OCTOBER 29 | 2021

Appendix T: Obstruction Evaluation and Additional Analysis

Coastal Virginia Offshore Wind Commercial Project

Dominion Energy®

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The assessment presented herein is consistent with the Project Design Envelope considered by Dominion Energy Virginia (Dominion Energy) prior to summer 2022. Due to maturation of the Coastal Virginia Offshore Wind Commercial Project (Project) design, Dominion Energy was able to refine several components of the Project and has subsequently revised the Construction and Operations Plan (COP) as re-submitted in February 2023. The primary changes are summarized as follows:

- The Maximum Layout includes up to 202 wind turbine generators (WTGs), with a maximum WTG capacity of 16 megawatts. As the Preferred Layout, Dominion Energy proposes to install a total of 176, 14.7-megawatt capacity WTGs with 7 additional positions identified as spare WTG locations. For both the Preferred Layout and Maximum Layout, the Offshore Substations will be within the WTG grid pattern oriented at 35 degrees and spaced approximately 0.75 nautical mile (1.39 kilometers) in an east-west direction and 0.93 nautical mile (1.72 kilometers) in a north-south direction.
- Removal of Interconnection Cable Route Options 2, 3, 4, and 5 from consideration. As the Preferred Interconnection Cable Route Option, Dominion Energy proposes to install Interconnection Cable Route Option 1.

The analysis presented in this appendix reflects the initial 205 WTG position layout as well as Interconnection Cable Route Options 1, 2, 3, 4, 5, and 6 as the maximum Project Design Envelope. Reduction in the Project Design Envelope is not anticipated to result in any additional impacts not previously considered in the COP. Therefore, in accordance with the Bureau of Ocean Energy Management's Draft Guidance Regarding the Use of a Project Design Envelope in a Construction and Operations Plan (2018), the appendix has not been revised. Additional details regarding evolution of the Project is provided in Section 2 of the COP and details regarding the full Project Design Envelope are provided in Section 3 of the COP.

Coastal Virginia Offshore Wind (CVOW) Commercial Project

Tetra Tech, Inc.

Offshore, Virginia

Obstruction Evaluation & Airspace Analysis

September 30, 2020

Capitol Airspace Group

capitolairspace.com

(703) 256 - 2485

Summary

Capitol Airspace conducted an obstruction evaluation and airspace analysis for the Coastal Virginia Offshore Wind (CVOW) Commercial Project (CVOW Commercial Project) off the coast of Virginia Beach, Virginia. The purpose for this analysis was to identify the potential for impacts on Visual Flight Rules (VFR) and Instrument Flight Rules (IFR) operations as a result of 820 and 869-foot-tall wind turbines. At the time of this analysis, 205 wind turbine locations had been identified as the maximum quantity for the Project Design Envelope (black points, **Figure 1**). This analysis assessed height constraints overlying each location as well as an approximately 180-square-mile study area (black outline, **Figure 1**) to aid in identifying optimal wind turbine locations.

The Bureau of Ocean Energy Management (BOEM) is responsible for regulating renewable energy activities on the outer continental shelf in accordance with "30 CFR, Part 585." As part of the application process for leases, grants, and easements, BOEM may require the inclusion of a Federal Aviation Administration (FAA) aeronautical study to determine the proposal's impact on airspace use and safety. If a project is determined to have an unacceptable impact on civil aviation or military activities, it could result in denial of the application.

Regulations in "14 CFR, Part 77" apply to all structures within US territorial airspace. Regulations in "14 CFR, Part 77.9" require that that all structures exceeding 200 feet above ground level (AGL) be submitted to the FAA so that an aeronautical study can be conducted. The FAA's objective in conducting aeronautical studies is to ensure that proposed structures do not affect the safety of air navigation or the efficient utilization of navigable airspace by aircraft. The result of an aeronautical study is the issuance of a determination of 'hazard' or 'no hazard' that can be used by the proponent to obtain necessary local construction permits. It should be noted that the FAA has no control over land use in the United States and cannot enforce the findings of its studies. Executive Order 10854 extends the FAA's jurisdiction beyond US territorial airspace to include any area of land or water where the United States has jurisdiction or control. However, for projects located outside of territorial airspace, the FAA has historically adjusted airspace to accommodate offshore wind development.

The lowest obstacle clearance surfaces overlying the CVOW Commercial Project range from 749 to 4,549 feet above mean sea level (AMSL) and are associated with an enroute airway and minimum vectoring altitude (MVA) sectors. At 820 and 869 feet tall, 48 proposed wind turbines in the western section of the study area would exceed these surfaces and require an increase to MVAs. If the increase to MVAs is anticipated to affect as few as one radar vectoring operation per week, it may result in FAA objections to proposed wind development.

This study did not consider electromagnetic interference on FAA communication or surveillance radar systems.

Methodology

Capitol Airspace studied the proposed CVOW Commercial Project based on a study area and proposed wind turbine location information provided by Dominion Energy. Using this information, Capitol Airspace generated graphical overlays to determine proximity to airports (**Figure 1**), published instrument procedures, enroute airways, FAA MVA and minimum IFR altitude charts, and military airspace and training routes.

Capitol Airspace evaluated all "14 CFR, Part 77" imaginary surfaces, published instrument approach and departure procedures, visual flight rules operations, FAA MVAs and minimum IFR altitudes, and enroute operations. All formulas, headings, altitudes, bearings, and coordinates used during this study were derived from the following documents and data sources:

- "14 CFR, Part 77, Safe, Efficient Use, and Preservation of the Navigable Airspace,"
- "FAA Order 7400.2M, Procedures for Handling Airspace Matters,"
- "FAA Order 8260.3D, United States Standard for Terminal Instrument Procedures,"
- "FAA Order 8260.58A, United States Standard for Performance Based Navigational (PBN) Instrument Procedure Design,"
- "Technical Operations Evaluation Desk Guide for Obstruction Evaluation/Airport Airspace Analysis (1.5.1),"
- "United States Government Flight Information Publication, US Terminal Procedures," and
- "National Airspace System Resource Aeronautical Data."

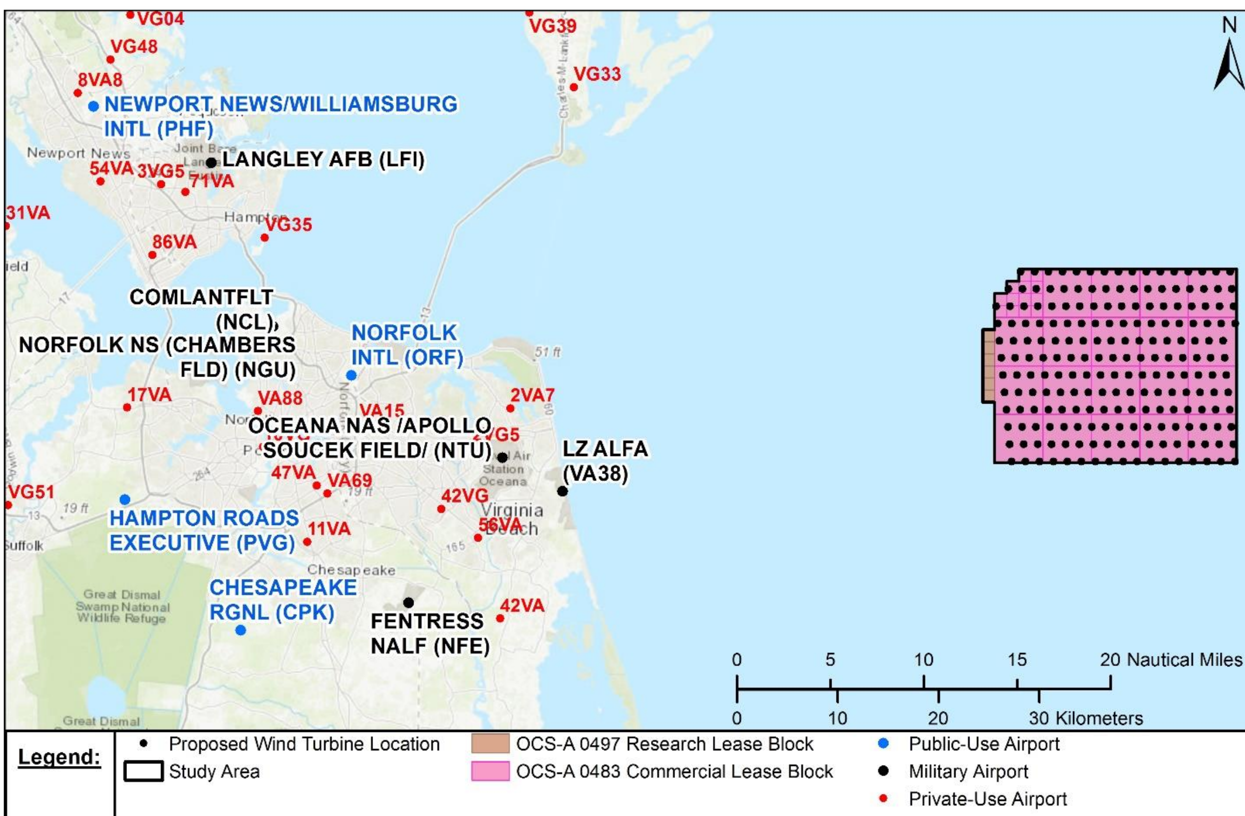


Figure 1*: Public-use, private-use, and military airports in proximity to the CVOW Commercial Project*

Study Findings

Territorial Airspace

The FAA conducts aeronautical studies for structures proposed within any state, territory, or possession of the United States, within the District of Columbia, or within territorial waters[1] surrounding the United States.[2] Although an offshore wind project may be located outside of territorial waters, BOEM may require an aeronautical study as part of the application process.

The CVOW Commercial Project is not located within territorial waters (purple, **Figure 2**). Therefore, the FAA does not have a mandate to conduct aeronautical studies for wind turbines proposed within the defined study area. However, Executive Order 10854 extends the FAA's jurisdiction beyond US territorial airspace to include any area of land or water where the United States has jurisdiction or control. Historically, for projects located outside of territorial airspace, the FAA has adjusted airspace to accommodate offshore wind development. Additionally, BOEM may require consultation with the FAA as part of the application process, as well as an aeronautical study to support these consultations.

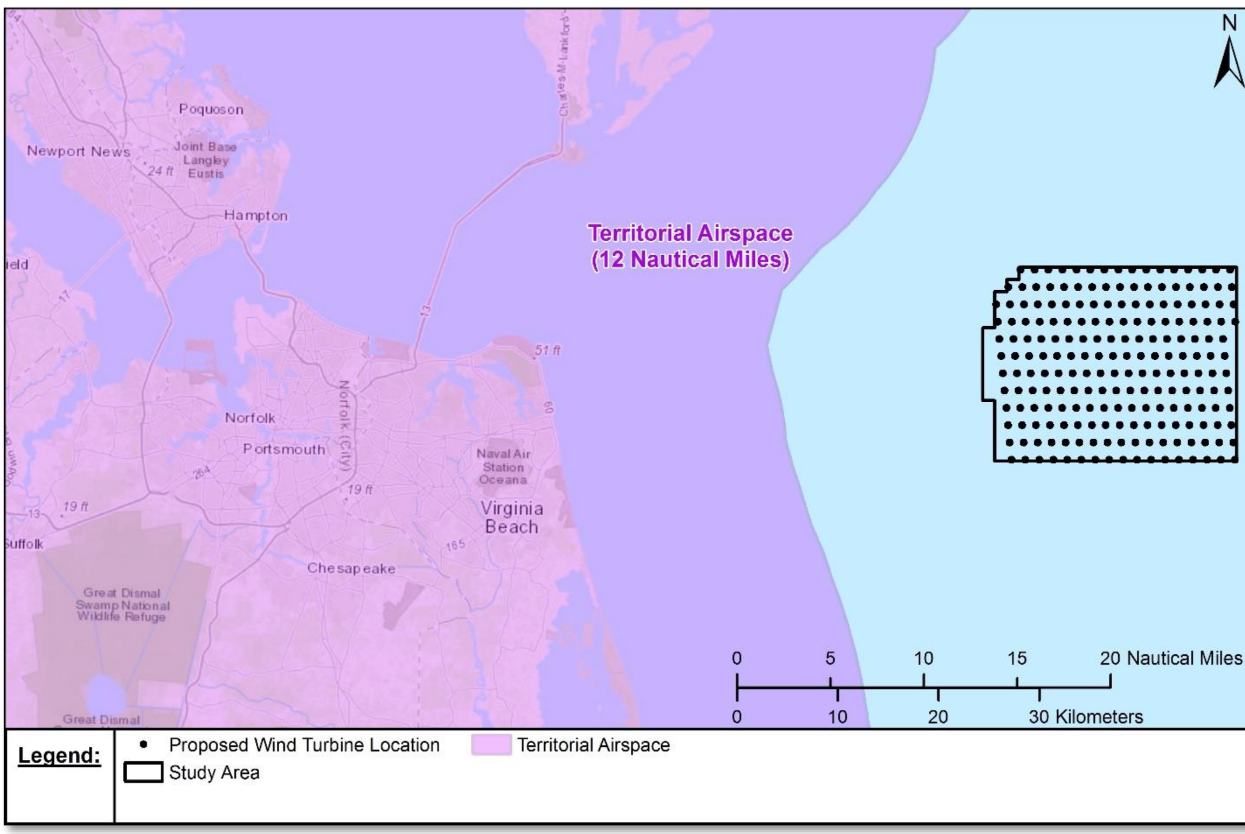


Figure 2: Territorial Airspace in proximity to the CVOW Commercial Project

[1] The National Oceanic and Atmospheric Administration (NOAA) defines territorial waters as 12 nautical miles (NM) measured from the official U.S. baseline – a recognized low water line along the coast. NOAA publishes this boundary in a publicly available ***Web Map Service***.

[2] As described in FAA Order 7400.2M 5-1-4(a), "Scope."

"14 CFR, Part 77" Obstruction Standards and Imaginary Surfaces

The FAA uses level and sloping imaginary surfaces to determine if a proposed structure is an obstruction to air navigation. Structures that are identified as obstructions are then subject to a full aeronautical study and increased scrutiny. However, exceeding a Part 77 imaginary surface does not automatically indicate that a structure would have a substantial adverse effect on aviation operations. Proposed structures must have an impact on a significant volume of VFR or IFR operations in order to constitute a substantial adverse effect.

Military and public-use airport "14 CFR, Part 77.17(a)(2)" obstruction standards and "14 CFR Part 77.19/21/23" imaginary surfaces do not overlie the CVOW Commercial Project (e.g., **Figure 3**). However, at 820 and 869 feet tall, proposed wind turbines will exceed the "14 CFR Part 77.17(a)(1)" obstruction standard – a height of 499 feet AGL at the site of the object – and will be identified as obstructions regardless of location.

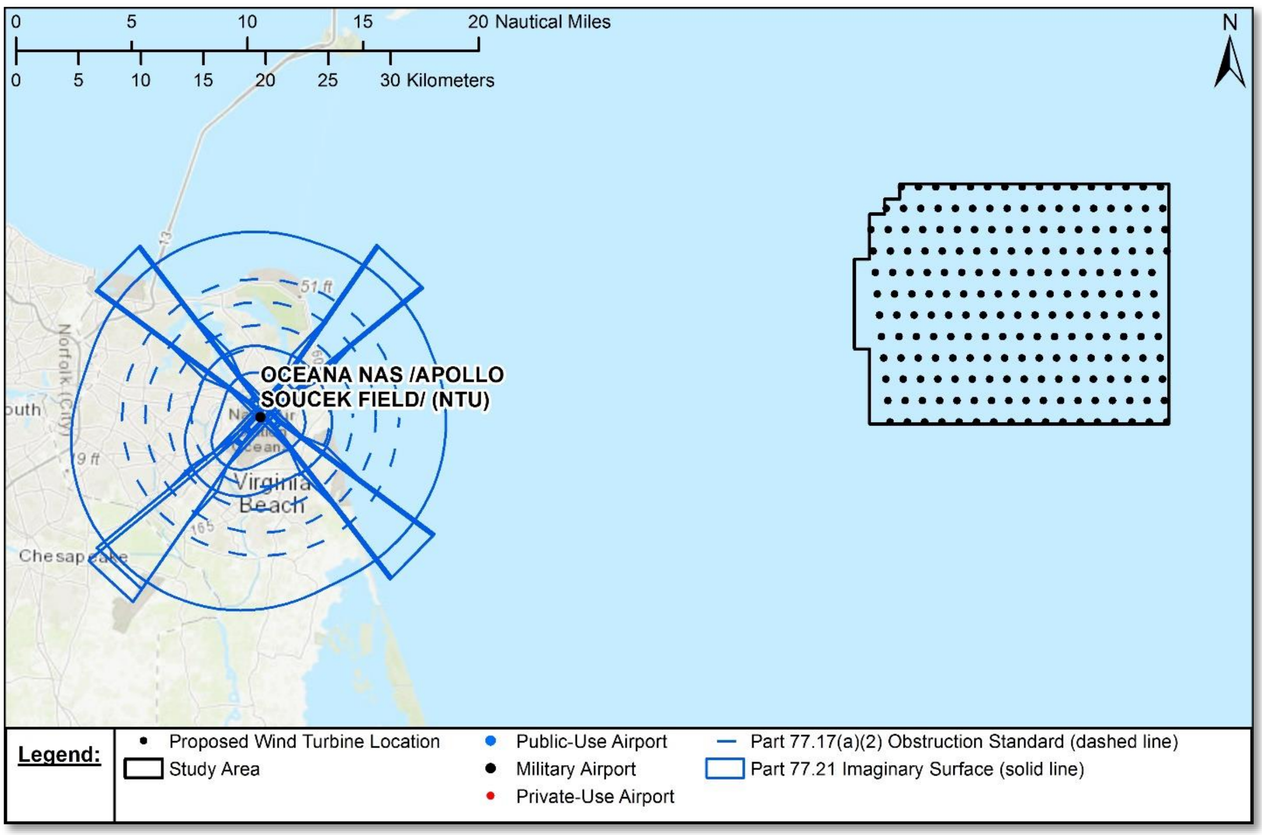


Figure 3: 14 CFR, Part 77.17(a)(2) obstruction standard and Part 77.21 imaginary surfaces

Visual Flight Rules Traffic Pattern Airspace

VFR traffic pattern airspace is used by pilots operating during visual meteorological conditions (VMC). The airspace dimensions are based upon the category of aircraft which, in turn, is based upon the approach speed of the aircraft. "14 CFR, Part 77.17(a)(2) and 77.19" (as applied to a visual runway) imaginary surfaces establish the obstacle clearance surface heights within VFR traffic pattern airspace.

VFR traffic pattern airspace does not overlie the CVOW Commercial Project (e.g., **Figure 4**). As a result, 820 and 869-foot-tall wind turbines within the defined study area should not have an impact on VFR traffic pattern airspace.

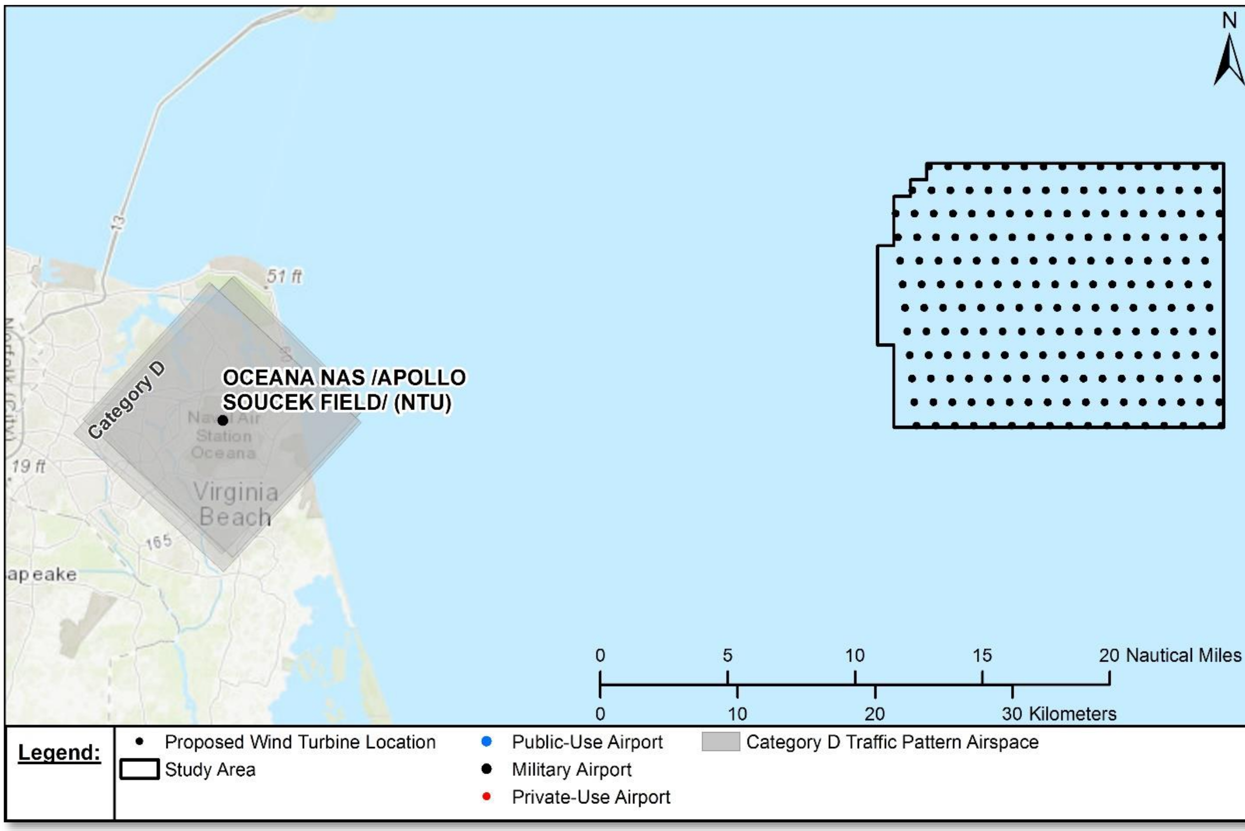


Figure 4: VFR traffic pattern airspace in proximity to the CVOW Commercial Project

Visual Flight Rules Routes

During periods of marginal VMC – low cloud ceilings and 1 statute mile visibility – pilots often operate below the floor of controlled airspace. Operating under these weather conditions requires pilots to remain within 1 statute mile of recognizable landmarks such as roads, rivers, and railroad tracks. The FAA protects for known and regularly used VFR routes by limiting structure heights within 2 statute miles of these routes to no greater than "14 CFR, Part 77.17(a)(1)" – a height of 499 feet AGL at the site of the object.

The CVOW Commercial Project is not located within 2 statute miles of landmarks that could be used as VFR routes (hatched purple, **Figure 5**). As a result, 820 and 869-foot-tall wind turbines within the defined study area should not impact VFR routes.

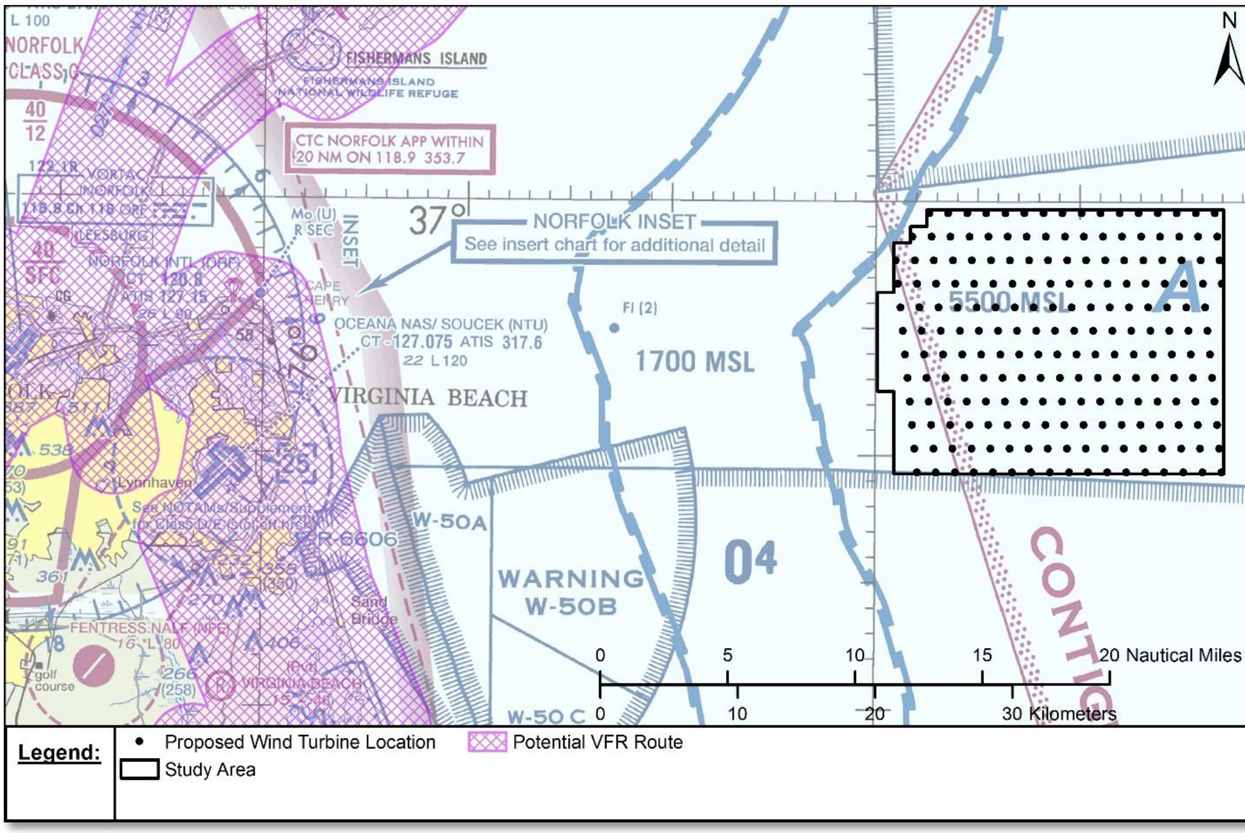


Figure 5: Potential VFR routes in proximity to the CVOW Commercial Project

Instrument Departures

In order to ensure that aircraft departing during marginal weather conditions do not fly into terrain or obstacles, the FAA publishes instrument departure procedures that provide obstacle clearance to pilots as they transition between the terminal and enroute environments. These procedures contain specific routing and minimum climb gradients to ensure clearance from terrain and obstacles.

Proposed structures that exceed instrument departure procedure obstacle clearance surfaces would require an increase to instrument departure procedure minimum climb gradients. If the increase to minimum climb gradients is anticipated to affect as few as one flight per week, it may result in FAA objections to proposed wind development.

Instrument departure procedure obstacle clearance surfaces (e.g., **Figure 6**) do not overlie the CVOW Commercial Project. As a result, 820 and 869-foot-tall wind turbines within the defined study area should not have an impact on instrument departure procedures.

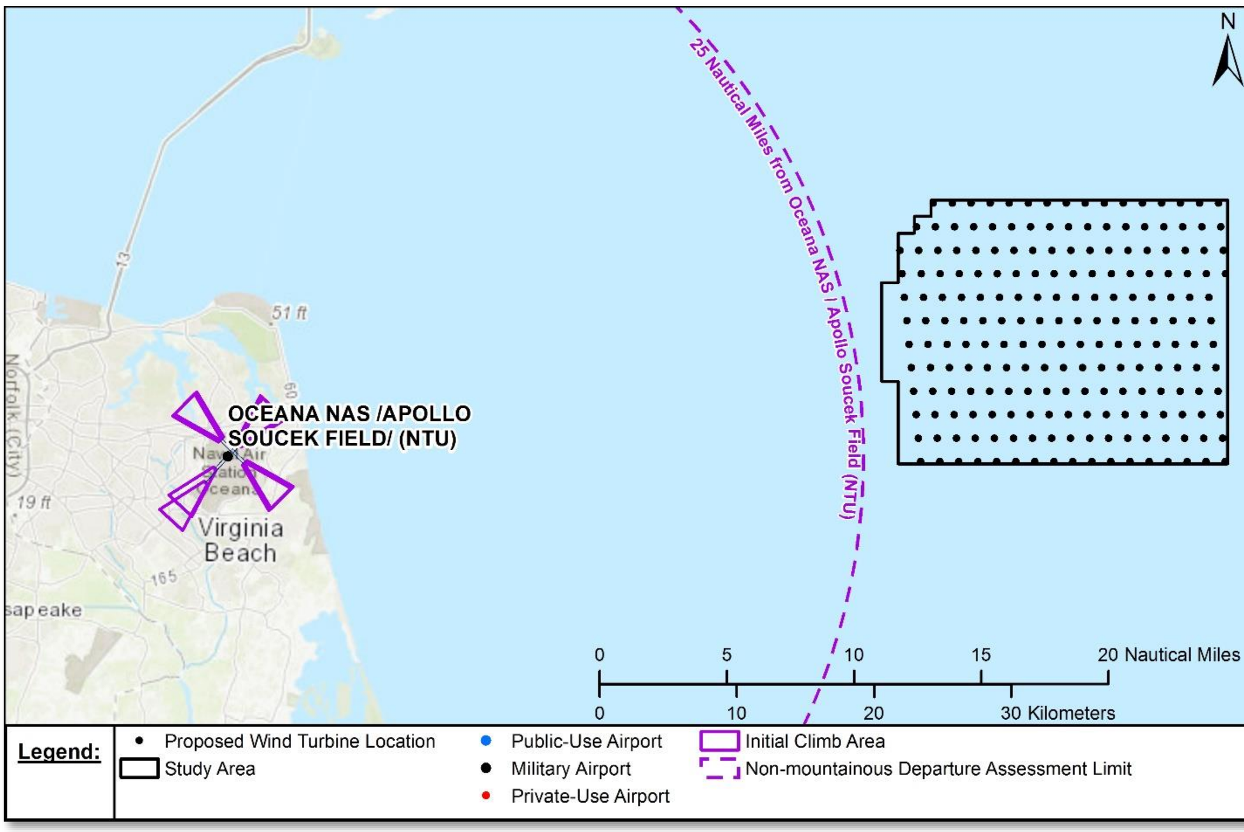


Figure 6: Oceana Naval Air Station (NAS)/Apollo Soucek Field (NTU) diverse departure procedure assessment

Instrument Approaches

Pilots operating during periods of reduced visibility and low cloud ceilings rely on terrestrial- and satellite-based navigational aids (NAVAIDS) in order to navigate from one point to another and to locate runways. The FAA publishes instrument approach procedures that provide course guidance to on-board avionics that aid the pilot in locating the runway. Capitol Airspace assessed 13 published instrument approach procedures at the Oceana Naval Air Station (NAS)/Apollo Soucek Field (NTU) military airport, which is in proximity to the CVOW Commercial Project:[3]

1) RNAV (GPS) Approach to Runway 05L,
2) RNAV (GPS) Approach to Runway 05R,
3) RNAV (GPS) Approach to Runway 23L,
4) RNAV (GPS) Approach to Runway 23R,
5) RNAV (GPS) Approach to Runway 32L/R,
6) HI-TACAN Approach to Runway 05L,
7) HI-TACAN Approach to Runway 05R,
8) HI-TACAN Approach to Runway 23L/R,
9) HI-TACAN Approach to Runway 32L/R,
10) TACAN Approach to Runway 05L,
11) TACAN Approach to Runway 05R,
12) TACAN Approach to Runway 23L/R and,
13) TACAN Approach to Runway 32L/R.

Proposed structures that exceed instrument approach procedure obstacle clearance surfaces would require an increase to their minimum altitudes. Increases to these altitudes, especially critical decision altitudes (DAs) and minimum descent altitudes (MDAs), can directly impact the efficiency of instrument approach procedures. If the increase to instrument approach procedure minimum altitudes is anticipated to affect as few as one flight per week, it may result in FAA objections to proposed wind development.

[3] Capitol Airspace assessed instrument approach procedures within 30 NM of the study area. Although approach surfaces – including terminal arrival areas (TAA), feeder segments, and initial segments – from airports farther than 30 NM may overlie the study area, the obstacle clearance surfaces present a lower risk to projects than the surfaces identified in this report. Therefore, height constraints associated with instrument approach surfaces for airports beyond 30 NM were not considered and are not included in the Composite Map (**Figure 12**).

Oceana NAS / Apollo Soucek Field (NTU)

Minimum Safe Altitudes (MSA)

The Tactical Air Navigation System (TACAN) approaches' MSAs are 1,400 feet AMSL where they overlie the CVOW Commercial Project. The obstacle clearance surfaces (hatched purple, **Figure 7**) are 400 feet AMSL and would be the lowest height constraints overlying the eastern section of the study area. At 820 and 869 feet tall, 27 proposed wind turbines in this area (orange area, **Figure 7**) would exceed these surfaces and require an increase to MSAs. However, MSAs are for emergency use only and cannot be used as the basis for identifying a substantial adverse effect on air navigation. Therefore, height constraints associated with MSAs are not included in the Composite Map.

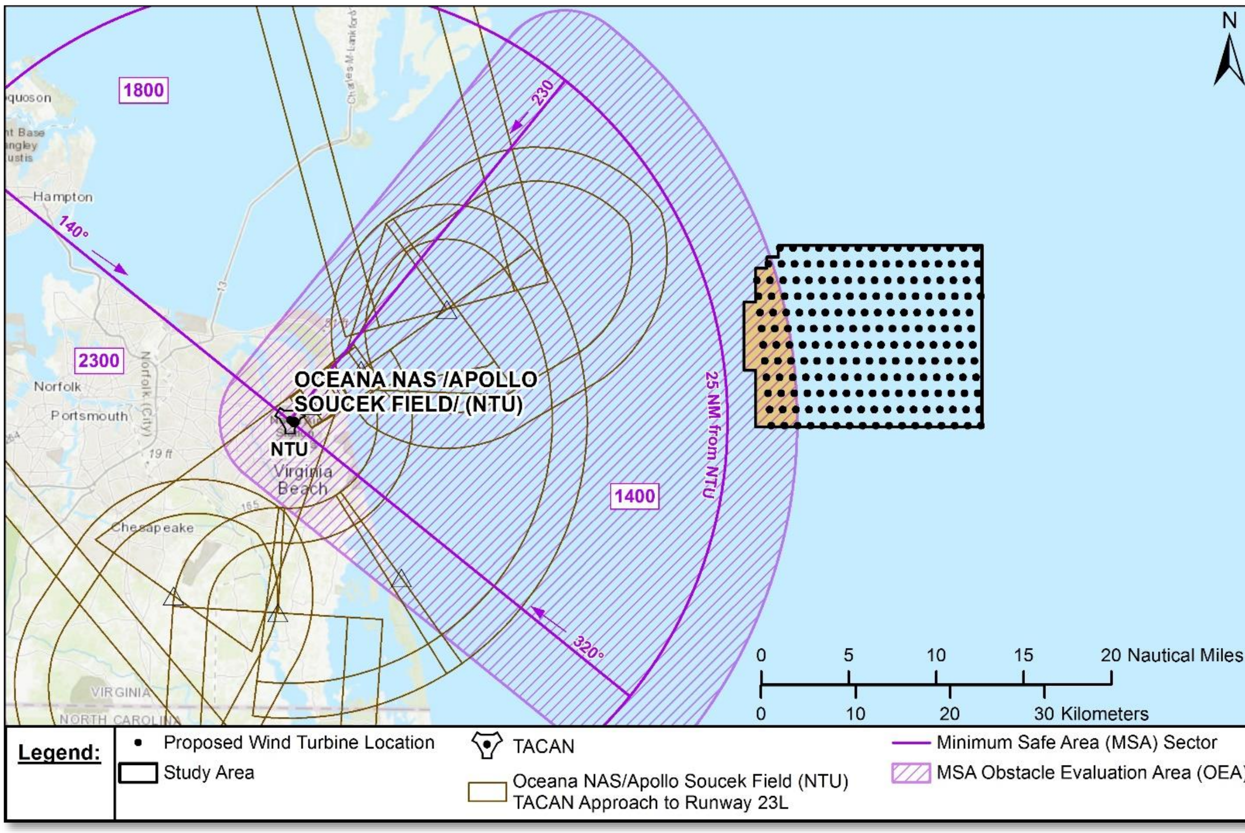


Figure 7: Oceana NAS/ Apollo Soucek Field (NTU) TACAN Approach to Runway 23L with 230° to 320° MSA sector obstacle evaluation area

Enroute Airways

Enroute airways provide pilots a means of navigation when flying from airport to airport and are defined by radials between Very High Frequency (VHF) omni-directional ranges (VORs). The FAA publishes minimum altitudes for airways to ensure clearance from obstacles and terrain. The FAA requires that each airway have a minimum obstacle clearance of 1,000 feet in non-mountainous areas and normally 2,000 feet in mountainous areas.

Proposed structures that exceed enroute airway obstacle clearance surfaces would require an increase to their minimum obstruction clearance altitudes (MOCA) and/or minimum enroute altitudes (MEA). If the increase to enroute airway minimum altitudes is anticipated to affect as few as one flight per week, it may result in FAA objections to proposed wind development.

AR9

Norfolk (ORF) VORTAC to ZIBUT

The MEA is 5,500 feet AMSL. The primary area obstacle clearance surface (purple, **Figure 8**) is 4,500 feet AMSL and is the lowest height constraint overlying most of the study area. However, 820 and 869-foot-tall wind turbines would not exceed this surface and should not require an increase to the AR9 MEA.

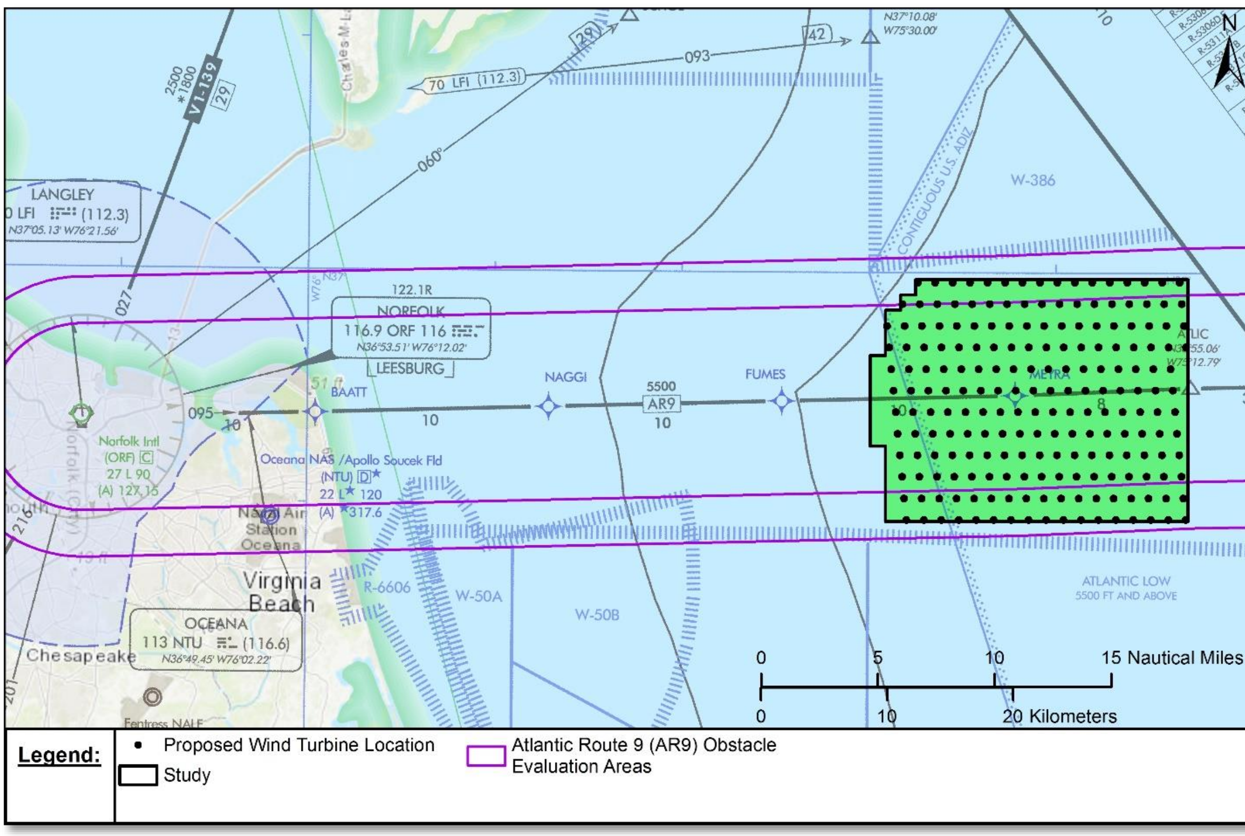


Figure 8: Low altitude enroute chart L-35 with AR9 obstacle evaluation areas

Minimum Vectoring/IFR Altitudes[4]

The FAA publishes MVA and minimum IFR altitude (MIA) charts that define sectors with the lowest altitudes at which air traffic controllers can issue radar vectors to aircraft based on obstacle clearance. The FAA requires that sectors have a minimum obstacle clearance of 1,000 feet in non-mountainous areas and normally 2,000 feet in mountainous areas.

Proposed structures that exceed MVA/MIA sector obstacle clearance surfaces would require an increase to the altitudes usable by air traffic control for vectoring aircraft. If the increase to MVAs or MIAs is anticipated to affect as few as one flight per week, it may result in FAA objections to proposed wind development.

Norfolk (ORF) Terminal Radar Approach Control (TRACON)

Sector B (ORF_MVA_FUS3_2020 & ORF_MVA_FUS5_2020)

The MVA is 1,700 feet AMSL. The obstacle clearance surface (hatched purple, **Figure 9**) is 749 feet AMSL and is the lowest height constraint overlying the western section of the study area. At 820 and 869 feet tall, 48 proposed wind turbines in this area (red area, **Figure 9**) would exceed this surface and require an increase to the Sector B MVA. If the increase to the Sector B MVA is anticipated to affect as few as one radar vectoring operation per week, it may result in FAA objections to proposed wind development.

Sector K (ORF_MVA_FUS3_2020 & ORF_MVA_FUS5_2020)

The MVA is 5,500 feet AMSL. The obstacle clearance surface is 4,549 feet AMSL and is one of the lowest height constraints overlying the northeastern and southeastern sections of the study area. However, 820 and 869-foot-tall wind turbines would not exceed this surface and should not require an increase to the Sector K MVA.

[4] NAS Oceana (NTU) Radar Air Traffic Control Facility (RATCF) MVA sectors overlie the study area. However, RATCF MVA charts are not publicly available. It is possible that Oceana Approach Control MVA sector obstacle clearance surfaces are lower than those described in this report.

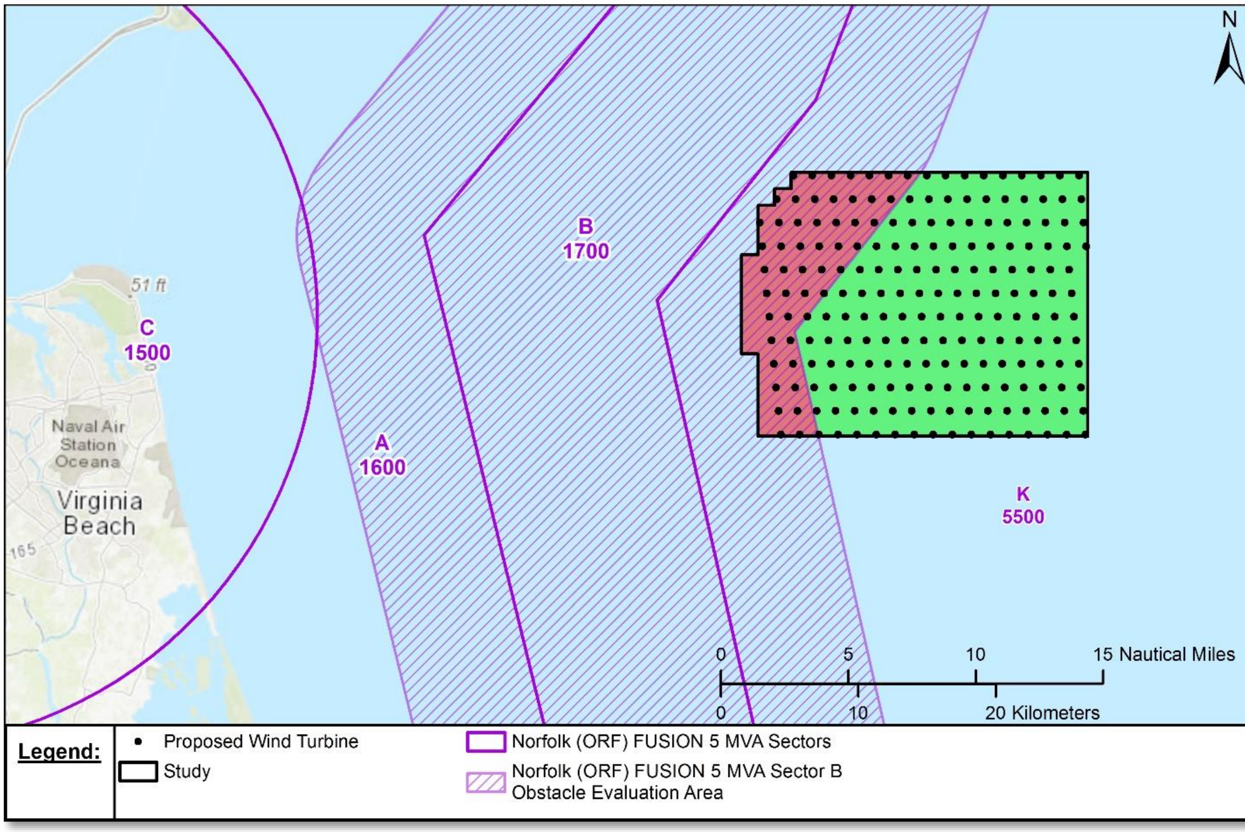


Figure 9: Norfolk (ORF) TRACON FUSION 5 MVA sectors and Sector B obstacle evaluation area

Terminal and Enroute Navigational Aids

The FAA has established protection areas in order to identify proposed structures that may have a physical and/or electromagnetic effect on NAVAIDs. The protection area dimensions vary based on the proposed structure type as well as the NAVAID type. Proposed structures within these areas may interfere with NAVAID services and will require further review by FAA Technical Operations. If further review determines that proposed structures would have a significant physical and/or electromagnetic effect on NAVAIDs, it may result in FAA objections to proposed wind development.

NAVAID protection areas do not overlie the CVOW Commercial Project (**Figure 10**). As a result, it is unlikely that proposed wind turbines would have a physical or electromagnetic effect on terminal or enroute NAVAIDs.

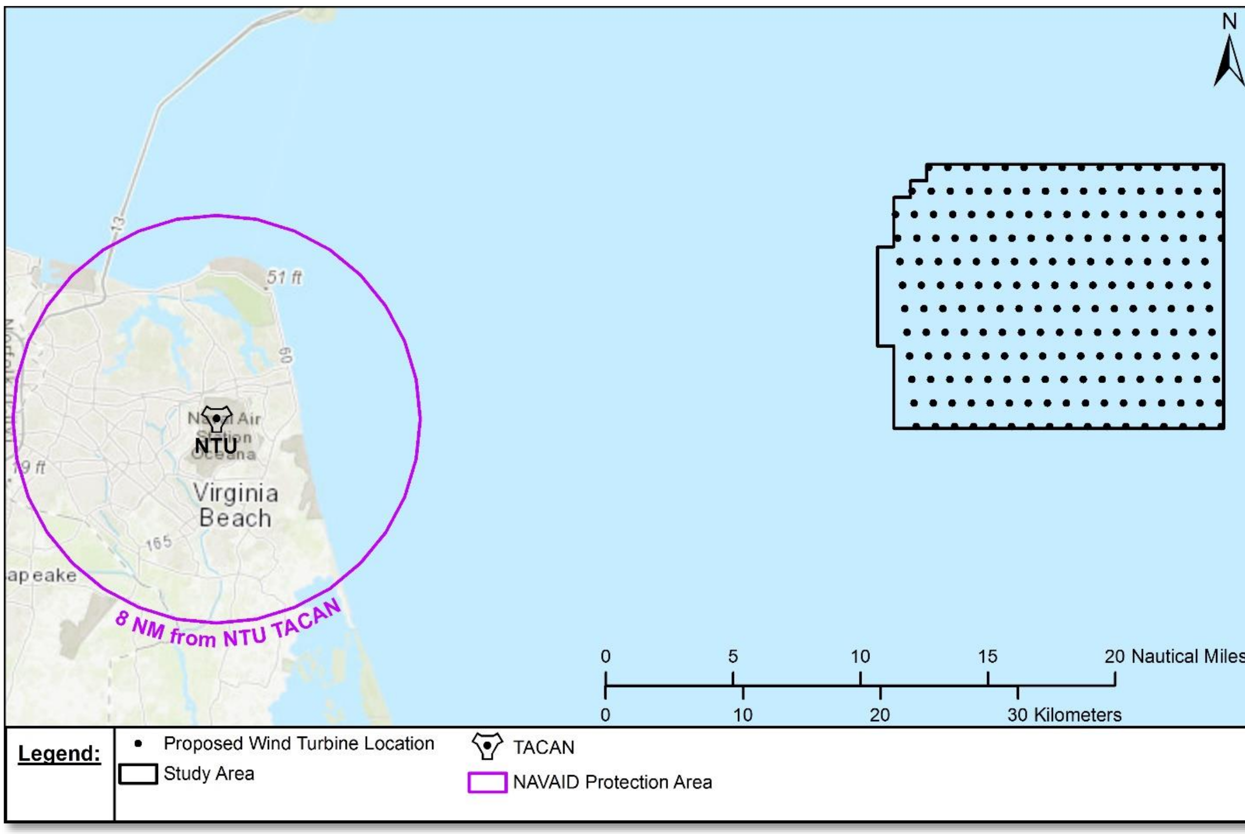


Figure 10: Oceana (NTU) TACAN protection area and the CVOW Commercial Project

Military Airspace and Training Routes

Although the FAA does not consider impact on military airspace or training routes, it will notify the military of proposed structures within these segments of airspace. Impact on these segments of airspace can result in military objections to the proposed development. [5]

Military airspace and training routes do not overlie the CVOW Commercial Project (e.g., **Figure 11**). Therefore, these segments of airspace should not result in military objections to proposed wind development.

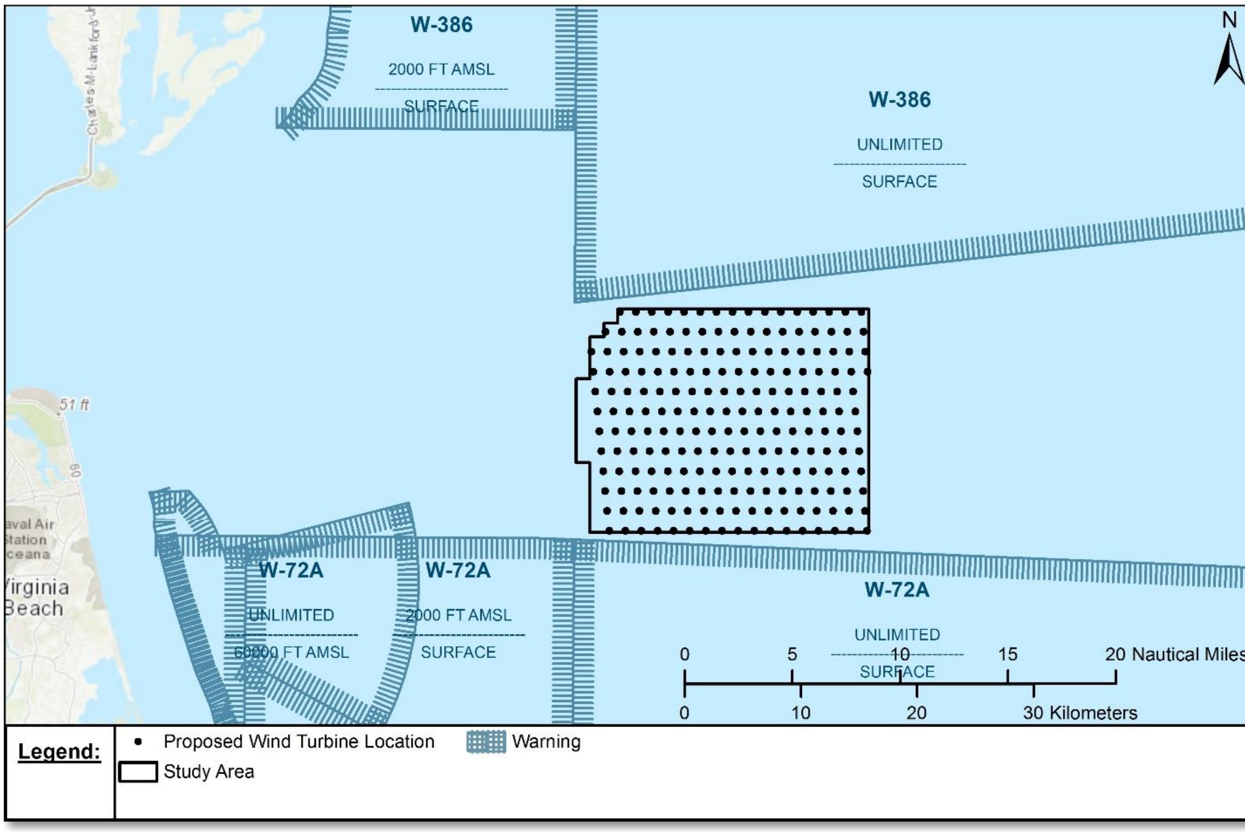


Figure 11: Special use airspace in proximity to the CVOW Commercial Project

[5] Under the provisions of the 2018 National Defense Authorization Act (NDAA), when the military has concerns about a project, the Military Aviation and Installation Assurance Siting Clearinghouse (Clearinghouse) may issue a Notice of Presumed Risk to National Security (NPR) letter to initiate mitigation discussions. These discussions are facilitated through the Clearinghouse and with the affected bases or organizations with operational interests. Per the legislative directive, NPR letters are provided to the Governor of the state(s). The Clearinghouse typically attempts to notify developers shortly before the issuance of an NPR letter.

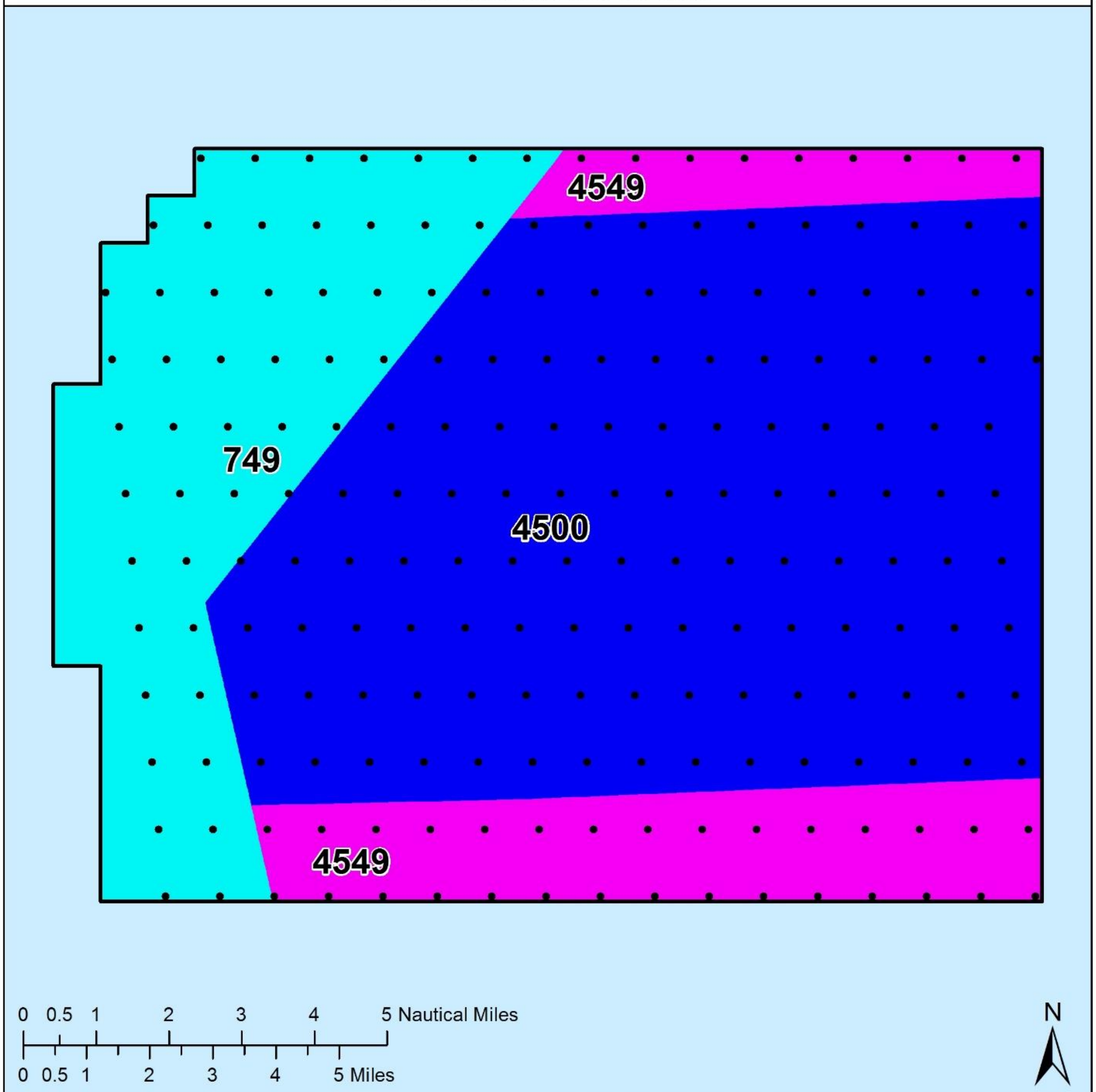
Conclusion

At 820 and 869 feet tall, proposed wind turbines will exceed the obstruction standard defined within "14 CFR, Part 77.17(a)(1)" – a height of 499 feet AGL at the site of the object – and will be identified as obstructions regardless of their location. However, exceeding this standard does not automatically indicate that a structure would have a substantial adverse effect on aviation operations. Proposed structures must have an impact on a significant volume of VFR or IFR operations in order to constitute a substantial adverse effect.

The lowest obstacle clearance surfaces overlying the CVOW Commercial Project range from 749 to 4,549 feet AMSL (**Figure 12**) and are associated with enroute airway AR9 (**Figure 8**) and Norfolk (ORF) TRACON MVA Sector B and Sector K (**Figure 9**). At 820 and 852 feet tall, 48 proposed wind turbines in the western section of the study area (red area, **Figure 13**) would exceed the Norfolk (ORF) TRACON MVA Sector B obstacle clearance surface and require an increase to its MVA. If the increase to Sector B MVA is anticipated to affect as few as one radar vectoring operation per week, it may result in FAA objections to proposed wind development.

Questions regarding the findings of this study should be directed to ***Dan Underwood*** or ***Wesley Williamson*** at (703) 256-2485.

Proposed structures that exceed 14 CFR Part 77.17(a)(1) - a height of 499 feet AGL at the site of the object - will be identified as obstructions regardless of location.



Obstacle Clearance Surface

Height - AMSL Feet

- 749
- 4,500
- 4,549
- Project Boundary
- • Proposed Wind Turbine

All heights above mean sea level (AMSL)

Dominion CVOW Project
Composite Height Constraint Map

Plot Date:
30 September 2020

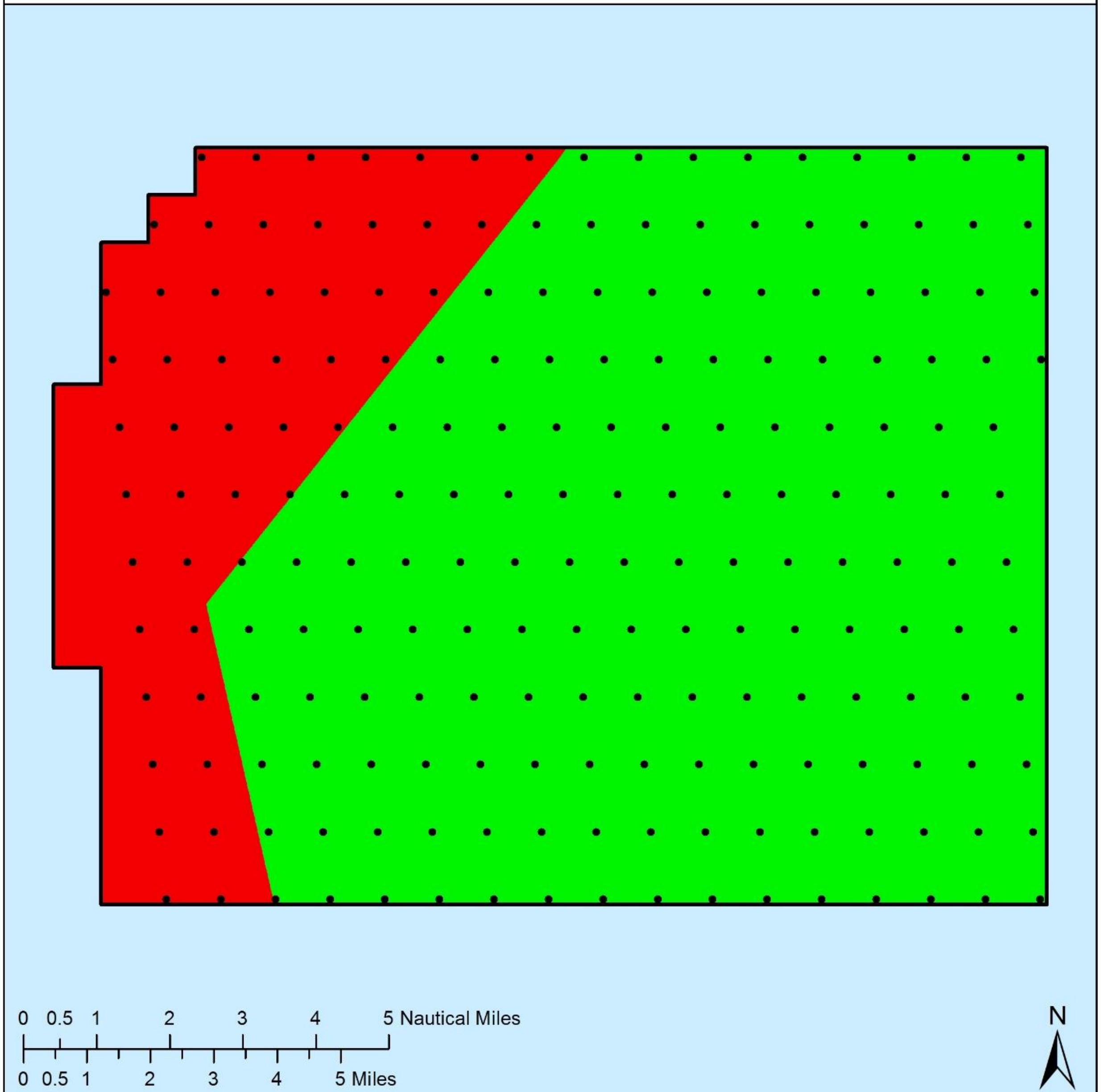
Coordinate System:
NAD 1983 UTM Zone 18N

Wesley Williamson

Figure 12

Capitol Airspace Group

Proposed structures that exceed 14 CFR Part 77.17(a)(1) - a height of 499 feet AGL at the site of the object - will be identified as obstructions regardless of location.



Clearance

Height - AMSL Feet

- < 820
- ≥ 820 < 853
- ≥ 853
- Project Boundary
- Proposed Wind Turbine

All heights above mean sea level (AMSL)

Dominion CVOW Project
Above Mean Sea Level (AMSL) Clearance Map

Plot Date:
30 September 2020

Coordinate System:
NAD 1983 UTM Zone 18N

Wesley Williamson

Figure 13

Capitol Airspace Group

DOMINION ENERGY

COASTAL VIRGINIA OFFSHORE WIND (CVOW) COMMERCIAL PROJECT

RADAR AND NAVIGATIONAL AID SCREENING STUDY

OCTOBER 19, 2021

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INTRODUCTION

The Dominion Energy CVOW Commercial Project consists of up to 205 proposed wind turbines off the coast of Virginia. This report provides the results of a radar and navigational aid screening study conducted by Westslope Consulting, LLC (Westslope) for the proposed wind turbines and a study area encompassing the proposed wind turbines using blade-tip heights of 820 feet above ground level (AGL) and 869 feet AGL.

This study includes the following:

- An initial analysis using the Department of Defense (DoD) Preliminary Screening Tool (PST);
- Research into other radar sites and Very High Frequency Omnidirectional Range (VOR) navigational aid sites near the proposed wind turbines;
- An Air Route Surveillance Radar (ARSR) and Airport Surveillance Radar (ASR) line-of-sight (LOS) analysis;
- A Relocatable Over-the Horizon Radar (ROTHR) screening analysis;
- An Advanced Dynamic Aircraft Measurement System (ADAMS) screening analysis;
- A VOR screening analysis;
- A Next Generation Radar (NEXRAD) weather radar screening analysis; and
- A coastal High Frequency (HF) radar LOS analysis.

ANALYSIS

DoD Preliminary Screening Tool

Westslope conducted an initial analysis for Long Range Radar (LRR) and NEXRAD using the DoD PST on the Federal Aviation Administration (FAA) Obstruction Evaluation/Airport Airspace Analysis website.[1] This analysis provides a cursory indication of whether wind turbines may be within line-of-sight of one or more radar sites, and likely to affect radar performance.

The PST LRR analysis accounts for ARSR sites and ASR sites used for air defense by the DoD at the North American Aerospace Defense Command and for homeland security by the Customs and Border Protection Air and Marine Operations Center.[2] Further, the PST NEXRAD analysis accounts for DoD, FAA, and National Oceanic and Atmospheric Administration (NOAA) Weather Surveillance Radar model-88 Doppler (WSR-88D) sites.[3] The PST does not account for all DoD, Department of Homeland Security (DHS), or FAA ground-based radar sites, including ROTHR sites, tethered aerostat radar sites, or FAA Terminal Doppler Weather Radar sites.

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[1] See http://oeaaa.faa.gov.
[2] For LRR, the PST uses a buffered line-of-sight analysis at a blade-tip height of 750 feet AGL.
[3] For NEXRAD, the PST uses a blade-tip height of 160 meters AGL (525 feet AGL).

The PST is helpful for identifying potential impacts to LRR and NEXRAD; however, the results are preliminary, as suggested by the title of the PST, and do not provide an official decision as to whether impacts are acceptable to operations.

Please note that the PST NEXRAD analysis does not account for blade-tip heights greater than 525 feet AGL, does not account for WSR-88D sites authorized to scan at elevation angles below 0.5 degrees, and does not reflect the wind farm impact zone scheme updated in 2018 by the NOAA WSR-88D Radar Operations Center (ROC). The updated scheme expands the red area, or “No Build Zone,” from three to four kilometers (km) and to areas where wind turbines penetrate the third elevation angle scanned by a WSR-88D.

Based on the study area, Westslope created a single point and a four-point polygon for PST analysis purposes.

The PST single point and the polygon analysis results for LRR show that the 205 proposed wind turbines fall within multiple yellow areas. A yellow area indicates that impacts are likely to air defense and homeland security radar. See Figure 1, where the black rotor represents the single point, the black line represents the polygon, the black dots represent the proposed wind turbines, and the red line represents the study area.

Westslope identified the closest four radar sites in the PST LRR results as the Naval Air Station (NAS) Oceana Airport Surveillance Radar model-11 (ASR-11), Norfolk Airport Surveillance Radar model-9 (ASR-9), Oceana Air Route Surveillance Radar model-4 (ARSR-4), and the Wallops Island Airport Surveillance Radar model-8 (ASR-8). In addition to the DoD and DHS using these radar sites for air defense and homeland security, the DoD uses the NAS Oceana ASR-11 for air traffic control at the NAS Oceana Radar Air Traffic Control Facility (RATCF) and the FAA uses the Norfolk ASR-9 and the Oceana ARSR-4 for air traffic control at the Norfolk Terminal Radar Approach Control and the Washington Air Route Traffic Control Center (ARTCC).

For NEXRAD, the PST analysis results for the single point and the polygon show that the 205 proposed wind turbines fall within a green area. A green area, or “No Impact Zone,” indicates that impacts are not likely to WSR-88D operations. Please note that blue and grey areas also represent green areas in the PST NEXRAD results. See Figure 2. Westslope identified the closest two radar sites in the PST NEXRAD results as the Dover Air Force Base (AFB) WSR-88D and the Norfolk WSR-88D.

Research conducted by Westslope shows that the lowest elevation angle scanned by the Dover AFB WSR-88D and the Norfolk WSR-88D is 0.5 degrees.

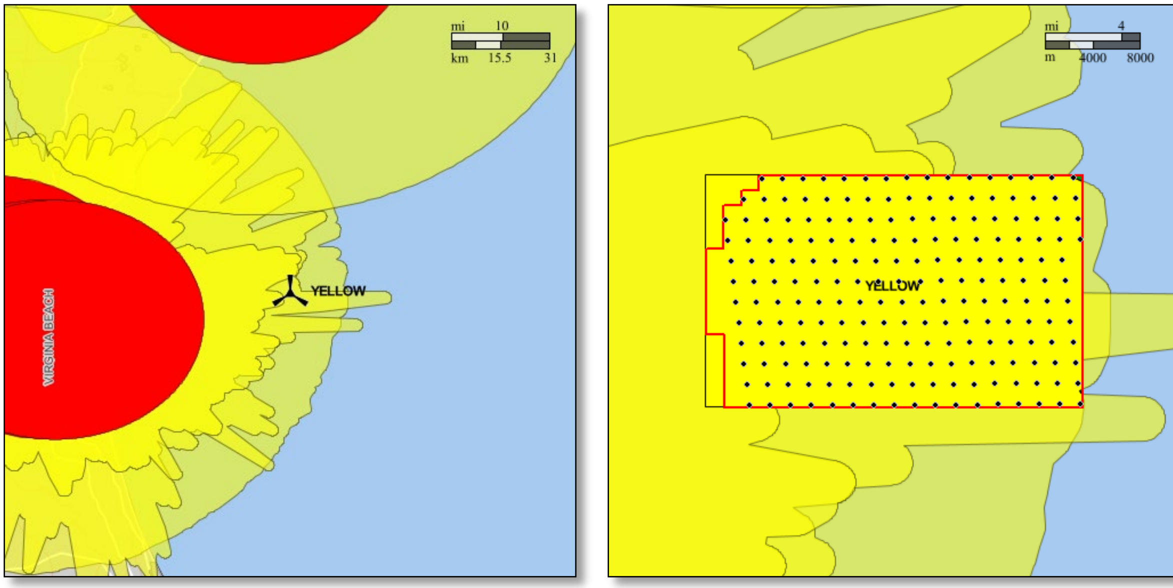

Figure 1 Long Range Radar Results for the Single Point (left) and for the Polygon (right)

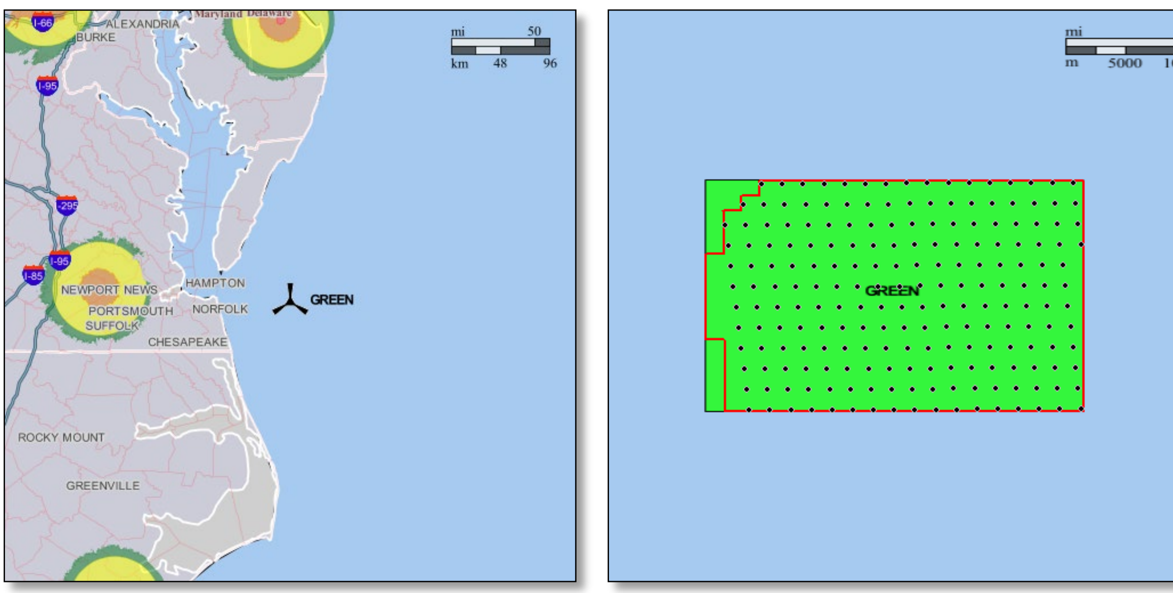

Figure 2 NEXRAD Results for the Single Point (left) and for the Polygon (right)

Other ARSR and ASR Sites

Research conducted by Westslope identified the following three additional ARSR and ASR sites near the proposed wind turbines:

- Binns Hall Common Air Route Surveillance Radar (CARSR);
- Dover AFB Digital Airport Surveillance Radar (DASR); and
- NAS Patuxent River ASR-11.

The FAA uses the Binns Hall CARSR for air traffic control at the Washington ARTCC. The DoD uses the Dover AFB DASR for air traffic control at the Dover AFB Radar Approach Control and uses the NAS Patuxent River ASR-11 at the NAS Patuxent River RATCF.

Co-Located Secondary Surveillance Radar

Research conducted by Westslope identified the following secondary surveillance radar systems co-located with the ARSR and ASR systems:

- An Air Traffic Control Beacon Interrogator model-6 is co-located with the Binns Hall CARSR and the Oceana ARSR-4;
- An AN/UPX-27 is co-located with the Wallops Island ASR-8;
- A Mode S is co-located with the Norfolk ASR-9; and
- A Monopulse Secondary Surveillance Radar is co-located with the Dover AFB DASR, NAS Oceana ASR-11, and the NAS Patuxent River ASR-11.

In general, secondary surveillance radar systems are less susceptible to interference from wind turbines than primary surveillance radar systems, such as the ARSR and ASR systems.

ROTHR

Research conducted by Westslope identified the Virginia ROTHR near the proposed wind turbines.

The DoD uses this radar site at the United States Southern Command for drug interdiction.

ADAMS

Research conducted by Westslope identified the ADAMS radar facility near the proposed wind turbines.

The DoD uses the ADAMS at the Atlantic Test Range on the NAS Patuxent River for radar cross section measurements.

VOR Sites

Research conducted by Westslope identified the following three navigational aid sites near the proposed wind turbines:

- Cape Charles VOR and co-located Tactical Air Navigation system (VORTAC);
- Norfolk VORTAC; and
- Oceana Tactical Air Navigation system (TACAN).

Correspondence with the FAA indicates that the Cape Charles VORTAC is a conventional VOR and the Norfolk VORTAC is a Doppler VOR.

In general, conventional VORs are more susceptible than Doppler VORs to interference from wind turbines.

HF Radar Sites

Research conducted by Westslope identified the following seven HF radar sites near the proposed wind turbines:

- Assateague Island HF radar;
- Cedar Island HF radar;
- Duck HF radar;
- First Landing State Park HF radar;
- Little Island Park HF radar;
- Ocean View Beach HF radar; and
- Sunset Beach Resort HF radar.

The Assateague Island HF radar, Cedar Island HF radar, First Landing State Park HF radar, Little Island Park HF radar, Ocean View Beach HF radar, and the Sunset Beach Resort HF radar are operated by Old Dominion University. The Duck HF radar is operated by the University of North Carolina.

Various federal agencies in partnership with NOAA's Integrated Ocean Observing System (IOOS) use the ocean surface current and wave data provided by these HF radar sites in support of multiple missions.

ARSR and ASR LOS Analysis

Westslope conducted an ARSR and ASR LOS analysis using a 4/3 earth's radius model and the United States Geological Survey (USGS) 10-meter National Elevation Dataset (NED). A 4/3 earth's radius model accounts for the refraction of radio waves as these waves propagate through the lowest layer of the atmosphere under standard atmospheric conditions. This analysis shows whether wind turbines at blade-tip heights of 820 feet AGL or 869 feet AGL will be within line-of-sight of one or more ARSR or ASR sites.

Westslope conducted the LOS analysis for the following seven ARSR and ASR sites:

- Binns Hall CARSR;
- Dover AFB DASR;
- NAS Oceana ASR-11;
- NAS Patuxent River ASR-11;
- Norfolk ASR-9;
- Oceana ARSR-4; and
- Wallops Island ASR-8.

The proposed wind turbines are beyond the instrumented range of the Dover AFB DASR and the NAS Patuxent River ASR-11. As such, no additional analysis was considered necessary for these radar sites.

<u>Binns Hall CARSR</u>

The LOS analysis results show that the 205 proposed wind turbines will not be within line-of-sight of and will not interfere with the Binns Hall CARSR at blade-tip heights of 820 feet AGL or 869 feet AGL. As a result, Westslope does not expect any radar effects at or below these blade-tip heights.

<u>NAS Oceana ASR-11</u>

The LOS analysis results show that all 205 proposed wind turbines will be within line-of-sight of and will interfere with the NAS Oceana ASR-11 at blade-tip heights of 820 feet AGL and 869 feet AGL. See Figure 3. The radar effects will include unwanted radar returns (clutter) resulting in a partial loss of primary target detection and a number of false primary targets over and in the immediate vicinity of the proposed wind turbines. Other radar effects include a partial loss of weather detection and false weather indications over and in the immediate vicinity of the proposed wind turbines.

<u>Norfolk ASR-9</u>

The LOS analysis results show that 196 of the 205 proposed wind turbines will be within line-of-sight of and will interfere with the Norfolk ASR-9 at a blade-tip height of 820 feet AGL. At a blade-tip height of 869 feet AGL, 201 of the 205 proposed wind turbines will be within line-of-sight of and will interfere with this radar site. See Figure 4. The radar effects will include clutter resulting in a partial loss of primary target detection and a number of false primary targets over and in the immediate vicinity of the proposed wind turbines within line-of-sight. Other radar effects include a partial loss of weather detection and false weather indications over and in the immediate vicinity of the proposed wind turbines within line-of-sight.

Oceana ARSR-4

The LOS analysis results show that all 205 proposed wind turbines will be within line-of-sight of and will interfere with the Oceana ARSR-4 at blade-tip heights of 820 feet AGL and 869 feet AGL. See Figure 5. The radar effects will include clutter resulting in a partial loss of primary target detection and a number of false primary targets over and in the immediate vicinity of the proposed wind turbines.

Wallops Island ASR-8

The LOS analysis results show that the 205 proposed wind turbines will not be within line-of-sight of and will not interfere with the Wallops Island ASR-8 at blade-tip heights of 820 feet AGL or 869 feet AGL. As a result, Westslope does not expect any radar effects at or below these blade-tip heights.

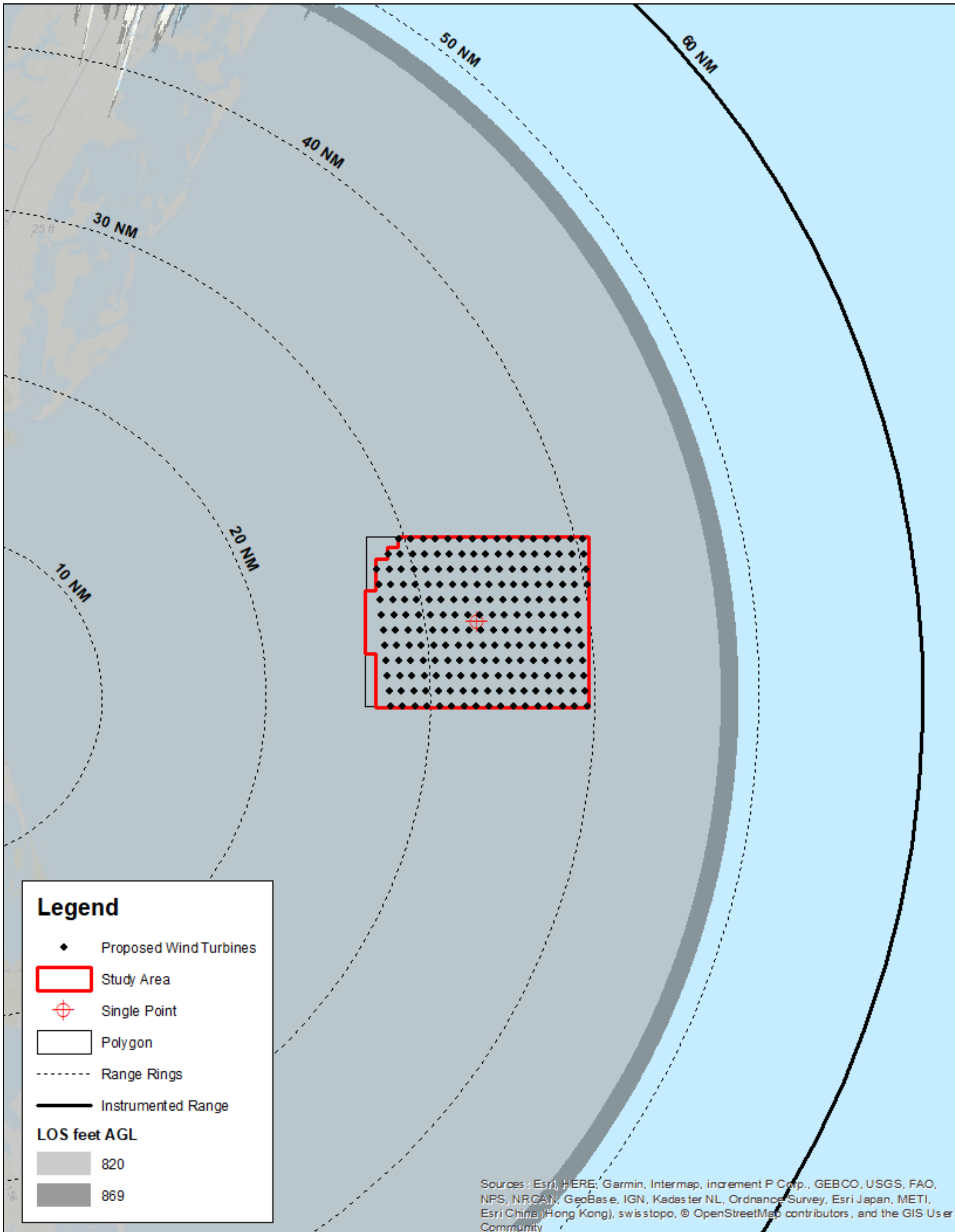

Figure 3 LOS Analysis Results for the NAS Oceana ASR-11 using 10-meter NED

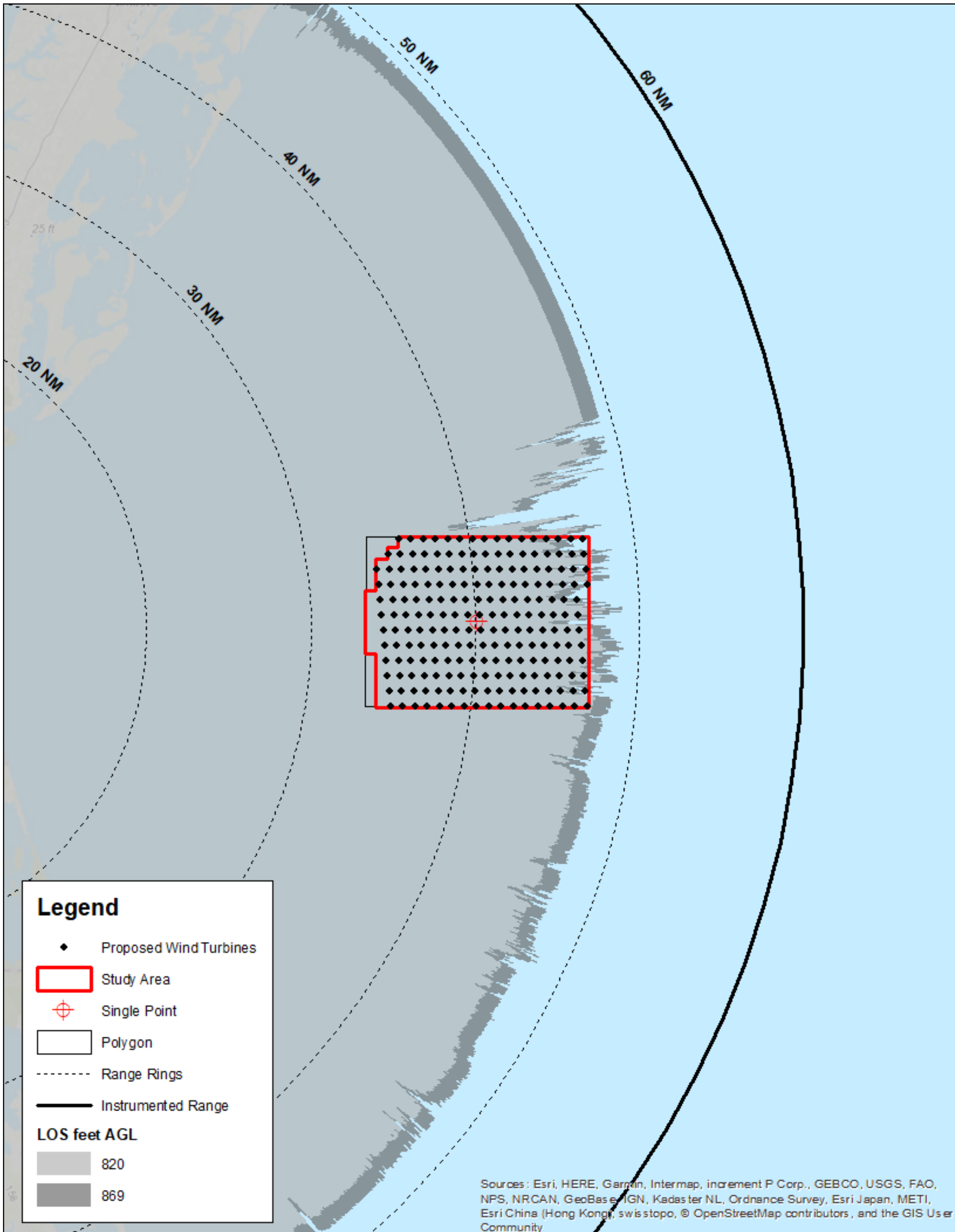

Figure 4 LOS Analysis Results for the Norfolk ASR-9 using 10-meter NED

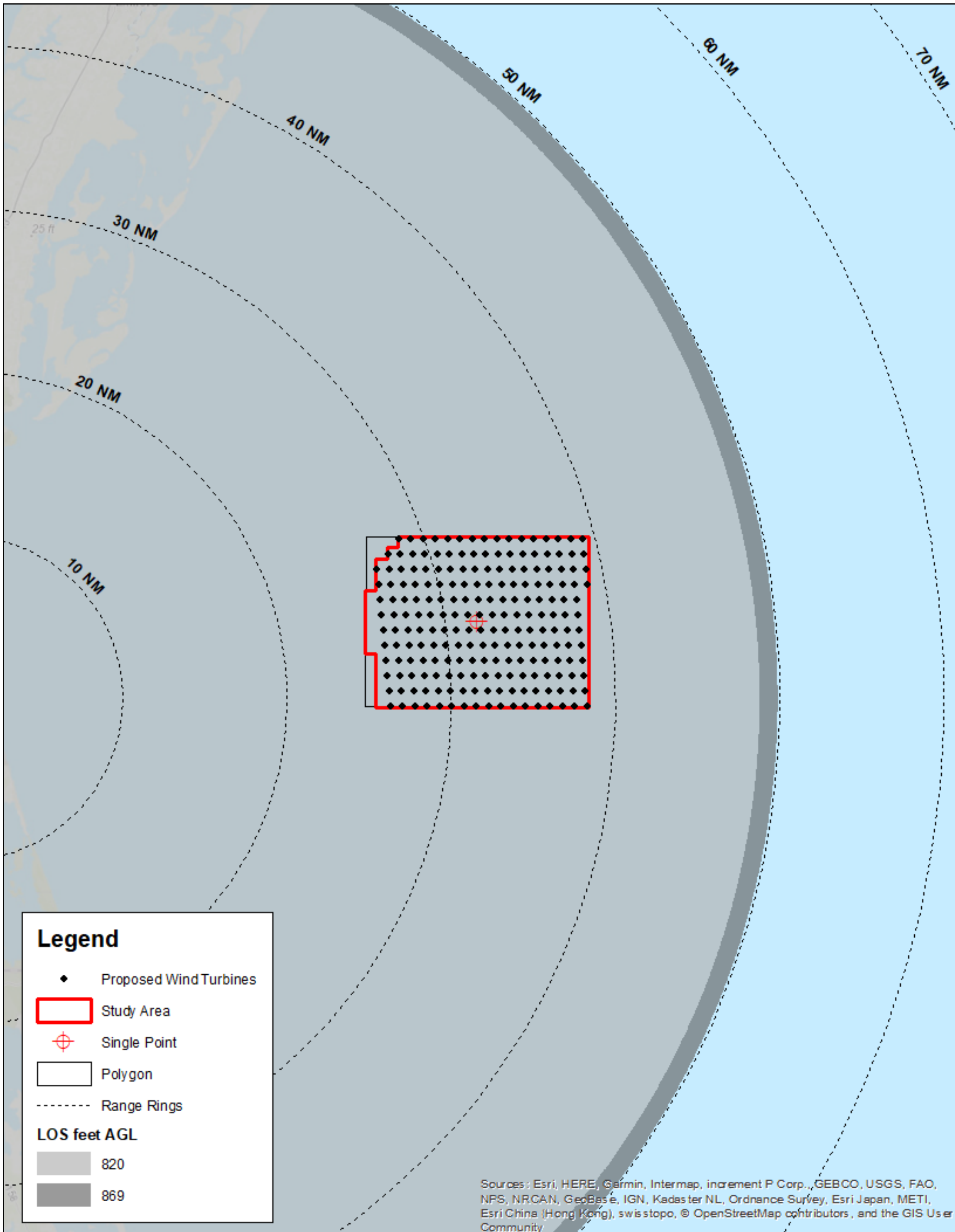

Figure 5 LOS Analysis Results for the Oceana ARSR-4 using 10-meter NED

ROTHR Screening Analysis

Westslope conducted a screening analysis for the ROTHR. This analysis includes a review of the counties identified by the DoD as a concern for the ROTHR and shows whether wind turbines will fall within the azimuth sectors scanned by the ROTHR transmit and receive sites.

Virginia ROTHR

The ROTHR screening analysis results show that the 205 proposed wind turbines will not fall within the impacted counties for the Virginia ROTHR. The results also show that 45 of the 205 proposed wind turbines will fall within the azimuth sector scanned by the Virginia ROTHR transmit site. See Figure 6. As such, it is possible that the DoD will have concerns with the proposed wind turbines based on potential interference to this radar site. The 205 proposed wind turbines will not fall within the azimuth sector scanned by the Virginia ROTHR receive site. See Figure 7.

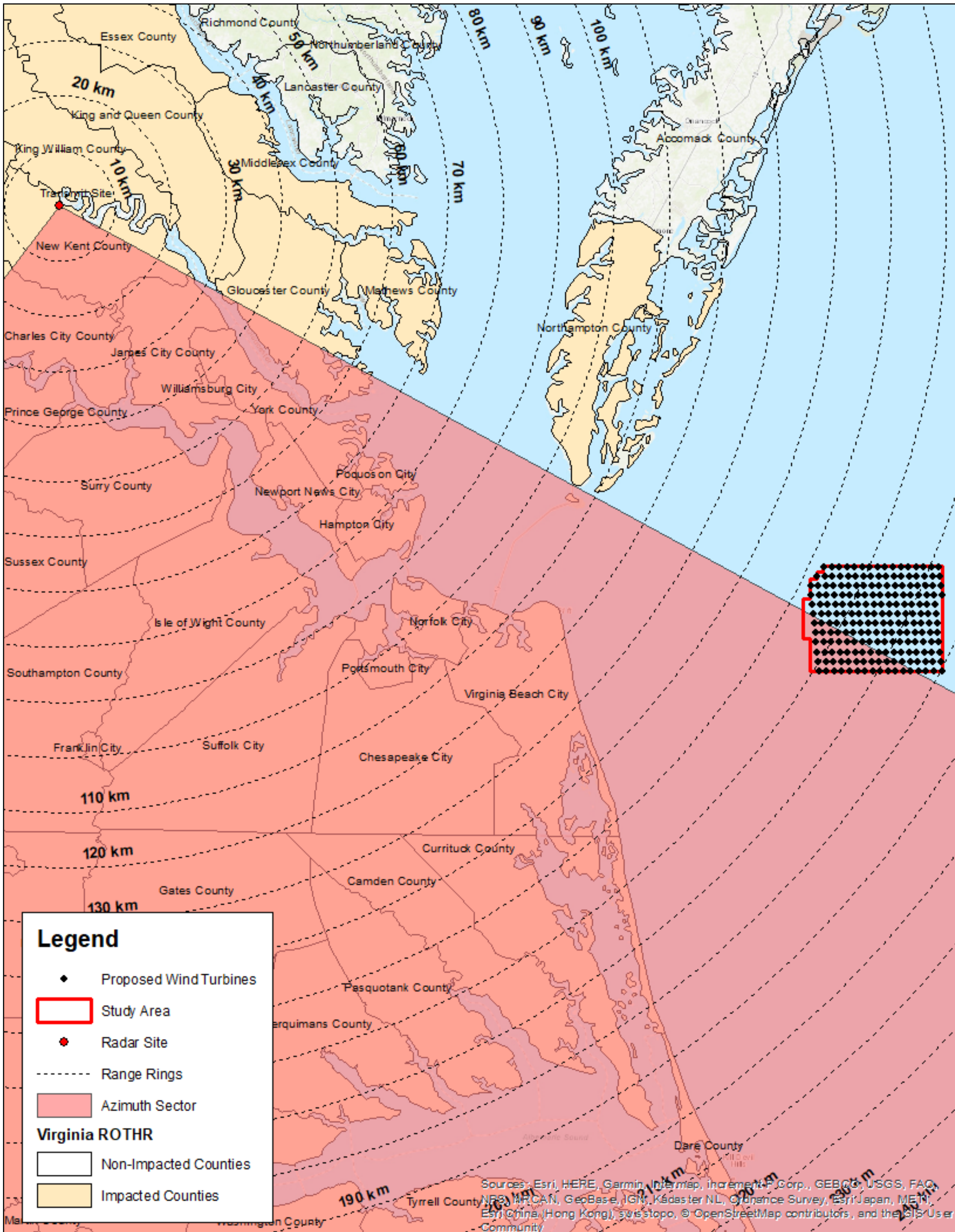

Figure 6 Virginia ROTHR Transmit Site Counties of Concern and Azimuth Sector

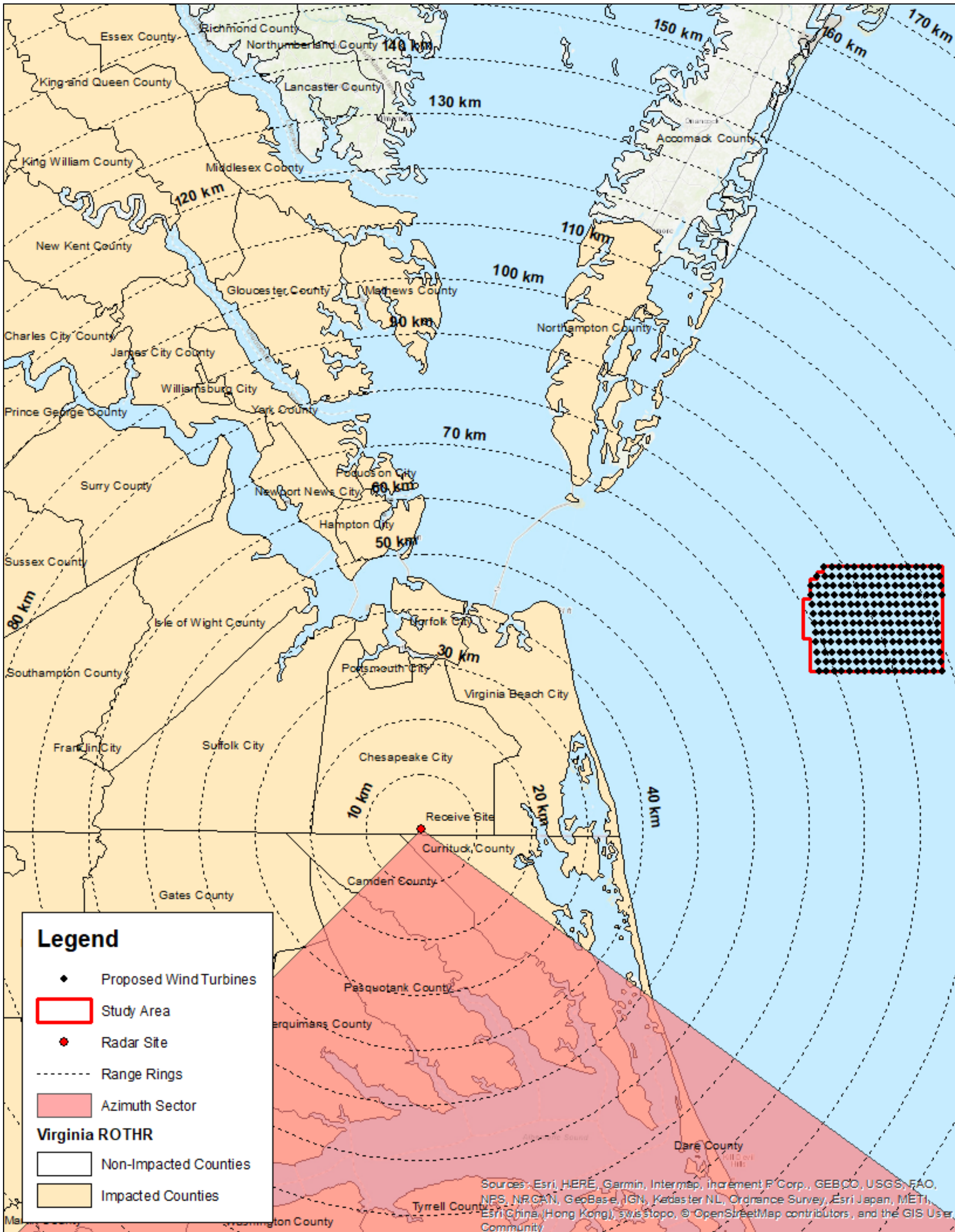

Figure 7 Virginia ROTHR Receive Site Counties of Concern and Azimuth Sector

ADAMS Screening Analysis

Westslope conducted a screening analysis for the ADAMS using a 4/3 earth's radius model and USGS 10-meter NED. Westslope's analysis shows whether wind turbines at blade-tip heights of 820 feet AGL or 869 feet AGL will be within line-of-sight of the ADAMS and reviews whether the proposed wind turbines will fall within the proposed NAS Patuxent River Geographic Area of Concern (GAOC). [1][2]

The ADAMS screening analysis results show that the 205 proposed wind turbines will not be within line-of-sight of and will not interfere with the ADAMS at blade-tip heights of 820 feet AGL or 869 feet AGL under standard atmospheric conditions. See Figure 8. The results also show that all 205 proposed wind turbines will fall within the "ducting impact region" of the GAOC. The ducting impact region represents an area where radio waves can propagate further than line-of-sight under standard atmospheric conditions. See Figures 9 and 10.

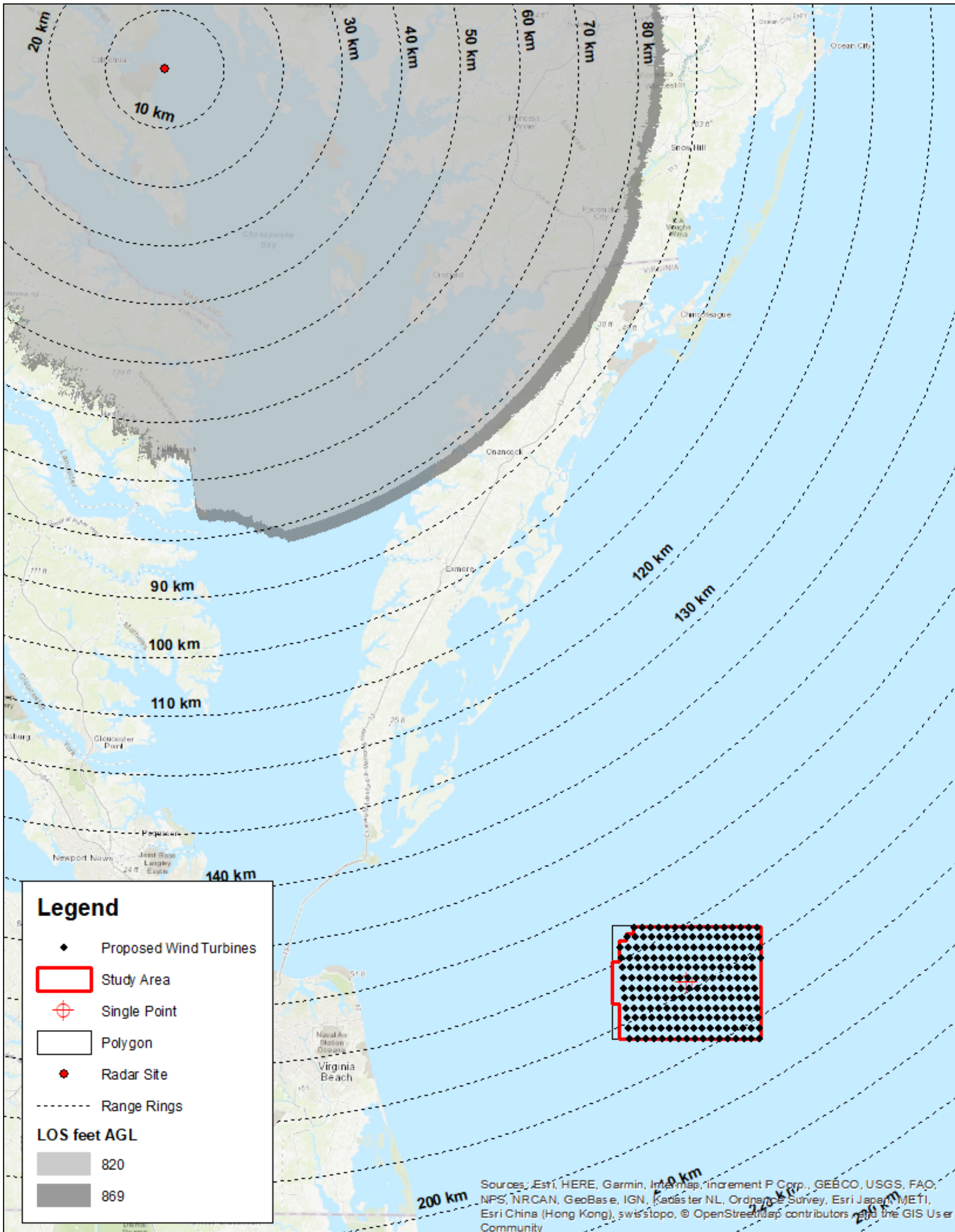

Figure 8 LOS Analysis Results for the ADAMS using 10-meter NED

Figure 9 NAS Patuxent River Area GAOC

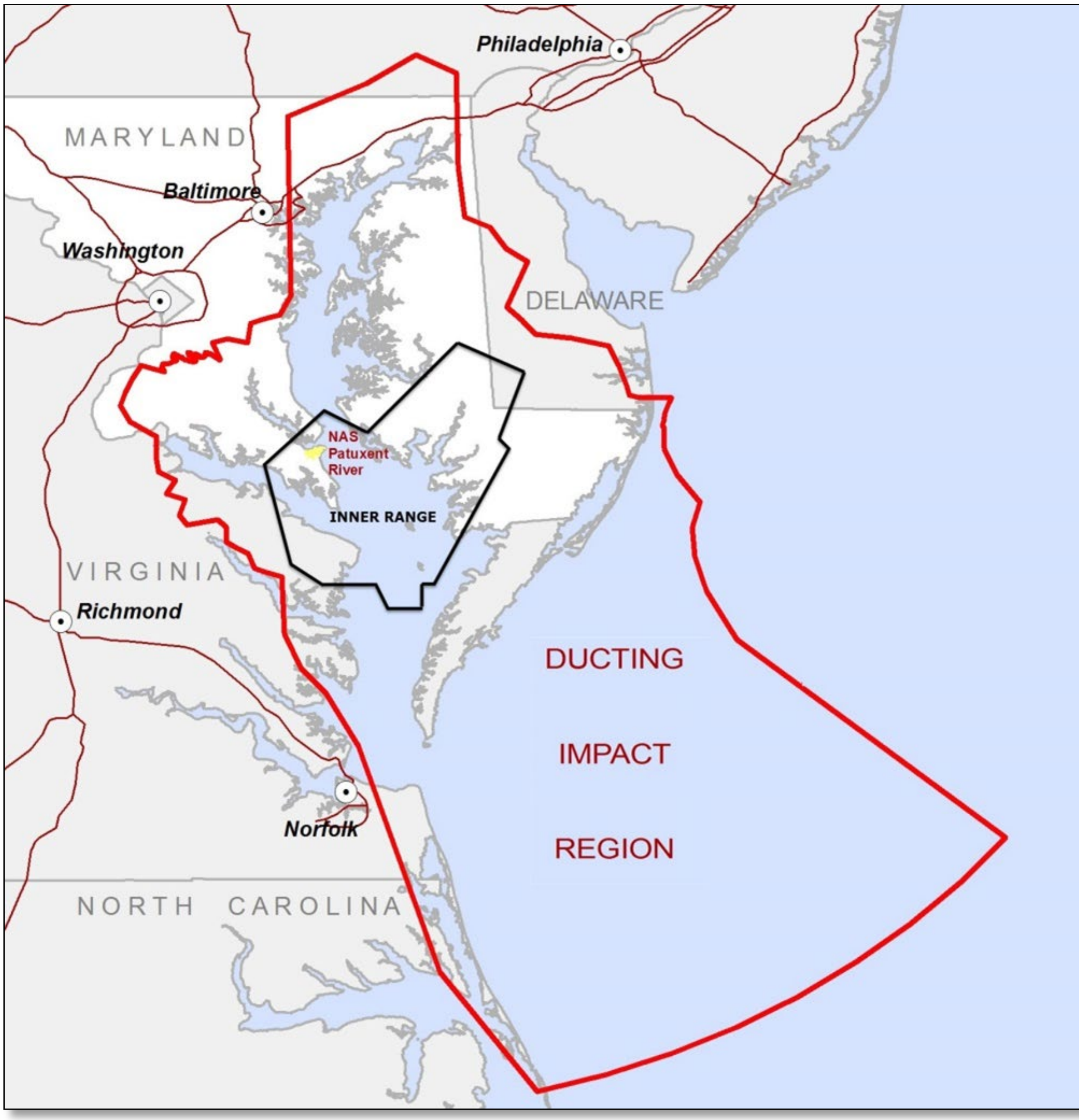

Figure 10 Ducting Impact Region

VOR Screening Analysis

Westslope conducted a VOR screening analysis using USGS 10-meter NED. This analysis shows whether the proposed wind turbines (1) are less than or equal to 8 nautical miles (NM) from a VOR site; (2) will subtend elevation angles greater than 0.60 degrees from the base elevation of a conventional VOR at blade-tip heights of 820 feet AGL or 869 feet AGL, or 0.75 degrees for a Doppler VOR; and (3) will fall within line-of-sight of a VOR site. This screening analysis provides a cursory indication of whether the proposed wind turbines may affect VOR performance and is similar to the FAA's analysis approach for VOR sites. The same criteria will also protect for TACANs.

Westslope conducted the VOR screening analysis for the following three navigational aid sites:

- Cape Charles VORTAC;
- Norfolk VORTAC; and
- Oceana TACAN.

The 205 proposed wind turbines are greater than 8 NM from the Cape Charles VORTAC, Norfolk VORTAC, and the Oceana TACAN. As such, no additional analysis was considered necessary for these navigational aid sites.

NEXRAD Weather Radar Screening Analysis

The PST NEXRAD analysis does not account for blade-tip heights greater than 525 feet AGL, does not account for WSR-88D sites authorized to scan at elevation angles below 0.5 degrees, and does not reflect the wind farm impact zone scheme updated in 2018 by the NOAA WSR-88D ROC. The updated scheme expands the red area, or “No Build Zone,” from three to four kilometers and to areas where wind turbines penetrate the third elevation angle scanned by a WSR-88D.

Westslope conducted a NEXRAD weather radar screening analysis using a 4/3 earth’s radius model and USGS 10-meter NED. This analysis shows whether wind turbines at blade-tip heights of 820 feet AGL or 869 feet AGL will be within line-of-sight of one or more WSR-88D sites and incorporates the updated wind farm impact zone scheme.

Westslope conducted the NEXRAD weather radar screening analysis for the following two radar sites:

- Dover AFB WSR-88D; and
- Norfolk WSR-88D.

Research conducted by Westslope shows that the lowest elevation angle scanned by the Dover AFB WSR-88D and the Norfolk WSR-88D is 0.5 degrees.

<u>Dover AFB WSR-88D</u>

Westslope’s NEXRAD weather radar screening analysis shows that the 205 proposed wind turbines will not be within line-of-sight of and will not interfere with the Dover AFB WSR-88D at blade-tip heights of 820 feet AGL or 869 feet AGL. The results also show that the 205 proposed wind turbines at blade-tip heights of 820 feet AGL and 869 feet AGL will fall within a NOAA green area for this radar site. A green area, or “No Impact Zone,” indicates that impacts are not likely to WSR-88D operations. See Figures 11 and 12.

<u>Norfolk WSR-88D</u>

Westslope’s NEXRAD weather radar screening analysis shows that the 205 proposed wind turbines will not be within line-of-sight of and will not interfere with the Norfolk WSR-88D at blade-tip heights of 820 feet AGL or 869 feet AGL. The results also show that the 205 proposed wind turbines at blade-tip heights of 820 feet AGL and 869 feet AGL will fall within a NOAA green No Impact Zone for this radar site. See Figures 13 and 14.

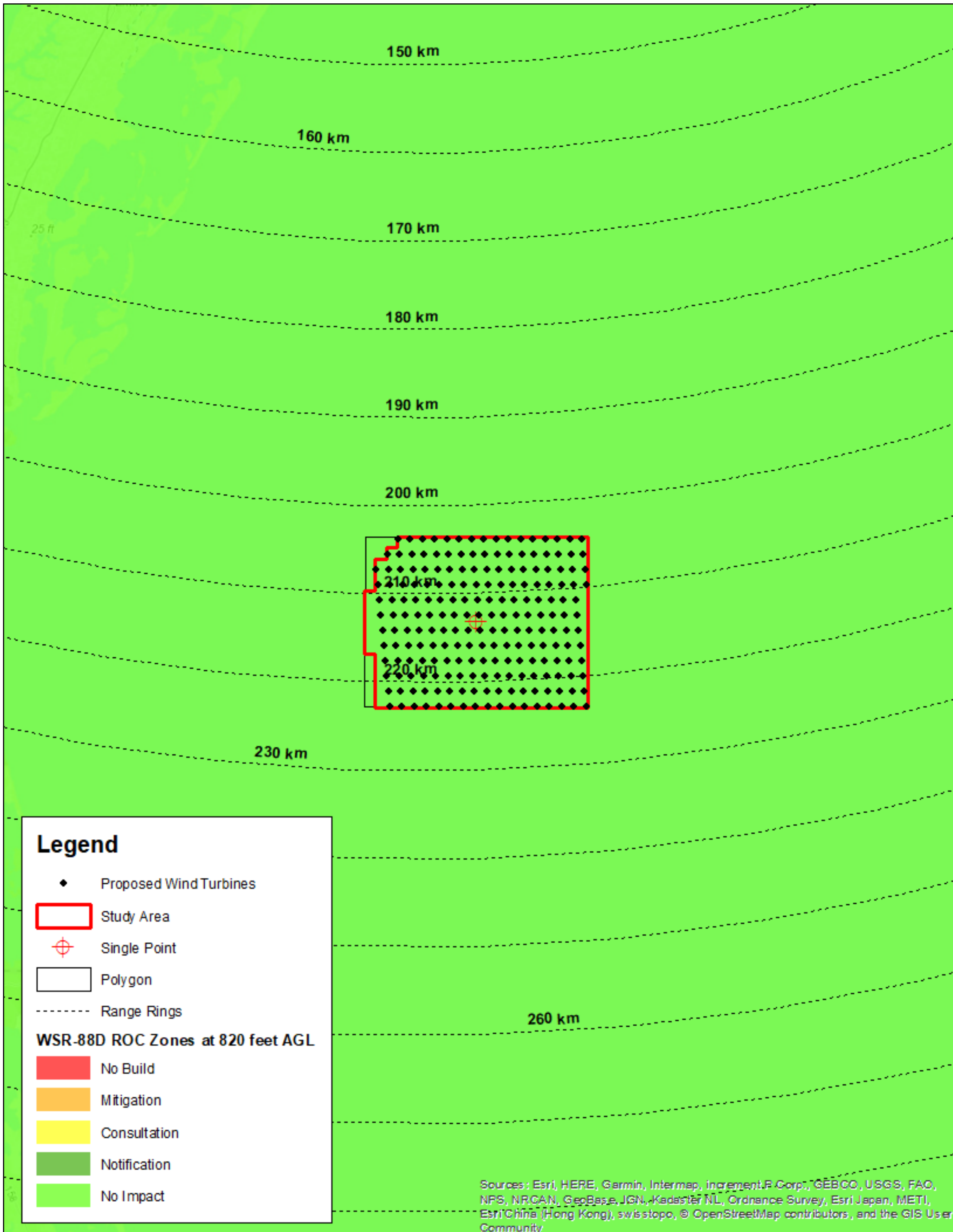

Figure 11 WSR-88D ROC Zone Results at 820 feet AGL for the Dover AFB WSR-88D using 10-meter NED

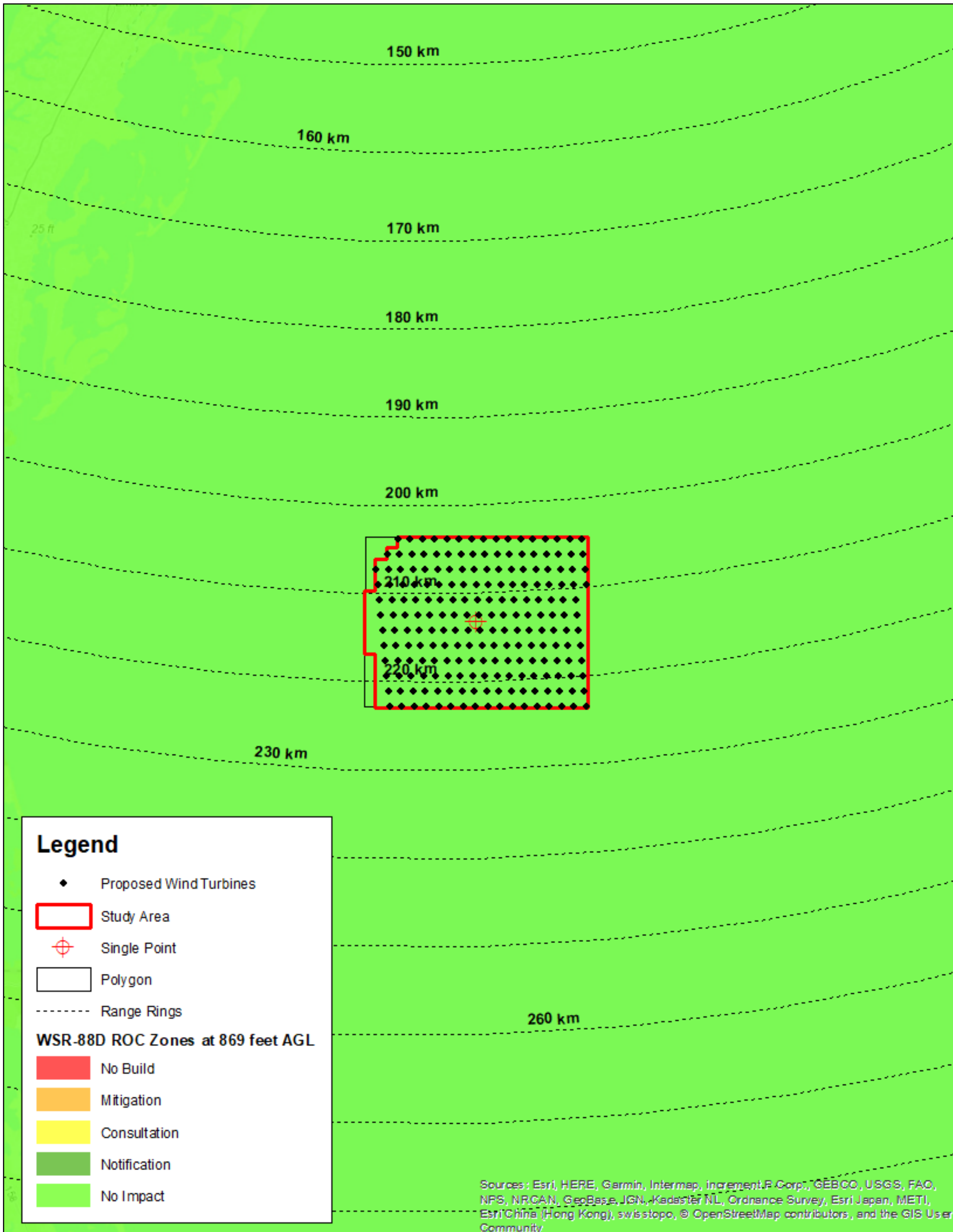

Figure 12 WSR-88D ROC Zone Results at 869 feet AGL for the Dover AFB WSR-88D using 10-meter NED

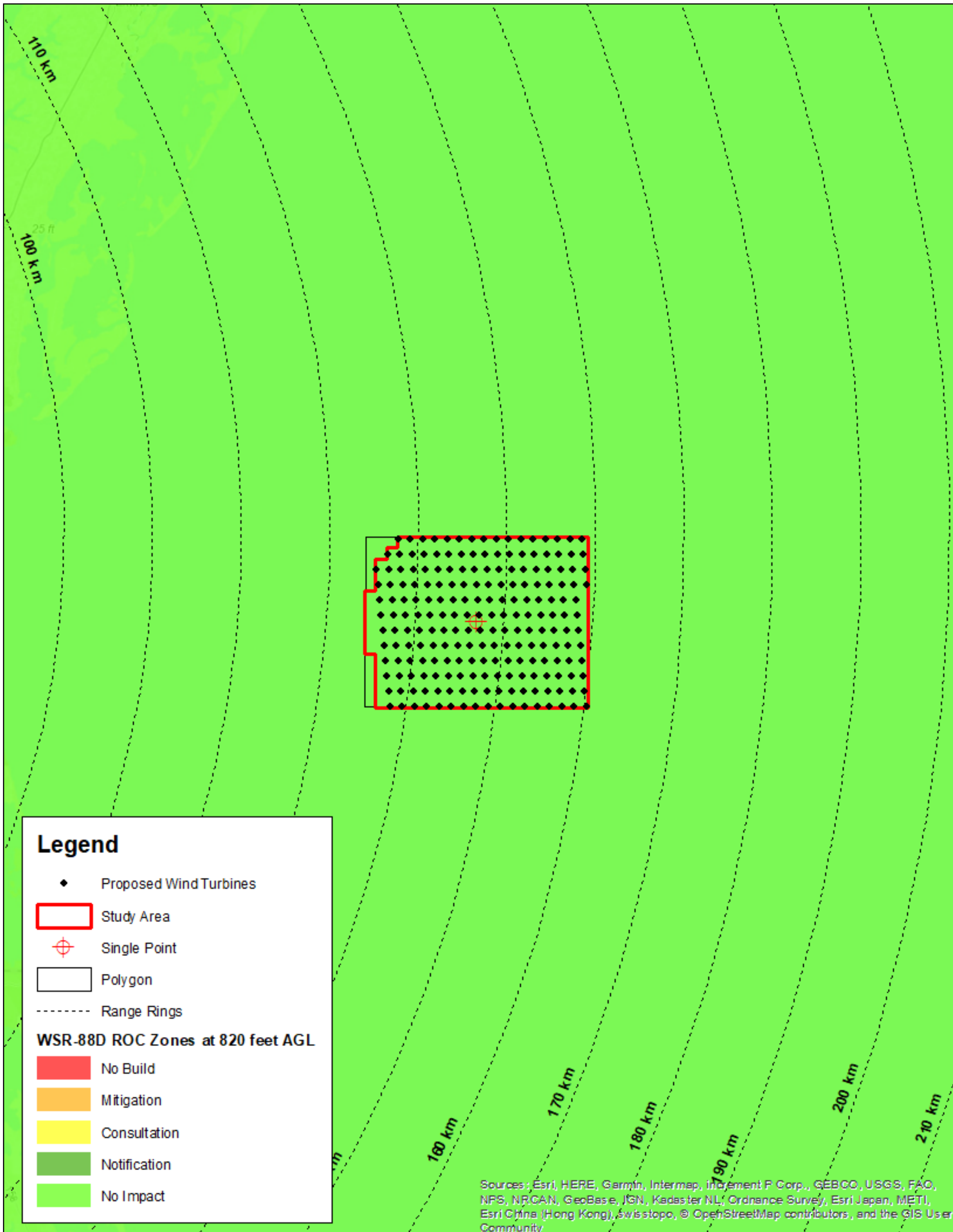

Figure 13 WSR-88D ROC Zone Results at 820 feet AGL for the Norfolk WSR-88D using 10-meter NED

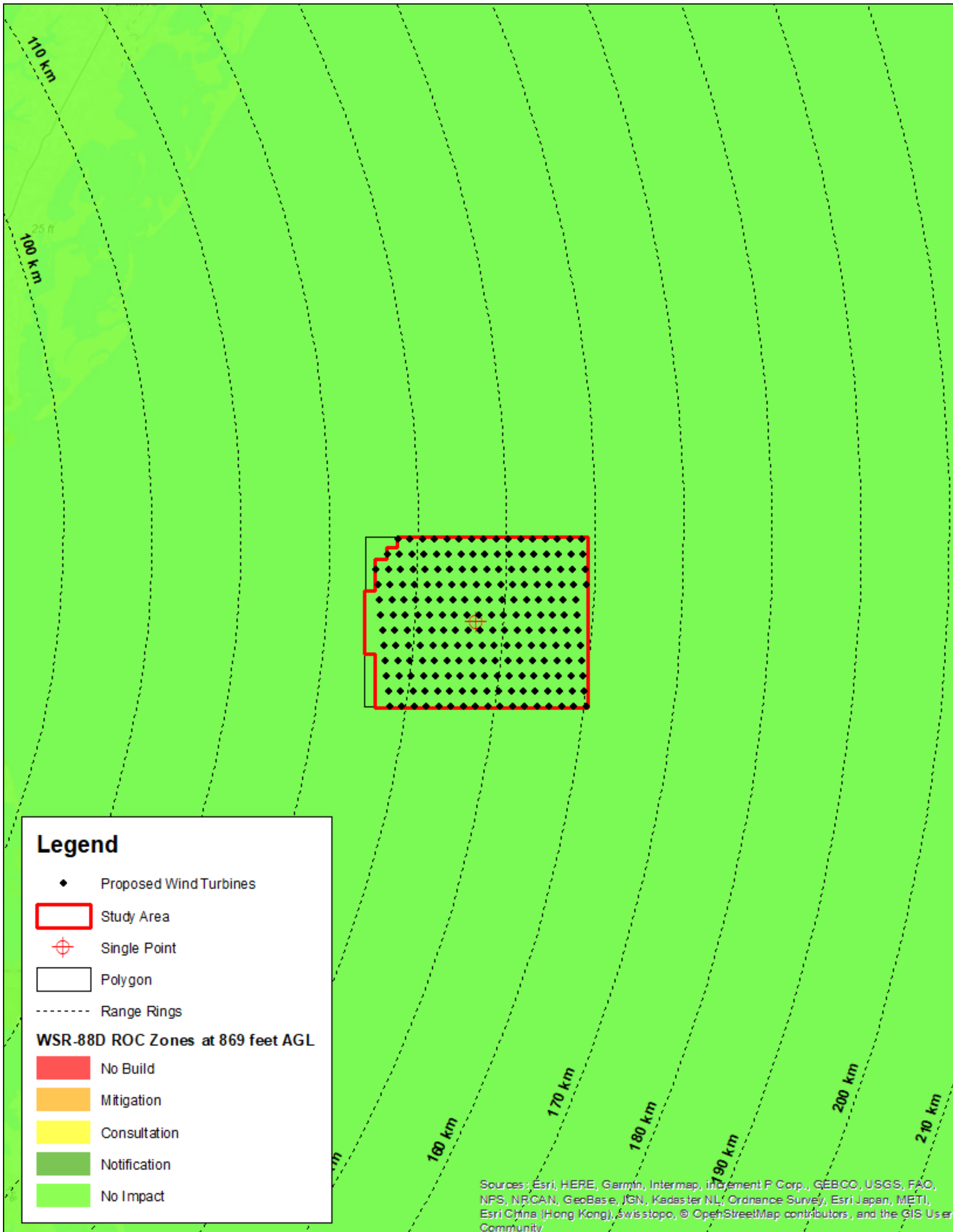

Figure 14 WSR-88D ROC Zone Results at 869 feet AGL for the Norfolk WSR-88D using 10-meter NED

HF Radar LOS Analysis

Westslope conducted an HF radar LOS analysis using a 4/3 earth's radius model and USGS 10-meter NED. This analysis shows whether wind turbines at blade-tip heights of 820 feet AGL or 869 feet AGL will be within line-of-sight of one or more HF radar sites.

Westslope conducted the LOS analysis for the following seven HF radar sites:

- Assateague Island HF radar;
- Cedar Island HF radar;
- Duck HF radar;
- First Landing State Park HF radar;
- Little Island Park HF radar;
- Ocean View Beach HF radar; and
- Sunset Beach Resort HF radar.

The proposed wind turbines are beyond the instrumented range of the First Landing State Park HF radar, Ocean View Beach HF radar, and the Sunset Beach Resort HF radar. As such, no additional analysis was considered necessary for these radar sites.

Assateague Island HF Radar

The LOS analysis results show that the 205 proposed wind turbines will not be within line-of-sight of the Assateague Island HF radar at blade-tip heights of 820 feet AGL or 869 feet AGL. See Figure 15. Although the proposed wind turbines will not be within line-of-sight of this radar site, radar effects are still possible beyond line-of-sight due to the propagation of HF electromagnetic waves over the ocean surface.

Cedar Island HF Radar

The LOS analysis results show that the 205 proposed wind turbines will not be within line-of-sight of the Cedar Island HF radar at blade-tip heights of 820 feet AGL or 869 feet AGL. See Figure 16. Although the proposed wind turbines will not be within line-of-sight of this radar site, radar effects are still possible beyond line-of-sight due to the propagation of HF electromagnetic waves over the ocean surface.

Duck HF Radar

The LOS analysis results show that nine of the 205 proposed wind turbines will be within line-of-sight of the Duck HF radar at a blade-tip height of 820 feet AGL. At a blade-tip height of 869 feet AGL, 19 of the 205 proposed wind turbines will be within line-of-sight of this radar site. See Figure 17. The radar effects will include clutter in the vicinity of the proposed wind turbines within line-of-sight and possibly in the vicinity of the proposed wind turbines beyond line-of-sight due to the propagation of HF electromagnetic waves over the ocean surface. As a result, impacts to Duck HF radar operations are possible.

Little Island Park HF Radar

The LOS analysis results show that all 205 proposed wind turbines will be within line-of-sight of the Little Island Park HF radar at blade-tip heights of 820 feet AGL and 869 feet AGL. See Figure 18. The radar effects will include clutter in the vicinity of the proposed wind turbines. As a result, impacts to Little Island Park HF radar operations are possible.

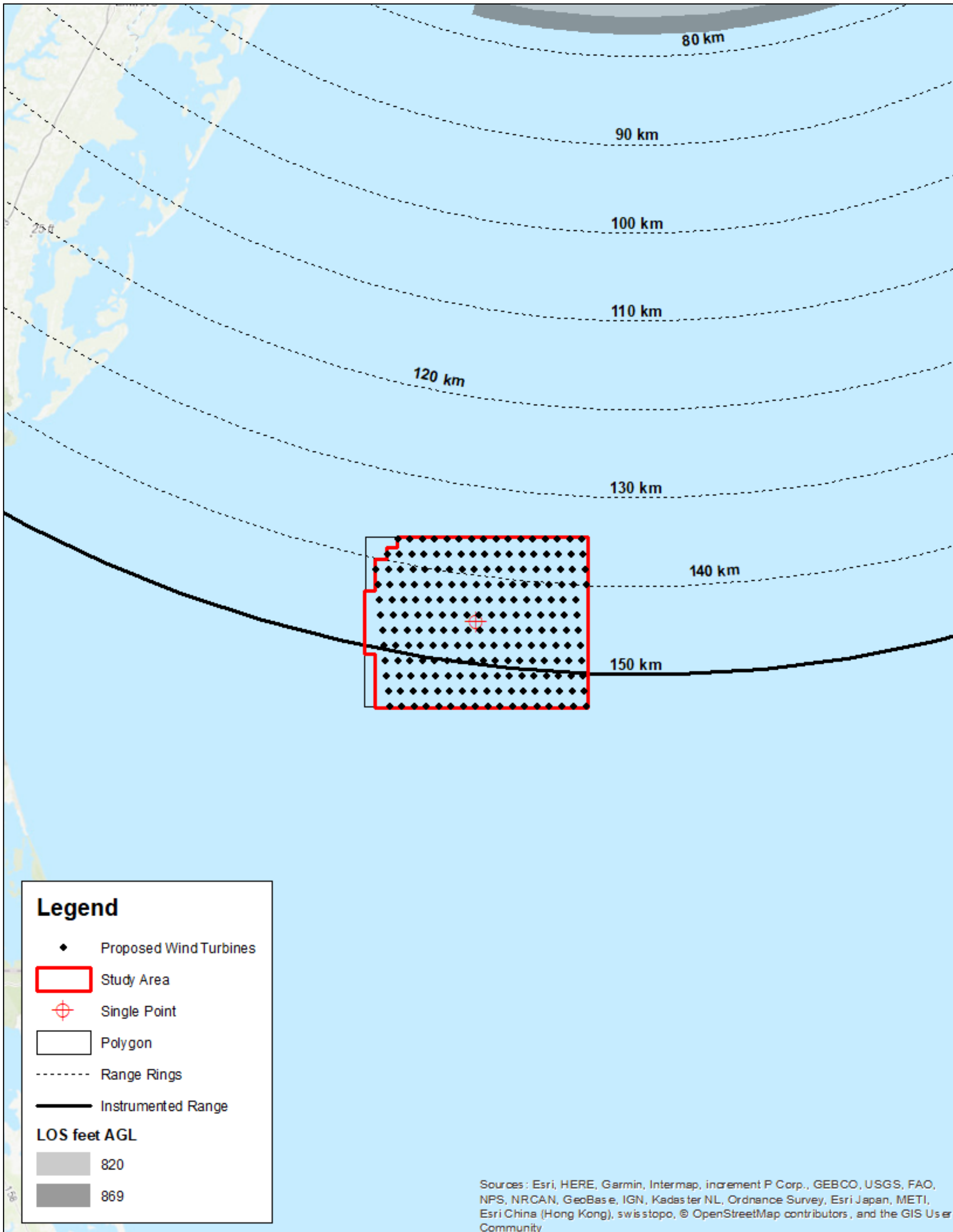

Figure 15 LOS Analysis Results for the Assateague Island HF Radar using 10-meter NED

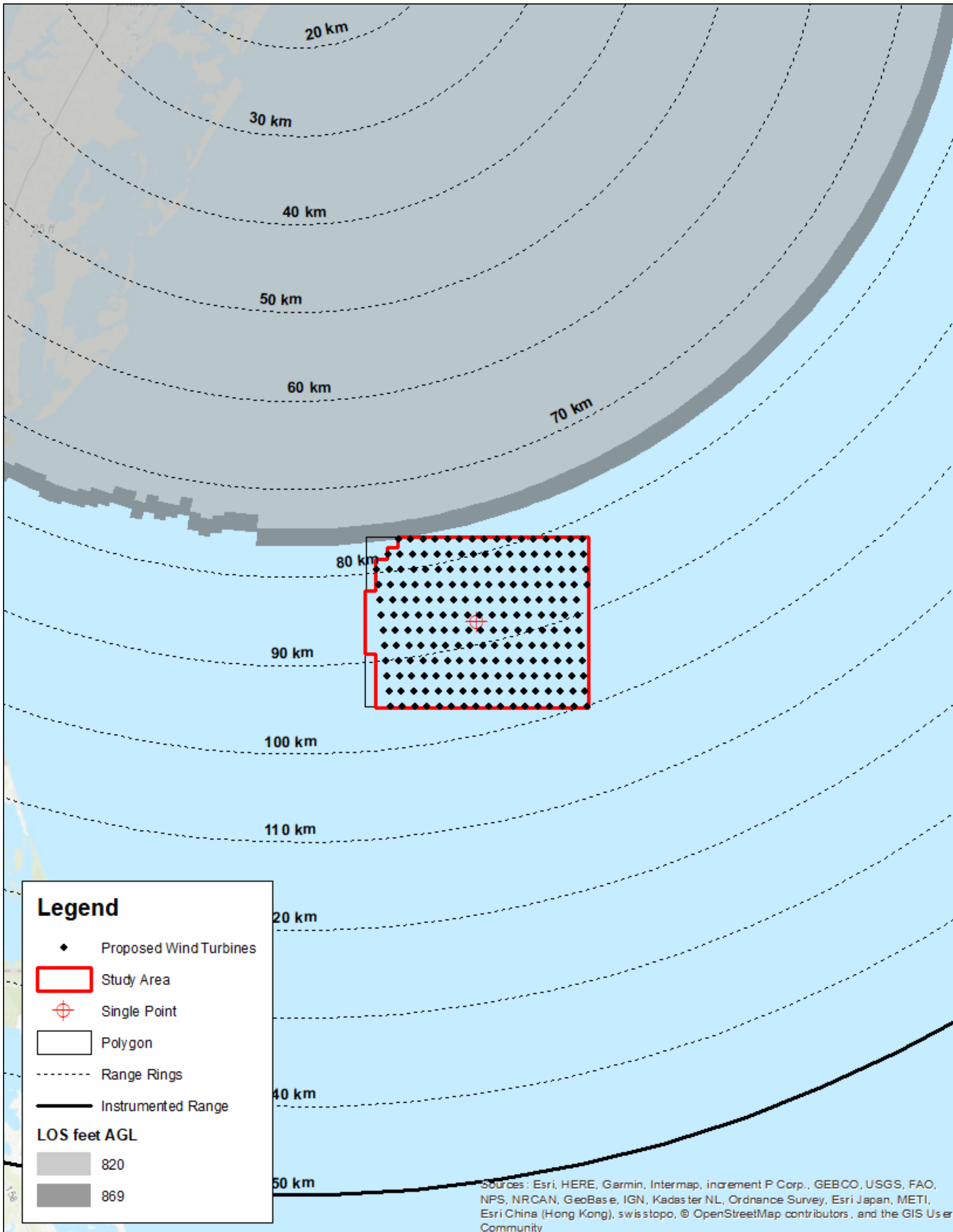

Figure 16 LOS Analysis Results for the Cedar Island HF Radar using 10-meter NED

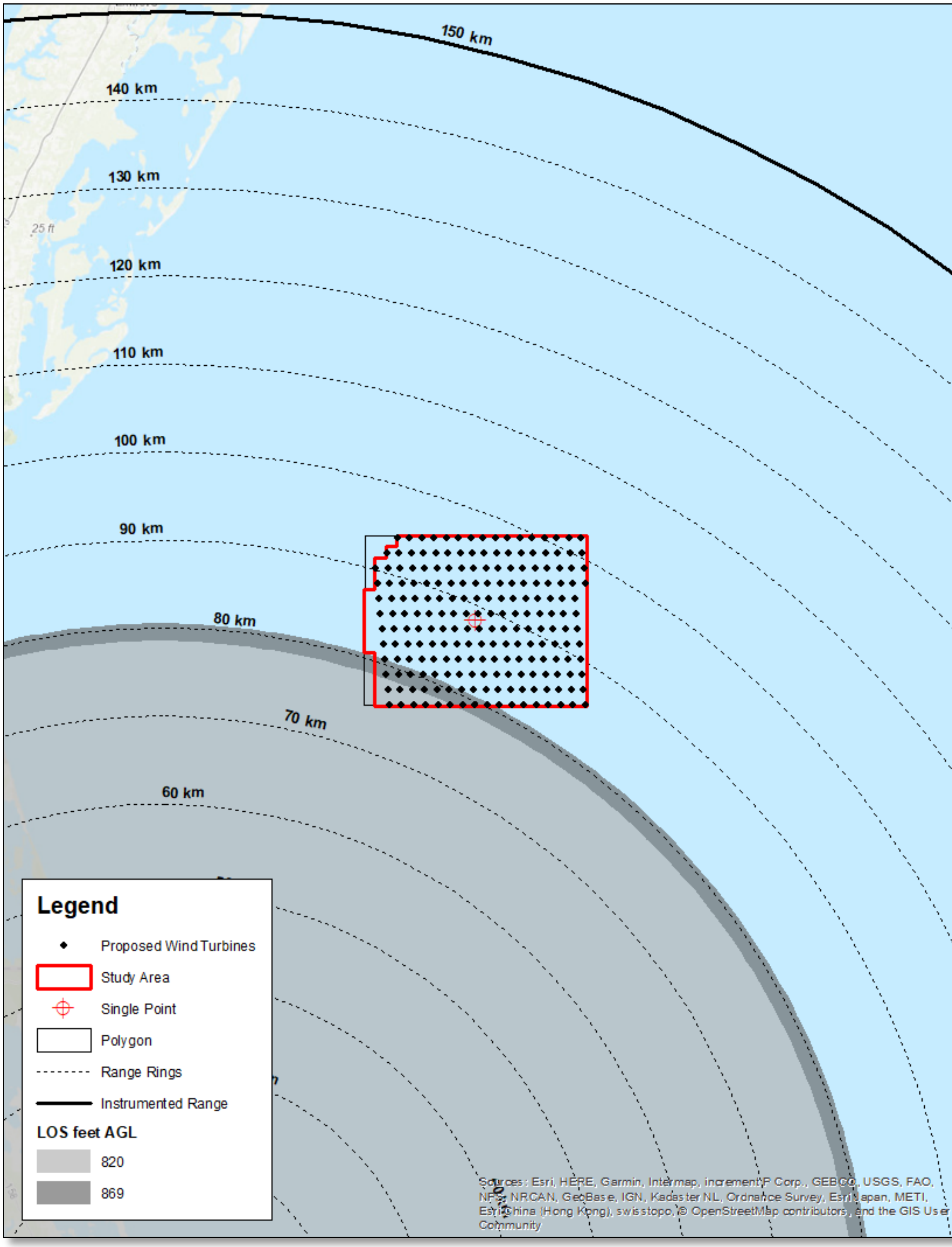

Figure 17 LOS Analysis Results for the Duck HF Radar using 10-meter NED

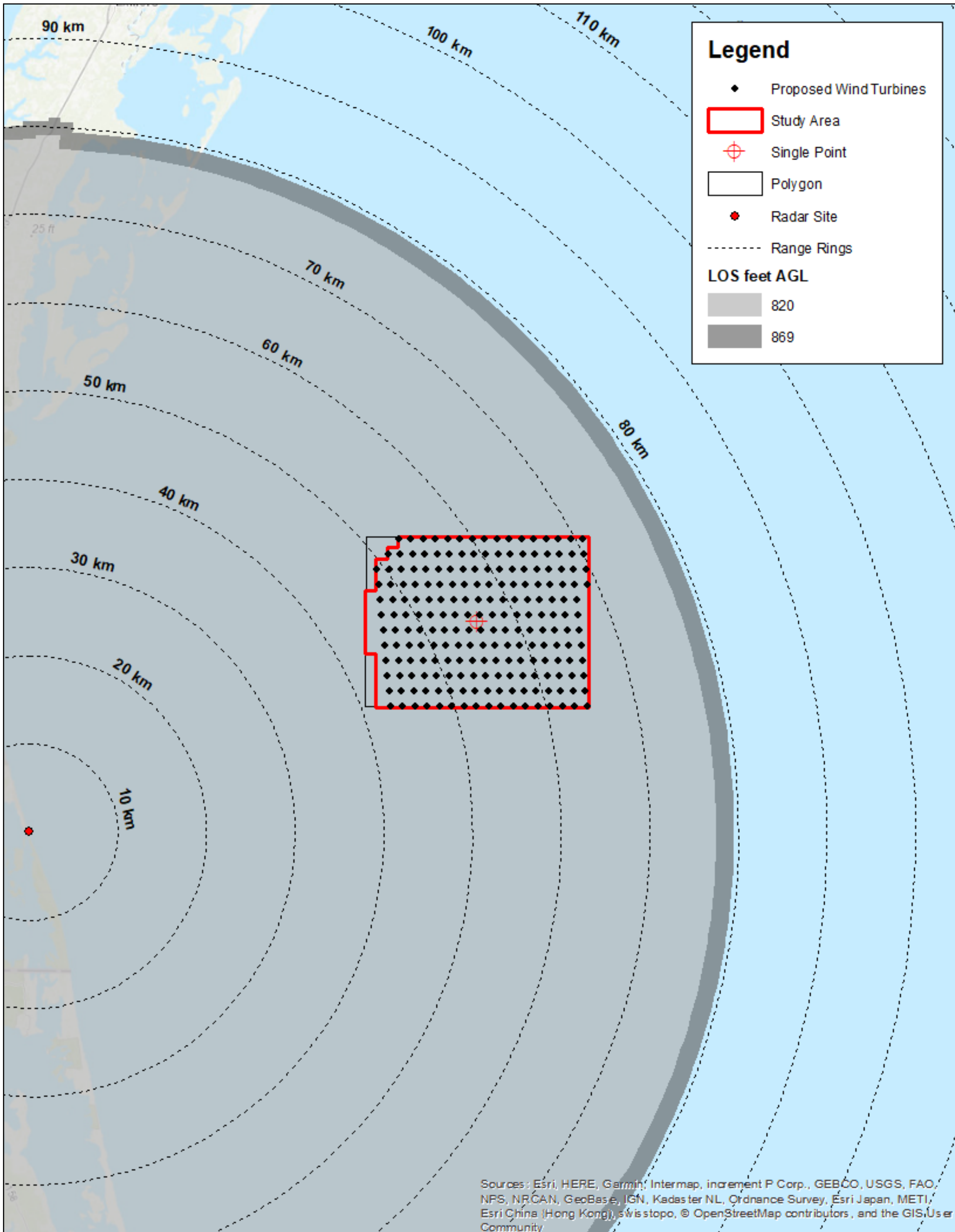

Figure 18 LOS Analysis Results for the Little Island Park HF Radar using 10-meter NED

CONCLUSIONS

The DoD PST analysis results for the proposed wind turbines indicate the following:

- Impacts to air defense and homeland security radar are likely; and
- Impacts to WSR-88D weather radar are not likely.

Westslope identified the closest four radar sites in the PST analysis results for Long Range Radar as the NAS Oceana ASR-11, Norfolk ASR-9, Oceana ARSR-4, and the Wallops Island ASR-8. Further, Westslope identified the closest two radar sites in the PST analysis results for NEXRAD as the Dover AFB WSR-88D and the Norfolk WSR-88D.

Research conducted by Westslope identified three additional ARSR and ASR sites near the proposed wind turbines: the Binns Hall CARSR, Dover AFB DASR, and the NAS Patuxent River ASR-11.

Westslope conducted an ARSR and ASR LOS analysis for the following seven radar sites:

- Binns Hall CARSR;
- Dover AFB DASR;
- NAS Oceana ASR-11;
- NAS Patuxent River ASR-11;
- Norfolk ASR-9;
- Oceana ARSR-4; and
- Wallops Island ASR-8.

The proposed wind turbines are beyond the instrumented range of the Dover AFB DASR and the NAS Patuxent River ASR-11. As such, no additional analysis was considered necessary for these radar sites.

The ARSR and ASR LOS analyses conducted by Westslope show the following:

- For the NAS Oceana ASR-11 and the Oceana ARSR-4, all 205 proposed wind turbines will be within line-of-sight of and will interfere with these radar sites at blade-tip heights of 820 feet AGL and 869 feet AGL.
- For the Norfolk ASR-9, 196 of the 205 proposed wind turbines will be within line-of-sight of and will interfere with this radar site at a blade-tip height of 820 feet AGL. At a blade-tip height of 869 feet AGL, 201 of the 205 proposed wind turbines will be within line-of-sight of and will interfere with this radar site.
- For the Binns Hall CARSR and Wallops Island ASR-8, the 205 proposed wind turbines will not be within line-of-sight of and will not interfere with these radar sites at blade-tip heights of 820 feet AGL or 869 feet AGL.

For the NAS Oceana ASR-11 and the Norfolk ASR-9, without mitigation, the radar effects due to clutter will include a partial loss of primary target detection and a number of false primary targets over and in the immediate vicinity of the proposed wind turbines within line-of-sight. Other radar effects include a partial loss of weather detection and false weather indications over and in the immediate vicinity of the proposed wind turbines within line-of-sight. Please note that radar effects do not always translate into operational impacts.

For the Oceana ARSR-4, without mitigation, the radar effects due to clutter will include a partial loss of primary target detection and a number of false primary targets over and in the immediate vicinity of the proposed wind turbines.

Because wind turbines will be within line-of-sight of the NAS Oceana ASR-11, Norfolk ASR-9, and the Oceana ARSR-4, Westslope expects that the DoD and FAA will have concerns with the proposed wind turbines within line-of-sight at blade-tip heights of 820 feet AGL and 869 feet AGL based on electromagnetic interference to air navigation facilities. The FAA's aeronautical study process and the DoD Siting Clearinghouse process will provide an official decision as to whether impacts are acceptable to operations. Although possible, Westslope does not expect that the DHS will have concerns with the proposed wind turbines within line-of-sight at blade-tip heights of 820 feet AGL or 869 feet AGL based on impacts to these radar sites.

Westslope does not expect that the 205 proposed wind turbines will affect the secondary surveillance radar co-located with the NAS Oceana ASR-11, Norfolk ASR-9, or the Oceana ARSR-4.

Westslope's ROTHR screening analysis shows that the 205 proposed wind turbines will not fall within a county of concern for the Virginia ROTHR. The results also show that 45 of the 205 proposed wind turbines will fall within the azimuth sector scanned by the Virginia ROTHR transmit site. As such, it is possible that the DoD will have concerns with the proposed wind turbines based on potential interference to this radar site. The 205 proposed wind turbines will not fall within the azimuth sector scanned by the Virginia ROTHR receive site.

Westslope's ADAMS screening analysis shows that the 205 proposed wind turbines will not be within line-of-sight of and will not interfere with the ADAMS at blade-tip heights of 820 feet AGL or 869 feet AGL under standard atmospheric conditions. The results also show that all 205 proposed wind turbines will fall within the ducting impact region for the proposed NAS Patuxent River GAOC. The ducting impact region represents an area where radio waves can propagate further than line-of-sight under standard atmospheric conditions.

Westslope conducted a VOR screening analysis for the following three navigational aid sites:

- Cape Charles VORTAC;
- Norfolk VORTAC; and
- Oceana TACAN.

Westslope's VOR screening analysis for the Cape Charles VORTAC, Norfolk VORTAC, and the Oceana TACAN shows that the 205 proposed wind turbines are greater than 8 NM from these navigational aid sites. Although possible, Westslope does not expect that the FAA will have concerns with the proposed wind turbines at blade-tip heights of 820 feet AGL or 869 feet AGL based on impacts to these navigational aid sites.

Westslope conducted a NEXRAD weather radar screening analysis for the following two radar sites:

- Dover AFB WSR-88D; and
- Norfolk WSR-88D.

Westslope's NEXRAD weather radar screening analysis for the Dover AFB WSR-88D and the Norfolk WSR-88D shows that the 205 proposed wind turbines will not be within line-of-sight of and will not interfere with these radar sites at blade-tip heights of 820 feet AGL or 869 feet AGL. The results also show that the 205 proposed wind turbines at blade-tip heights of 820 feet AGL and 869 feet AGL will fall within a NOAA green No Impact Zone for these radar sites.

Westslope conducted an HF radar LOS analysis for the following seven radar sites:

- Assateague Island HF radar;
- Cedar Island HF radar;
- Duck HF radar;
- First Landing State Park HF radar;
- Little Island Park HF radar;
- Ocean View Beach HF radar; and
- Sunset Beach Resort HF radar.

The proposed wind turbines are beyond the instrumented range of the First Landing State Park HF radar, Ocean View Beach HF radar, and the Sunset Beach Resort HF radar. As such, no additional analysis was considered necessary for these radar sites.

The HF radar LOS analyses conducted by Westslope show the following:

- For the Duck HF radar, nine of the 205 proposed wind turbines will be within line-of-sight of this radar site at a blade-tip height of 820 feet AGL. At a blade-tip height of 869 feet AGL, 19 of the 205 proposed wind turbines will be within line-of-sight of this radar site.
- For the Little Island Park HF radar, all 205 proposed wind turbines will be within line-of-sight of this radar site at blade-tip heights of 820 feet AGL and 869 feet AGL.
- For the Assateague Island HF radar and the Cedar Island HF radar, the 205 proposed wind turbines will not be within line-of-sight of these radar sites at blade-tip heights of 820 feet AGL or 869 feet AGL. Although the proposed wind turbines will not be within line-of-sight of these

radar sites, radar effects are still possible beyond line-of-sight due to the propagation of HF electromagnetic waves over the ocean surface.

For the Duck HF radar and the Little Island Park HF radar, without mitigation, the radar effects will include clutter in the vicinity of the proposed wind turbines within line-of-sight and possibly in the vicinity of the proposed wind turbines beyond line-of-sight due to the propagation of HF electromagnetic waves over the ocean surface. Because wind turbines will be within line-of-sight of these radar sites, Westslope expects that multiple federal agencies in partnership with NOAA's IOOS may have concerns with the proposed wind turbines within line-of-sight at blade-tip heights of 820 feet AGL and 869 feet AGL based on potential interference to these HF radar sites.

Westslope recommends that the proposed wind turbines be submitted to the DoD Siting Clearinghouse for an informal review and to the National Telecommunications Information Administration (NTIA) for a detailed review. The NTIA is essentially a clearinghouse for other federal agencies, including the National Oceanic and Atmospheric Administration. Additionally, Westslope recommends consultation with NOAA's IOOS Program Office.

If you have any questions regarding this analysis, please contact Geoff Blackman at (405) 816-2604 or via email at gnblackman@westslopeconsulting.com.

REFERENCES

[1] DoD, Office of the Secretary, "*Military Aviation and Installation Assurance Siting Clearinghouse; Notice and Request for Public Comment on Boardman, Oregon, and NAS Patuxent River, Maryland, Geographic Areas of Concern*," August 8, 2018, [https://www.federalregister.gov/documents/2018/08/08/2018-16886/military-aviation-and-installation-assurance-siting-clearinghouse-notice-and-request-for-public].

[2] DoD, Department of the Navy, "*Geographic Area of Concern (GAOC): Naval Air Station (NAS) Patuxent River Area, including the Advanced Dynamic Aircraft Measurement System (ADAMS) and the Digital Airport Surveillance Radar (DASR)*," May 14, 2018, [Tab_D_-_INSTALLATION_MANAGEMENT_20180514,_GAOC_for_Pax_River_Final.docx].

Coastal Virginia Offshore Wind (CVOW) Commercial Project

Tetra Tech, Inc.

Offshore Virginia

Air Traffic Flow Analysis

February 23, 2021

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capitolairspace.com

Summary

Capitol Airspace conducted an air traffic flow analysis for Dominion Energy's Coastal Virginia Offshore Wind (CVOW) Commercial Project (CVOW Commercial Project) (black outline, **Figure 1**) located off the coast of Virginia. At the time of this analysis, 205 individual wind turbine locations had been identified (black points, **Figure 1**). At either 820 or 869 feet tall, up to 48 proposed wind turbines in the western section of the analytic study area would require an increase to Norfolk (ORF) Terminal Radar Approach Control (TRACON) minimum vectoring altitudes (MVA). The purpose for this analysis was to determine the number of operations potentially affected by the airspace changes required to accommodate wind development up to 869 feet tall.

The Federal Aviation Administration (FAA) conducts aeronautical studies to ensure that proposed structures do not affect the safety of air navigation and the efficient utilization of navigable airspace by aircraft. Proposed structures undergoing aeronautical study that exceed obstacle clearance surfaces will be identified as having an adverse effect. If the FAA determines that the adverse effect would impact a significant volume of operations, it could be used as the basis for determinations of hazard. For instrument flight rules (IFR) operations the significant volume threshold is one per week; for visual flight rules (VFR) operations the threshold is one per day.

Historical air traffic data indicates that the required changes to Norfolk (ORF) TRACON MVA Sector B should not affect a significant volume of radar vectoring operations. As a result, it is possible that Norfolk (ORF) TRACON would be willing to increase the affected MVAs in order to accommodate wind development up to 869 feet tall. This mitigation option is subject to FAA approval.

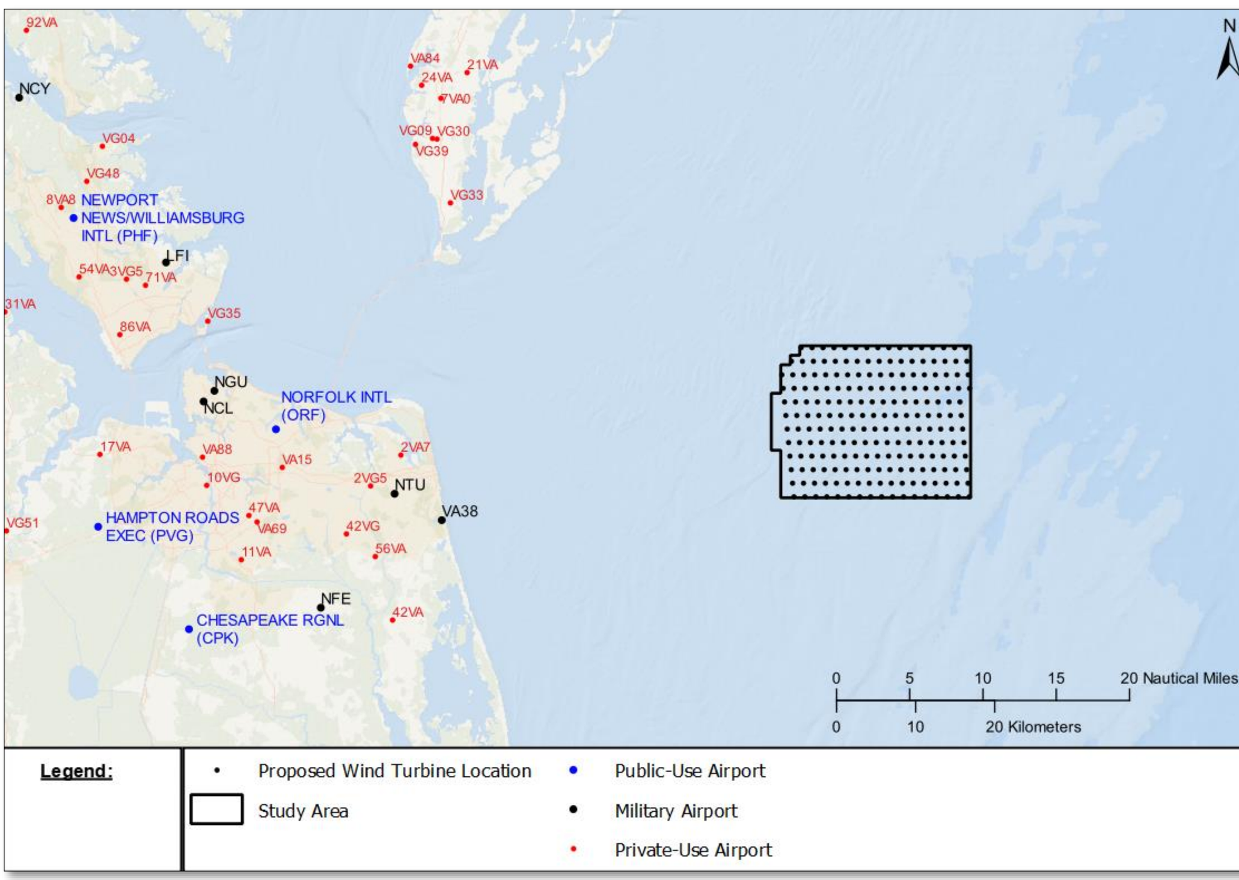

Figure 1: Public-use (blue), private-use (red), and military (black) airports in proximity to the CVOW Commercial Project

Methodology

At either 820 or 869 feet tall, proposed wind turbines in the western section of the study area (red areas, **Figure 2** & **Figure 3**) will exceed MVA sector obstacle clearance surfaces (hatched purple, **Figure 2** & **Figure 3**). As a result, the FAA must modify sector boundaries or establish isolation areas with increased MVAs. These sector modifications result in a three-dimensional volume of affected airspace where radar vectoring would be unavailable. If the FAA determines that this impact would affect as few as one radar vectoring operation per week, it could result in determinations of hazard.

In order to quantify the number of radar vectoring operations potentially affected by MVA sector modifications, Capitol Airspace evaluated FAA National Offload Program (NOP) radar returns covering the period between January 1, 2019 and December 31, 2019. The FAA NOP data contained 88,945,292 radar returns associated with 614,260 flights receiving air traffic control services.[1] Each flight that had at least one radar return within the affected airspace was analyzed for altitude and direction trends.

Flights that maintained one or more specific headings within the affected airspace operated in a manner consistent with receiving radar vectoring services. These flights also maintained or climbed/descended to maintain an altitude within the affected airspace. The historical presence of these flights within the affected airspace is an indicator that the required MVA sector modifications could affect future air traffic control operations.

[1] NOP data excludes certain military flights due to the sensitive nature of some operations.

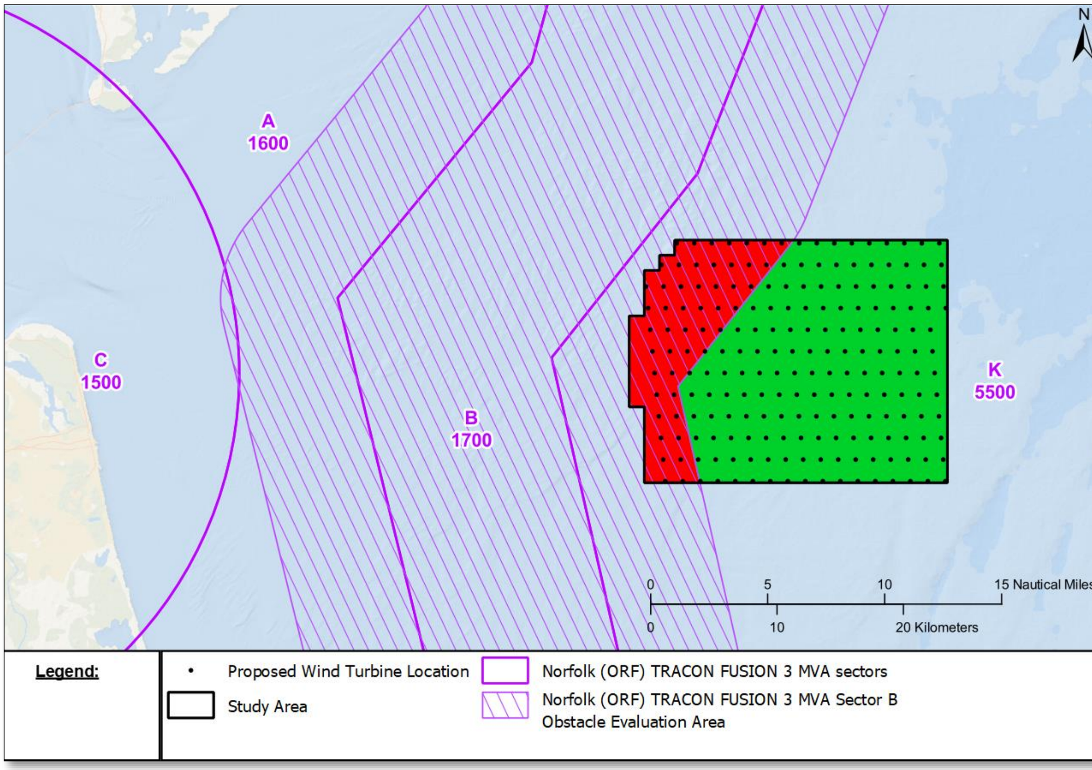

Figure 2: Norfolk (ORF) TRACON FUSION 3 MVA sectors (purple) with Sector B obstacle evaluation area (hatched purple)

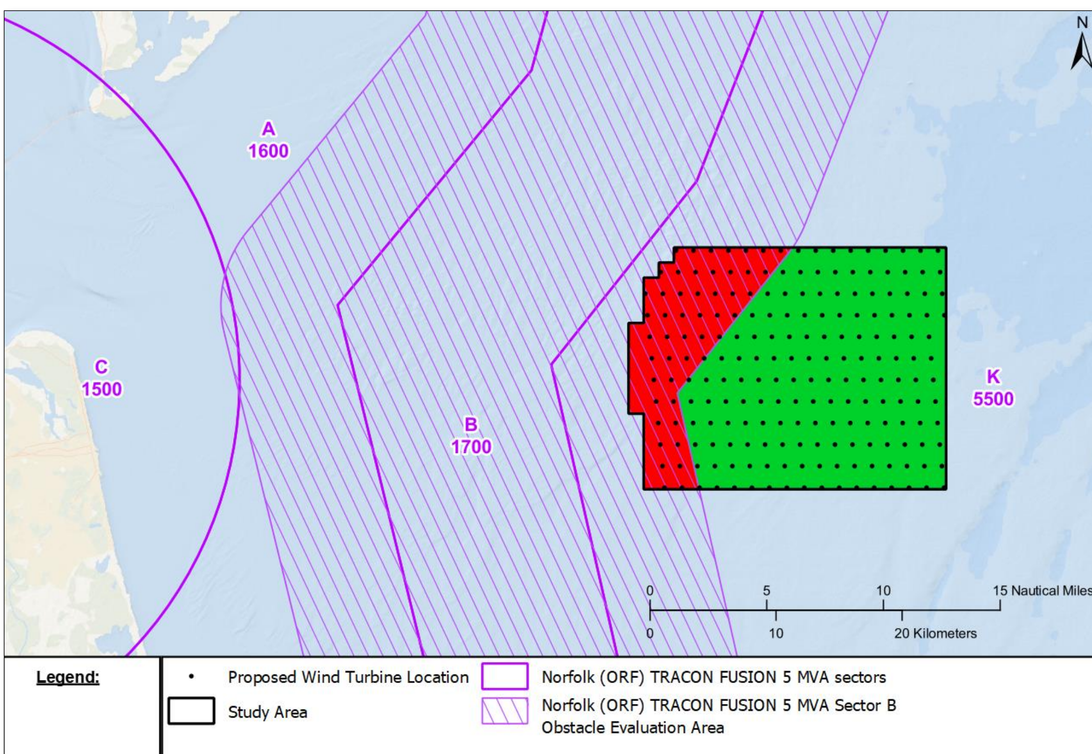

Figure 3: Norfolk (ORF) TRACON FUSION 5 MVA sectors (purple) with Sector B obstacle evaluation area (hatched purple)

Findings

Norfolk (ORF) TRACON [2]

FUSION 3 (ORF_MVA_FUS3_2020) & FUSION 5 (ORF_MVA_FUS5_2020)[3]

Sector B

In order to accommodate wind development up to 869 feet tall, the FAA must increase the existing MVA from 1,700 feet AMSL to as high as 1,900 feet AMSL. However, flight track data indicates that no flights operated within the affected airspace (dashed purple outline, **Figure 4**). This flight total represents an average of *0.00 flights per week* which is below the FAA's threshold for a significant volume of operations.

As a result of these findings, it is possible that Norfolk (ORF) TRACON would not object to modifying Sector B in order to accommodate wind development up to 869 feet tall. This mitigation option is subject to FAA approval.

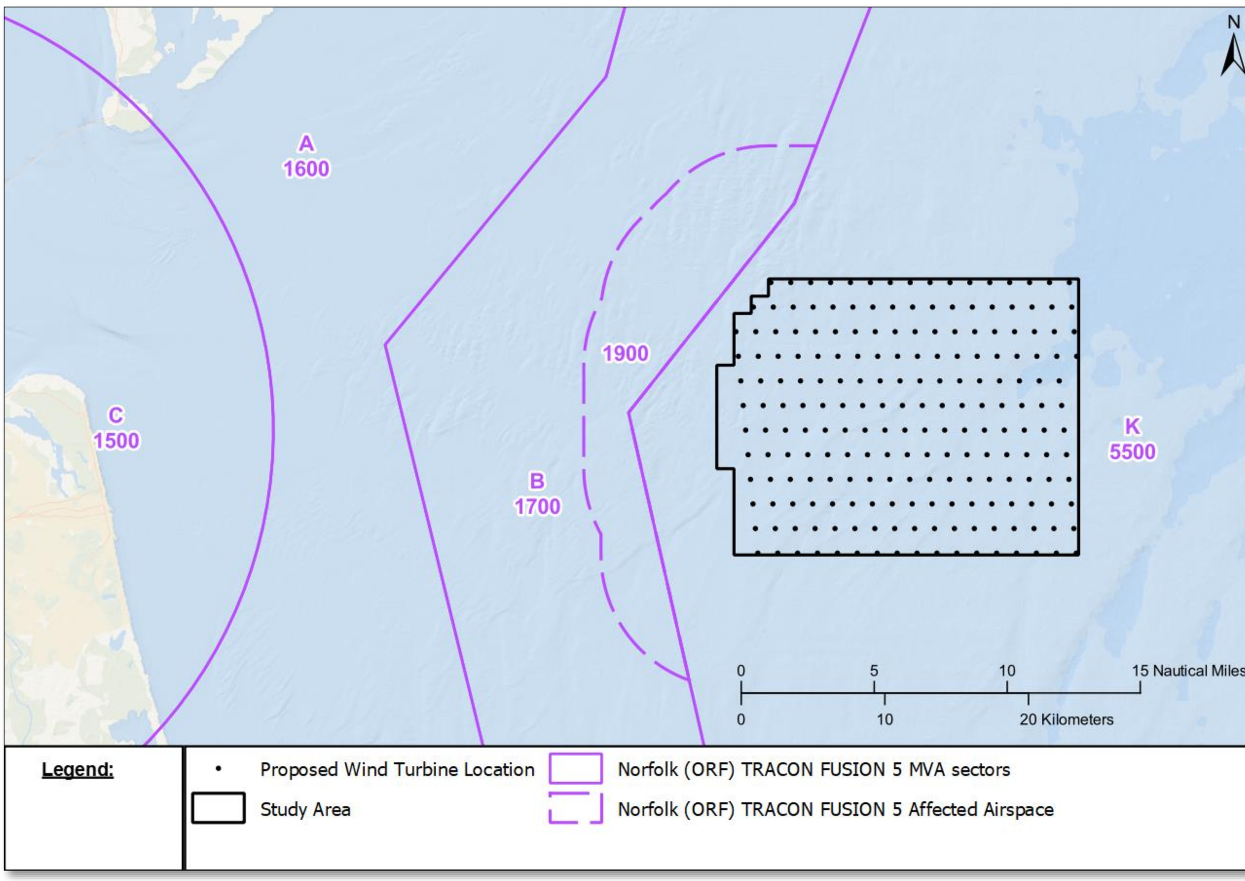

Figure 4: Norfolk (ORF) TRACON FUSION 5 MVA sectors (purple) and affected airspace (dashed purple outline)

[2] NAS Oceana (NTU) Radar Air Traffic Control Facility (RATCF) MVA sectors overlie the study area. However, RATCF MVA charts are not publicly available. It is possible that Oceana Approach Control MVA sector obstacle clearance surfaces are lower than those described in this report.

[3] FUSION is the combination of all available surveillance sources (airport surveillance radar [ASR], air route surveillance radar [ARSR], ADS-B, etc.) into the display of a single-tracked target for air traffic control separation services. MVA Charts are developed for the lateral limits of the associated approach control airspace, plus an appropriate buffer outside the lateral control airspace boundaries of either 3NM or 5NM.

Conclusion

Capitol Airspace assessed historical FAA radar track data covering the period of one year to determine the number of operations that could be affected by increasing the Norfolk (ORF) TRACON Sector B MVA. In order to accommodate wind development up to 869 feet tall, the affected MVA must be increased from 1,700 to as high as 1,900 feet AMSL.

Historical radar track data indicates that proposed wind turbines should not affect a significant volume of Norfolk (ORF) TRACON radar vectoring operations (0.00 flights per week). These numbers are below the FAA threshold for a significant volume of operations. As a result of these findings, it is possible that Norfolk (ORF) TRACON would not object to modifying Sector B in order to accommodate wind development up to 869 feet tall.

Questions regarding the findings of this study should be directed to ***Dan Underwood*** or ***Candace Childress*** at (703) 256-2485.

Coastal Virginia Offshore Wind (CVOW) Commercial Project

Tetra Tech, Inc.

Offshore Virginia

Aircraft Detection Lighting System (ADLS) Efficacy Analysis

February 23, 2021

Capitol Airspace Group

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Summary

Capitol Airspace conducted an Aircraft Detection Lighting System (ADLS) efficacy analysis for Dominion Energy's Coastal Virginia Offshore Wind (CVOW) Commercial Project (CVOW Commercial Project) (blue area, **Figure 1**) located off the coast of Virginia. This analysis utilized historic air traffic data obtained from the Federal Aviation Administration (FAA) in order to determine the total duration that an ADLS-controlled obstruction lighting system would have been activated. The results of this analysis can be used to predict an ADLS's effectiveness in reducing the total amount of time that an obstruction lighting system would be activated.

An ADLS utilizes surveillance radar to track aircraft operating in proximity to the wind project. The ADLS will activate the obstruction lighting system when aircraft enter the light activation volume and will deactivate the system when all aircraft depart. As a result, the ADLS provides nighttime conspicuity on an as-needed basis thereby reducing the amount of time that obstruction lights will be illuminated. Depending on the volume of nighttime flights transiting a wind project's light activation volume, an ADLS could result in a significant reduction in the amount of time obstruction lights are illuminated.

Historical air traffic data for flights passing through the light activation volume indicates that ADLS-controlled obstruction lights would have been activated for a total of 25 hours 33 minutes and 49 seconds over a one-year period. Considering the local sunrise and sunset times, an ADLS-controlled obstruction lighting system could result in over a 99% reduction in system activated duration as compared to a traditional always-on obstruction lighting system.

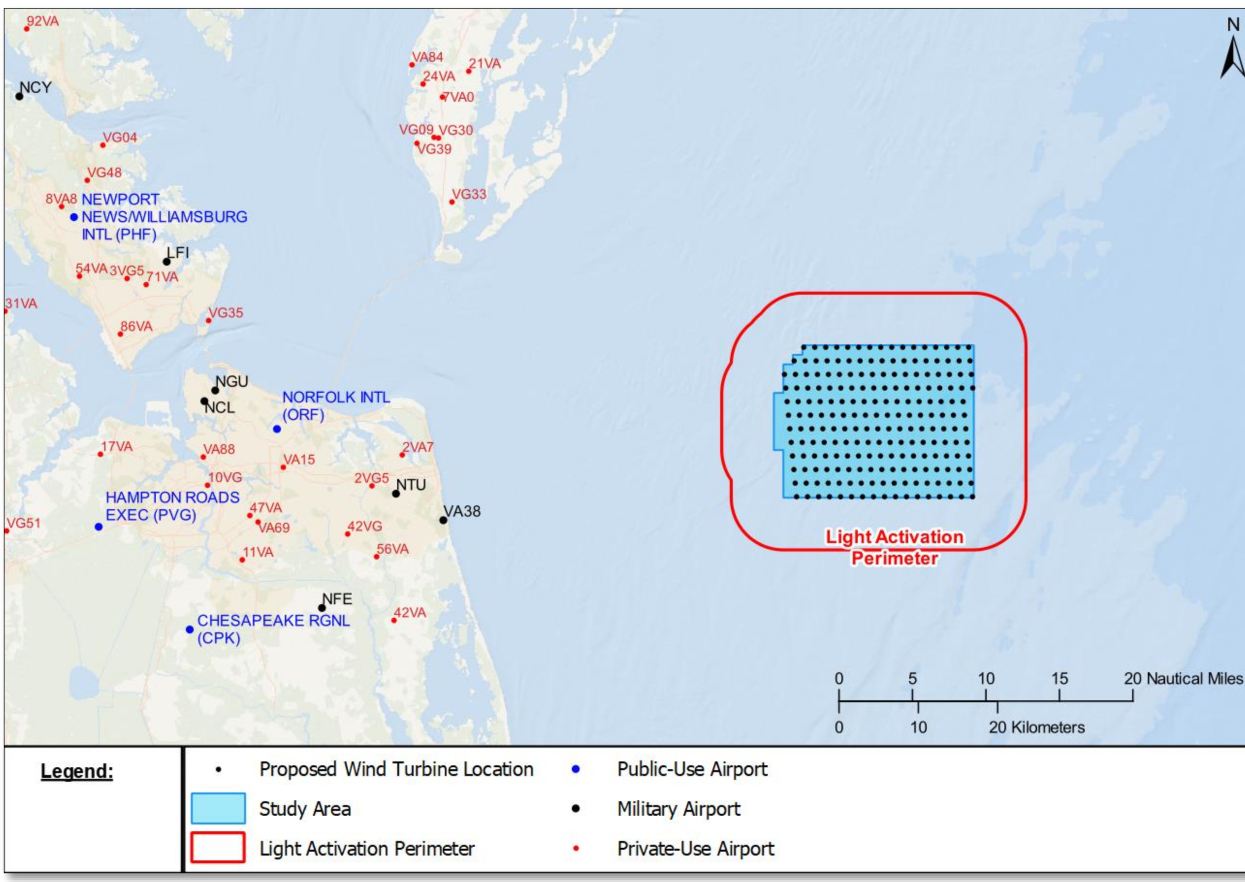

Figure 1: Public-use (blue), private-use (red), and military (black) airports in proximity to the CVOW Commercial Project

Methodology

Capitol Airspace analyzed FAA National Offload Program (NOP) radar returns in proximity to Dominion Energy's CVOW Commercial Project for the period between January 1, 2019 and December 31, 2019. FAA NOP data only includes secondary radar returns which are created if the identified aircraft is equipped with a transponder. Aircraft operations without an active transponder were not captured as part of this dataset. Within 65 nautical miles of the wind project, the NOP data contained 127,830,837 different radar returns from six different air traffic control (ATC) facilities.[1] These radar returns were associated with 1,354,713 unique flight tracks.

The following process was used to determine the frequency of nighttime aviation operations in proximity to the CVOW Commercial Project:

1. **Define Three-Dimensional Light Activation Volume** – In accordance with FAA Advisory Circular 70/7460-1M, obstruction lights controlled by an ADLS must be activated and illuminated prior to an aircraft reaching three nautical miles from, and 1,000 feet above, any obstruction. However, the actual light activation volume will vary depending on the ADLS. At the time of this analysis, a specific ADLS had not been selected for the CVOW Commercial Project. In order to account for varying radar systems as well as aircraft speeds and descent rates, Capitol Airspace assessed a 3.55 nautical mile buffer (solid red outline, **Figure 2**) around the wind project at altitudes up to 3,500 feet above the highest wind turbine (4,400 feet above mean sea level [AMSL] based on 820 or 869-foot-tall wind turbines).
2. **Calculate Sunrise and Sunset –** Sunrise and sunset times were calculated for each day of the year based on the United States Naval Observatory definition of sunrise and sunset. Sunrise time was calculated at the westernmost edge of the light activation perimeter. Sunset time was calculated at the easternmost edge of the light activation perimeter.
3. **Select Nighttime Radar Returns –** Since traditional obstruction lights can rely on ambient light sensors to identify darkness, nighttime was considered to occur between 30 minutes prior to sunset until 30 minutes after sunrise. This represents the time during which a traditional obstruction lighting system would likely be activated. All radar returns within the light activation volume that occurred during this period were evaluated. In accordance with guidance provided by the FAA, if an ADLS loses track of an aircraft, a 30-minute timer should be initiated to keep the obstruction lights activated while the aircraft can clear the wind project area. Since the application of ADLS requires site specific radar surveillance systems that will be focused on the project area, Capitol Airspace does not anticipate a likelihood of dropped tracks.
4. **Remove Time Overlap –** To remove the duration of overlap occurring when more than one flight transits the light activation volume at the same time, each nighttime flight was compared to every other nighttime flight. Where overlapping flights were found, the overlapping flight's duration within the light activation volume was removed from the total obstruction lighting system activation time.

[1] Source facilities included Norfolk (ORF) Terminal Radar Approach Control (TRACON), Potomac Consolidated (PCT) TRACON, Philadelphia (PHL) TRACON, Washington (ZDC) Air Route Traffic Control Center (ARTCC), Jacksonville (ZJX) ARTCC, and New York (ZNY) ARTCC.

Results

FAA NOP data indicates that as many as 1,475 flights had at least one radar return within the light activation volume (red outline, **Figure 2**). However, many of these flights occurred during daytime. Using local sunrise and sunset times, Capitol Airspace determined that as many as 659 flights (purple tracks, **Figure 3**) had at least one radar return within the light activation volume during the nighttime period when a traditional obstruction lighting system would be activated.

Each of the 659 flights was further evaluated to determine the amount of time it remained within the light activation volume. Over a one-year period, these flights would have resulted in a total obstruction light system activated duration of 25 hours 33 minutes and 49 seconds for either 820 or 869-foot-tall wind turbines. Considering that the CVOW Commercial Project ADLS light activation perimeter observes approximately 4,741 hours of nighttime each year, an ADLS-controlled obstruction lighting system could result in over a 99% reduction in system activated duration as compared to a traditional always-on obstruction lighting system (**Table 1**).

Month	Nighttime Observed (HHH:MM:SS)	Light System Activated Duration (HH:MM:SS)	
		820-foot-tall wind turbines	869-foot-tall wind turbines
January	471:40:34	00:41:56 (0.15%)	00:41:56 (0.15%)
February	401:21:47	03:14:09 (0.81%)	03:14:09 (0.81%)
March	409:27:20	07:21:53 (1.80%)	07:21:53 (1.80%)
April	360:52:06	00:20:54 (0.10%)	00:20:54 (0.10%)
May	341:59:22	03:54:01 (1.14%)	03:54:01 (1.14%)
June	315:51:20	02:53:59 (0.92%)	02:53:59 (0.92%)
July	334:02:14	00:40:03 (0.20%)	00:40:03 (0.20%)
August	360:55:30	00:52:33 (0.24%)	00:52:33 (0.24%)
September	383:02:19	00:18:27 (0.08%)	00:18:27 (0.08%)
October	432:07:42	03:05:04 (0.71%)	03:05:04 (0.71%)
November	448:57:30	01:37:00 (0.36%)	01:37:00 (0.36%)
December	480:25:52	00:33:50 (0.12%)	00:33:50 (0.12%)
Total	**4740:43:36**	**25:33:49 (0.54%)**	**25:33:49 (0.54%)**

Table 1: Typical duration of light system activation time during each month

Questions regarding the findings of this study should be directed to ***Dan Underwood*** or ***Candace Childress*** at (703) 256-2485.

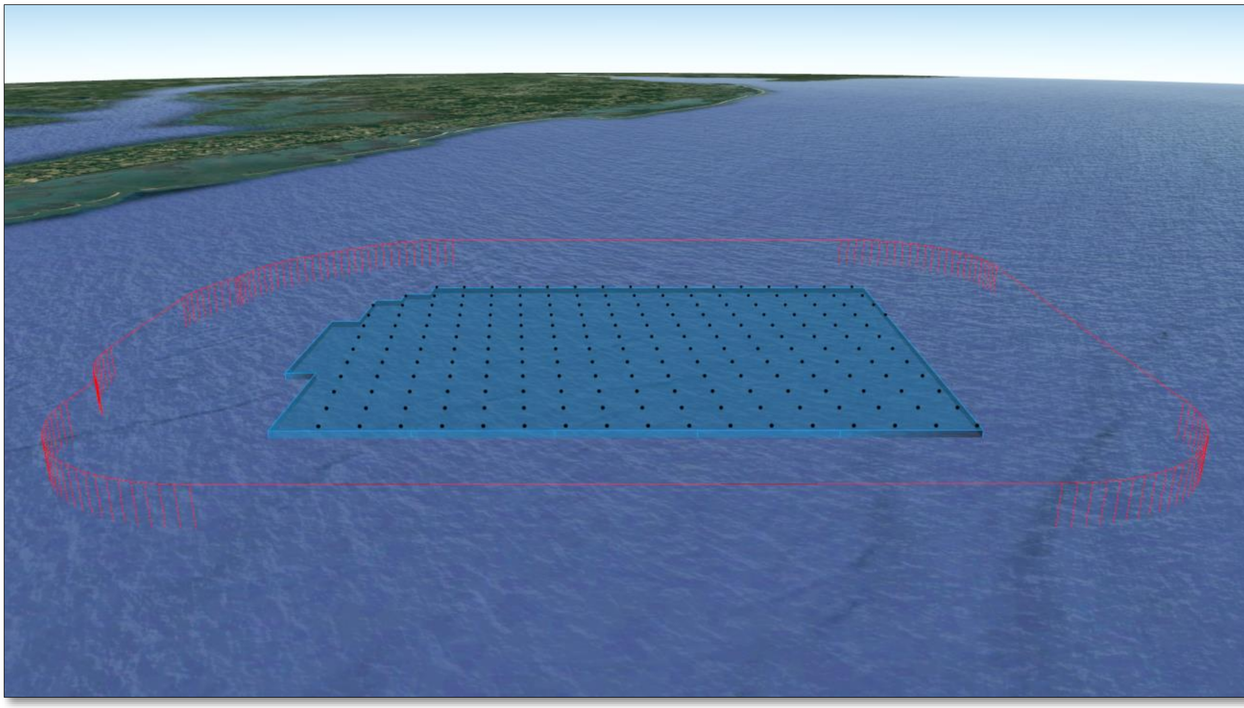

Figure 2: CVOW Commercial Project (blue) and light activation volume (red outline)

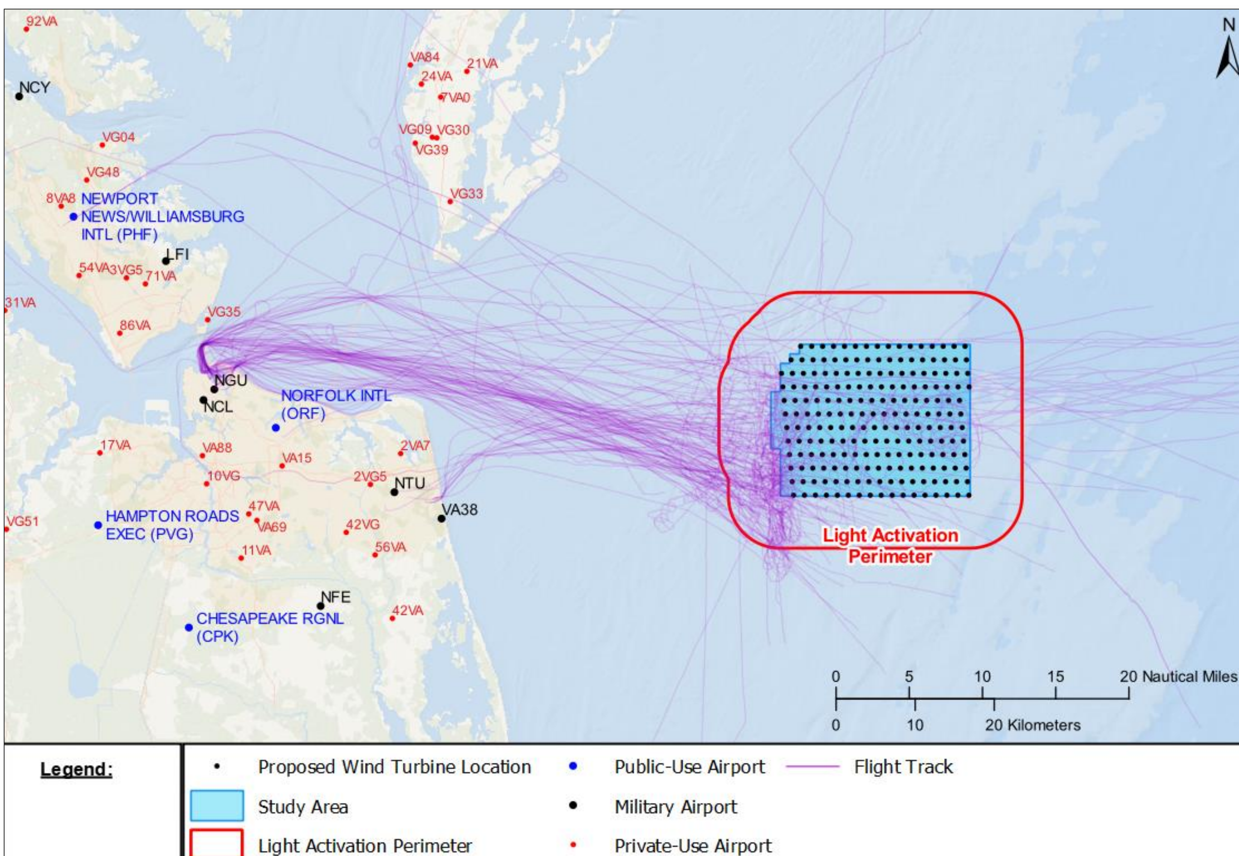

Figure 3: Flight tracks (purple) that would have activated ADLS obstruction lights

OFFICE OF THE ASSISTANT SECRETARY OF DEFENSE
3500 DEFENSE PENTAGON
WASHINGTON, DC 20301-3500

SUSTAINMENT

June 2, 2021

William Kinnan
Dominion Energy
707 East Main Street
Richmond, VA 23219

Dear Mr. Kinnan,

As requested, the Military Aviation and Installation Assurance Siting Clearinghouse coordinated within the Department of Defense (DoD) an informal review of the Coastal Virginia Offshore Wind. The results of our review indicated that the offshore wind project located in Offshore, Virginia, as proposed, may have an impact on military operations conducted in the area.

The proposed siting location of the offshore wind project may impact the Department of Navy (DoN) as the project lies within the Atlantic Test Range Geographical Area of Concern and presents potential impacts to the test capabilities of the Advanced Dynamic Aircraft Measurement System at Patuxent River Naval Air Station. The DoN requests continuted coordination on the undersea cable route, and cable landing location, currently planned for Navy property. The DoN also requests notification if there are plans to put monitoring equipment on the undersea cable such as distributed acoustic sensing, and coordination on the use of foreign-owned or controlled vendors in the project. Please contact Mr. Matthew Senska (matthew.senska@navy.mil), Director, Marine Resources and At-Sea Policy, to discuss the potential impacts to the Department of Navy. Additionally, there is also a potential impact to the North American Aerospace Defense Command (NORAD) homeland defense radar. Please contact Mr. Frederick Shepherd (frederick.l.shepherd.civ@mail.mil), Chief, Radar Analysis Branch, to discuss the impact to NORAD.

Please note that this informal review by the DoD Military Aviation and Installation Assurance Siting Clearinghouse does not constitute an action under 49 United States Code Section 44718 and that the DoD is not bound by the conclusion arrived at under this informal review. To expedite our review in the Obstruction Evaluation Airport Airspace Analysis (OE/AAA) process, please add the project number or advise Dominion Energy to add the project number 2021-03-OW-DEV-35 in the comments section of the filing. If you have any questions, please contact me at steven.j.sample4.civ@mail.mil or at (703) 571-0076.

Sincerely,

Steven J. Sample
Executive Director
Military Aviation and Installation
Assurance Siting Clearinghouse

cc:
Capitol Airspace Group