APPENDIX S – AVIATION REPORT

Invenergy
Deuel Harvest North Project
ASI # 18-N-0437.030

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Common Acronyms and Abbreviations

1A Survey	A survey with horizontal +20 ft (6 m) and vertical +3 ft (1 m) accuracy
2C Survey	A survey with horizontal +50 ft (15 m) and vertical +20 ft (6 m) accuracy
AGL	Above Ground Level
AMSL	Above Mean Sea Level
ATC	Air Traffic Control
ARSR	Air Route Surveillance Radar
ATRCC	Air Route Traffic Control Center (Center)
ASI	Aviation Systems, Inc.
ASR	Airport Surveillance Radar
CAT	Category
CFR	Code of Federal Regulations
DA	Decision Altitude
DHS	Department of Homeland Security
DME	Distance Measuring Equipment
DNH	Determination of No Hazard
DoD	Department of Defense
DOH	Determination of Hazard
EMI	Electromagnetic Interference
FAA	Federal Aviation Administration
FAR	Federal Aviation Regulations
HP	Holding Pattern
IAP	Instrument Approach Procedures
ICA	Initial Climb Area
IFR	Instrument Flight Rules
ILS	Instrument Landing System
IMC	Instrument Meteorological Procedures
LNAV	Lateral Navigation
LPV	Localizer Performance with Vertical Guidance
LOC	Localizer Directional Aid
LoS	Line of Sight
LRR	Long Range Radar
MAH	Missed Approach Hold
MAP	Missed Approach Procedure
MDA	Minimum Descent Altitude
MEA	Minimum Enroute Altitude
MOA	Military Operations Areas
MOCA	Minimum Obstacle Clearance Altitude
MSA	Minimum Safe/Sector Altitude
MTR	Military Training Route
MVA	Minimum Vectoring Altitude
NAS	National Airspace System
NAVAID	Navigational Aid
NDB	Non-directional Beacon

NEXRAD	Next-Generation Radar (WSR-88D)
NM	Nautical Miles
NOAA	National Oceanic and Atmospheric Administration
NPH	Notice of Presumed Hazard
OCS	Obstacle Clearance Surface
PRI	Private Instrument Approach
PT	Procedure Turn
RNAV	Area Navigation (GPS)
ROC	Required Obstacle Clearance
RWY	Runway
SFC	Surface
SID	Standard Instrument Departure
SM	Statute Mile
SR	Slow Speed Route
TAA	Terminal Arrival Area
TACAN	Tactical Air Navigation System
TPA	Traffic Pattern Airspace
TRACON	Terminal Radar Approach Control Facility
VFR	Visual Flight Rules
VNAV	Vertical Navigation
VOR	Very High Frequency Omnidirectional Range
WTG	Wind Turbine Generator

Executive Summary

As requested, ASI, has evaluated the feasibility of the Deuel Harvest North Project, hereinafter referred to as the "Project," from an aviation and airspace point of view.

The goal of this analysis was to evaluate the regulatory compliance and potential impacts of wind turbines at a height of less than or equal to 499 feet AGL. The FARs (14 CFR 77) requires structures that exceed 200 feet AGL to be submitted to the FAA for an aeronautical study to determine whether the structures may be a hazard (or not) to air navigation per 14 CFR §77.9.

Depending on specific location, vertical limits overlying the Project area will limit turbine building to heights ranging from 1,954 feet to 2,400 feet AMSL. Wind turbines that exceed these limits, may receive NPHs from the FAA requiring remedial revisions to the airspace to allow construction.

The Project will not impact any military airspace assets. The turbines may be in the LoS of FAA/DoD radar. See the sections infra on Military Airspace and Training Routes and Radar Systems Interference for more detail.

The Project impacts approaches into Milbank Municipal and Myers Field which mostly will not limit WTGs aside from the southwest corner of the Project area. No other IAPs, including circling limits, impact the Project area.

There are no MVA or IFR Departure limits on wind turbines in the Project area. There is a small portion in the north that is affected by the MOCA of Low Altitude Enroute Airway V78. See the sections infra on MVAs, Departures, and Enroute Airways for more detail.

This analysis did not consider EMI on communications or navigation systems.

Currently, 499-foot AGL wind turbines could be constructed in the Project area where ground elevations do not exceed heights (ft AMSL) as follows: Sector D: 1,801, Sector E: 1,901, and Sector F: 2,001 (See Attached Figure 9). In Sectors A-C, wind turbines will not be able to be constructed because of ground elevation.

Basic Project Information

We reviewed the Project against Federal aviation and airspace criteria set forth in:

- FAR Part 77 (14 CFR 77), the *Safe, Efficient Use and Preservation of the Navigable Airspace;*
- FAA Order 8260.3D, the *United States Standard for Terminal Instrument Procedures* (referred to as TERPs);
- FAA Order 8260.58A Change 1 & 2, the *United States Standard for Performance Based Navigation (PBN) Instrument Procedure Design;*
- FAA Order JO 7400.2L, the *Procedures for Handling Airspace Matters;*
- FAA Order 7610.4, *Special Military Operations;*
- DoD Flight Information Publication AP/IB, *Military Training Routes, North and South America*; and
- FAR Part 95 (14 CFR Part 95), Subpart B, *Designated Mountainous Areas.*

The criteria in these documents comprise the factors the FAA will use in evaluating the aeronautical compatibility and regulatory compliance of the Project when it is submitted for their official regulatory review under FAR Part 77 as specified in Title 49 U.S. Code Section 44718.

Our task was to apply those criteria and determine the airspace regulatory feasibility of wind turbines up to 499 feet AGL proposed in an area of approximately 176 NM^2 or about 149,168 acres in both Yellow Medicine and Lac qui Parle Counties in Minnesota as well as Deuel County, South Dakota. Please see Figure 1 depicting the Project boundaries and surrounding area in the regional setting.

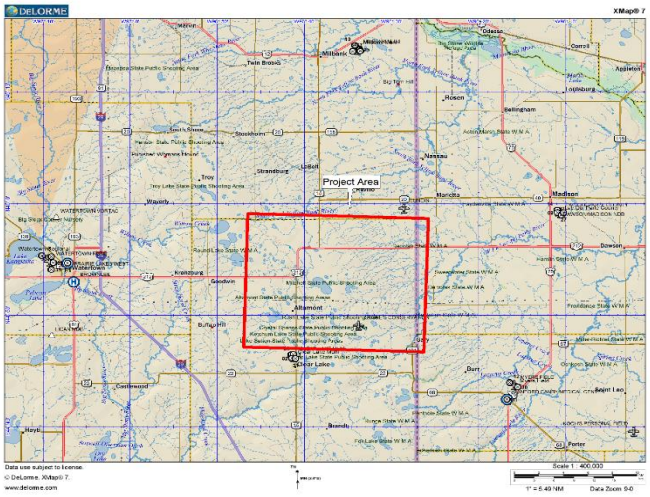


Figure 1: Regional Setting

Terrain within the Project area varies from approximately 1,142 feet AMSL to 1,950 feet AMSL. With a proposed overall turbine height of 499 feet AGL, the highest point of the Project could theoretically be 2,449 feet AMSL. A 51-foot buffer is added for terrain variations and to establish the "Target Height"[1] of 2,500 feet AMSL.

The nearest public-use facility subject to the Federal regulatory criteria above is Clear Lake Municipal Airport (FAA Identifier: 5H3) located 7.28 NM southwest of the Project center point and is 0.56 NM from the Project boundary. 5H3 is an VFR airport with no IAPs; two turf runways (2/20 & 13/31); three based aircraft and approximately 552 annual operations.

There are six other regional public-use facilities subject to the Federal regulatory criteria which were also evaluated for effect (See Table 1).

Table 1: Regional Public-Use Facilities

Airport	Distance (NM)	Direction	Approaches
Milbank Municipal Airport (1D1)	20.80	N	RNAV (GPS) RWY 31
Appleton Municipal Airport (AQP)	32.66	NE	RNAV (GPS) RWY 13; NDB RWY 13
Watertown Regional Airport (ATY)	23.06	W	ILS OR LOC RWY 35; RNAV (GPS) RWYs 12, 17, 30, & 35; LOC BC RWY 17; VOR OR TACAN RWY 17
Myers Field Airport (CNB)	16.79	SE	RNAV (GPS) RWYs 12 & 30
Lac Qui Parle County Airport (DXX)	19.11	E	RNAV (GPS) RWYs 14 & 32; NDB RWY 32
Ortonville Municipal Airport-Martinson Field (VVV)	26.20	N	RNAV (GPS) RWY 34; NDB RWY 34

[1]The "Target Height" is not an official FAA vertical limitation but, rather, an in-house artificial convention used to limit the analysis to only relevant and material factors which might influence building heights and FAA approvability. In simple terms, if you do not exceed the "Target Height" your structures should have no FAA FAR Part 77 operational airspace issues.

Analytical Findings

Part 77 Imaginary Surfaces

In 14 CFR §77.19 Imaginary Surfaces are defined as those which have a relationship to an airport and to each of its runways. The dimensions of each category of Imaginary Surface are based on the type of approach available or planned. Exceeding an Imaginary Surface does not automatically mean a DOH will be issued from the FAA. That outcome depends on other airspace factors as well, but it does trigger more in-depth scrutiny. The Project impacts for 5H3 Imaginary Surfaces but none of the other facilities in Table 1 (See Figure 2).

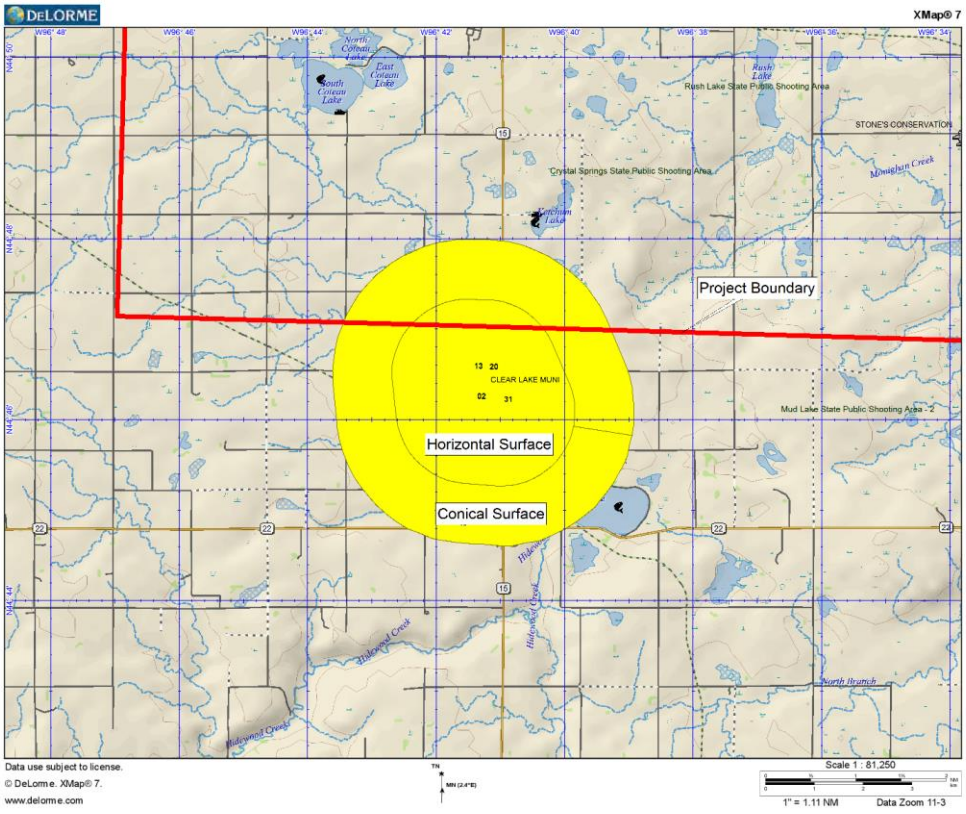


Figure 2: 5H3 Part 77 Imaginary Surfaces

TPA

TPA is used for VFR maneuvering by pilots in the area surrounding an airport. The dimensions of the TPA are based on the category of aircraft operating at the field and their approach speeds to the runways. In addition to approach speed, other factors such as: weight bearing capacity, runway surface type, and runway length are also considered. Be advised for any given airport, the FAA may apply a Traffic Pattern category that may not necessarily represent the type of traffic the airport receives, but the airport must be protected using that criteria. 5H3 supports up to a Category B TPA which reaches an altitude of 2,154 feet AMSL and impacts the Project area (See Figure 3).

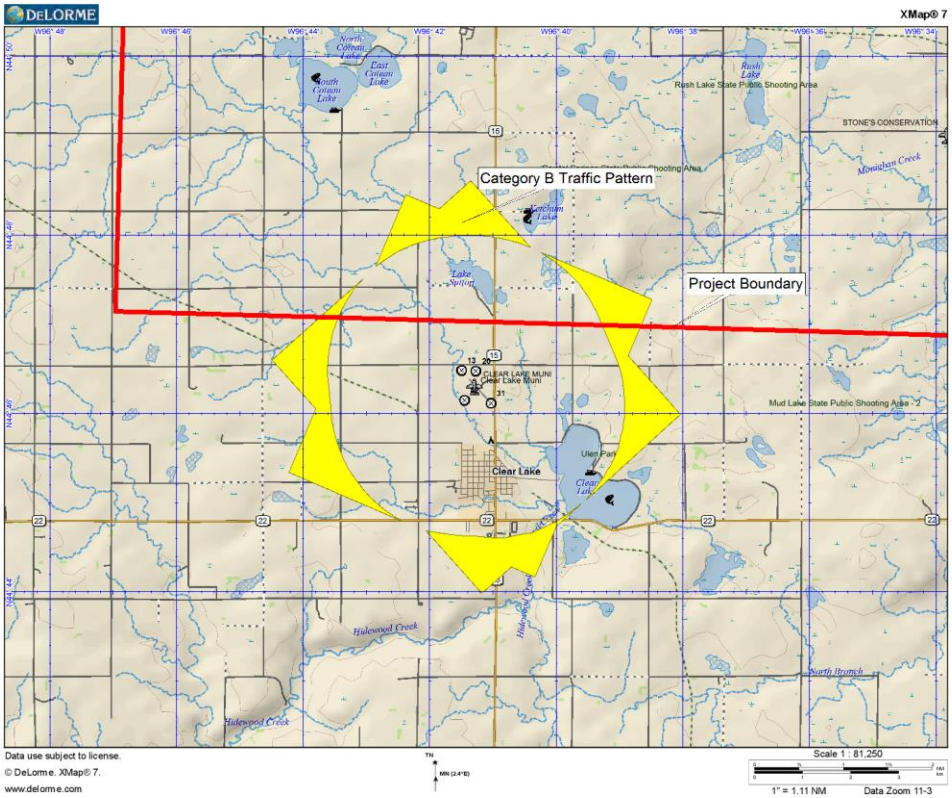


Figure 3: 5H3 Traffic Pattern

Enroute Airways

In the NAS, there are both High Altitude Enroute Airways and Low Altitude Enroute Airways separated at 18,000 feet AMSL and are eight NM wide. In this evaluation, we are only concerned with Low Altitude Enroute Airways (known as Victor Airways). These airways are used by pilots to navigate between VOR NAVAIDs. The FAA publishes minimum altitudes for the 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 terrain areas and normally 2,000 feet in mountainous areas. These areas are delineated in 14 CFR Part 95, Subpart B. The Project falls within the non-mountainous area.

The Project will impact Victor Airways (See solid black lines in Figure 4). Victor Airway V78 is north of the Project area. The Project lies partially below the V78 corridor. V78 has a MOCA of 3,300 feet AMSL and a MEA of 5,500 feet AMSL. Applying the ROC of 1,000 feet for non-mountainous terrain implies underlying OCSs at 2,300 and 2,500 feet AMSL, respectively. Victor Airway V24-398 is south in the Project. The Project lies below the V24-398 corridor. V24-398 has a MEA of 3,800 feet AMSL. Applying the ROC of 1,000 feet yields an underlying OCS at 2,800 feet AMSL; hence, at the Target Height of 2,500 feet AMSL, the Project will impact the MOCA of V78, but not the MEAs of V78 or V24-398.

As a point of information, a MEA is an Operational Limitation whilst a MOCA is an Obstruction Standard of FAR Part 77, §77.17(a)(4). For any structures exceeding an Obstruction Standard, the FAA may initially issue NPHs. However, please note that as a measure of impact severity, Obstruction Standards are not considered ultimate operational limitations and in the absence of any other limiting factor, the FAA should issue DNHs after conducting a more in-depth impact study.

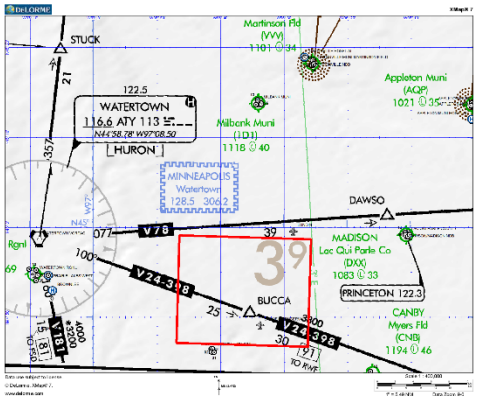


Figure 4: En-Route Chart

MVAs

MVAs are the lowest altitude clearances that may be assigned by ATC to pilots during vectoring or direct routing. These altitudes in an MVA chart depiction are broken up into sectors and encompass a 60 NM radial area around a radar station. There is a three NM buffer area around each sector within 40 NM of the station and a five NM buffer area around each sector beyond 40 NM.

There are no MVAs that impact the Project area.

Radar Systems Interference

The DoD Screening Tool and LoS calculations indicate that areas of the Project are visible to FAA/DoD LRR (See Figures 5 and 5a). There is one ASR within 80 NM and one ARSR within 45 NM of the Project (See Table 2) and only the ARSR may have an LoS to the Project. An in-depth FAA radar impact study after filing may be required.

The Project will not impact NEXRAD weather radar (See Figure 6). Further weather radar study will not be necessary.

Table 2: ASR and ARSR Regional Radar Stations

Name	Type	Distance (NM)	Direction
FSD	ASR	78.31	S
Tyler (QJC)	ARSR	44.78	SE

Figure 5: Long Range Radar Screening Tool

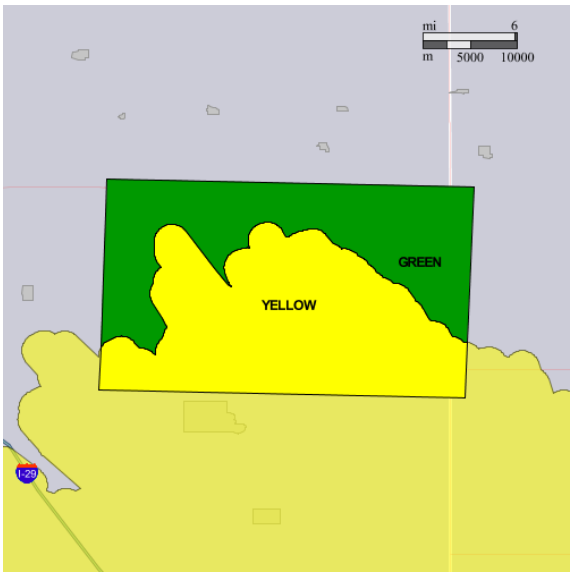
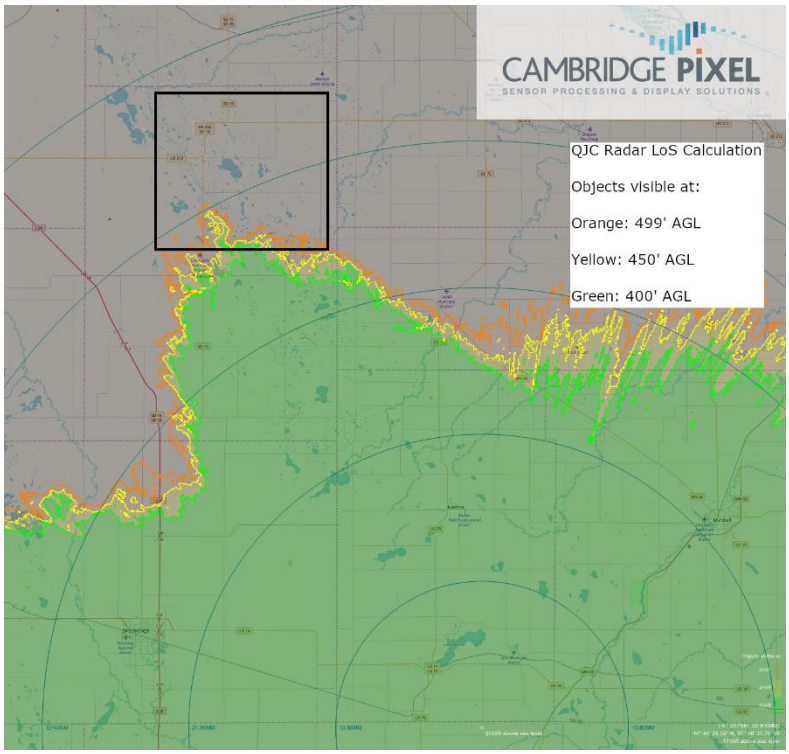


Figure 5a: QJC Radar LoS Calculation Tool



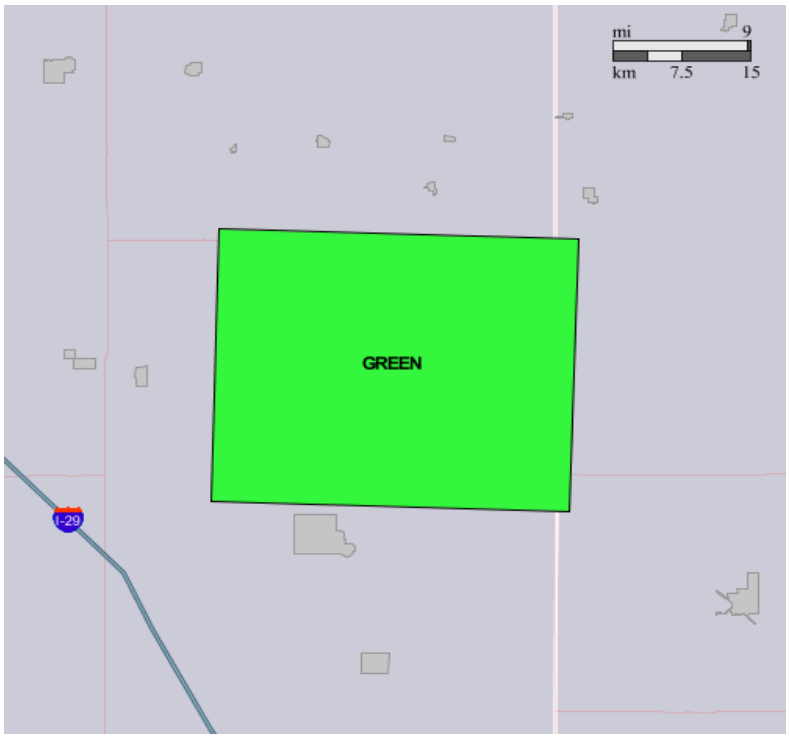


Figure 6: NEXRAD Screening Tool

Military Airspace and Training Routes

The MTR Program is a joint venture by the FAA and the DoD, developed for use by military aircraft to gain and maintain proficiency in tactical “low level” flying. These low-level training routes are generally established below 10,000 feet AMSL for speeds in excess of 250 knots to accommodate both VFR and IFR. Visual MTRs (VRs) are generally designed to be flown below 1,500 feet AGL while Instrument MTRs (IRs) are designed to be flown above 1,500 feet AGL. The Project will not impact any military airspace such as MOAs, Restricted Airspace, or MTRs (See Figure 7).

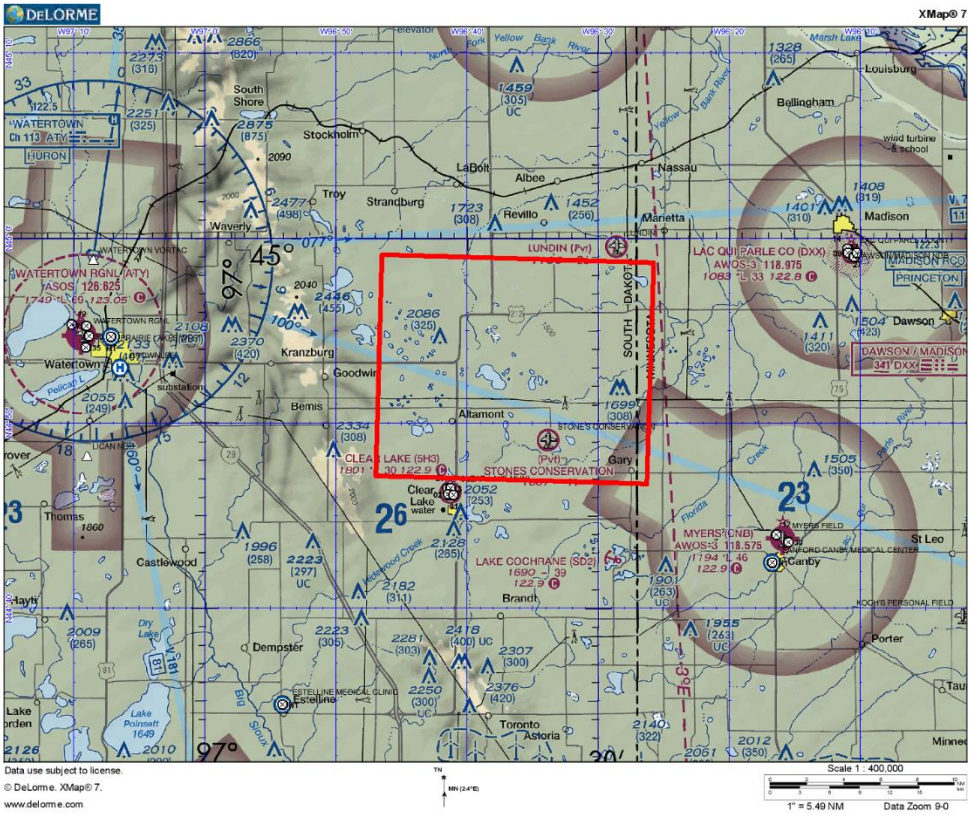


Figure 7: VFR Sectional Chart

IAPs

IAPs are used by pilots to land at airports during periods of IMC, i.e., when there is reduced visibility and low cloud ceilings. ASI analyzed 17 IAPs as part of this evaluation (See Table 1).

There are two TAAs into 1D1 that overlie the Project at 3,400 feet AMSL. There is a ROC of 1,000 for non-mountainous terrain, which equates to an OCS of 2,400 feet AMSL. The Project is also impacted by the RNAV (GPS) RWY 12 approach into CNB in the Intermediate Primary and Secondary areas. In the Primary area (center) there is an OCS of 2,300 feet AMSL and the Secondary area has a slope of 7:1 ranging from 2,300-2,800 feet AMSL (See Figure 8).

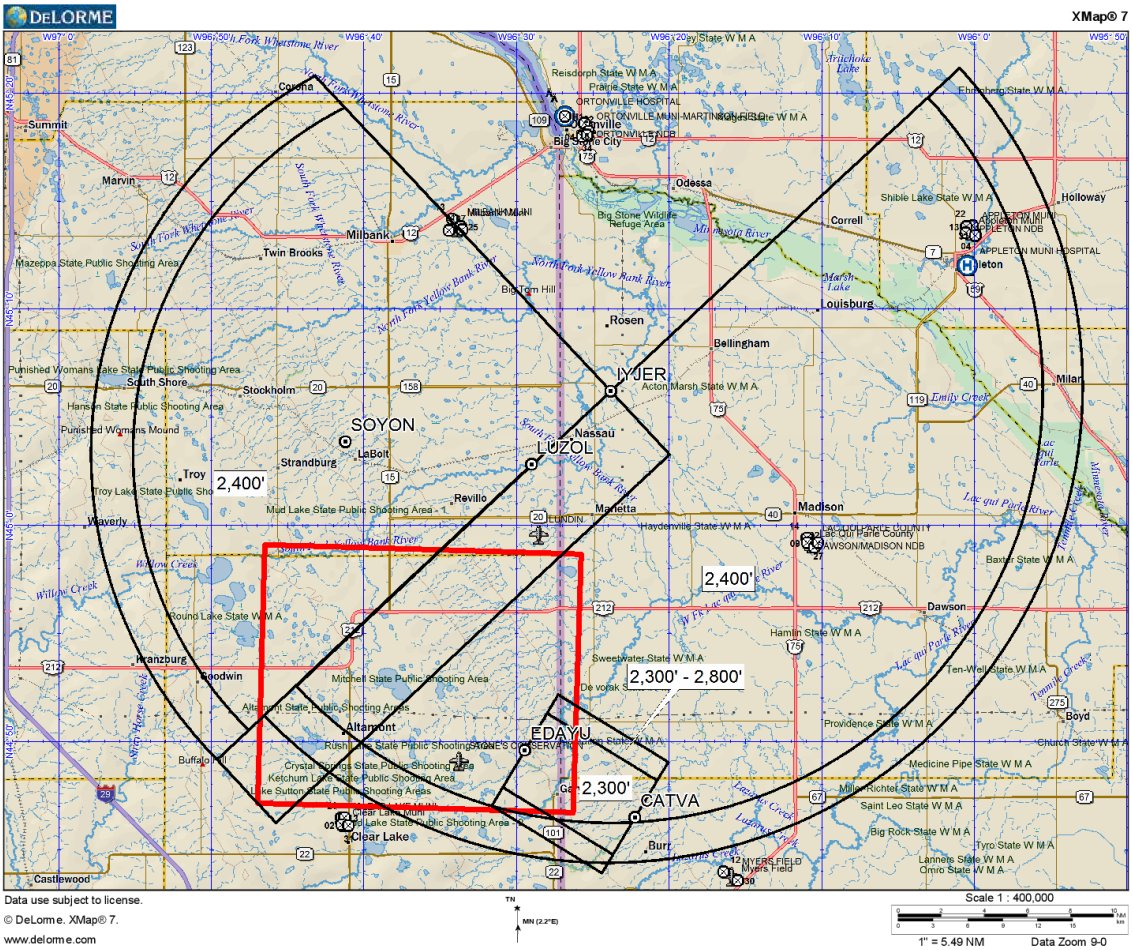


Figure 8: 1D1 and CNB Approaches

Approach Circling Areas

IAPs may include Approach Circling Minimums; however, there are none that impact the Project.

IFR and VFR Departure

The FAA protects aircraft from obstacles and terrain on departure, whether they are using VFR or IFR. Instrument departures usually have prescribed procedures either charted in a SID or a standard/accelerated climb to an altitude. Visual departures have more directional flexibility but are constrained by specific ceiling and visibility minima requirements and the “see and avoid” practice of FAR Part 91 §91.113. The IFR diverse departure has a 40:1 slope that is measured from the edge of the ICA trapezoid out to the end of the departure. The VFR departure is incorporated inside of the TPA of the 5H3 airport. There is no impact to IFR departure procedures.

VFR Flyways

At this time, we understand the Project is envisioned for turbines ≤ 499 feet AGL, however, be advised turbines above 499 feet AGL may impact VFR Flyway Areas. A VFR Flyway is four SM wide, centered on a geographic landmark, i.e., highways, railroads, rivers, powerlines, canals, radials of a VOR NAVAID, Enroute Airways, and other man-made structures. Potential VFR Flyways in the Project area are listed below. The FAA will determine the potential for adverse impact, if any, upon VFR flights by structures sited within these possible Flyways that exceed the 499 feet AGL threshold. Depending on the activity level along the route, the FAA could declare the proposed structures sited within a VFR Flyway to be a potential hazard or perhaps an actual hazard to air navigation.

Vertical Findings

Mapping and analysis of the relevant and material aviation factors of the Project's airspace environment indicates the following vertical AMSL limits of each Project Sector (See Table 3 and Attached Figure 9). Table 4 indicates ground elevations at which 499-foot turbines can be built. Areas where ground elevation prohibits construction are shaded red.

Table 3: Vertical Limits

SECTOR	LIMIT (ft AMSL)	CAUSAL FACTOR
A	1,954	5H3 HORIZONTAL SURFACE
B	1,954-2,154	5H3 CONICAL SURFACE
C	2,154	5H3 CATEGORY B TPA
D	2,300	CNB RNAV (GPS) INTERMEDIATE SEGMENT
E	2,400	1D1 TAAs
F	2,500	TARGET HEIGHT

Table 4: Maximum Ground Elevation to Build

SECTOR	LIMIT (ft AMSL)
A	1,455
B	1,455-1,655
C	1,655
D	1,801
E	1,901
F	2,001

Conclusion

The results of this analysis indicate that an FAA aeronautical study will likely identify the following airspace impacts resulting from the proposed 499-foot AGL wind turbines:

- **Imaginary Surfaces:** Clear Lake Airport lies within the Project area and the Imaginary Surfaces cover a certain extent of the area (See Figure 2).

- **Minimum Vectoring Altitude Sectors:** There are no MVAs in the Project area.

- **Traffic Pattern Airspace:** Clear Lake Airport's Traffic Pattern encompasses an area inside the Project to a height of 2,154 feet AMSL (See Figure 3).

- **Instrument Departures:** The Project does not impact any instrument departure procedures.

- **Instrument Approach Procedures:** Milbank Municipal has one approach which overlies (See Sector E) and Myers Field also has one approach that partially overlies (See Sector D) the Project and neither will prevent WTG construction due to ground elevation except for a few areas that exceed 1,901 and 1,801 feet AMSL, respectively.

- **Approach Circling Areas:** The Project does not impact any Approach Circling Areas.

- **Radar Line of Sight:** The Project area may be in LoS of one ARSR which could trigger extended studies delaying the process and result in Determinations of Hazard. An in-depth FAA further study may be required after filing to determine adverse effect.

- If the FAA determines that one impact or the cumulative impacts constitute a substantial adverse effect, that conclusion could be used as the basis for DOHs. In that event, for the Project to proceed, mitigation options will have to be identified, approved, and implemented. Be advised that all mitigation options are subject to FAA approval, which is not guaranteed.

Cautionary Notes

- The FAA makes changes to the National Airspace System every day. New approaches are published, departure procedures are changed, new runways are planned, MVAs are modified, etc. Consequently, it is possible for the study findings to become obsolete in a relatively short time. We recommend the study findings be reviewed for currency before filing sites within the study area. Studies older than 12 months should automatically be re-visited, and their findings confirmed.

- While Federal requirements take precedence, local requirements for tall structures may still exist within the county and the municipality in addition to the Federal regulations. Furthermore, there may also be local zoning ordinances adopted at nearby airports. It is highly advisable to contact the specific county and/or city the turbines are in for any special requirements before construction.

- Furthermore, study findings are intended as a planning tool in conjunction with the resolution of other pertinent issues. Actual construction activities are not advisable until DNHs are issued for any structures that require filing.

- During the aeronautical study process, the FAA may request a certified survey with an accuracy of either 1A or 2C for mitigation. Those must be provided to receive DNHs.