous category B
42	High speed craft (HSC), Hazardous category B	83	Tanker, Hazardous category C
43	High speed craft (HSC), Hazardous category C	84	Tanker, Hazardous category D
44	High speed craft (HSC), Hazardous category D	85	Tanker, Reserved for future use

45	High speed craft (HSC), Reserved for future use	86	Tanker, Reserved for future use
46	High speed craft (HSC), Reserved for future use	87	Tanker, Reserved for future use
47	High speed craft (HSC), Reserved for future use	88	Tanker, Reserved for future use
48	High speed craft (HSC), Reserved for future use	89	Tanker, No additional information
49	High speed craft (HSC), No additional information	90	Other Type, all ships of this type
50	Pilot Vessel	91	Other Type, Hazardous category A
51	Search and Rescue vessel	92	Other Type, Hazardous category B
52	Tug	93	Other Type, Hazardous category C
53	Port Tender	94	Other Type, Hazardous category D
54	Anti-pollution equipment	95	Other Type, Reserved for future use
55	Law Enforcement	96	Other Type, Reserved for future use
56	Spare - Local Vessel	97	Other Type, Reserved for future use
57	Spare - Local Vessel	98	Other Type, Reserved for future use
58	Medical Transport	99	Other Type, No additional information
59	Ship according to RR Resolution No. 18	103	Unknown

2. Quantity of Traffic by Wind Energy Area 2009

2009

Wind Energy Area	**Unique MMSI**	**Unique Transits**	**Area (square Meters)**	**Area (square Nautical Miles)**	**Unique MMSI per square NM**	**Unique Transits per square NM**
Maine Statoil	44	133	57600000.0000	16.79	2.62	7.92
Massachusetts WEA	373	1206	3,006,720,022.15	876.62	0.43	1.38
Massachusetts Cape Wind	170	1087	119,079,480.82	34.72	4.90	31.31
Rhode Island (Area of Mutual Interest with MA)	347	2609	666,720,000.00	194.38	1.79	13.42
New York	220	677	328,320,010.49	95.72	2.30	7.07
New Jersey	1257	10774	1,434,238,661.85	418.16	3.01	25.77
New Jersey - Fishermens Energy LLC	119	533	8,639,999.97	2.52	47.24	211.59
New Jersey - GSOE-I LLC	160	360	23,040,000.00	6.72	23.82	53.59
Delaware WEA	459	1508	390,238,019.22	113.78	4.03	13.25
Maryland WEA	823	2841	322,560,000.00	94.04	8.75	30.21
Virginia WEA	892	2263	456,479,995.48	133.09	6.70	17.00
North Carolina - Kitty Hawk WEA	1553	7180	3,552,481,058.64	1,035.74	1.50	6.93
North Carolina - Wilmington East WEA	1008	4119	1,120,029,032.83	326.55	3.09	12.61
North Carolina - Wilmington West WEA	87	218	268,049,258.26	78.15	1.11	2.79

3. Count of Unique Maritime Mobile Service Identification Number by Vessel Type, Virginia WEA 2009

VesselType		Cnt_VeselType
0	Unknown	31
1	Unknown	1
6	Unknown	1
7	Unknown	1
9	Unknown	1
10	Unknown	1
16	Unknown	1
30	Fishing	1
31	Towing	13
32	Towing: length exceeds 200m or breadth exceeds 25m	11
33	Dredging or underwater ops	1
35	Military Ops	11
36	Sailing	2
37	Pleasure Craft	11
40	High speed craft (HSC), all ships of this type	1
50	Pilot Vessel	1
51	Search and Rescue vessel	1
52	Tug	13
55	Law Enforcement	2

60	Passenger, all ships of this type	2
69	Passenger, No additional information	2
70	Cargo, all ships of this type	507
71	Cargo, Hazardous category A	81
72	Cargo, Hazardous category B	12
73	Cargo, Hazardous category C	2
74	Cargo, Hazardous category D	8
75	Cargo, Reserved for future use	1
76	Cargo, Reserved for future use	1
79	Cargo, No additional information	70
80	Tanker, all ships of this type	37
81	Tanker, Hazardous category A	9
82	Tanker, Hazardous category B	6
83	Tanker, Hazardous category C	6
84	Tanker, Hazardous category D	6
85	Tanker, Reserved for future use	2
89	Tanker, No additional information	15
90	Other Type, all ships of this type	13
99	Other Type, No additional information	6
103	Unknown	1

4. Unique Transits of Virginia WEA by Vessel Class
2009

ShipClass	CountOfShipClass	sum
Cargo	1784	2263
High speed craft (HSC)	1	
Other Type	55	
Passenger	4	
Tanker	152	
Dredging or underwater ops	1	
Fishing	1	
Law Enforcement	2	
Military Ops	83	
Pilot Vessel	5	
Pleasure Craft	11	
Sailing	2	
Search and Rescue vessel	1	
Towing	17	
Towing: length exceeds 200m or breadth exceeds 25m	22	
Tug	27	
Unknown	95	

The following data are for Virginia Ports and were derived from U.S. Maritime Administration Reports on Vessel Calls at Ports, 2002-2011. Accessed at: http://www.marad.dot.gov

	All Types		Tanker	Product	Crude	Container	Dry Bulk	Ro-Ro	Vehicle	Gas Carrier	Combination	General Cargo
	Calls	Capacity	Calls	Calls	Calls	Calls	Calls	Calls	Calls	Calls	Calls	Calls
2002	2,258	100,980,195	129	104	25	1,529	293	157	48	4	50	96
2003	1,539	70,066,365	77	55	22	1,064	197	100	40	6	30	65
2004	2,595	120,641,749	135	97	38	1,717	423	152	44	12	59	97
2005	2,547	119,456,161	147	102	45	1,731	391	160	72	6	54	58
2006	2,597	123,503,269	125	87	38	1,882	377	144	70	6	20	43
2007	2,775	137,548,193	164	123	41	1,940	426	121	51	9	51	64
2008	2,759	146,066,252	174	124	50	1,752	608	132	61	7	35	51
2009	2,502	134,679,513	131	75	56	1,615	547	122	55	6	13	68
2010	3,021	168,781,177	141	104	37	1,908	692	176	91	4	27	73
2011	3,671	216,323,007	142	130	12	2,160	1,017	243	151	10	34	65

Attachment IV Casualty and Marine Environmental Response Data

The following tables were created from the USCG database entitled "Marine Casualty and Pollution Database" covering the years 1982 to 2013. The data were maintained by the Office of Investigations and Casualty Analysis (G-INV) and were provided from the National Technical Information Service (NTIS) on two separate Compact Discs dated 16 December 2013 following a Freedom of Information Act request.

The first table lists the significant marine casualties for the past 10 years seaward of Chesapeake Bay from the Chesapeake Bay Bridge Tunnel to 20 nm beyond the VOWTAP Project area and those within a 20 nm radius of the VOWTAP WTGs.

The second table lists the significant marine casualties for the past 10 years that occurred within Chesapeake Bay and its tributaries from the mouth of the James River to the Chesapeake Bay Bridge Tunnel.

The Activity Identifier in each table is a unique number assigned by the USCG for purposes of compiling data regarding each incident, and tracking it from reporting through the completion of the investigation or other action to close the incident reporting. Information regarding the individual incidents can be obtained from USCG Marine Information Exchange (MSIX) web site at http://cgmix.uscg.mil/IIR/Default.aspx.

Marine Casualties and Pollution Incidents Outside Chesapeake Bay Bridge Tunnel to Twenty Miles Offshore 2003-2013

Activity Identifier	Incident Date	Vessel Number	Vessel Name	Vessel Service	Vessel Class	Vessel Flag	Waterway	Type of Incident	Latitude	Longitude	Description of Incident
1731753	1/16/03	257375	MAJOR HUBAL	Freight Ship	General Dry Cargo Ship	Poland	Chesapeake Bay Entrance	Grounding	36.95	-75.92	Grounding at edge of Precautionary Area.
1737445	1/28/03	224305	BULK AMERICA	Freight Ship	Bulk Carrier	Malta	Chesapeake Bay Entrance	Engine Failure	36.92	-75.92	While awaiting pilot, engine failed to respond.
1763377	3/22/03	23458	SLUISGRACHT	Freight Ship	General Dry Cargo Ship	Netherlands	Chesapeake Bay Entrance	Equipment Failure	36.87	-75.80	Equipment failure while outbound.
1803674	5/24/03	231983	USNS ZEUS	Industrial Vessel	Cable laying Vessel	US	Chesapeake Bay Entrance	Engine Failure	36.82	-75.76	During sea trials vessel lost power.
2405217	6/24/05	224230	MSC SAMIA	Freight Ship	Container Ship	Panama	Atlantic Deepwater Access	Engine Failure	36.96	-75.98	Lost power.
2951182	6/1/07	629572	LAST CALL	Recreational	Recreational	US	Chesapeake Bay Entrance	Allision	36.90	-75.71	Fishing vessels anchored near Ches. Light drifted into each other.
3087004	10/23/07	293375	HYUNDAI KENNEDY	Freight Ship	General Dry Cargo Ship	Singapore	SE Approach	Engine Failure	36.92	-75.92	Loss of propulsion enroute pilot station.
3094135	11/6/07	452476	THE JUDE THADDEUS	Passenger (Inspected)	Passenger Ship	US	Offshore north of Cape Charles	Engine Failure	37.20	-75.65	Cracked reduction gear.
3106411	11/19/07	932978	FISHUNTER	Commercial Fishing Vessel	Fishing Vessel	US	Offshore	Collision	36.63	-75.34	Collision between 2 fishing vessels offshore.

Marine Casualties and Pollution incidents Outside Chesapeake Bay Bridge Tunnel to Twenty Miles Offshore 2003-2013 (cont.)

Activity Identifier	Incident Date	Vessel Number	Vessel Name	Vessel Service	Vessel Class	Vessel Flag	Waterway	Type of Incident	Latitude	Longitude	Description of Incident
3143171	2/6/08	567795	MSC COLOMBIA	Freight Ship	Container Ship	UK	Chesapeake Bay Entrance	Grounding	36.87	-75.78	Grounding in SE Approach.
3323824	9/13/08	39594	GYPSUM CENTENNIAL	Freight Ship	Bulk Carrier	Bermuda	Chesapeake Bay Entrance	Steering Casualty	36.98	-75.97	Steering casualty.
3443022	3/29/09	964327	OREGON HIGHWAY	Freight Ship	Ro-Ro Cargo Ship	Panama	Off Cape Charles	Engine Failure	37.12	-75.68	Loss of propulsion.
3619693	9/23/09	51544	GEYSIR	Freight Ship	Container Ship	US	Entrance to Chesapeake Bay	Loss of steering	36.97	-75.91	Loss of steering.
3708119	4/2/10	363999	KNOCKDOWN	Recreational	Recreational	US	SE Approach	Stuck submerged object	36.62	-75.82	Struck unknown object.
3801882	7/16/10	240535	MAERSK TEXAS	Freight Ship	Ro-Ro Cargo Ship	US	Offshore south of Cape Henry	Loss of propulsion	36.72	-75.58	Lost power.
3892850	11/16/10	662811	MISS TAMARA	Commercial Fishing Vessel	Fishing Vessel	US	Off Cape Charles	Loss of propulsion	37.06	-75.84	Lost power.
4073684	7/3/11	16336	RESOLUTE	Recreational	Recreational	US	Off Cape Charles	Fire	37.13	-75.54	Fire aboard vessel contained.

Marine Casualties and Pollution Incidents Inside Chesapeake Bay Bridge Tunnel to James River Entrance 2003-2013

Activity Identifier	Incident Date	Vessel Number	Vessel Name	Vessel Service	Vessel Class	Vessel Flag	Waterway	Type of Incident	Latitude	Longitude	Description of Incident
2448775	8/1/05	580302	GENMAR ORION	Tank Ship	Tank Ship	Marshal Is.	Chesapeake Bay Channel	Grounding	37.11	-76.15	Vessel touched bottom at York River Entrance Channel.
2878003	2/26/07	158961	CAPE HENRY EXPRESS	Passenger	Crew Boat	US	Lynnhaven Inlet	Allision	36.97	-76.28	Vessel struck a submerged object.
2915362	4/24/07	225497	MARLIN	Freight Ship	General Dry Cargo Ship	Bahamas	Elizabeth River	Allision	36.81	-76.29	Vessel struck bridge fendering system.
2974328	6/23/07	267083	PONTODROMON	Freight Ship	Bulk Carrier	Cyprus	Norfolk Harbor	Collision	36.96	-76.42	Tug collided with vessel during maneuvers.
3357755	11/2/08	452374	BLUE STREAK	Passenger (Inspected)	Passenger Ship	US	Chesapeake Bay	Grounding	37.19	-76.15	Vessel grounded at slow speed outside of channel.
3392522	1/7/09	990475	SATURNUS	Freight Ship	Bulk Carrier	Norway	James River	Allision	36.96	-76.36	Vessel allided with pier while under tow.
3530384	7/6/09	677772	KS 4003	Freight Barge	Deck Barge	US	Chesapeake Bay	Allision	36.98	-76.11	Barge broke free and drifted onto trestle at CBBT.
3619704	9/17/09	299407	GRINDSTONE	Commercial Fishing Vessel	Fishing Vessel	US	Chesapeake Bay	Equipment Failure	37.00	-76.29	Vessel lost steering and was towed to effect repairs.
3635628	11/12/09	146742	SENTRY	Towing Vessel	Towing Vessel	US	Chesapeake Bay Channel	Grounding	37.09	-76.11	Towline parted and barge grounded.
3647221	12/8/09	270652	AMY SAMANTHA	Commercial Fishing Vessel	Fishing Vessel	US	James River	Collision	36.98	-76.45	Towing vessel collided with commercial fishing vessel.
3648449	11/11/09	405042	ASC 300	Tank Barge	Bulk Liquid Cargo Barge	US	Thimble Shoal Channel	Grounding	37.02	-76.22	Towline parted and barge grounded.

Marine Casualties and Pollution Incidents Inside Chesapeake Bay Bridge Tunnel to James River Entrance 2003-2013 (cont.)

Activity Identifier	Incident Date	Vessel Number	Vessel Name	Vessel Service	Vessel Class	Vessel Flag	Waterway	Type of Incident	Latitude	Longitude	Description of Incident
3659225	1/4/10	198511	CAPT. RUSSI	Towing Vessel	Towing Vessel	US	Thimble Shoal Channel	Equipment Failure	37.01	-76.26	Tug lost propulsion and transferred towed barge to another towing vessel.
3664486	1/14/10	606439	MSC ULSAN	Freight Ship	Container Ship	Bahamas	Chesapeake Bay Channel	Equipment Failure	37.09	-76.11	Vessel lost propulsion and drifted.
3717803	4/15/10	172599	NIGHT OWL	Towing Vessel	Towing Vessel	US	Elizabeth River	Equipment Failure	36.80	-76.29	Vessel lost propulsion and drifted. Was assisted by another vessel.
3731915	5/1/10	172599	NIGHT OWL	Towing Vessel	Towing Vessel	US	Thimble Shoal Channel	Equipment Failure	37.09	-76.20	Vessel lost propulsion and was relieved of tow by another vessel.
3733313	5/6/10	298472	GOLD COAST	Towing Vessel	Towing Vessel	US	Elizabeth River	Equipment Failure	36.85	-76.31	Tug lost steering and allided with bridge.
3813026	7/18/10	16040	APL PEARL	Freight Ship	Container Ship	US	Elizabeth River	Collision	36.88	-76.35	Tug assisting struck side of vessel causing hull damage.
3872713	10/17/10	917215	SEA TOW DUSKY	Towing Vessel	Towing Vessel	US	James River	Collision	37.00	-76.47	Two small boats collided at high speed.
3895463	11/20/10	1011306	NYK RIGEL	Freight Ship	Container Ship	Panama	Elizabeth River	Allision	36.92	-76.33	Vessel allided with pier during berthing.
4199952	11/30/11	852053	CS CHARA	Freight Ship	Bulk Carrier	Bahamas	James River	Equipment Failure	36.96	-76.36	Vessel lost propulsion and successfully anchored.
4215983	12/29/11	460100	PERA	Freight Ship	General Dry Cargo Ship	Antigua & Barbuda	Chesapeake Bay	Equipment Failure	36.93	-76.18	Vessel lost electrical power to nav. Equipment and successfully anchored.

Attachment V Lighting and Marking Plan

Turbine ID	Latitude (NAD 83)	Longitude (NAD 83)	Lighting	Marking
1	36° 53’ 46.63” N	75° 29’ 29.88” W	2 amber lights with 4 nm (7.4 km) visibility on the same horizontal plane at a height of not more than 50 ft (15 m) above HAT or the level of the platform, whichever is greater, 180° apart providing 360° visibility, quick flashing (ISO 50 FPM), synchronized with Turbine 2.	The jacket portion of the foundation will be painted yellow all around from the level of HAT to 50 ft (15 m) or at least to the bottom of the transition deck, whichever is greater. Above the yellow demarcation line, each WTG will be painted bright white or slightly off-white (less than 5% grey tone). Alphanumeric marking “B1” in black retro reflective material, at least 15 ft (4.6 m) in height, located 120° apart with the letters mounted vertically from a point 10 ft (3 m) above the platform. Two yellow bands of retro reflective material each 6 ft (2 m) high and separated by 6 ft (2 m), which will be situated around the tower above the alphanumeric “B1”.
2	36° 53’ 12.6” N	75° 29’ 29.66” W	2 amber lights with 4 nm (7.4 km) visibility on the same horizontal plane at a height of not more than 50 ft (15 m) above HAT or the level of the platform, whichever is greater, 180° apart providing 360° visibility, quick flashing (ISO 50 FPM), synchronized with Turbine 1.	The jacket portion of the foundation will be painted yellow all around from the level of HAT to 50 ft (15 m) or at least to the bottom of the transition deck, whichever is greater. Above the yellow demarcation line, each WTG will be painted bright white or slightly off-white (less than 5% grey tone). Alphanumeric marking “B2” in black retro reflective material, at least 15 ft (4.6 m) in height, located 120° apart with the letters mounted vertically from a point 10 ft (3 m) above the platform. Two yellow bands of retro reflective material each 6 ft (2 m) high and separated by 6 ft (2 m), which will be situated around the tower above the alphanumeric “B2”.