Appendix H

Obstruction Evaluation & Airspace Analysis

Three Waters Wind Project

Scout Clean Energy

Jackson County, Minnesota

Obstruction Evaluation & Airspace Analysis

August 07, 2018

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Summary

Capitol Airspace conducted an obstruction evaluation and airspace analysis for the Three Waters wind project in Jackson County, Minnesota. The purpose for this analysis was to identify obstacle clearance surfaces established by the Federal Aviation Administration (FAA) that could limit the placement of 586 and 643 foot above ground level (AGL) wind turbines. At the time of this analysis, individual wind turbine locations had not been identified. This analysis assessed height constraints overlying an approximately 73 square mile study area (red outline, ***Figure 1***) to aid in identifying optimal wind turbine locations.

14 CFR Part 77.9 requires that 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.

Height constraints overlying the Three Waters wind project are a constant 2,300 feet above mean sea level (AMSL) and are associated with Worthington Municipal Airport (OTG) instrument approach procedures and an enroute airway. Proposed structures that exceed these surfaces would require an increase to instrument approach procedure minimum altitudes and minimum enroute altitudes. If the FAA determines that either of these impacts would constitute a substantial adverse effect, it could result in determinations of hazard. However, United States Geological Survey (USGS) elevation data indicates that these surfaces should not limit 586 or 643 foot AGL wind turbines within the defined study area.

This study did not consider electromagnetic interference on communications or navigation systems.

Methodology

Capitol Airspace studied the proposed project based upon location information provided by Scout Clean Energy. 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, as well as 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 7400.2L 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
- United States Government Flight Information Publication, US Terminal Procedures
- National Airspace System Resource Aeronautical Data

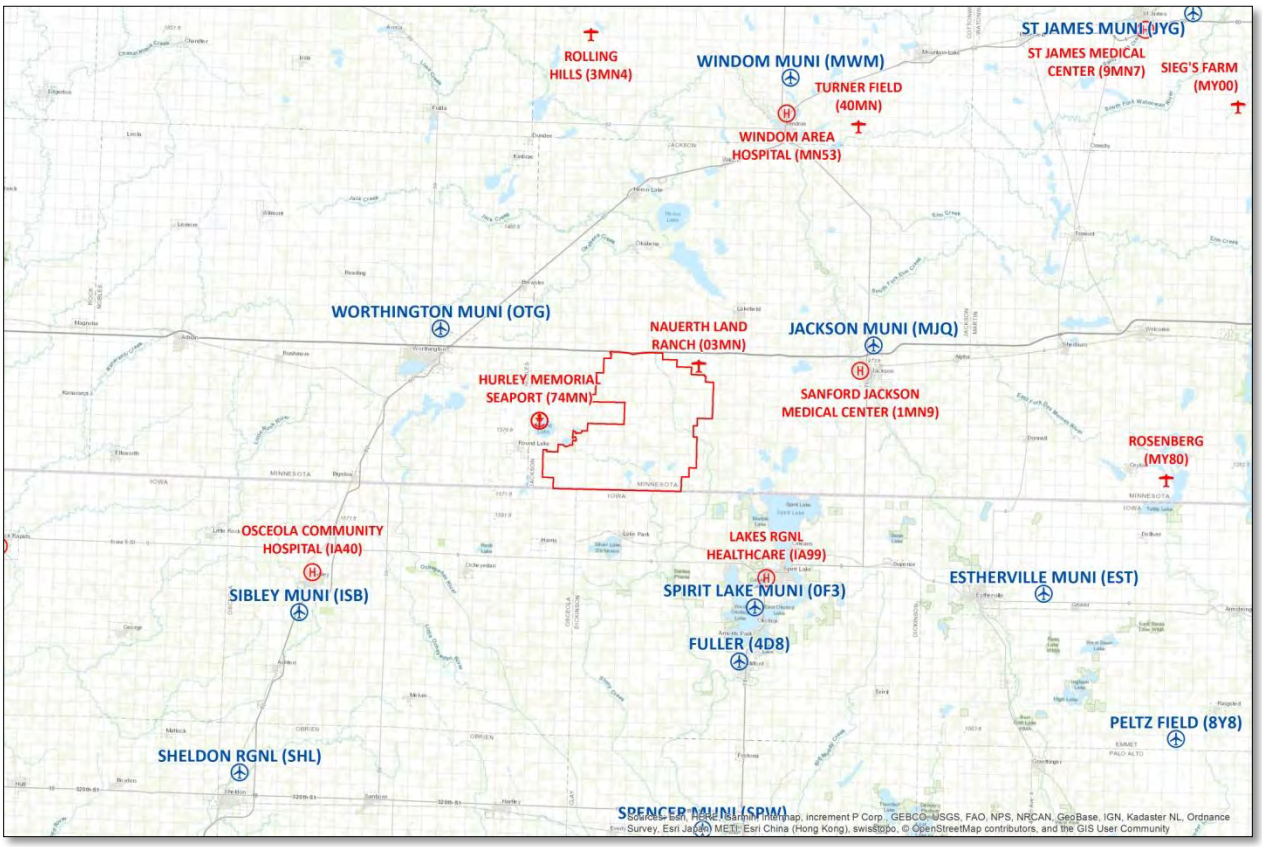


Figure 1: Public-use (blue) and private-use (red) airports in proximity to the Three Waters wind project

Study Findings

14 CFR Part 77 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.

Public-use airport 14 CFR Part 77.17(a)(2) and 77.19/21/23 imaginary surfaces do not overlie the Three Waters wind project (***Figure 2***). However, at 586 and 643 feet AGL, 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.

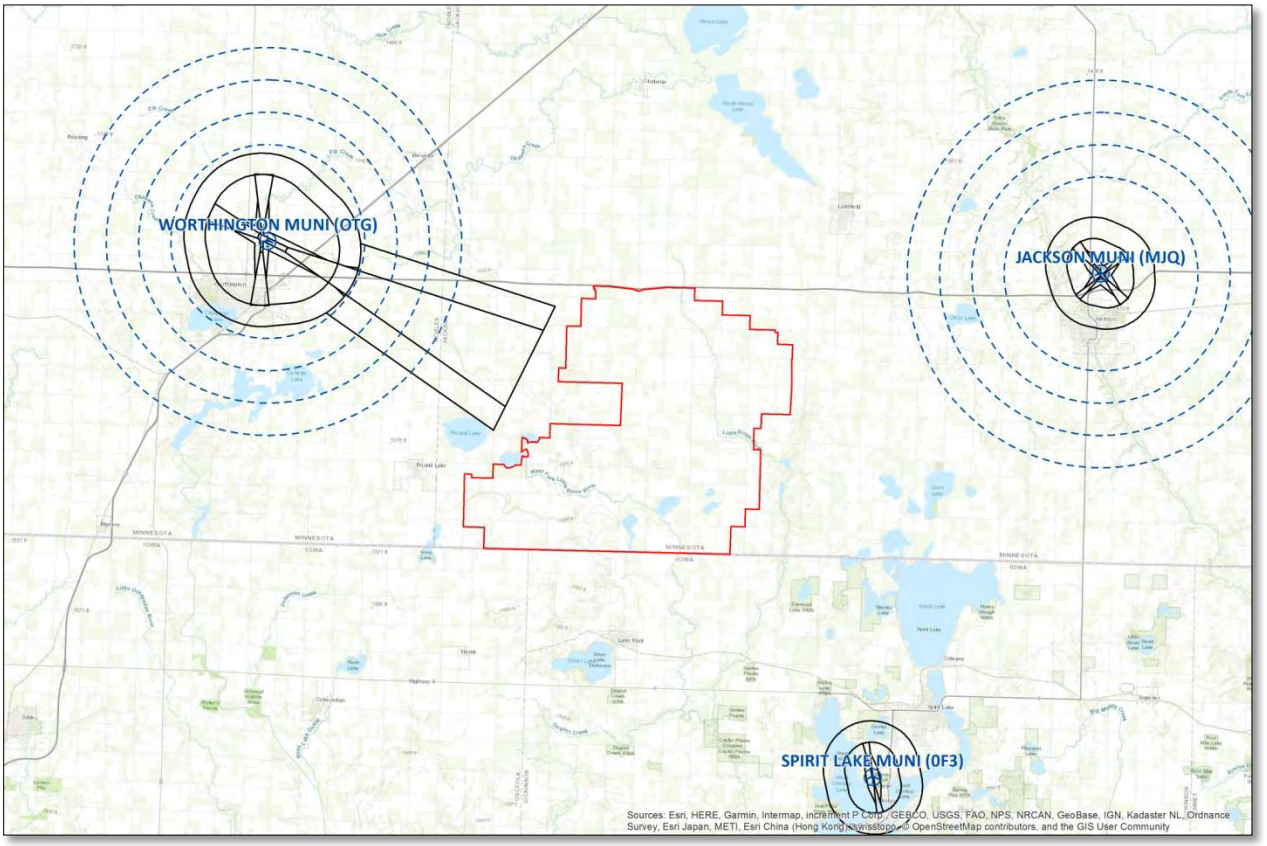


Figure 2: 77.17(a)(2) (dashed blue) and 77.19 (black) imaginary surfaces in proximity to the Three Waters wind project

Visual Flight Rules (VFR) Traffic Pattern Airspace

VFR traffic pattern airspace is used by pilots operating during visual meteorological conditions. 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 Three Waters wind project and should not limit 586 or 643 foot AGL wind turbines within the defined study area (***Figure 3***).

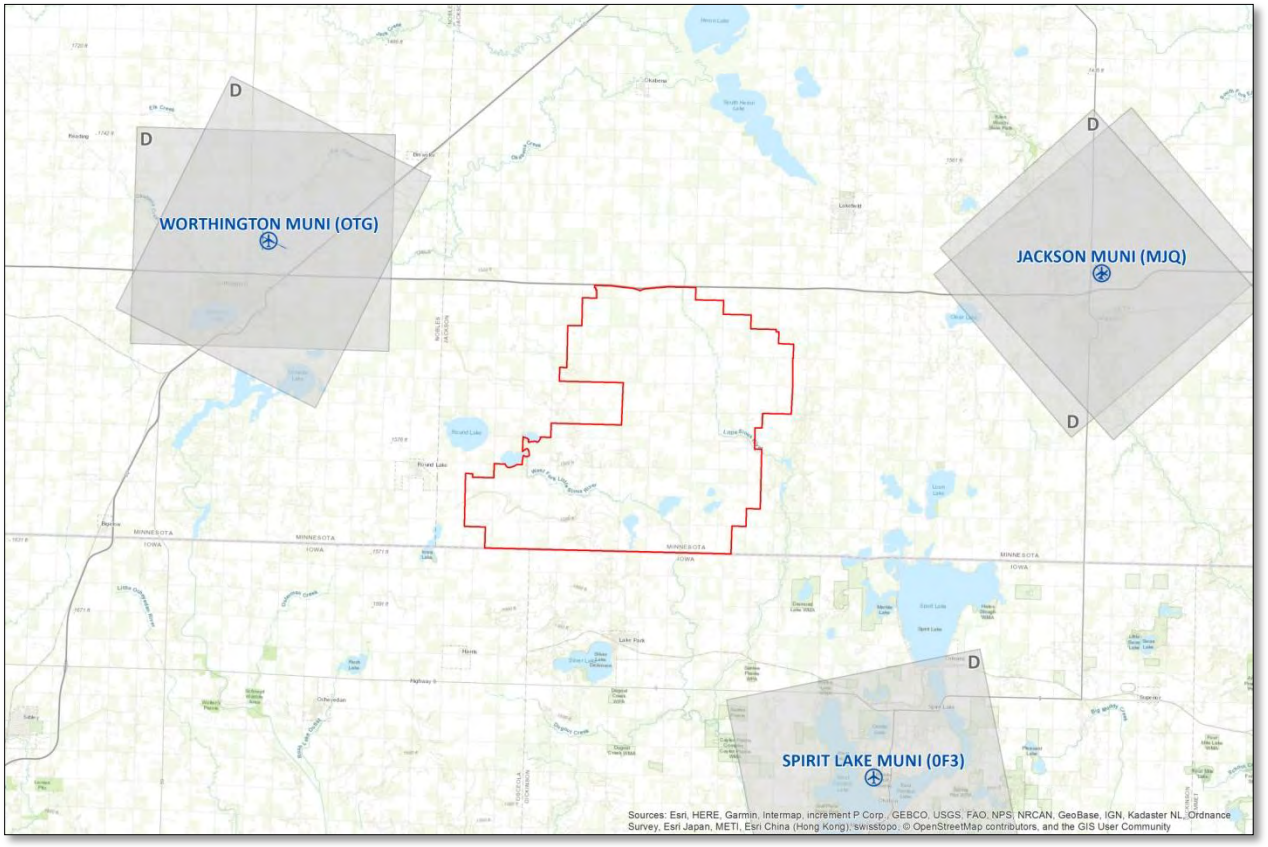


Figure 3: VFR traffic pattern airspace in proximity to the Three Waters wind project

Visual Flight Rules (VFR) Routes

During periods of marginal Visual Meteorological Conditions (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 land marks 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.

The Three Waters wind project is located in proximity to highways and transmission lines that may be used as VFR routes (***Figure 4***). However, operational data describing the usage of these potential routes is not available. If the FAA determines that these potential VFR routes are flown regularly, it could limit wind development in excess of 499 feet AGL and within two statute miles of these landmarks (hatched orange, ***Figure 4***).

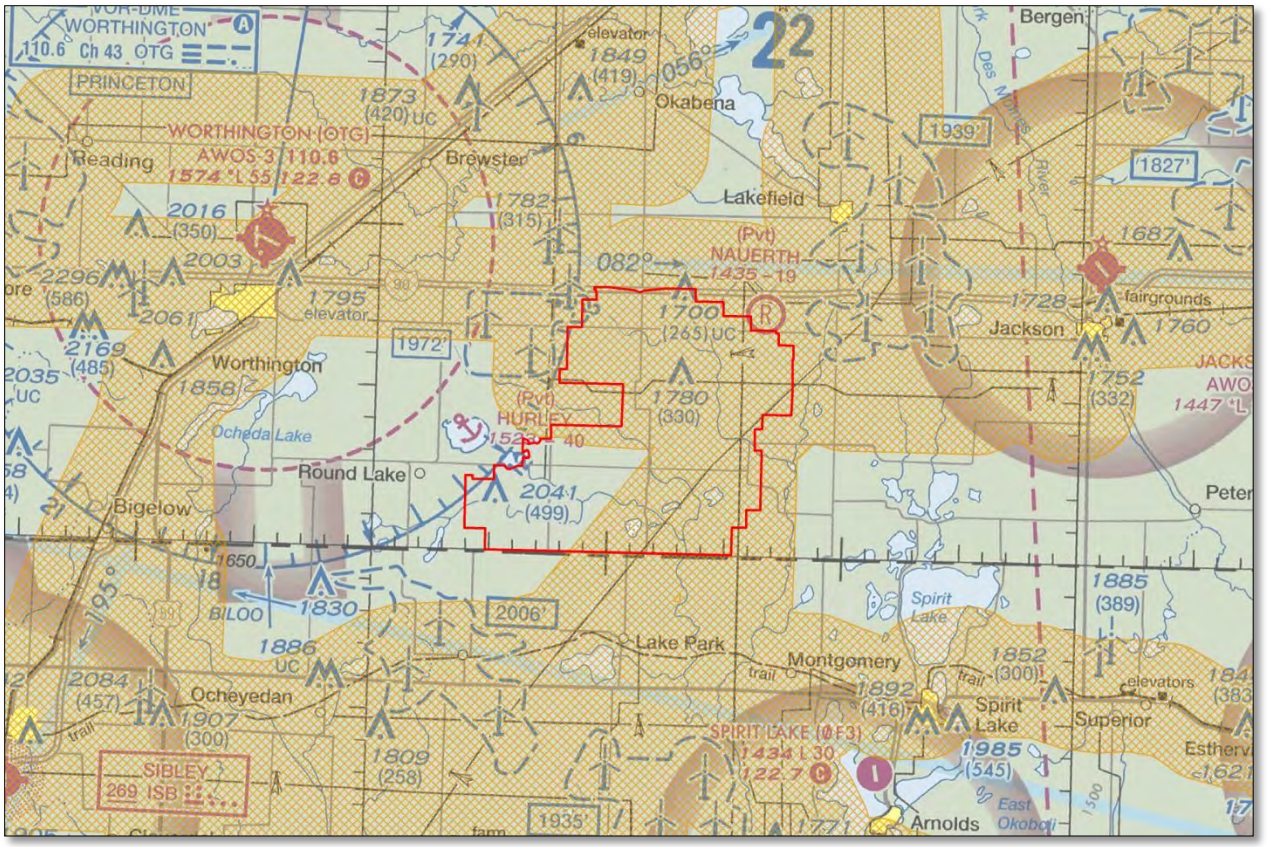


Figure 4: Potential VFR routes in proximity to the Three Waters wind project

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 constitute a substantial adverse effect, it could be used as the basis for determinations of hazard.

Instrument departure procedure obstacle clearance surfaces (e.g., ***Figure 5***) are in excess of other lower surfaces and should not limit 586 or 643 foot AGL wind turbines within the defined study area.

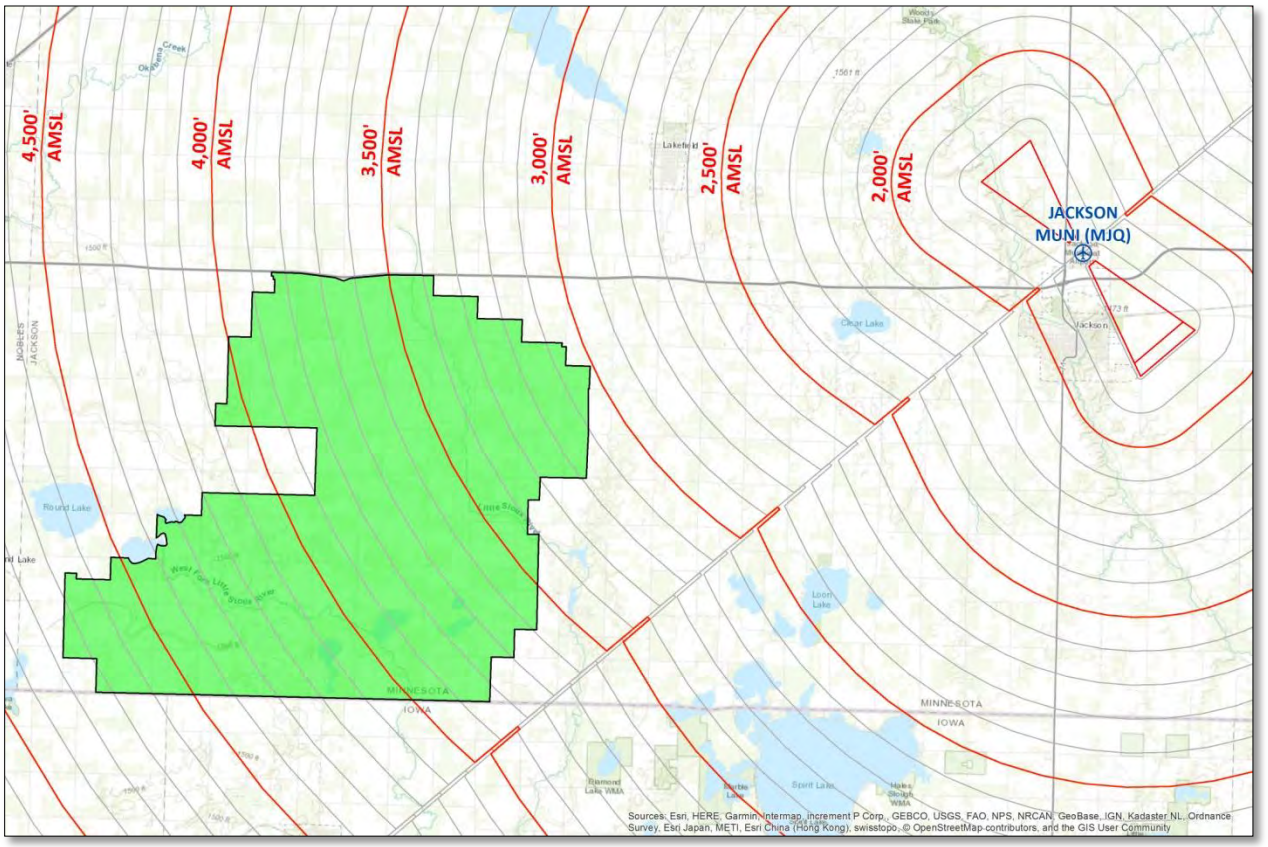


Figure 5: Jackson Municipal Airport (MJQ) obstacle departure procedure assessment

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 23 published instrument approach procedures at eight public-use airports in proximity to the Three Waters wind project:

Sibley Municipal (ISB)
NDB or GPS Approach to Runway 35

Worthington Municipal (OTG)
ILS or Localizer Approach to Runway 29
RNAV (GPS) Approach to Runway 11
RNAV (GPS) Approach to Runway 18
RNAV (GPS) Approach to Runway 29
RNAV (GPS) Approach to Runway 36
VOR Approach to Runway 11
VOR Approach to Runway 18

Wagner Municipal (SPW)
ILS or Localizer Approach to Runway 12
RNAV (GPS) Approach to Runway 12
RNAV (GPS) Approach to Runway 18
RNAV (GPS) Approach to Runway 30
RNAV (GPS) Approach to Runway 36
VOR/DME Approach to Runway 30

Jackson Municipal (MJQ)
RNAV (GPS) Approach to Runway 13
RNAV (GPS) Approach to Runway 31

Windom Municipal (MWM)
RNAV (GPS) Approach to Runway 17
RNAV (GPS) Approach to Runway 35

Estherville Municipal (EST)
RNAV (GPS) Approach to Runway 16
RNAV (GPS) Approach to Runway 34

Fuller (4D8)
VOR/DME or GPS-A Circling Approach

Sheldon Regional (SHL)
RNAV (GPS) Approach to Runway 15
RNAV (GPS) Approach to Runway 33

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 to constitute a substantial adverse effect it could be used as the basis for determinations of hazard.

Worthington Municipal (OTG)

ILS or Localizer Approach to Runway 29

The initial segment minimum altitude, procedure turn completion altitude, and missed approach minimum holding altitude are 3,300 feet AMSL. The associated obstacle clearance surfaces (***Figure 6***) are 2,300 feet AMSL and are some of the lowest height constraints overlying the entire study area.

RNAV (GPS) Approach to Runway 11

The missed approach climb-to altitude and missed approach minimum holding altitude are 3,300 feet AMSL. The associated obstacle clearance surfaces are 2,300 feet AMSL and are some of the lowest height constraints overlying the majority of the study area.

RNAV (GPS) Approach to Runway 29

The feeder segment minimum altitude, initial segment minimum altitudes, and hold-in-lieu of procedure turn minimum altitude are 3,300 feet AMSL. The associated obstacle clearance surfaces are 2,300 feet AMSL and are some of the lowest height constraints overlying the majority of the study area.

USGS elevation data indicates that these surfaces should not limit 586 or 643 foot AGL wind turbines within the defined study area.

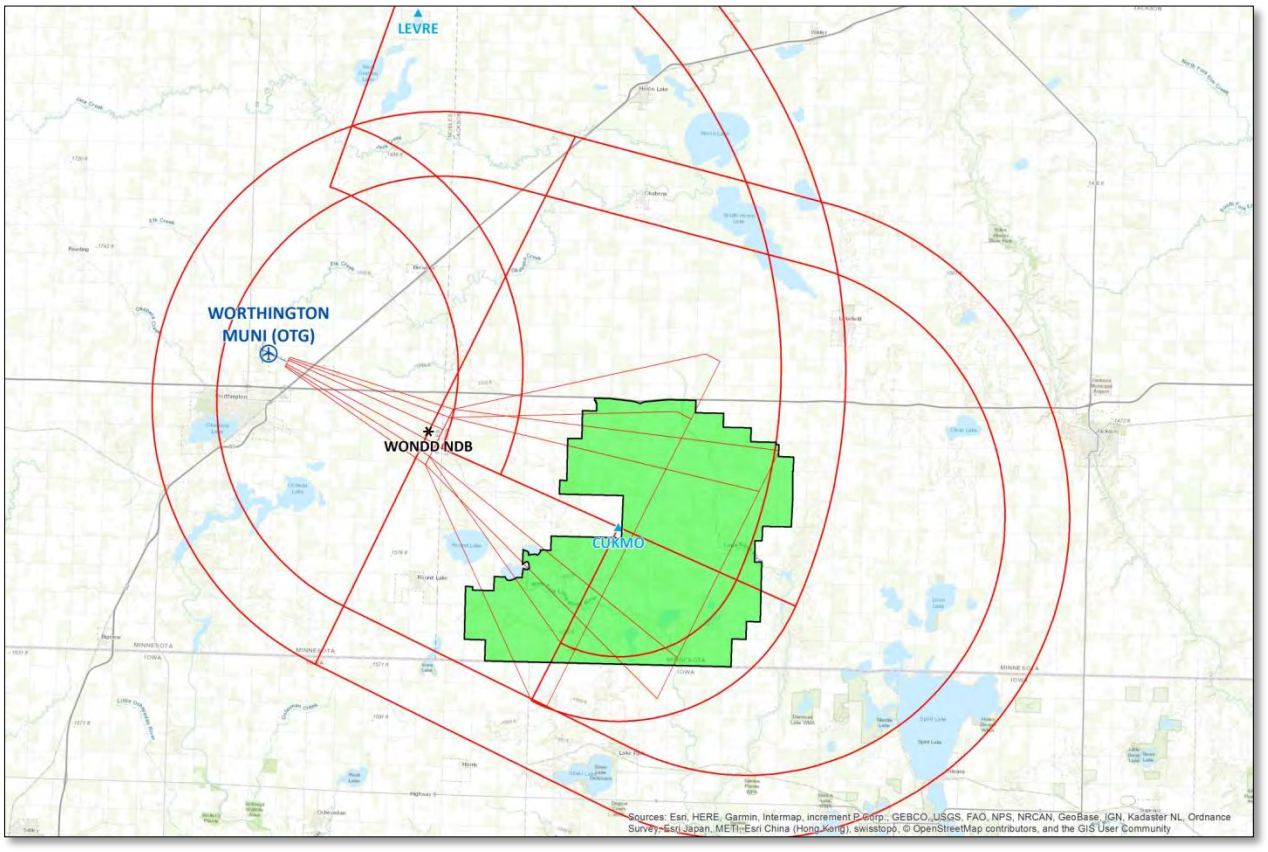


Figure 6: Worthington Municipal Airport (OTG) ILS Approach to Runway 29

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 of 1,000 feet of obstacle clearance 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 a significant volume of operations it could be used as the basis for determination of hazard.

V120

BILOO to *BANCO*

The MOCA is 3,100 feet AMSL. The associated obstacle clearance surface (orange, ***Figure 7***) is 2,100 feet AMSL and would be one of the lowest height constraints in the southern section of the study area. USGS elevation data indicates that 586 and 643 foot AGL wind turbines in this area would require an increase to the V120 MOCA. However, due to the project's location, this impact should not be used as the basis for determinations of hazard.[1]

The MEA is 6,800 feet AMSL. The associated obstacle clearance surface is 5,800 feet AMSL and is in excess of other lower surfaces. Additionally, USGS elevation data indicates that this surface should not limit 586 or 643 foot AGL wind turbines within the defined study area.

V170

Worthington (OTG) VOR/DME to *Fairmont (FRM) VOR/DME*

The MEA is 3,300 feet AMSL. The associated obstacle clearance surface is 2,300 feet AMSL (purple, ***Figure 7***) and is one of the lowest height constraints in the northern section of the study area. However, USGS elevation data indicates that this surface should not limit 586 or 643 foot AGL wind turbines within the defined study area.

Obstacle clearance surfaces associated with other enroute airways are in excess of other lower surfaces and should not limit 586 or 643 foot AGL wind turbines within the defined study area.

[1] In accordance with FAA Order 7400.2L Paragraph 6-3-9(d)(2), proposed structures beyond 22 nautical miles from an airway's supporting NAVAIDs that impact only the MOCA are not considered to have a substantial adverse effect. Therefore, height constraints associated with the V120 MOCA are not included in the Composite Map (***Figure 10***).

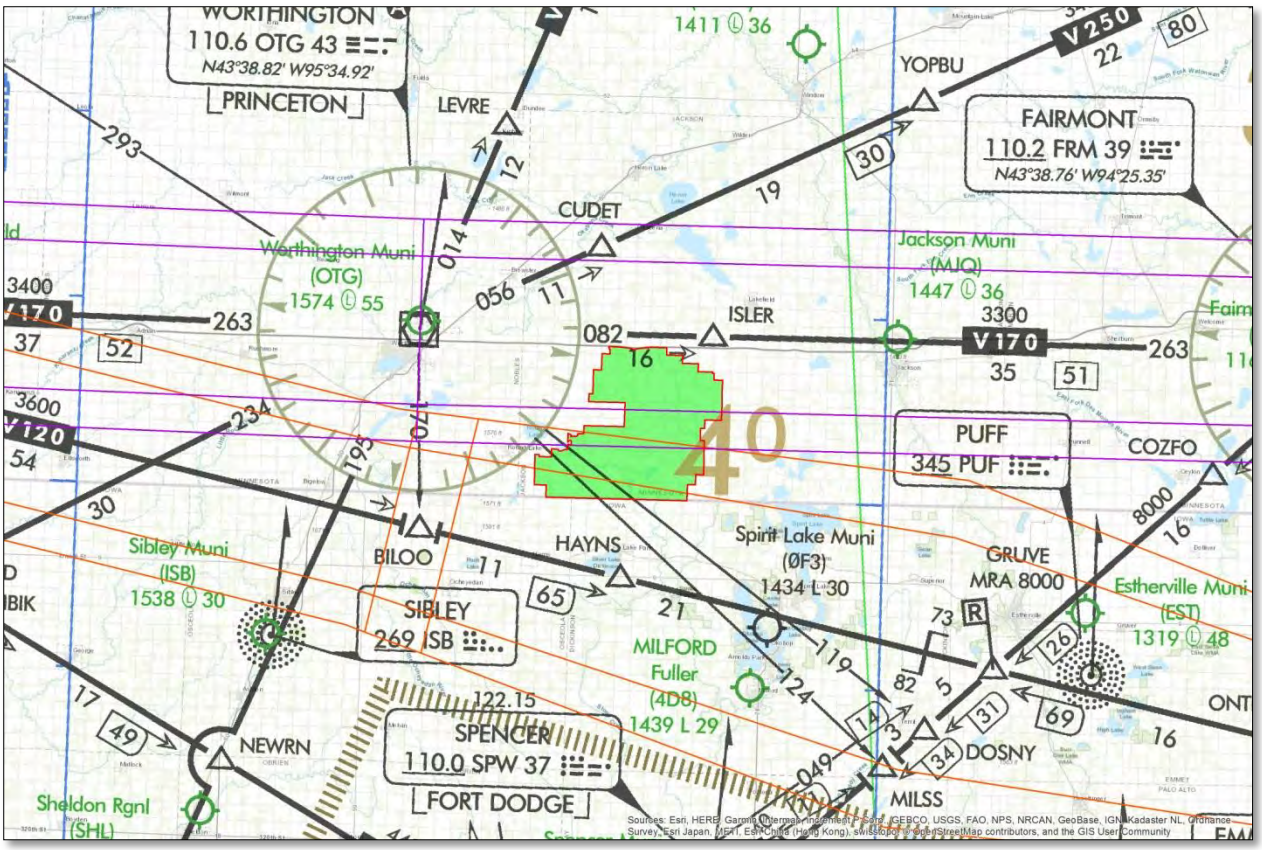


Figure 7: Low altitude enroute chart L-12 with V120 (orange) and V170 (purple) obstacle evaluation areas

Minimum Vectoring/IFR Altitudes

The FAA publishes minimum vectoring altitude (MVA) and minimum instrument flight rules (IFR) altitude 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 of 1,000 feet of obstacle clearance in non-mountainous areas and normally 2,000 feet in mountainous areas.

Proposed structures that exceed minimum vectoring/IFR altitude 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 a significant volume of operations (*as few as one per week*), it could result in determinations of hazard.

Minimum vectoring/IFR altitude obstacle clearance surfaces (e.g., ***Figure 8***) are in excess of other lower surfaces and should not limit 586 or 643 foot AGL wind turbines within the defined study area.

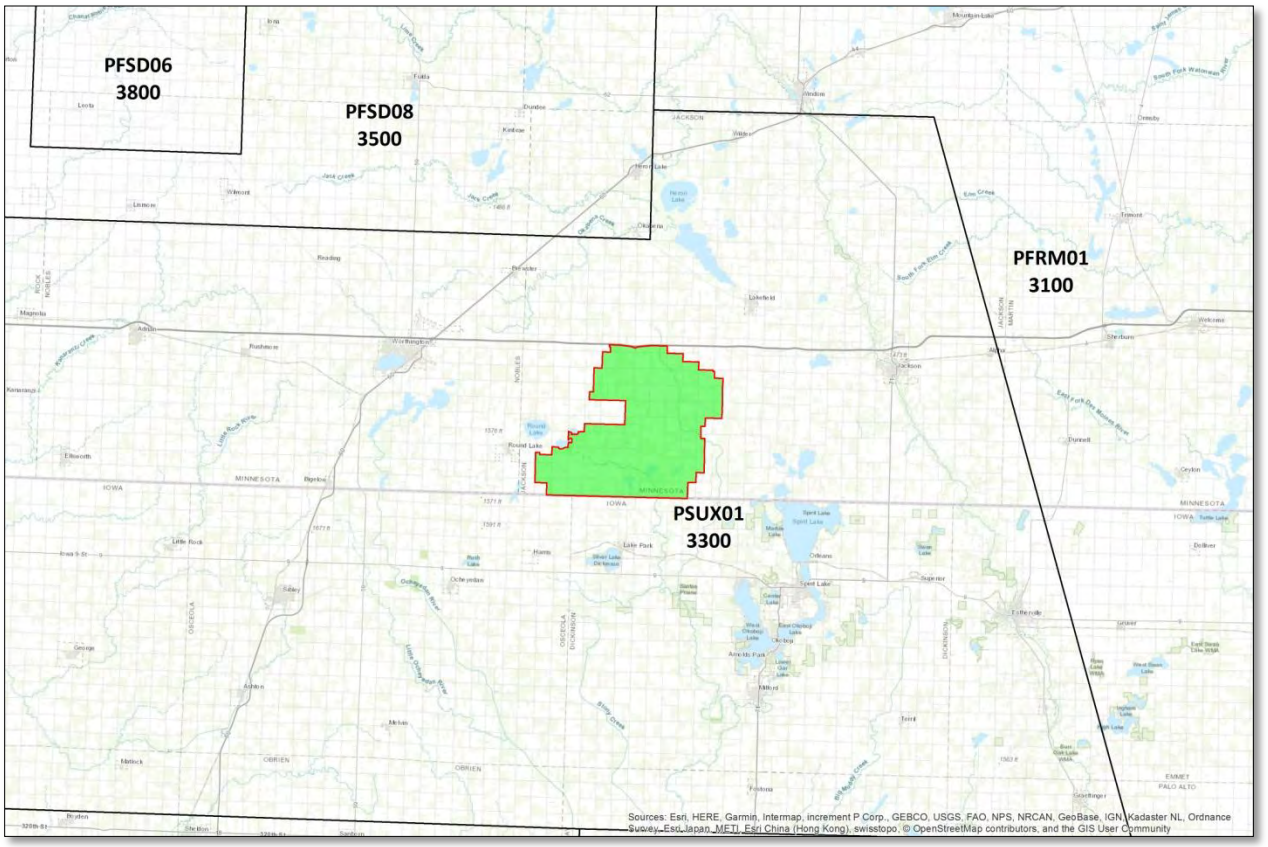


Figure 8: Minneapolis (ZMP) ARTCC minimum IFR altitude sectors (black)

Military Airspace and Training Routes

Since the FAA does not protect for military airspace or training routes, impact on their operations cannot result in a determination of hazard. However, the FAA will notify the military of proposed wind turbines located within these segments of airspace. If the planned development area is located on federal land, impact on military airspace or training routes may result in the denial of permits by the Bureau of Land Management.

Military airspace and training routes do not overlie the Three Waters wind project (***Figure 9***). Therefore, proximity to these segments of airspace should not result in military objections to proposed wind development.

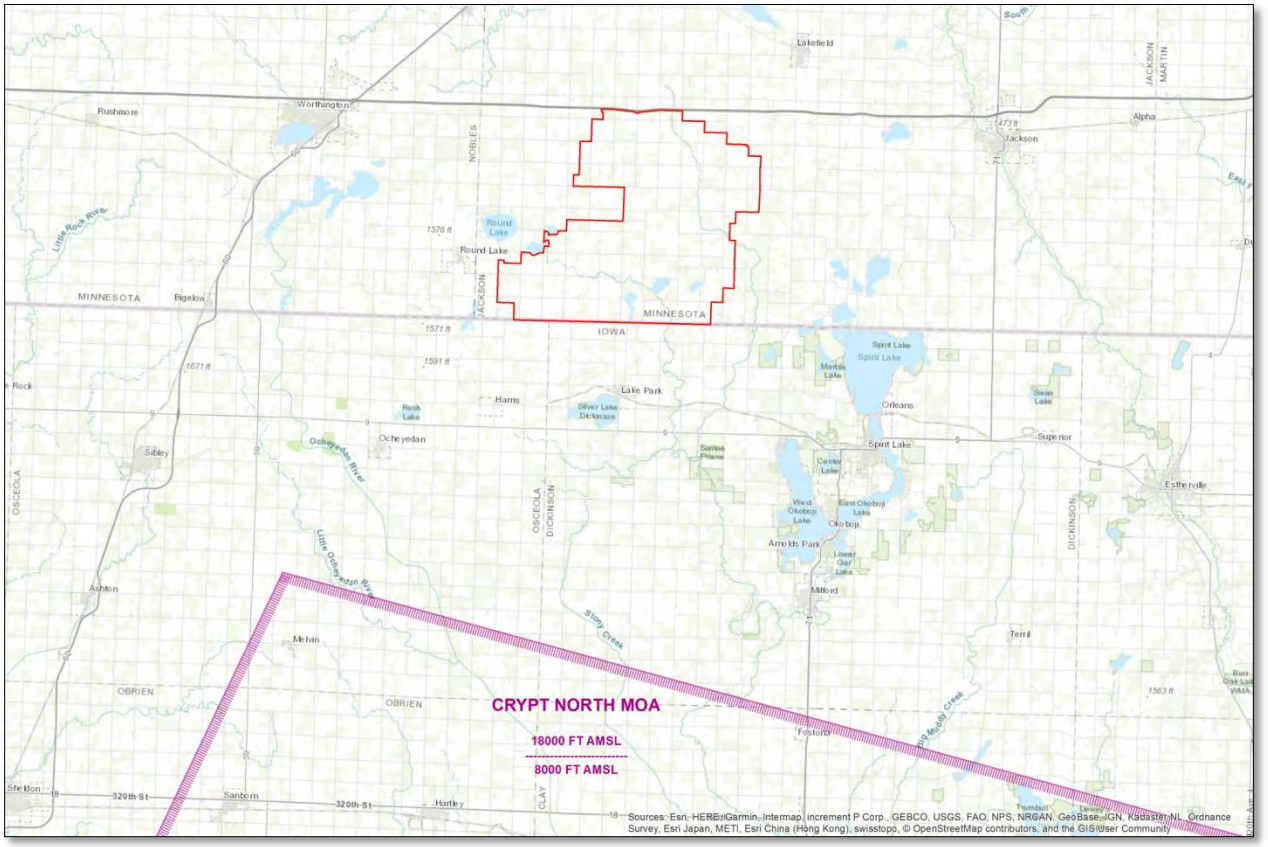


Figure 9: Military airspace in proximity to the Three Waters wind project

Radar Surveillance Systems

Various radar systems support air traffic control operations as well as weather detection. Proposed wind turbines within radar line of sight (RLOS) are "visible" to radars and could create unwanted clutter resulting in false radar returns and decrease in radar sensitivity. If the FAA determines that these radar effects would impact air traffic control operations, the FAA may conduct further review to identify potential safety hazards and the associated risks to the National Airspace System. The additional analysis may extend the FAA's timeline for review of proposed wind turbines and could ultimately result in determinations of hazard.

Radar	Visible at 586' AGL	Visible at 643' AGL
Sioux Falls Airport Surveillance Radar Model 11 (ASR-11)	No	No
Tyler Common Air Route Surveillance Radar (CARSR)	No	No
Sioux Falls Weather Surveillance Radar Model 1988 Doppler (WSR-88D)	No	No

Table 1: Radar surveillance systems assessed and preliminary RLOS results

The preliminary RLOS analysis (*Table 1*) indicates that 586 and 643 foot AGL wind turbines within the Three Waters wind project will not be visible to any air traffic control, air defense, homeland security, or weather radar sites. As a result, the proposed wind turbines should not interfere with radar surveillance systems.

Conclusion

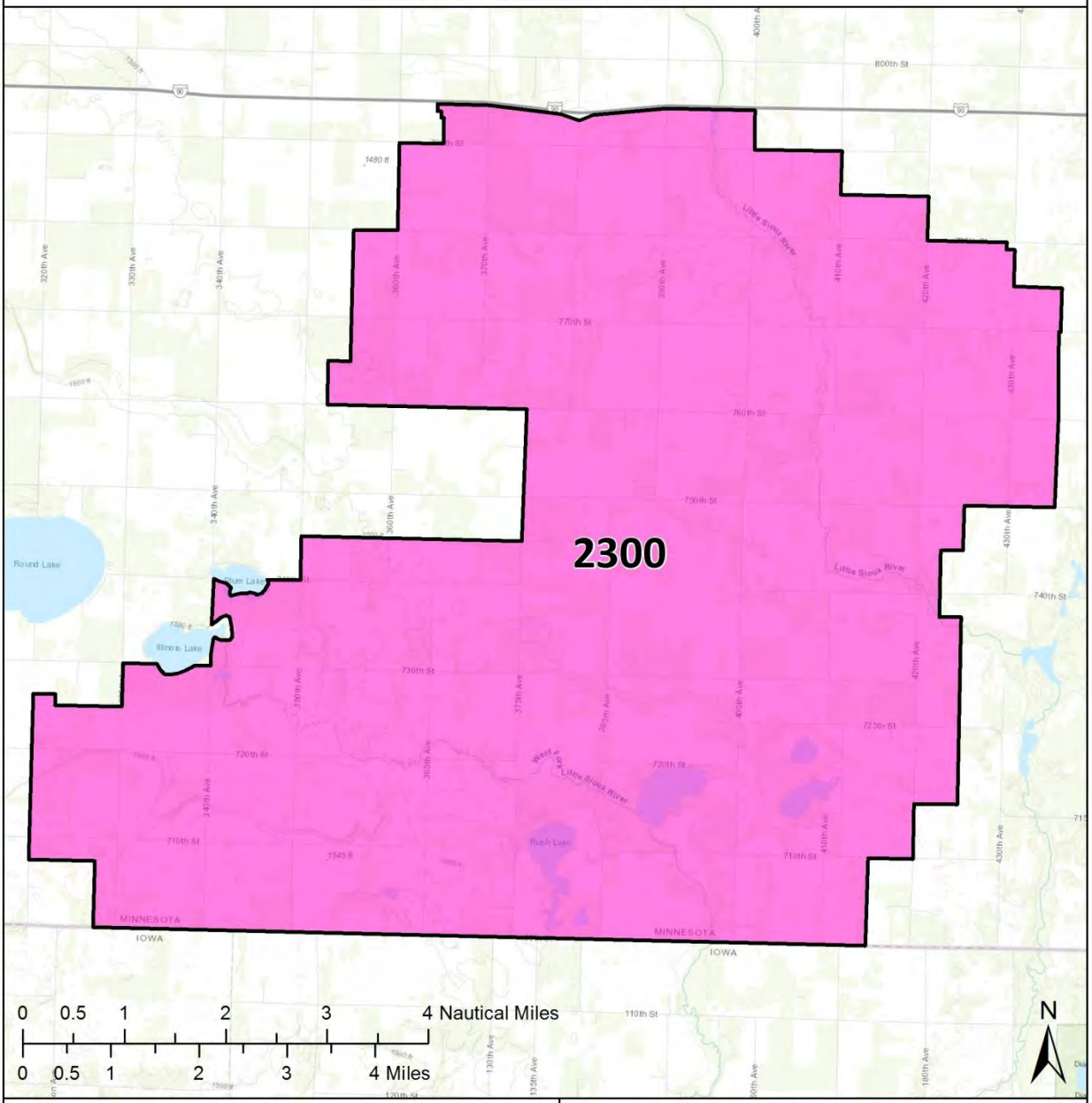
At 586 and 643 feet AGL, the proposed wind turbines will not exceed 14 CFR Part 77.17(a)(2) or 77.19/21/23 imaginary surfaces (***Figure 2***). However, at 586 and 643 feet AGL, proposed wind turbines will exceed 14 CFR Part 77.17(a)(1) – a height of 499 feet AGL at the site of the object – and will be identified as obstructions regardless of location. However, heights in excess of 499 feet AGL are feasible provided proposed wind turbines do not exceed FAA obstacle clearance surfaces.

Obstacle clearance surfaces overlying the Three Waters wind project are a constant 2,300 feet AMSL (***Figure 10***) and are associated with Worthington Municipal Airport (OTG) instrument approach procedures (***Figure 6***) and enroute airway V170 (***Figure 7***). Proposed wind turbines that exceed these surfaces would require an increase to instrument approach procedure minimum altitudes and the V170 MEA. If the FAA determines that either of these impacts would constitute a substantial adverse effect, it could result in determinations of hazard. However, USGS elevation data indicates that these surfaces should not limit 586 or 643 foot AGL wind turbines within the defined study area (green, ***Figure 11***).

The AGL Clearance Map (***Figure 11***) is based on USGS National Elevation Dataset (NED) 1/3 Arc Second data which has a vertical accuracy of generally +/- 7 meters. Therefore, the AGL Clearance Map should only be used for general planning purposes and not exact wind turbine siting. In order to avoid the likelihood of determinations of hazard, proposed wind turbine heights must adhere to the height constraints depicted in the Composite Map (***Figure 10***).

If you have any questions regarding the findings of this study, please contact ***Joe Anderson*** or ***Orlando Olivas*** 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 their location.



Obstacle Clearance Surface

2,300 Feet AMSL

Project Boundary

All heights above mean sea level (AMSL)

Three Waters Wind Project
Composite Height Constraint Map

Plot Date:
7 August 2018

Figure 10

Coordinate System:
NAD 1983 UTM Zone 15N

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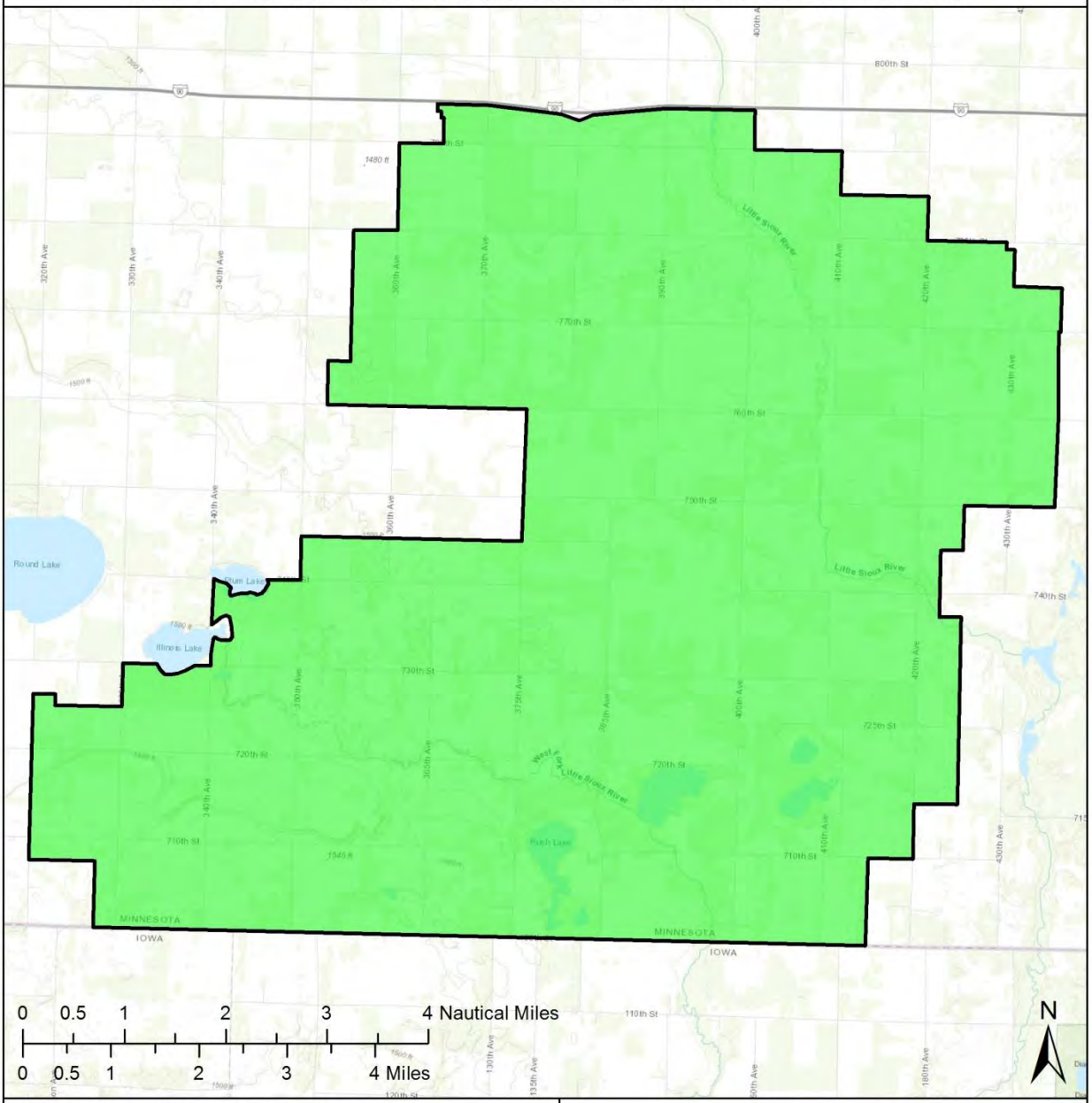
The USGS 1/3 Arc Second Digital Elevation Model (DEM) data used to create this map has a vertical accuracy of +/- 7 meters. This map should only be used for general planning purposes and not exact structure siting.



Above Ground Level (AGL) Clearance

- < 586 Feet AGL
- ≥ 586 < 643 Feet AGL
- ≥ 643 Feet AGL
- Project Boundary

Three Waters Wind Project
Above Ground Level (AGL) Clearance Map

Plot Date:
7 August 2018

Coordinate System:
NAD 1983 UTM Zone 15N

Orlando Olivas

Figure 11

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