AECOM

APPENDIX Z

Obstruction Evaluation and Airspace Analysis

Photo credit: Matt Goldsmith, Equinor

June 2023

Prepared for

Beacon Wind LLC

Beacon Wind Project

AECOM

Offshore Massachusetts

Obstruction Evaluation & Airspace Analysis

May 11, 2021

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Summary

Capitol Airspace conducted an obstruction evaluation and airspace analysis for the Beacon Wind project located off the coast of Massachusetts. The purpose for this analysis was to identify obstacle clearance surfaces established by the Federal Aviation Administration (FAA) that could limit the placement of 850 (259 meters) and 1,116-foot tall (340 meters) wind turbines[1]. At the time of this analysis, 157 wind turbine locations had been identified[2] (black points, ***Figure 1***). This analysis assessed height constraints overlying each location as well as an approximately 201-square-mile study area (128,640 acres; 52,059 hectares) (black outline, ***Figure 1***).

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 an 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.

14 CFR Part 77 applies to all structures within US territorial airspace. 14 CFR Part 77.9 requires that all structures exceeding 200 feet 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 have an effect on the safety of air navigation and the efficient utilization of navigable airspace by aircraft. The end 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.

The lowest obstacle clearance surfaces overlying the Beacon Wind project range from 549 to 4,549 feet above mean sea level (AMSL) and are associated with minimum vectoring altitude sectors and minimum instrument flight rules (IFR) altitude sectors. Proposed structures that exceed these surfaces would require an increase to minimum vectoring altitudes and minimum IFR altitudes. If the FAA determines that any of these impacts would affect as few as one operation per week, it could result in determinations of hazard.

At 850 (259 meters) and 1,116 feet (340 meters) tall, proposed wind turbines in the northern corner of the study area would exceed these surfaces. However, no proposed wind turbine locations are in this area. At 1,116 feet (340 meters) tall, as many as 105 proposed wind turbines throughout the central and northern sections of the study area would exceed these surfaces.

Warning Area W-105A overlies the Beacon Wind project and could result in military objections to proposed wind development.

[1] This analysis was initiated prior to the Project's PDE reduction. The current maximum PDE is a 1,083 ft (330 m) turbine.
[2] 157 foundation positions (155 wind turbines and 2 offshore substation facilities). The analysis modeled 157 wind turbines.

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

Capitol Airspace applies FAA defined rules and regulations applicable to obstacle evaluation, instrument procedures assessment and visual flight rules (VFR) operations to the best of its ability and with the intent to provide the most accurate representation of limiting airspace surfaces as possible. Capitol Airspace maintains datasets obtained from the FAA which are updated on a 28-day cycle. The results of this analysis are based on the most recent data available as of the date of this report. Limiting airspace surfaces depicted in this report are subject to change due to FAA rule changes and regular procedure amendments. Therefore, it is of the utmost importance to obtain FAA determinations of no hazard prior to making substantial financial investments in this project.

Methodology

Capitol Airspace studied the proposed project based on location information provided by Beacon Wind. Using this information, Capitol Airspace generated graphical overlays to determine proximity to airports (***Figure 1***), published instrument procedures, enroute airways, FAA minimum vectoring altitude and minimum instrument flight rules (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 minimum vectoring altitudes, 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 8260.3E United States Standard for Terminal Instrument Procedures
- FAA Order 8260.58B 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
- National Airspace System Resource Aeronautical Data
- National Oceanic and Atmospheric Administration Maritime Boundaries Data

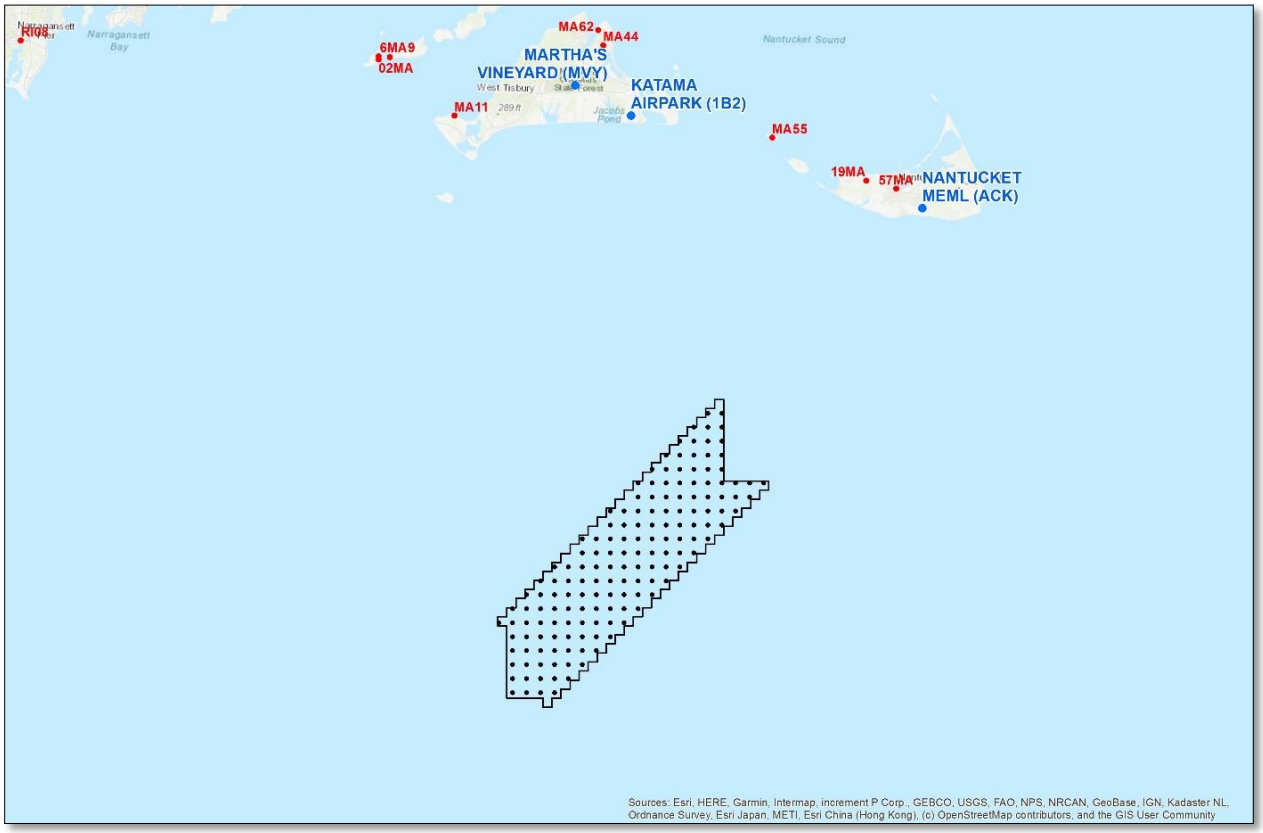


Figure 1: Public-use (blue) and private-use (red) airports in proximity to the Beacon Wind project

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[3] surrounding the United States.[4] 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 Beacon Wind 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. Regardless, BOEM may require consultation with the FAA as part of the application process, and providing an aeronautical study is useful to these consultations

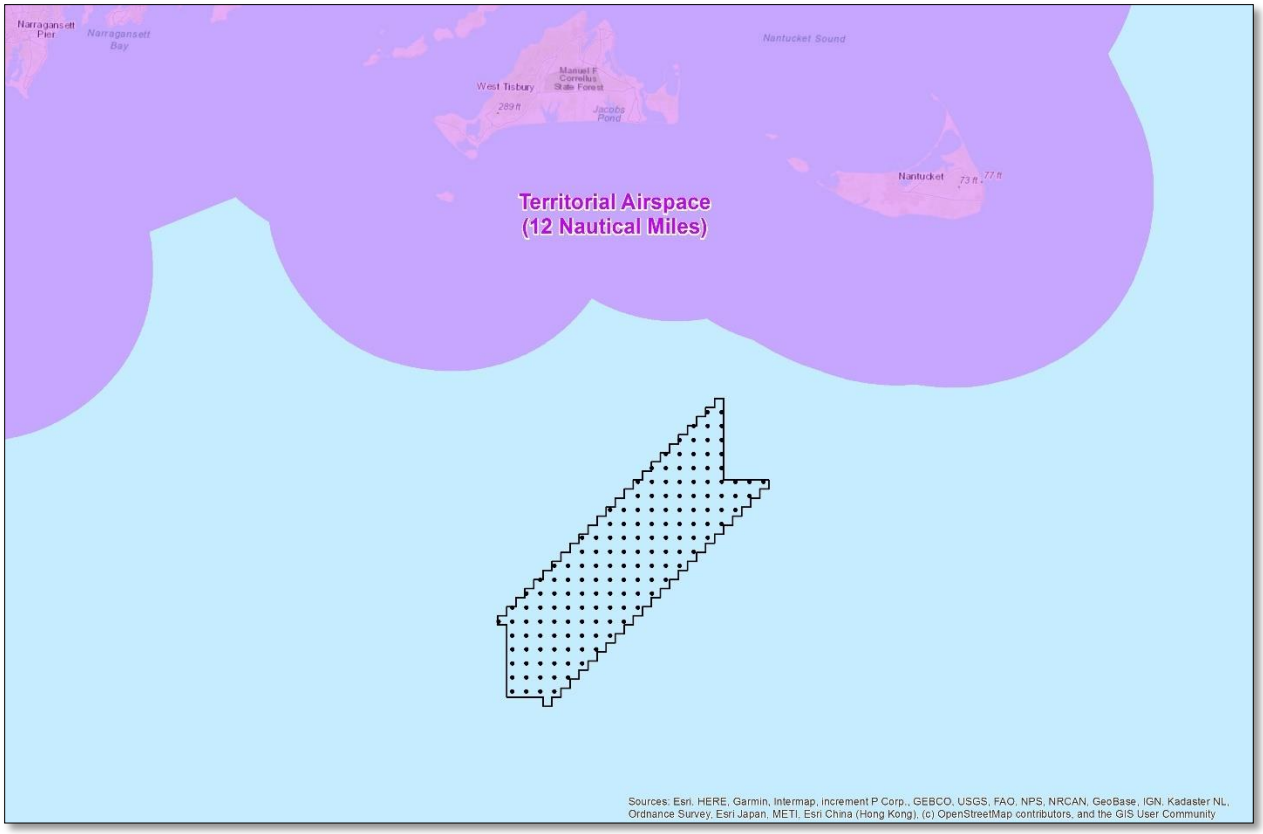


Figure 2: Territorial Airspace in proximity to the Beacon Wind project

[3] The National Oceanic and Atmospheric Administration (NOAA) defines territorial waters as 12 nautical miles 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***.

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

14 CFR Part 77.17(a)(2) Obstruction Standard and 77.19/21/23 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 result in the issuance of a determination of hazard. Proposed structures must have airspace impacts that constitute a substantial adverse effect in order to warrant the issuance of determinations of hazard.

Military and public-use airport 14 CFR Part 77.17(a)(2) obstruction standard and 77.19/21/23 imaginary surfaces do not overlie the Beacon Wind project (e.g., ***Figure 3***). However, at 850 (259 meters) and 1,116 feet (340 meters) tall proposed heights, wind turbines will exceed 77.17(a)(1) – a height of 499 feet AGL at the site of the object – and will be identified as obstructions regardless of location.

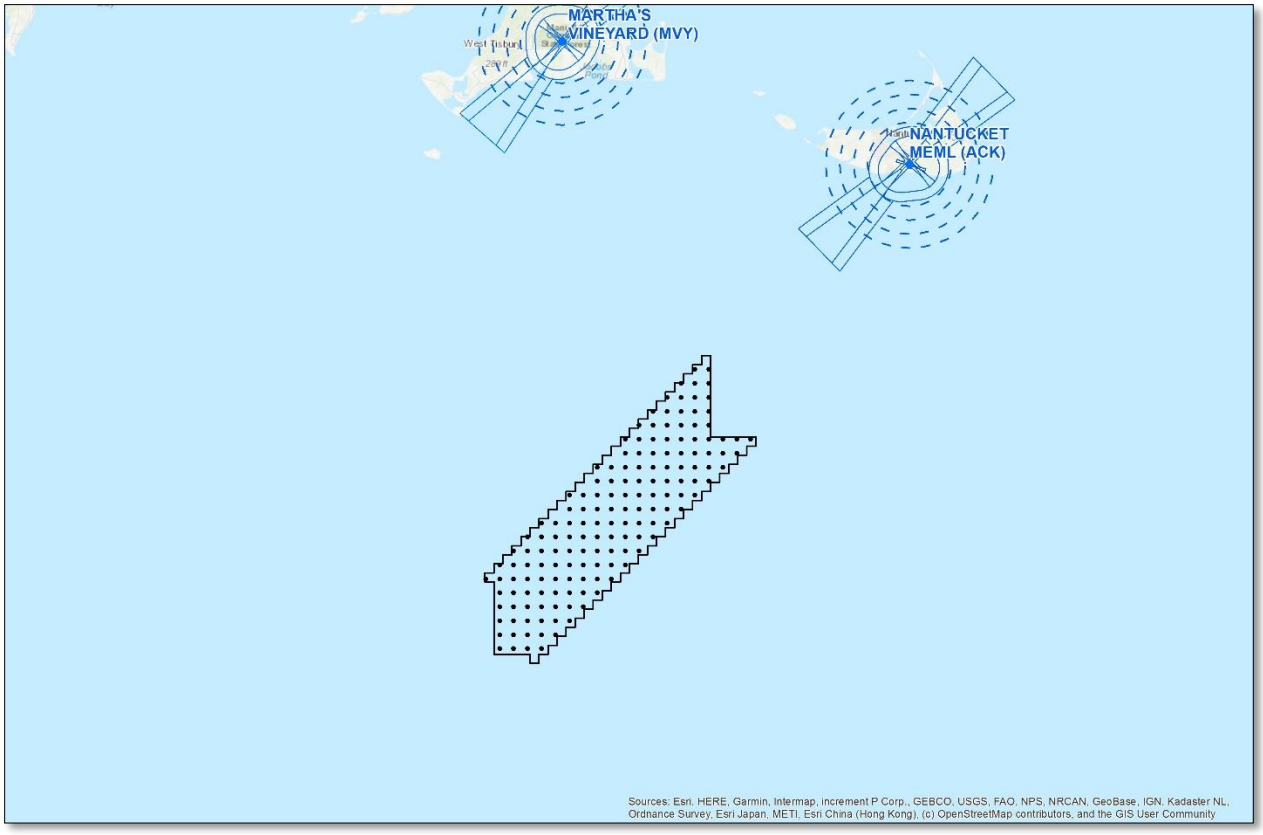


Figure 3: 14 CFR Part 77.17(a)(2) obstruction standard (dashed blue) and 77.19 (solid blue) imaginary surfaces in proximity to the Beacon Wind project

Visual Flight Rules (VFR) 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 Beacon Wind project and should not limit 850 (259 meters) or 1,116-foot (340 meters) tall wind turbines within the defined study area (***Figure 4***).

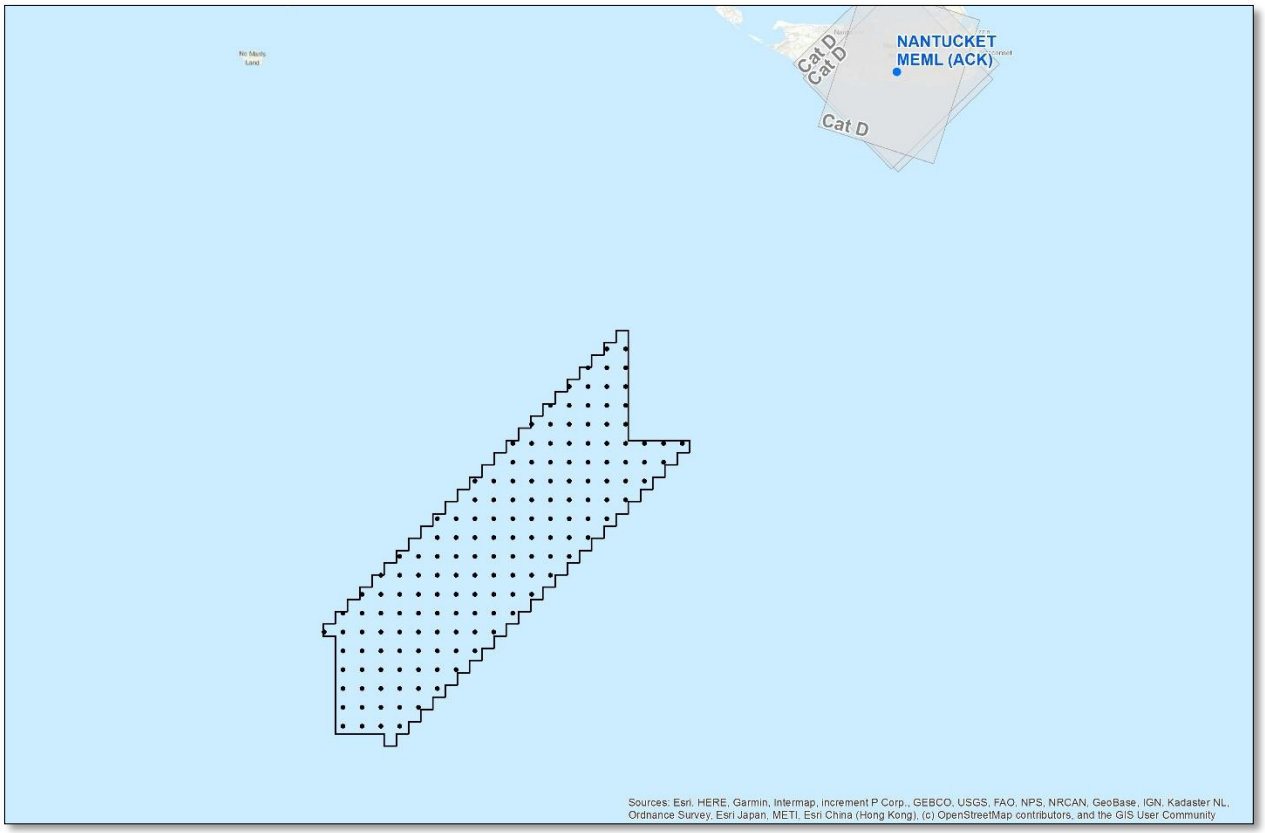


Figure 4: VFR traffic pattern airspace in proximity to the Beacon Wind project

Visual Flight Rules (VFR) Routes

During periods of marginal VMC – low cloud ceilings and one statute mile visibility – pilots often operate below the floor of controlled airspace. Operating under these weather conditions requires pilots to remain within one 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 two 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.

There is no dataset that identifies VFR routes or their utilization. However, the Beacon Wind project is not located within two statute miles of landmarks that could be used as VFR routes (hatched orange, ***Figure 5***). Therefore, VFR routes should not limit wind development within the defined study area.

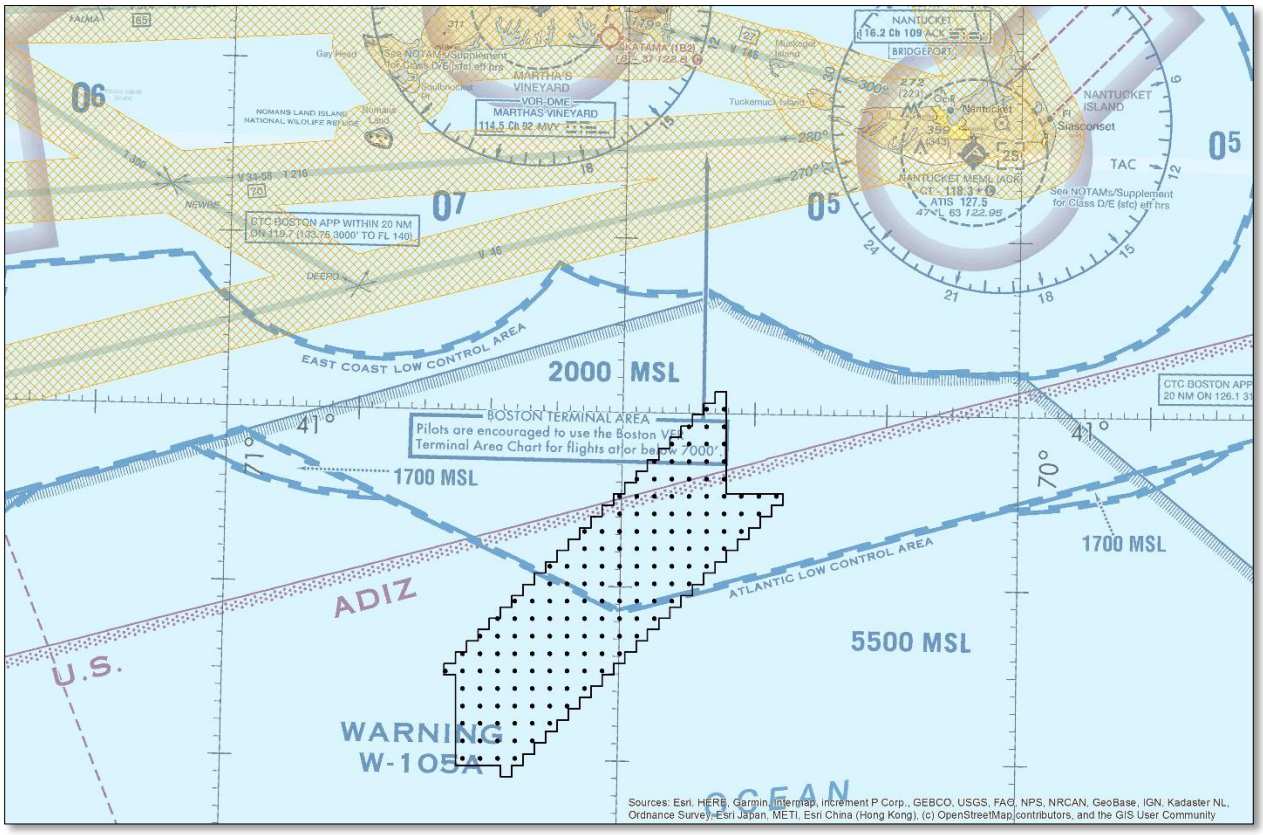


Figure 5: Potential VFR routes in proximity to the Beacon Wind project

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 FAA determines that this impact would affect as few as one instrument departure per week, it could be used as the basis for determinations of hazard.

Instrument departure procedure obstacle clearance surfaces (e.g., ***Figure 6***) are in excess of other, lower surfaces and should not limit 850 (259 meters) or 1,116-foot (340 meters) tall wind turbines within the defined study area.

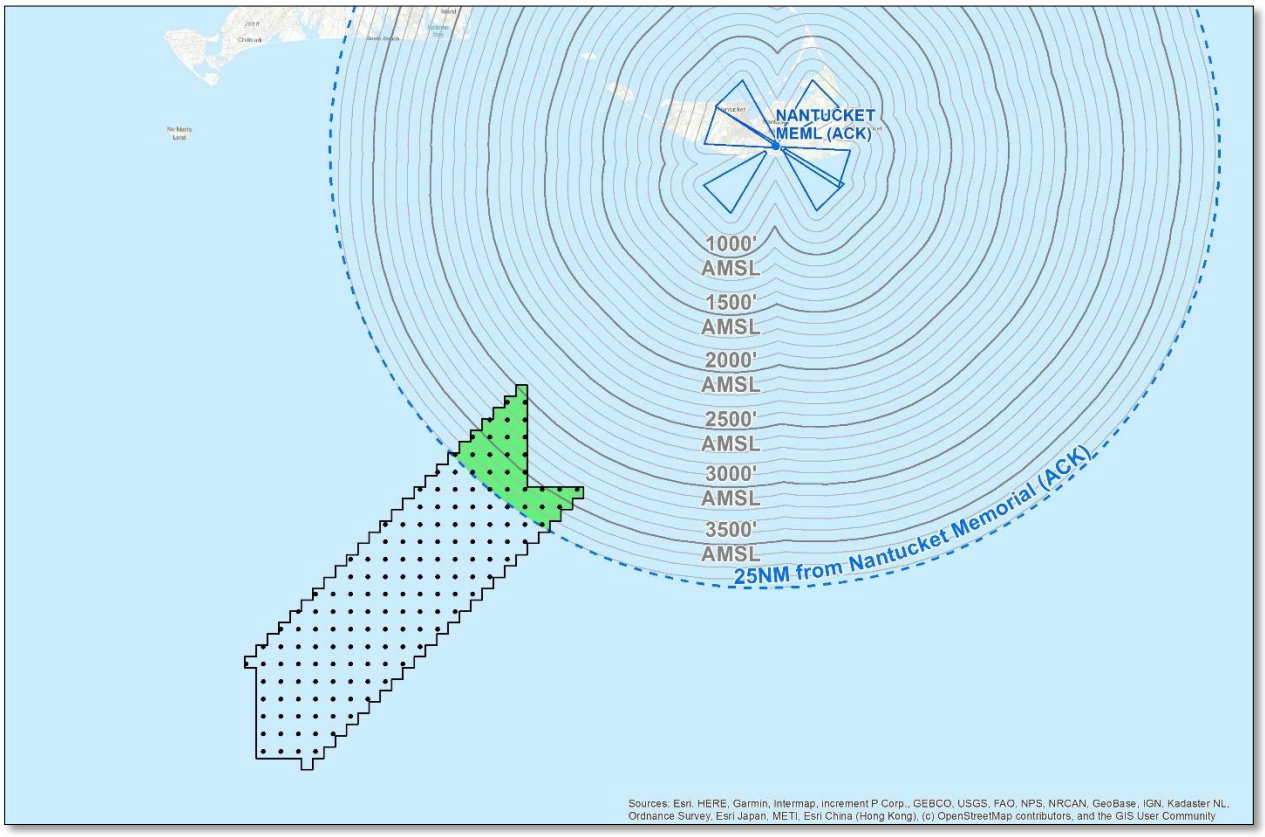


Figure 6: Nantucket Memorial (ACK) obstacle departure procedure assessment

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 a total of 13 published instrument approach procedures at two public-use airports in proximity to the Beacon Wind project: [5]

Nantucket Memorial (ACK)
ILS or Localizer Approach to Runway 06
ILS or Localizer Approach to Runway 24
RNAV (GPS) Approach to Runway 06
RNAV (GPS) Approach to Runway 15
RNAV (GPS) Approach to Runway 24
RNAV (GPS) Approach to Runway 33
VOR Approach to Runway 24

Martha's Vineyard (MVY)
ILS or Localizer Approach to Runway 24
RNAV (GPS) Approach to Runway 06
RNAV (GPS) Approach to Runway 15
RNAV (GPS) Approach to Runway 24
RNAV (GPS) Approach to Runway 33
VOR Approach to Runway 06

Proposed wind turbines that exceed instrument approach procedure obstacle clearance surfaces would require an increase to their minimum altitudes. Increases to these altitudes, especially critical decision altitudes (DA) and minimum descent altitudes (MDA), can directly impact the efficiency of instrument approach procedures. If the FAA determines this impact would affect as few as one operation per week, it could be used as the basis for determinations of hazard.

[5] Capitol Airspace assessed instrument approach procedures within 30 nautical miles (NM) of the study area. Although approach surfaces – including Terminal Arrival Areas (TAA), feeder segments, and initial segments – from airports further 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***.

Nantucket Memorial (ACK)

RNAV (GPS) Approach to Runway 06

The minimum safe altitude (MSA) is 1,500 feet AMSL. The obstacle clearance surface (hatched purple, ***Figure 7***) is 500 feet AMSL and would be the lowest height constraint overlying the northern section of the study area. At 850 (259 meters) and 1,116 feet (340 meters) tall, proposed wind turbines will exceed this surface. However, MSAs are for emergency use only and cannot be used as the basis for determinations of hazard. [6]

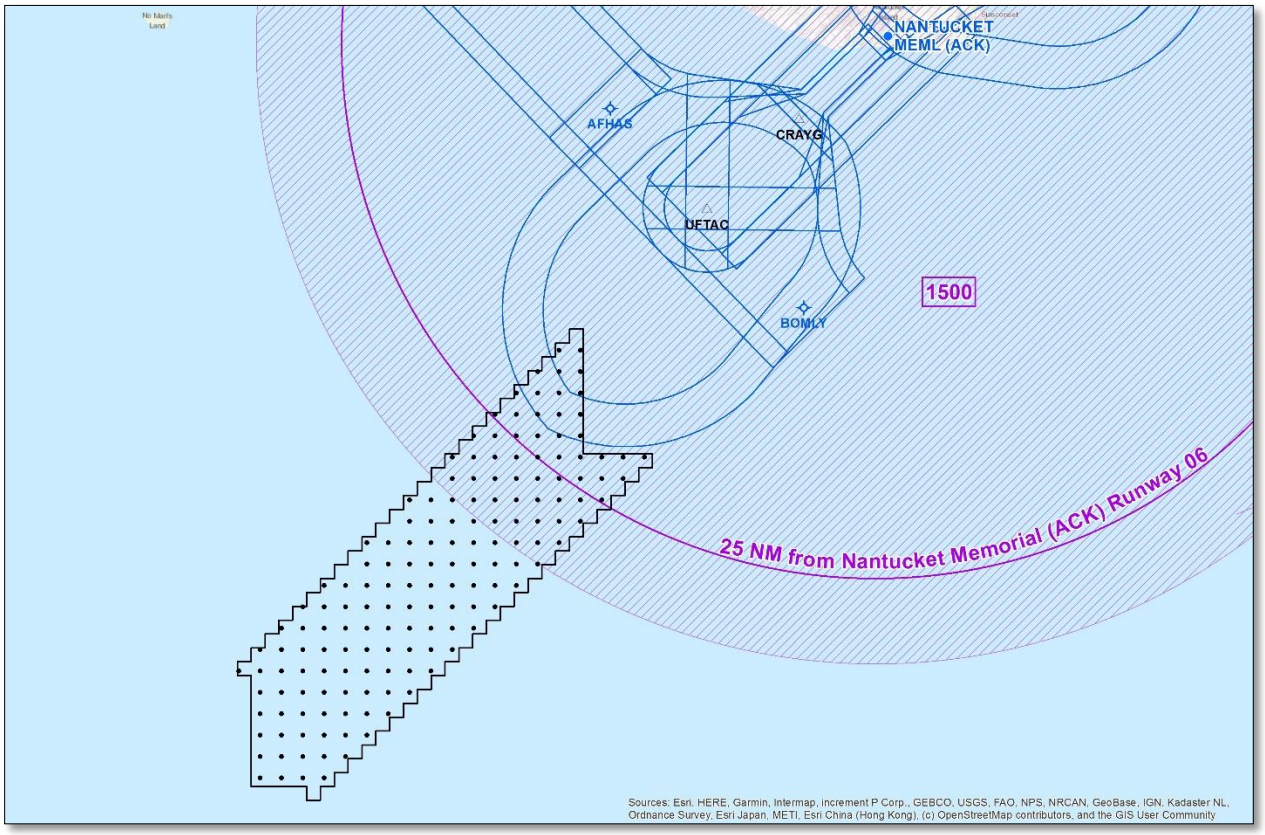


Figure 7: Nantucket Memorial (ACK) RNAV (GPS) Approach to Runway 06 (blue) with MSA obstacle evaluation area (hatched purple)

[6] Multiple minimum safe altitudes (MSA) overlie the study area. However, MSAs are for emergency use only and cannot be used as the basis for determinations of hazard in accordance with FAA Order 7400.2M Paragraph 6-3-9(e)(5). Therefore, height constraints associated with MSAs were not considered and are not included in the ***Composite Map***.

Enroute Airways

Enroute airways provide pilots a means of navigation when flying from airport to airport and are defined by radials between 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 FAA determines that this impact would affect as few as one enroute airway operation per week, it could be used as the basis for determinations of hazard.

Low altitude enroute airway obstacle clearance surfaces (e.g., ***Figure 8***) do not overlie the Beacon Wind project and should not limit 850 (259 meters) or 1,116-foot (340 meters) tall wind turbines within the defined study area.

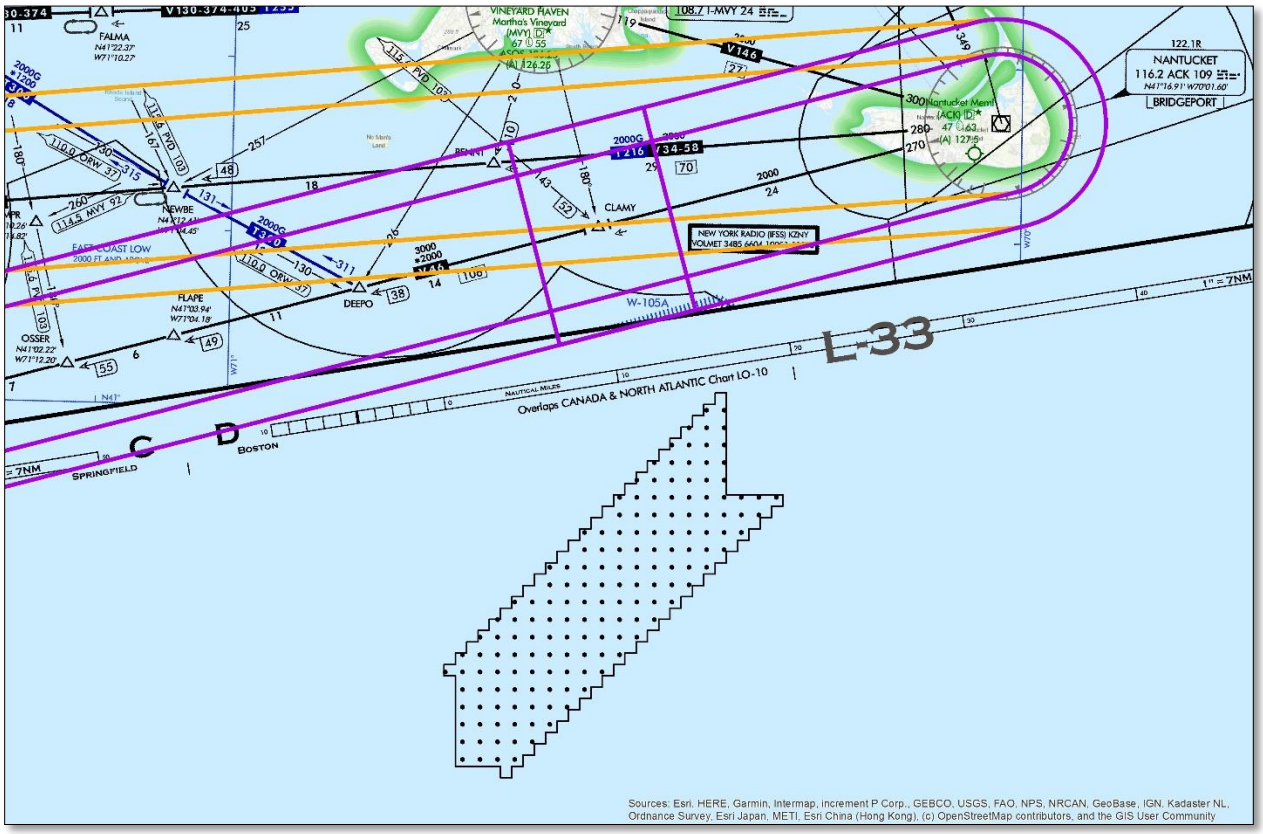


Figure 8: Low altitude enroute chart L-33 with V46 (purple outline) and V34 (yellow outline) obstacle evaluation areas

Minimum Vectoring/IFR Altitudes

The FAA publishes minimum vectoring altitude (MVA) and minimum instrument flight rules (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 FAA determines that this impact would affect as few as one radar vectoring operation per week, it could result in determinations of hazard.

Boston Consolidated (A90) Terminal Radar Approach Control (TRACON)

Sector U (A90_MVA_FUS3_2020)

The MVA is 2,000 feet AMSL. The obstacle clearance surface (hatched blue, ***Figure 9***) is 1,049 feet AMSL and is the lowest height constraint overlying the central and northern sections of the study area. This surface could limit 1,116-foot (340 meters) tall wind turbines in this area (orange area, ***Figure 9***), including 105 proposed locations.

Sector T (A90_MVA_FUS3_2020)

The MVA is 5,500 feet AMSL. The obstacle clearance surface is 4,549 feet AMSL and is the lowest height constraint overlying the southern section of the study area. However, this surface should not limit 850 (259 meters) or 1,116-foot (340 meters) tall wind turbines within the defined study area (green area, ***Figure 10***).

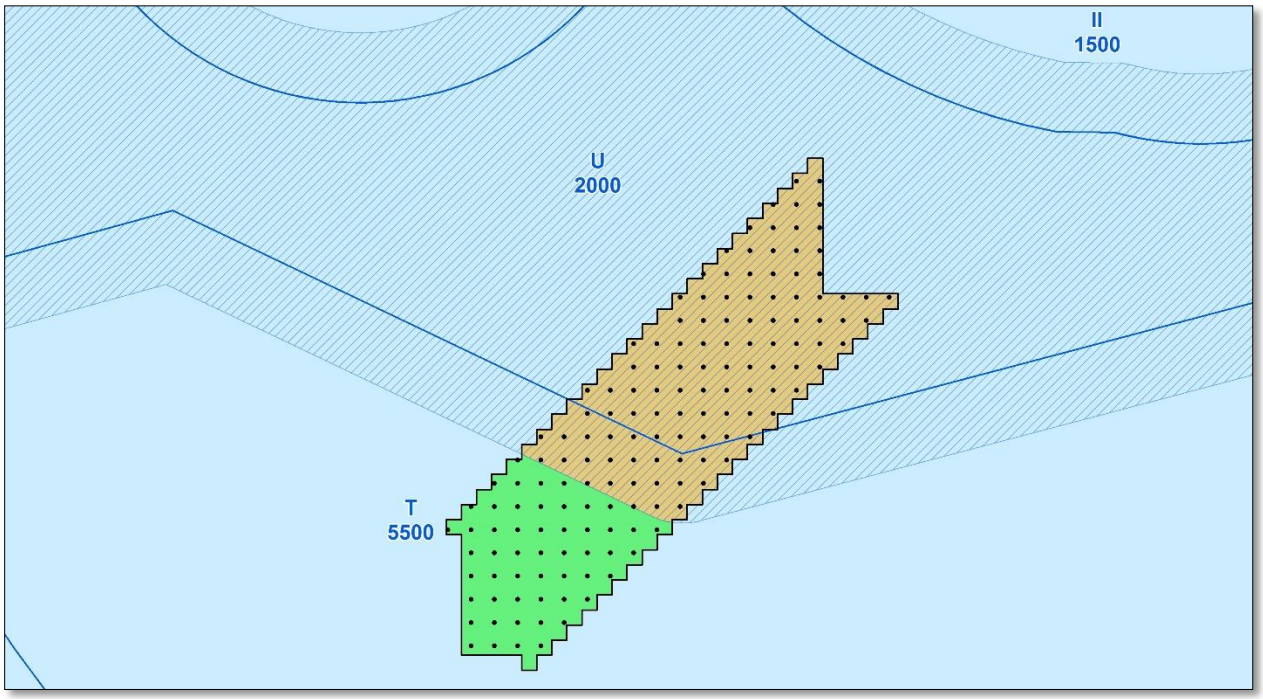


Figure 9: Boston Consolidated (A90) TRACON FUSION 3 MVA sectors (blue) with Sector U obstacle evaluation area (hatched blue)

Boston Consolidated (A90) TRACON - continued

Sector FF (A90_MVA_FUS5_2021)

The MVA is 1,500 feet AMSL. The obstacle clearance surface (hatched blue, ***Figure 10***) is 549 feet AMSL and is the lowest height constraint overlying the northern corner of the study area. This surface could limit 850 (259 meters) and 1,116-foot (340 meters) tall wind turbines in this area (red area, ***Figure 10***). However, none of the proposed wind turbine locations are in this area.

Sector HH (A90_MVA_FUS5_2021)

The MVA is 2,300 feet AMSL. The obstacle clearance surface is 1,349 feet AMSL and is one of the lowest height constraints overlying the central section of the study area. However, this surface should not limit 850 (259 meters) or 1,116-foot (340 meters) tall wind turbines within the defined study area.

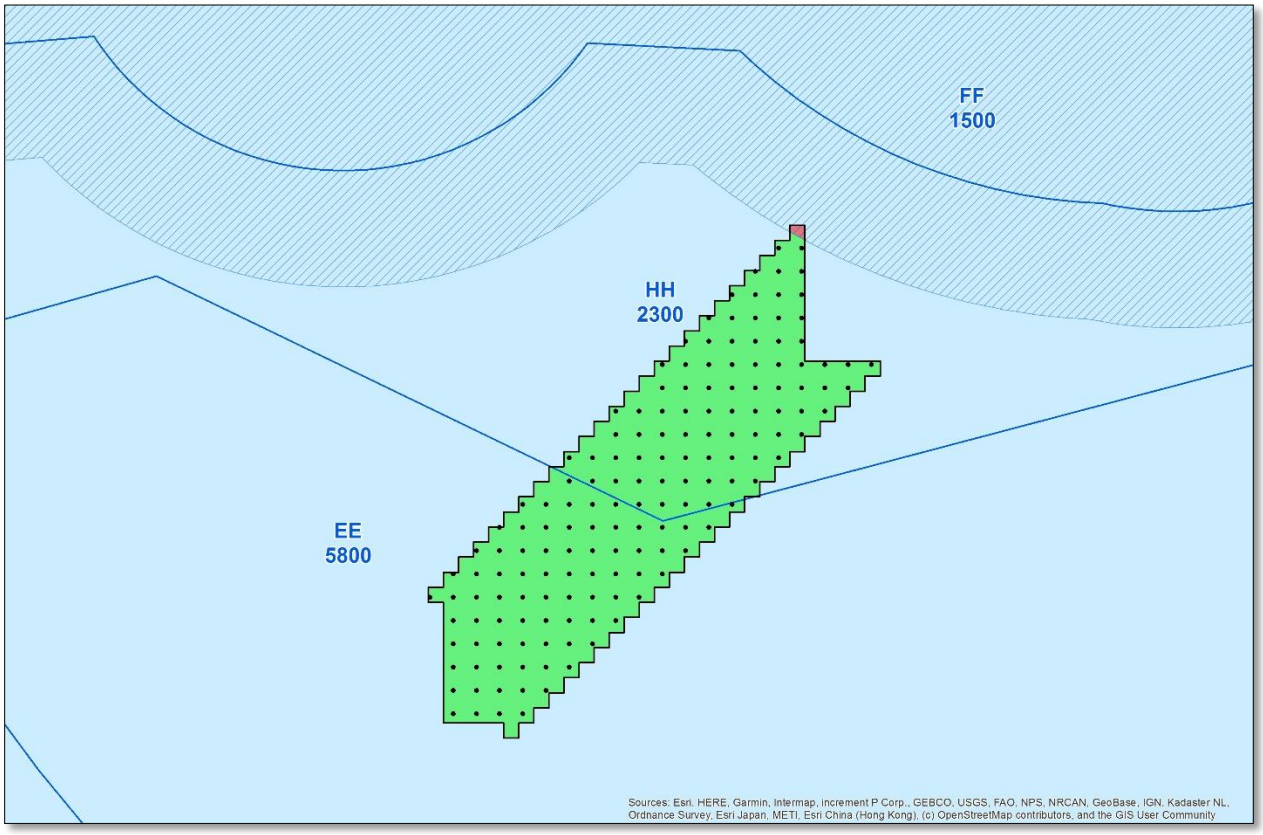


Figure 10: Boston Consolidated (A90) TRACON FUSION 5 MVA sectors (blue) with Sector FF obstacle evaluation area (hatched blue)

Boston (ZBW) Air Route Traffic Control Center (ARTCC) (ZBW_TAV_2020)

Sector bBOS04

The MIA is 2,300 feet AMSL. The obstacle clearance surface (hatched blue, ***Figure 11***) is 1,349 feet AMSL and is one of the lowest height constraints overlying the central section of the study area. However, this surface should not limit 850 (259 meters) or 1,116-foot (340 meters) tall wind turbines within the defined study area (green area, ***Figure 11***).

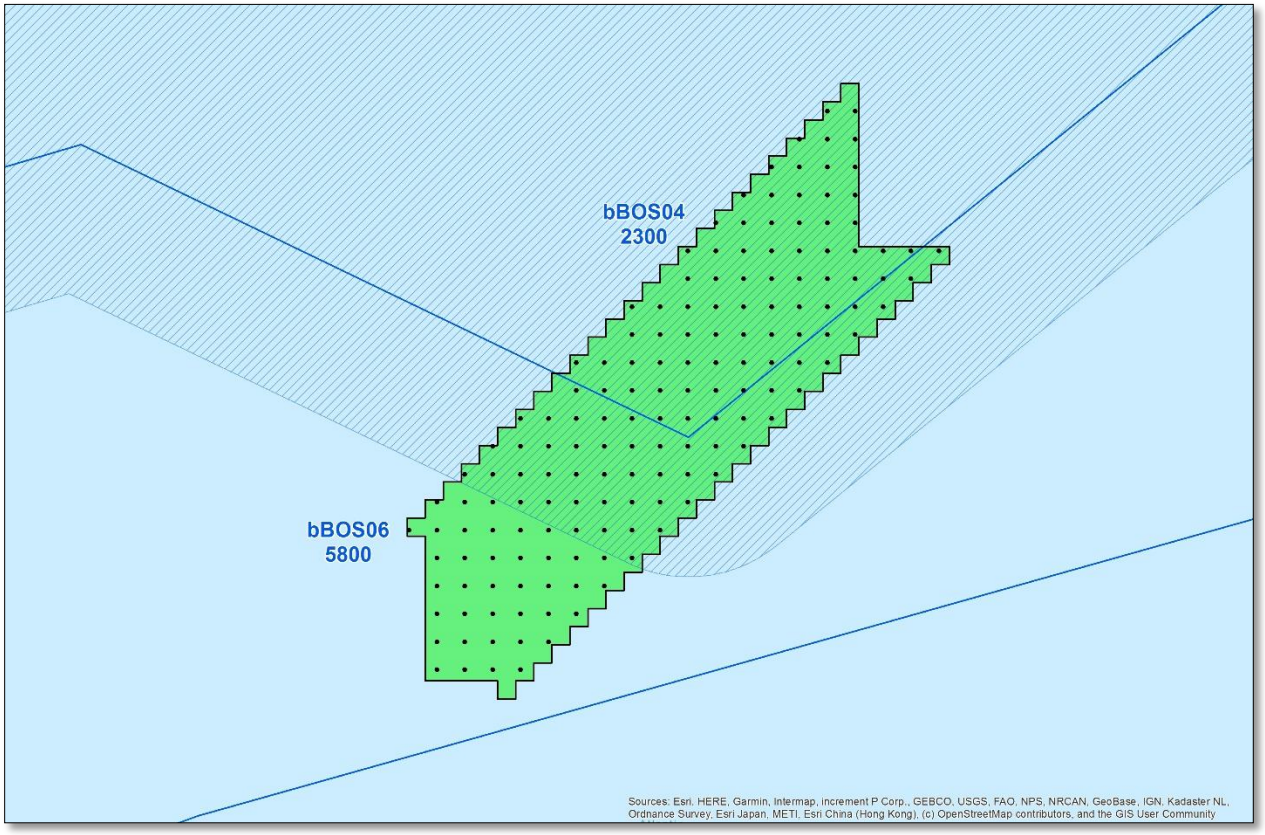


Figure 11: Boston (ZBW) ARTCC MIA sectors (blue) with Sector bBOS04 obstacle evaluation area (hatched blue)

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 navigational aids (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 could result in determinations of hazard.

NAVAID protection areas do not overlie the Beacon Wind project (***Figure 12***). As a result, it is unlikely that proposed wind turbines would have a physical or electromagnetic effect on terminal or enroute NAVAIDs.

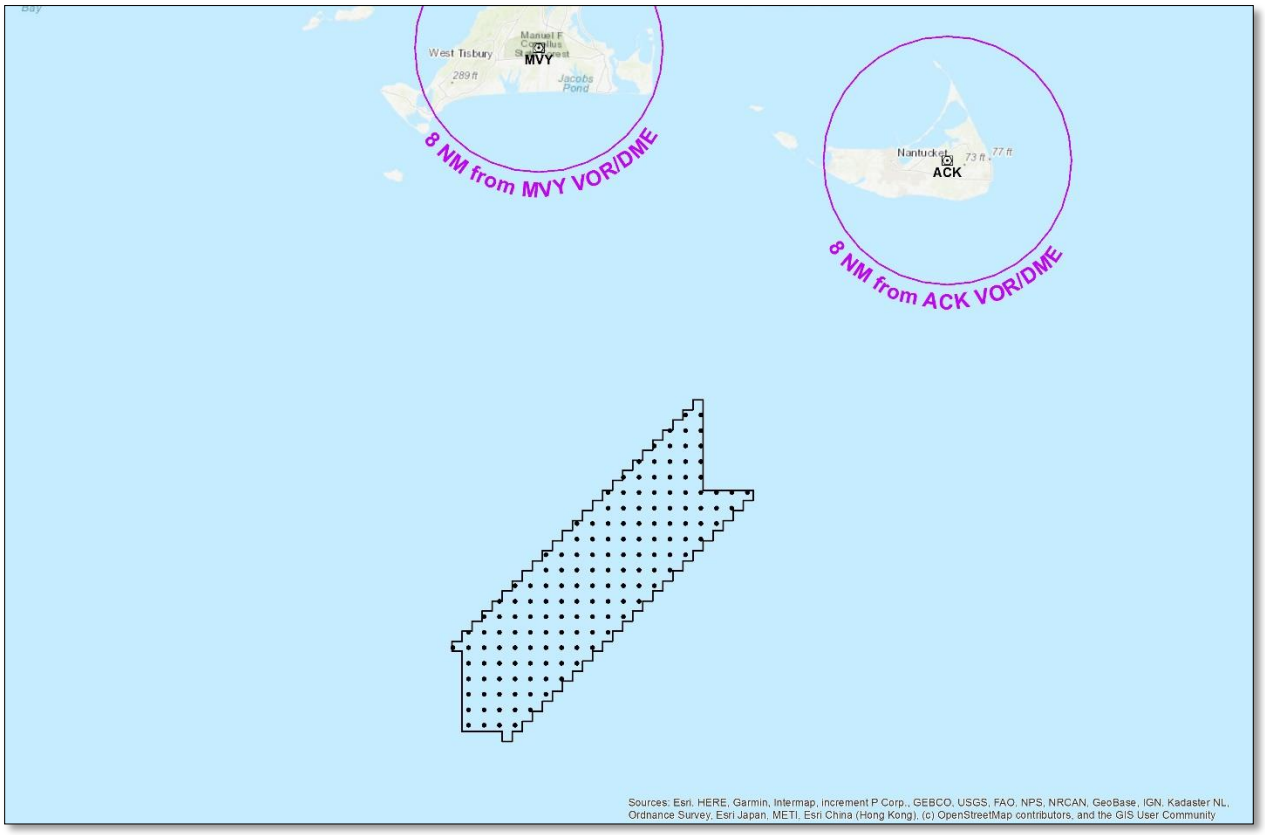


Figure 12: NAVAID protection areas in proximity to the Beacon Wind project

Military Airspace and Training Routes

Although the FAA does not consider impact on military airspace or training routes, they 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. If the planned development area is on federal land, impact on military airspace or training routes may result in the denial of permits.

Warning areas (W) overlying the Beacon Wind project (***Figure 13***):

U.S. Navy, Fleet Area Control and Surveillance Facility, Virginia Capes (FACSFAC VACAPES)

Route/Airspace	*Minimum Altitude*
W-105A	Surface

Due to the low altitudes associated with this airspace, wind development could have an impact on its operations. If FACSFAC VACAPES or other nearby units use this area regularly, they may object to proposed wind development within the area's boundaries. Under the provisions of the 2018 National Defense Authorization Act (NDAA), 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.

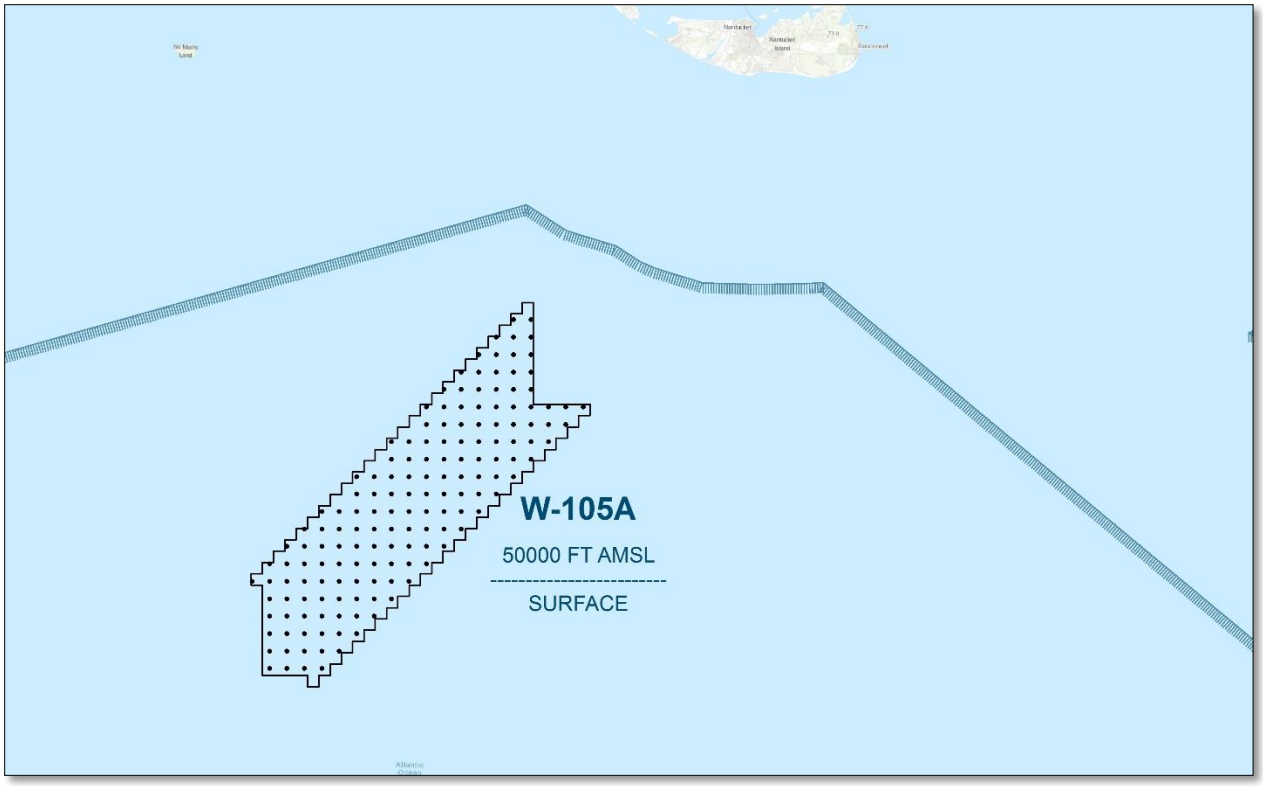


Figure 13: Military airspace overlying the Beacon Wind project

Conclusion

At 850 (259 meters) and 1,116 feet (340 meters) tall, proposed wind turbines will exceed 14 CFR Part 77.17(a)(1) – a height of 499 feet above ground level at the site of the object – and will be identified as obstructions regardless of location. However, exceeding these surfaces does not automatically result in the issuance of a determination of hazard. Proposed structures must have airspace impacts that constitute a substantial adverse effect in order to warrant the issuance of determinations of hazard.

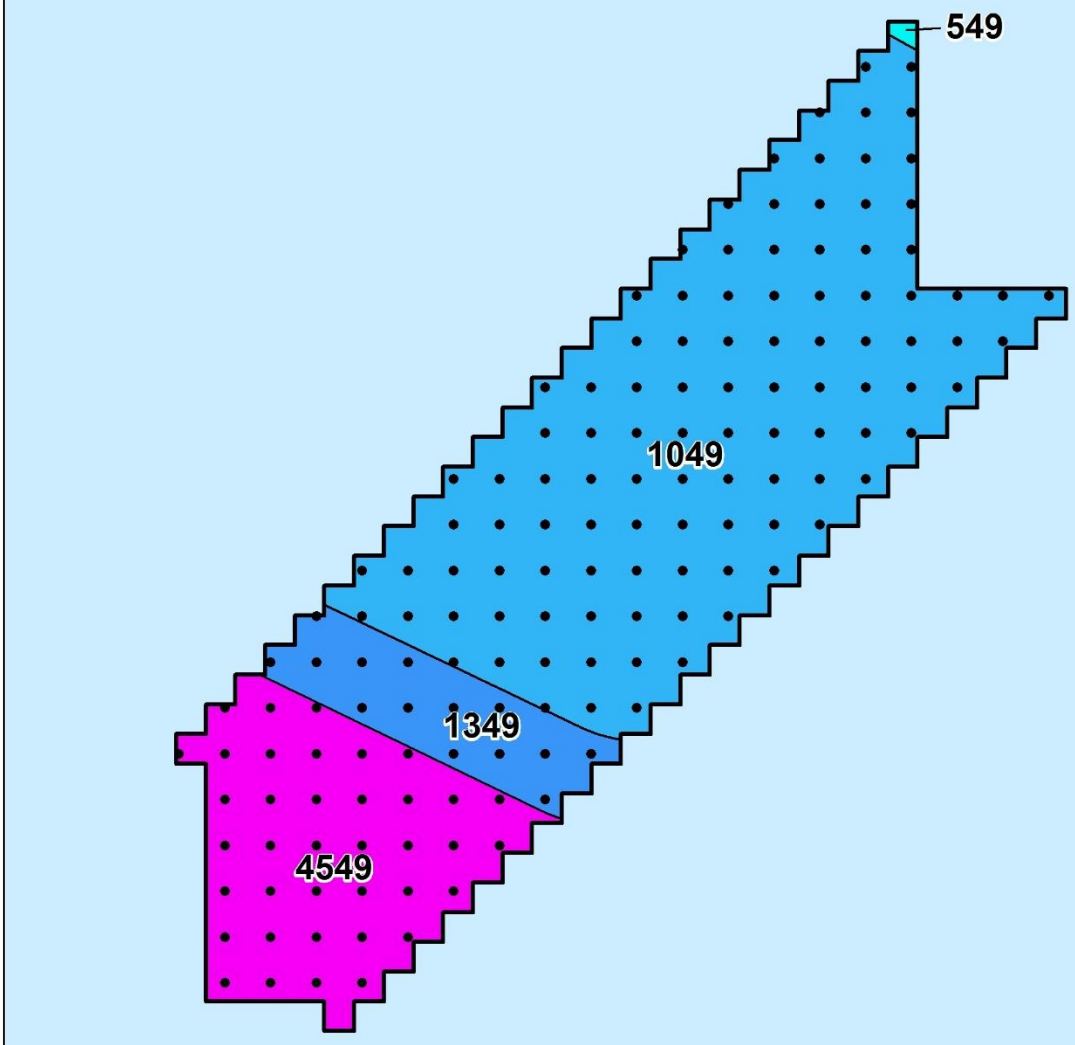
The lowest obstacle clearance surfaces overlying the Beacon Wind project range from 549 to 4,549 feet AMSL (***Figure 14***) and are associated with MVA sectors and MIA sectors. These surfaces could limit 850-foot tall (259 meters) wind turbines in the northern corner of the study area (red area, ***Figure 15***). These surfaces could further limit 1,116-foot (340 meters) tall wind turbines in the central and northern sections of the study area (red and orange areas, ***Figure 15***).

At 850 (259 meters) and 1,116 feet (340 meters) tall, wind turbines in the northern corner of the study area (red areas, ***Figure 10***) would require an increase to the Boston Consolidated (A90) TRACON Sector FF MVA. At 1,116 feet (340 meters) tall, 105 proposed wind turbines in the central and northern sections of the study area (red and orange areas, ***Figure 9***) would additionally require an increase to the Boston Consolidated (A90) TRACON Sector U MVA. If the FAA determines that any of these impacts would affect as few as one operation per week, it could result in determinations of hazard.

Warning Area W-105A overlies the wind project (***Figure 13***). Impact on this airspace could result in military objections to proposed wind development.

If you have any questions regarding the findings of this study, please contact ***Dan Underwood*** or ***Candace Childress*** 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.



0 0.5 1 2 3 4 5 6 7 8 9 10 Nautical Miles

0 0.5 1 2 3 4 5 6 7 8 9 10 Miles

N

Obstacle Clearance Surface

Height - AMSL Feet

High : 4,549

Low : 549

Lease Area OCS A 0520

Wind Turbine Location

All heights above mean sea level (AMSL)

Beacon Offshore Wind Project
Composite Height Constraint Map

Plot Date:
11 May 2021

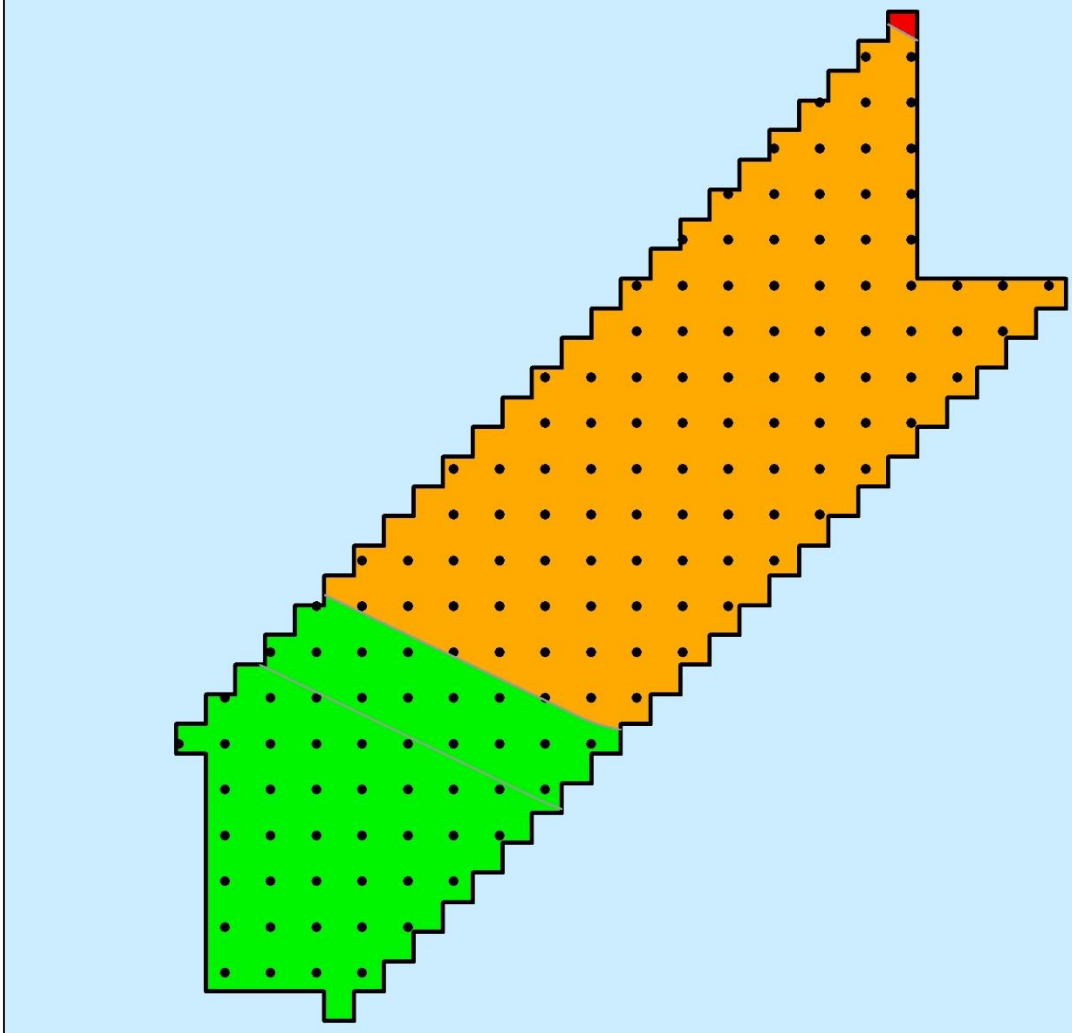
Figure 14

Coordinate System:
NAD 1983 UTM Zone 19N

Candace Childress

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
- < 850
- ≥ 850 < 1,116
- ≥ 1,116
- Lease Area OCS A 0520
- Wind Turbine Location

Beacon Offshore Wind Project
Above Mean Sea Level (AMSL) Clearance Map

Plot Date:
11 May 2021

Figure 15

Coordinate System:
NAD 1983 UTM Zone 19N

Candace Childress

Capitol Airspace Group

Photo credit: Matt Goldsmith, Equinor