

June 29, 2023

VIA E-MAIL AND FEDERAL EXPRESS

Mr. Steven Kahl
Executive Secretary
North Dakota Public Service Commission
600 E. Boulevard, Dept. 408
Bismarck, ND 58505-0480

**Re: Otter Tail Power Company
Amend – Ashtabula III Wind Energy Facility Upgrade Project
Siting Application – Barnes County
Case No. PU-23- __**

Dear Mr. Kahl:

Otter Tail Power Company (Otter Tail) plans to upgrade the Ashtabula III Wind Energy Facility (Upgrade Project) located in Barnes County, North Dakota. In support of the Upgrade Project, enclosed for filing in the above-referenced case are an original and six (6) copies of the following documents:

1. Certification of Timothy J. Rogelstad with accompanying:
 - a. Exhibit A – Environmental and Regulatory Compliance Memorandum, with associated Figures and the following appendices:
 - i. Appendix A – Acoustic Assessment Results and Sound Waivers;
 - ii. Appendix B – Shadow Flicker Assessment Results;
 - iii. Appendix C – FAA Filings;
 - iv. Appendix D – Microwave Beam Path Study;
 - v. Appendix E – Class I Literature Review – Cultural Resource Report and Unanticipated Discoveries Plan (PUBLIC);
 - vi. Appendix F – IPaC Resource List; and
 - vii. Appendix G – Setback Waiver.

A filing fee check in the amount of \$25,000 is also enclosed. An unredacted, NON-PUBLIC version of the Class I Literature Review – Cultural Resource Report and Unanticipated Discoveries Plan (the above-referenced Appendix E) and associated GIS data will be provided under separate cover with an Application for Protection of Information.

Mr. Steven Kahl
June 29, 2023
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Fredrikson

Electronic copies of the enclosed documents and this letter were filed with the Commission today via e-mail. If you have any questions, please let me know.

Sincerely,

A handwritten signature in black ink that reads "Mollie M. Smith". The signature is written in a cursive style with a large, looping initial "M".

MOLLIE M. SMITH

MMS/79416080
Enclosures

cc: Lisa McFarland (w/ enclosures, via e-mail)
Bryce Haugen (w/ enclosures, via e-mail)

STATE OF NORTH DAKOTA
PUBLIC SERVICE COMMISSION

Otter Tail Power Company
Amend – Ashtabula III Wind Energy Facility Upgrade Project
Siting Application – Barnes County

Case No. PU-23-__

CERTIFICATION OF TIMOTHY J. ROGELSTAD

STATE OF MINNESOTA)
) ss.
COUNTY OF OTTER TAIL)

Timothy J. Rogelstad, being first duly sworn upon oath, states and alleges as follows:

1. I am the President of Otter Tail Power Company (Otter Tail), which owns the Ashtabula III Wind Energy Facility (Facility) in Barnes County, North Dakota. I have the authority to bind Otter Tail with respect to the certifications made herein.

2. I provide this Certification pursuant to N.D.C.C. § 49-22-03(3)(a)(4).

3. Otter Tail plans to make equipment upgrades at the Facility, which involves replacing certain turbine technology (Upgrade Project).

4. The Upgrade Project will consist of removing and replacing the existing General Electric (GE) 1.6 megawatt (MW) generator technology and 82.5 meter (270.7 feet) rotor diameter (RD) blades, hub, and gearbox with an upgraded technology package of GE 1.6 MW generator technology and 91 meter (298.6 feet) RD blades, hub, and gearbox. The total nameplate generating capacity will remain 62.4 MW. Additionally, all 39 of the turbines will reuse the existing 80 meter (262.5 feet) structural steel towers and existing nacelles. As a result, the Upgrade Project will not affect the layout, which will remain as depicted in the as-built maps previously filed with the Commission.¹

¹ See Docket Item Nos. 98 and 125 in Case No. PU-10-147.

5. Due to the increased blade length, the overall turbine height will increase from 121.25 meters (397.8 feet) to 125.5 meters (411.8 feet).

6. Otter Tail plans to use the existing turbine foundations (with reinforcement, if needed), collection and communications systems, and permanent access roads. Other associated facilities will remain unchanged.

7. During installation of the upgraded equipment, existing access roads will be temporarily widened to accommodate delivery and staging of components and equipment. Temporary crane paths may also be needed to facilitate equipment removal and installation. A temporary laydown yard will also be used during installation. All activities are expected to occur within areas previously disturbed by initial construction.

8. The Upgrade Project activities are wholly within the site designated by the Commission for the Facility in its August 4, 2010 Findings of Fact, Conclusions of Law and Order (Case No. PU-10-147) (2010 Order), and are to improve the same type of facility for which Certificate of Site Compatibility No. 17 was issued.² See N.D.C.C. §§ 49-22-03(3)(a)(1), (3) and (4)(b).

9. Otter Tail has conducted an environmental and regulatory compliance analysis for the Upgrade Project, and an associated report prepared by its environmental consultant, Atwell, LLC (Atwell), is provided as **Exhibit A**. As set forth in **Exhibit A**:

a. **Cultural Resources.** The Upgrade Project construction activities will occur primarily within areas previously surveyed for cultural resources, and all construction activities will occur within areas previously disturbed by initial Facility

² On March 30, 2022, the Commission issued a Certificate of Public Convenience and Necessity (CPCN) to Otter Tail for the Facility (Case No. PU-22-27). On August 17, 2022, the Commission issued an Order approving transfer of Certificate of Site Compatibility Facility No. 17 to Otter Tail and issuing First Reissued Certificate of Site Compatibility No. 17 to Otter Tail for the Facility (Case No. PU-22-195).

construction. Based on recommendations made by the State Historical Society of North Dakota (SHSND) for Otter Tail's Langdon Wind Energy Center Upgrade Project (Langdon Upgrade Project), if any Upgrade Project crane paths are located outside of areas previously surveyed for cultural resources, Otter Tail will complete cultural resource field surveys and will avoid any resources identified that are eligible or unevaluated for listing on the National Register of Historic Places (NRHP). Therefore, no cultural resources will be affected by the Upgrade Project.

b. **Architectural Resources.** Although not recommended at the time the Facility was originally permitted and constructed, based on communications with SHSND for the Langdon Upgrade Project, consideration is being given to completion of an architectural history survey in the vicinity of wind energy generation facilities to identify architectural resources potentially eligible for NRHP-listing and to evaluate potential impact to those resources. Since the Upgrade Project involves technology upgrades to existing turbines, it is not anticipated that the limited modifications will adversely affect architectural history resources. However, in the event of an adverse impact, Otter Tail will coordinate with SHSND to identify appropriate mitigation, as needed.

c. **Wetlands.** Wetlands and waterbodies have been identified within the Upgrade Project Area. No permanent wetland impacts will occur as a result of Upgrade Project activities.

d. **Sound.** At Atwell's direction, Epsilon Associates, Inc. (Epsilon) completed a sound analysis for the Upgrade Project with the proposed upgraded technology. At the time the Facility was permitted, the Commission did not have a sound standard for wind energy facilities. The Commission's current sound level requirement is 45 dBA or less within 100 feet of occupied residences and community buildings. With the upgraded

equipment, sound levels within 100 feet of six occupied residences were modeled above 45 dBA, while sound levels were at or below 45 dBA within 100 feet of the remaining residences (no community buildings are present). Otter Tail has obtained sound waivers from the owners of three of the residences modeled above the 45 dBA requirement. With respect to the remaining three residences, Otter Tail has confirmed that the Upgrade Project is able to comply with the Commission's sound requirement at those three residences by installing noise-reduction technology, such as noise-reducing operation modes (NRO) and/or low noise trailing edge (LNTE) blades at up to eight turbines (as needed). Otter Tail will either obtain sound waivers or utilize the appropriate technology to comply with the standard.

e. **Shadow Flicker.** Epsilon completed a shadow flicker assessment for the Upgrade Project with the proposed upgraded technology. The Commission does not have a shadow flicker standard. The 2010 Order states that occupied residences were not anticipated to experience more than 30 hours of shadow flicker per year. With the exception of one occupied residence, shadow flicker levels from the Upgrade Project will not exceed 30 hours per year at occupied residences. For the one residence modeled at over 30 hours of shadow flicker per year, Otter Tail will either obtain a waiver from the residence owners or will utilize shadow flicker mitigating technology to reduce shadow flicker levels to 30 hours per year at the residence.

f. **Exclusion and Avoidance Areas.** Otter Tail has analyzed the Upgrade Project's compliance with the Commission's current exclusion area and avoidance area criteria. With the exception of four turbines that are within the non-participating property line exclusion area, and three turbines that are within the county roadway exclusion area, the Upgrade Project complies with all exclusion areas. Otter Tail has obtained one setback

waiver, and is in the process of obtaining waivers from the other non-participating landowner(s). With respect to the county roadways, Otter Tail plans to obtain approval from Barnes County. Otter Tail requests that the Commission grant a variance conditioned upon submission of the landowner waivers and Barnes County approval. If any landowner is not willing to grant a waiver, or if Barnes County is not willing to grant approval, Otter Tail will not upgrade equipment at the affected turbine. Accordingly, the Upgrade Project will comply with all current exclusion area and avoidance area criteria, and construction activities associated with the Upgrade Project will not affect any known exclusion or avoidance areas within the designated site. See N.D.C.C. §§ 49-22-03(3)(a)(2) and (4)(a).

10. The Facility will continue to comply with all requirements set forth in the Commission's Orders regarding the Facility, including applicable laws and rules designating the site. See N.D.C.C. §§ 49-22-03(3)(a)(1) and (4)(c).

FURTHER AFFIANT SAYETH NOT.



Timothy J. Rogelstad

Subscribed and sworn to before me
this 29th day of June 2023.



Notary Public

79419472

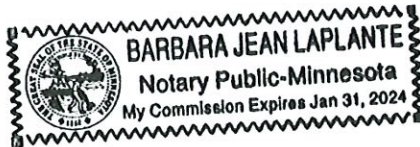


Exhibit A

Environmental and Regulatory Compliance Memorandum Amend – Ashtabula III Wind Energy Facility Upgrade Project Case No. PU-23-_____

Introduction

Otter Tail Power Company (Otter Tail) has retained Atwell, LLC (Atwell) to prepare this memorandum to support Otter Tail's certification of compliance with N.D.C.C. § 49-22-03(3)(a) in connection with equipment upgrading activities (Upgrade Project) for its 62.4-megawatt (MW) Ashtabula III Wind Energy Facility (Facility). Otter Tail, with assistance from Atwell, analyzed the Upgrade Project with respect to environmental, cultural, and natural resources, as well as sound and shadow flicker. The following sections and referenced figures and appendices summarize the results of the analysis.

Description of the Upgrade Project

The Upgrade Project involves replacing the current General Electric (GE) 1.6 MW turbine technology with updated technology. More specifically, the Upgrade Project will consist of removing and replacing the existing GE 1.6 MW generator technology, 82.5-meter (270.7 feet) rotor diameter (RD) blades, hub, and gearbox with a new equipment upgrade package of GE 1.6 MW generator technology and 91-meter (298.6 feet) RD blades, hub, and gearbox. All 39 existing 80 meter (262.5 feet) structural steel towers will be used as well as existing nacelles and, as a result, turbine locations will not change. Otter Tail plans to use the existing turbine foundations (with reinforcement, if needed), collection/communications systems, and permanent access roads. Other associated facilities will remain unchanged.

Once removed, the existing 82.5-meter RD blades will be cut on-site to fit into legal load transportation-size pieces. Loads will be secured and/or covered or other steps will be taken to ensure materials do not escape during transport. Otter Tail's contractor will transport the loads to an out-of-state facility that will grind the blade materials for repurposing, and no blades will be deposited in a landfill.

During installation of the equipment upgrade technology, existing access roads will be temporarily widened to accommodate delivery of components and equipment. Temporary crane paths may also be needed to facilitate equipment removal and installation. A temporary laydown yard will also be used during installation. Otter Tail currently plans to install the equipment upgrade technology in mid-2025.

Figure 1 depicts the Upgrade Project Area and layout. Figure 2 depicts the proposed turbine technology.

Compliance with Exclusion and Avoidance Areas

Exclusion Areas

Per N.D.A.C. §§ 69-06-08-01(1) and (2), the geographical areas listed in Table 1 shall be excluded in the consideration of a site for an energy conversion facility. Based on the Commission’s approach in prior equipment upgrade dockets, Otter Tail confirmed the Upgrade Project’s compliance with the Commission’s current exclusion area criteria. With the exception of four turbines that are within the non-participating property line exclusion area, and three turbines that are within the county roadway exclusion area, the Upgrade Project complies with all exclusion areas. Otter Tail has one property line setback waiver¹ and has identified the owners of the other non-participating properties at issue and is pursuing waivers. With respect to county roadways, Otter Tail plans to obtain approval from Barnes County. Otter Tail requests that the Commission grant a variance conditioned upon submission of the landowner waivers and Barnes County approval. If any landowner is not willing to grant a waiver, or if Barnes County is not willing to grant approval, Otter Tail will not upgrade equipment at the affected turbine. Exclusion areas are mapped for the Upgrade Project Area on Figure 3.

Table 1: Summary of Exclusion Areas		
General Exclusion Area	Present Within Upgrade Project Area?	Description
Designated or registered national: parks; memorial parks; historic sites and landmarks; natural landmarks; historic districts; monuments; wilderness areas; wildlife areas; wild, scenic, or recreational rivers; wildlife refuges; and grasslands.	Yes	United States Fish and Wildlife Service (USFWS) administered Waterfowl Production Areas (WPA) are located in the vicinity of the Upgrade Project Area. A minimum 0.25-mile buffer was and continues to be maintained from each WPA.

¹ The owners of the E/2NE/4 of Section 26, Township 142 North, Range 58 West, Barnes County, North Dakota are participating landowners. Only a portion of the land originally leased remains under lease due to a partial release; however, the landowners executed a setback waiver authorizing one wind turbine to be located less than 440 feet from their adjacent property. As a result, Otter Tail has a setback waiver for Turbine 275. Copies of the setback waiver and associated assignment to Otter Tail are provided in Appendix G.

Table 1: Summary of Exclusion Areas

General Exclusion Area	Present Within Upgrade Project Area?	Description
Designated or registered state: parks; forests; forest management lands; historic sites; monuments; historical markers; archaeological sites; grasslands; wild, scenic, or recreational rivers; game refuges; game management areas; management areas; and nature preserves.	None	N/A
County parks and recreational areas; municipal parks; parks owned or administered by other governmental subdivisions; hardwood draws; and enrolled woodlands.	None	N/A
Areas critical to the life stages of threatened or endangered animal or plant species.	None	N/A
Areas where animal or plant species that are unique or rare to this state would be irreversibly damaged.	None	N/A
Areas within 1,200 feet of the geographic center of an intercontinental ballistic missile (ICBM) launch or launch control facility.	None	N/A
Areas within thirty feet [9.14 meters] on either side of a direct line between an intercontinental ballistic missile (ICBM) launch facility and a missile alert or launch control facilities to avoid microwave interference. This restriction only applies to aboveground structures, not to surface features, such as roads, or belowground infrastructure.	None	N/A
Additional Exclusion Areas for Wind Energy Conversion Facilities – Areas within:		
1.1x the turbine height from the nearest edge of an interstate or state roadway right-of-way (ROW).	Present	No turbines will be located within this exclusion area.

Table 1: Summary of Exclusion Areas

General Exclusion Area	Present Within Upgrade Project Area?	Description
1.1x the turbine height plus 75 feet from the centerline of any county or maintained township roadway.	Present	Three turbines would be located within the exclusion area for a county roadway with the equipment upgrade technology. Otter Tail plans to obtain approval from Barnes County, and requests a variance from the Commission conditioned on providing a copy of the County approval.
1.1x the turbine height from the nearest edge of railroad ROW.	Present	No turbines will be located within this exclusion area.
1.1x the turbine height from the neared edge of a 115 kV or higher transmission line ROW.	Present	No turbines will be located within this exclusion area.
1.1x the turbine height from the property line of a non-participating landowner and 3x the height of the turbine from an inhabited rural residence of a non-participating landowner, unless a variance is granted. A variance may be granted if an authorized representative or agent of the permittee, the nonparticipating landowner, and affected parties with associated wind rights file a written agreement expressing all parties' support for a variance to reduce the setback requirement in this subsection. A nonparticipating landowner is a landowner that has not signed a wind option or an easement agreement with the permittee of the wind energy conversion facility as defined in NDCC Chapter 17-04.	Present	<p>Four turbines would be located within the non-participating property line exclusion area with the equipment upgrade technology. Otter Tail has obtained one setback waiver, and is in the process of obtaining waivers from the other non-participating landowner(s) to support issuance of variances.</p> <p>No turbines will be located within 3x the height of the upgraded turbines from a non-participating inhabited residence.</p>

Avoidance Areas

Per N.D.A.C. §§ 69-06-08-01(3) and (4), the geographical areas listed in Table 2 may not be approved as a site for an energy conversion facility unless the applicant shows that under the circumstances there is no reasonable alternative or (in the case of the sound limit) a waiver has been obtained. Based on the Commission’s approach in prior equipment upgrade dockets, Otter Tail confirmed the Upgrade Project’s compliance with the Commission’s current avoidance area criteria.

Avoidance Area	Present Within Upgrade Project Area?	Description
Historical resources which are not designated as exclusion areas.	Present	No impacts to historical resources are anticipated. An Unanticipated Discoveries Plan has been prepared for the Upgrade Project. A copy of that plan is provided as Appendix E.
Areas within the city limits of a city or the boundaries of a military installation.	None	N/A
Areas within known floodplains as defined by the geographical boundaries of the hundred-year flood.	None	N/A
Areas that are geologically unstable.	None	N/A
Woodlands and wetlands.	Present	No wetlands or woodlands will be impacted by the Upgrade Project.
Areas of recreational significance which are not designated as exclusion areas.	None	N/A
A geographic area where, due to the operation of the facility, the sound levels within one hundred feet on an inhabited residence or community building will exceed forty-five dBA. The sound level avoidance area criteria may be waived in writing by the owner of the occupied residence or the community building.	Present	Six residences were initially modeled to have sound levels in excess of the Commission’s sound standard with the Upgrade Project. Otter Tail has sound waivers from the owners of three of the residences. Additionally, Otter Tail has confirmed that the Commission’s sound standard can be met at the remaining three residences by installing noise-reduction technology. As such, Otter Tail will comply with the Commission’s sound standard by obtaining waiver(s) or utilizing noise-reduction technology.

Setback Compliance

In addition to compliance with the setbacks set forth above, the Upgrade Project continues to comply with the setback commitments listed in Table 3, which were made at the time a Certificate of Site Compatibility was issued for the Facility.

Setback Type	Distance
Occupied Residences	1,400 feet
USFWS WPA	1,320 feet (0.25 miles)
Existing transmission lines, roads, railroads, and property boundaries	440 feet (1.1 times turbine height)

Socioeconomics

The Upgrade Project will have positive impacts on socioeconomics by extending the life of the Facility, which, in turn, extends the time period for which landowners will receive easement payments. In addition, the Upgrade Project will create temporary construction jobs, with associated opportunities for increased local spending.

Land Use

The Upgrade Project will be constructed entirely within the previously-designated site, and turbine and other permanent infrastructure locations will remain the same. As a result, land use will also remain unchanged. The Upgrade Project will result in temporary disturbances, including temporary widening of access roads to accommodate transportation of components and equipment, a temporary laydown yard, and temporary crane paths (as needed). Temporarily impacted areas will be restored in compliance with applicable provisions of the Commission’s Findings of Fact, Conclusions of Law and Order, dated August 4, 2010 (Case No. PU-10-147) (2010 Order.)

Public Services

The Upgrade Project will result in a temporary increase in traffic in and near the Upgrade Project Area, but is not anticipated to interfere with local road use. Otter Tail will coordinate with Barnes County and the townships, as appropriate, regarding local road use, will obtain all necessary road use permits, and will restore roads impacted by the Upgrade Project in accordance with the requirements of the Commission’s 2010 Order and as required by Barnes County and the townships.

Sound, Shadow Flicker, and Human Health and Safety

As noted above, the Upgrade Project continues to maintain a turbine setback of 1,400 feet from occupied residences. Based on an initial sound analysis, sound levels within 100 feet of six occupied residences were modeled above 45 dBA with the Upgrade Project. Otter Tail has

obtained sound waivers from the owners of three of the residences. With respect to the remaining three residences, Otter Tail has confirmed that the Upgrade Project is able to comply with the Commission's sound requirement by installing noise-reduction technology, such as noise-reducing operation modes (NRO) and/or low noise trailing edge (LNTE) blades at up to eight turbines (as needed). As such, Otter Tail will comply with the Commission's sound standard by obtaining waiver(s) or utilizing noise-reduction technology. Copies of noise waivers obtained to-date are provided in Appendix A. A copy of the sound study report completed for the Upgrade Project (using GE 1.6 MW turbines with 91 meter hub height and noise-reduction technology) is also provided in Appendix A.²

The Commission does not have a shadow flicker regulation. At the time the Facility was permitted, shadow flicker modeling indicated shadow flicker would not exceed 30 hours per year at occupied residences. Otter Tail conducted a shadow flicker assessment for the Upgrade Project utilizing conservative modeling inputs. Based on the assessment, with the exception of one occupied residence, shadow flicker levels from the Upgrade Project will not exceed 30 hours per year at occupied residences. For the one residence modeled at over 30 hours of shadow flicker per year, Otter Tail will either obtain a waiver from the residence owners or will utilize shadow flicker mitigating technology to reduce shadow flicker levels to 30 hours per year at the residence. A copy of the shadow flicker assessment report is provided in Appendix B.

Otter Tail has submitted form 7460-1 to the Federal Aviation Administration (FAA) for each turbine (*see* Appendix C). Otter Tail will obtain Determinations of No Hazard from the FAA and will provide copies to the Commission prior to construction.

Comsearch completed a microwave study for the Upgrade Project. Based on the analysis, Comsearch found that none of the turbines would obstruct microwave beam paths in the area with the upgraded equipment (Appendix D).

The Upgrade Project will continue to comply with all safety-related and other conditions of the Commission's 2010 Order.

Cultural and Architectural Resources

In February of 2023, staff from Atwell conducted background research at the State Historical Society of North Dakota (SHSND) for information on previously identified archaeological sites and architectural properties within one mile (1.6 km) of the Upgrade Project Area and on surveys previously conducted within the Upgrade Project Area (Appendix E – Class I Literature Review).

² At the time the sound modeling was conducted, Otter Tail had not yet confirmed the participation status of two of the six residences, which were conservatively identified as non-participating. As a result, only one waiver is listed in the report and noise-reduction technology was modeled to ensure compliance without a waiver at five residences. Otter Tail has since confirmed three of the six residences at issue are participating, and Otter Tail has sound waivers for those three residences, which are included in Appendix A.

The Upgrade Project construction activities will occur primarily within areas previously surveyed for cultural resources, and all construction activities will occur within areas previously disturbed by initial Facility construction. Based on recommendations made by the SHSND regarding Otter Tail's Langdon Wind Energy Center Upgrade Project³ (Langdon Upgrade Project), if any Upgrade Project crane paths are located outside of areas previously surveyed for cultural resources, Otter Tail will complete cultural resource field surveys and will avoid any resources identified that are eligible or unevaluated for listing on the National Register of Historic Places (NRHP). Additionally, Otter Tail has prepared an Unanticipated Discoveries Plan, which will be implemented during Upgrade Project construction (*see* Appendix E).

Although not recommended at the time the Facility was originally permitted and constructed, based on communications with SHSND regarding the Langdon Upgrade Project, consideration is being given to completion of an architectural history survey in the vicinity of wind energy generation facilities to identify architectural resources potentially eligible for NRHP-listing and to evaluate potential impact to those resources. Since the Upgrade Project involves technology upgrades to existing turbines, it is not anticipated that the limited modifications will adversely affect architectural history resources. However, in the event of an adverse impact, Otter Tail will coordinate with SHSND to identify appropriate mitigation, as needed.

The Class I Literature Review, which includes the Unanticipated Discoveries Plan, has been submitted to the SHSND for review.

Recreational Resources

The Upgrade Project will not impact any recreational resources. The Upgrade Project continues to maintain a setback of at least 1,320 feet (0.25 miles) from nearby WPAs.

Land-Based Economics

The Upgrade Project will not result in any additional long-term land impact; as a result, the Upgrade Project will also not result in any long-term impacts to agricultural use or production. Otter Tail will compensate landowners for any temporary impacts to cropland in accordance with the terms of its wind lease agreements, as applicable.

Soils

Upgrade Project construction may result in minor short-term impacts to soils within the disturbance area. During construction, short-term impacts may include soil compaction, vegetation clearing, and the potential for localized soil erosion and sedimentation. No other impacts are anticipated. Measures to control erosion will be implemented during Upgrade Project construction to avoid or minimize soil erosion. Erosion and sedimentation will be reduced by implementation of best management practices (BMPs) such as mulching, hydroseeding, wildlife-friendly erosion control blankets, silt fence installation, matting, and revegetation, as appropriate. Once construction is completed, soils will be revegetated in accordance with Natural Resources

³ *See* Case No. PU-23-86.

Conservation Service requirements (unless otherwise specified by the landowner and approved by the Commission). No adverse impacts to soil resources are expected as a result of the Upgrade Project.

Geologic and Groundwater Resources

The Upgrade Project is not expected to disturb any geologic or groundwater resources.

Waterbodies, Wetlands, and Floodplain Resources

Previously, a wetland delineation and determination was conducted within the Facility boundary in 2010 (TetraTech EC, INC. 2010). The wetland delineation was performed in accordance with the *1987 U.S. Army Corps of Engineers Wetland Delineation Manual* (USACE 1987). The report did not identify any permanent impacts to jurisdictional wetlands within the Project Area. The Upgrade Project will remain within the areas previously disturbed by initial Facility construction, and no temporary or permanent impacts any wetlands or waterbodies are anticipated.

The Upgrade Project is located outside of Federal Emergency Management Agency (FEMA) mapped floodplains. As a result, the Upgrade Project will not impact floodplains.

Vegetation

No trees or shrubs will be removed in connection with the Upgrade Project. Otter Tail will comply with the site restoration and reseeding conditions in the Commission's 2010 Order and all other applicable permitting requirements.

Wildlife

Impacts to wildlife are expected to be minimal as the proposed construction disturbance areas were previously disturbed. If construction activities are planned during the springtime, ground nesting bird clearance surveys in uncultivated areas will be conducted, as applicable, prior to construction.

The USFWS Information for Planning and Consultation (IPaC) system was reviewed for a list of threatened, endangered, and candidate species that could occur within or near the Upgrade Project Area. The northern long-eared bat, Dakota Skipper, and monarch butterfly have the potential to occur in Barnes County. According to the USFWS IPaC system, no Designated Critical Habitat is present in the Upgrade Project Area. The existing turbines were built in open terrain outside of forested areas and riparian corridors. Additionally, Upgrade Project construction activities will be confined to previously disturbed areas, and no tree removal is anticipated. As a result, no impacts to these species are anticipated.

The Upgrade Project is not anticipated to have any measurable change in impact on migrating birds or bats. Impacts are expected to be similar to other operating wind projects in the area. Otter Tail will develop a Wildlife Conservation Strategy for the Facility, which will outline BMPs that are to be undertaken for the life of the Facility to minimize risks to birds, bats, and other wildlife from operation of the wind energy facility.

An IPaC Resource List is provided in Appendix F.

Conclusion

Table 4 below summarizes Otter Tail’s environmental and regulatory analysis of the Upgrade Project. As indicated in Table 4 and the prior sections, the Upgrade Project complies with the requirements of N.D.C.C. § 49-22-03(3)(a), including the Commission’s current exclusion area and avoidance area criteria. Additionally, the Upgrade Project will continue to comply with all applicable siting laws, rules, and Commission orders, including the conditions specified in the Commission’s 2010 Order.

Summary Table

Table 4: Summary of Environmental Resource Impact Analysis and Avoidance/Minimization Measures		
Resource	Potential Impact of Upgrade Project	Avoidance and/or Minimization Measures
Socioeconomics	Positive economic and social impacts.	None proposed.
Land Use	Temporary disturbances only; will utilize previously disturbed areas.	Will restore temporarily impacted areas in compliance with applicable provisions of the Commission's 2010 Order.
Public Services	A temporary increase in traffic due to construction will occur.	Will coordinate with Barnes County and applicable townships regarding local road use, obtain all necessary road use permits, and restore roads impacted by the Upgrade Project in accordance with the requirements of the Commission's 2010 Order and as required by Barnes County and the townships.
Human Health and Safety	<p>Turbine lighting will continue to meet FAA and Commission requirements.</p> <p>With the exception of one occupied residence, shadow flicker levels from the Upgrade Project will not exceed 30 hours per year at occupied residences.</p>	For the one residence modeled at over 30 hours of shadow flicker per year, Otter Tail will either obtain a waiver from the residence owners or will utilize shadow flicker mitigating technology to reduce shadow flicker levels to 30 hours per year at the residence.
Sound	<p>Initial modeling analysis determined that the sound may exceed 45 dBA within 100 feet of six occupied residences.</p> <p>Modeling was conducted with NRO and/or LNTE added to up to eight turbines.</p>	<p>Otter Tail has obtained sound waivers from the owners of three residences with sound levels in excess of the sound limit. Otter Tail has confirmed that the Commission's sound requirement can be met at the remaining three residences by installing noise-reduction technology. Accordingly, the Upgrade Project will comply with the</p>

Table 4: Summary of Environmental Resource Impact Analysis and Avoidance/Minimization Measures

Resource	Potential Impact of Upgrade Project	Avoidance and/or Minimization Measures
		current sound regulations by obtaining waiver(s) or utilizing noise-reduction technology.
Cultural/Architectural History Resources	Upgrade Project activities will occur within areas previously surveyed for cultural resources and/or in areas previously disturbed by initial Facility construction. The Upgrade Project is not anticipated to impact cultural or architectural history resources.	Prepared an Unanticipated Discoveries Plan.
Recreational Resources	No impacts to recreational resources are anticipated.	Will continue to maintain a setback of 0.25 miles from nearby WPAs.
Land Based Economics	Minimal cropland will be temporarily impacted during construction. No additional long-term impacts to agricultural use or production are anticipated.	Will compensate landowners for any temporary impacts to cropland in accordance with the terms of its wind lease agreements, as applicable.
Soils	Temporary land disturbance may cause soil surface to become more prone to wind and water erosion.	Will implement Best Management Practices (BMPs) to minimize erosion and sedimentation and will restore temporarily impacted areas.
Geologic and Groundwater Resources	No impacts to geological and groundwater resources are anticipated.	None proposed.
Waterbodies, Wetlands, and Floodplain Resources	No impacts are anticipated.	Will implement BMPs to minimize erosion and sedimentation.

Table 4: Summary of Environmental Resource Impact Analysis and Avoidance/Minimization Measures

Resource	Potential Impact of Upgrade Project	Avoidance and/or Minimization Measures
Vegetation	Will utilize previously disturbed areas; no trees or shrubs will be removed.	Will comply with the site restoration and reseeded conditions in the Commission’s 2010 Order and all other applicable requirements.
Wildlife	<p>Construction impacts will be confined to previously disturbed locations and minimal impacts to wildlife anticipated.</p> <p>The Upgrade Project is not anticipated to have an impact on threatened or endangered species or have any measurable change in impact on migrating birds or bats.</p>	Will implement BMPs from the Facility’s Wildlife Conservation Strategy to minimize risks to birds, bats, and other wildlife.

References

TetraTech EC, INC. 2010. Jurisdictional Determination Report for the Ashtabula III Wind Energy Center: Ashtabula Wind III, LLC, Barnes County, North Dakota. TetraTech EC, INC.

USACE [U.S. Army Corps of Engineers]. 1987. Corps of Engineers Wetlands Delineation Manual. USACE, Environmental Laboratory Report No.: Technical Report Y-87-1 (online edition). <http://el.erdc.usace.army.mil/elpubs/pdf/wlman87.pdf>.

Attachments

Figure 1. Upgrade Project Map

Figure 2. Wind Turbine Diagram

Figure 3. Exclusion and Avoidance Area Map

Appendix A – Acoustic Assessment Results and Sound Waivers

Appendix B – Shadow Flicker Assessment Results

Appendix C – FAA Filings

Appendix D – Microwave Beam Path Study

Appendix E – Class I Literature Review – Cultural Resource Report and Unanticipated Discoveries Plan (PUBLIC)

Appendix F – IPaC Resource List

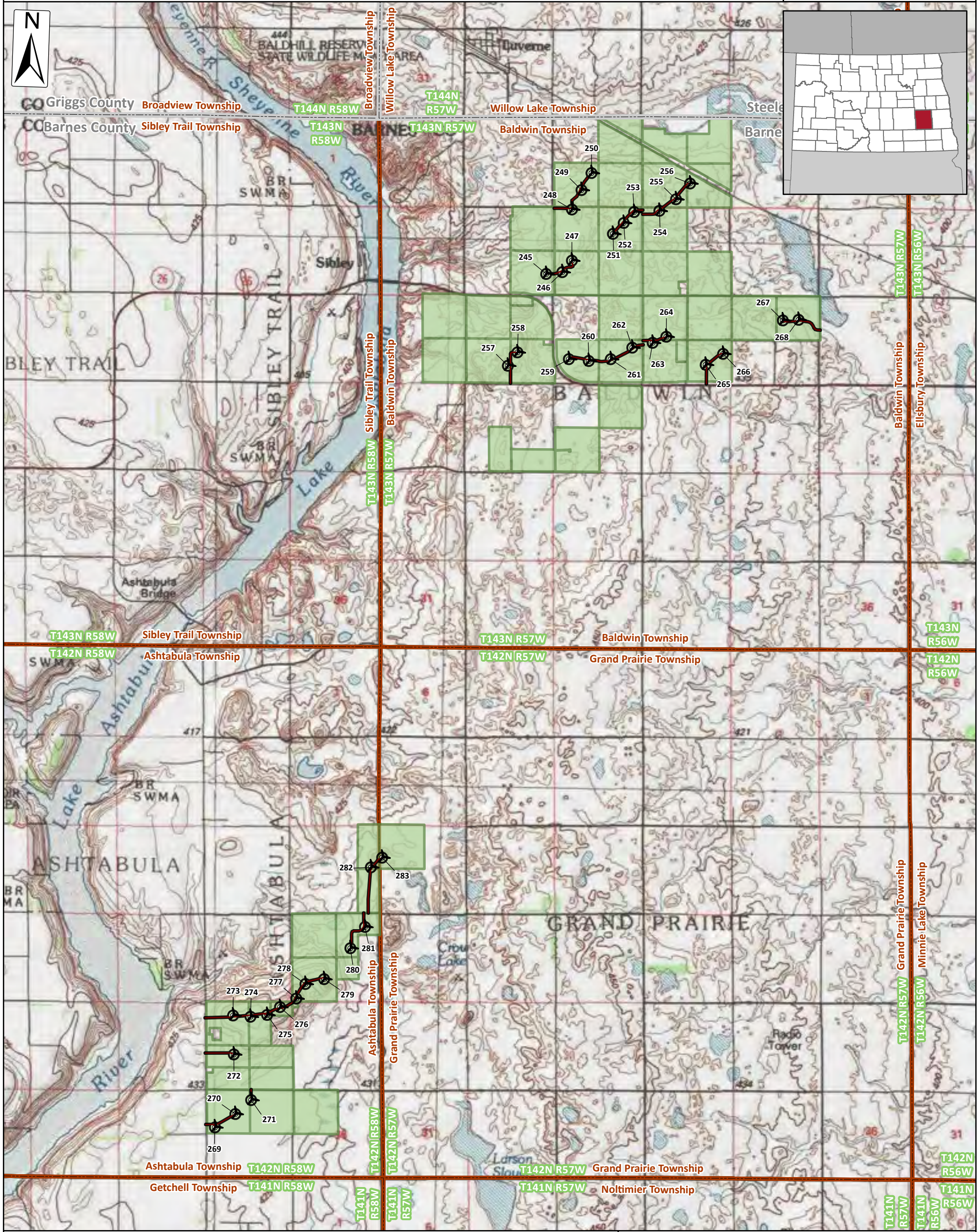
Appendix G – Setback Waiver









Ashtabula III Wind Upgrade Project

Issue Date:
6/28/2023

Figure 1- Site Overview

Barnes County, North Dakota



-  Existing Turbine Locations
-  Existing Access Roads
-  Disturbance Area (~94 acres)
-  Participating Parcels
-  Consent Parcels
-  Environmental Study Area
-  Township
-  County

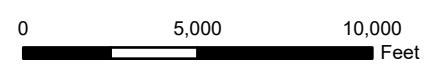
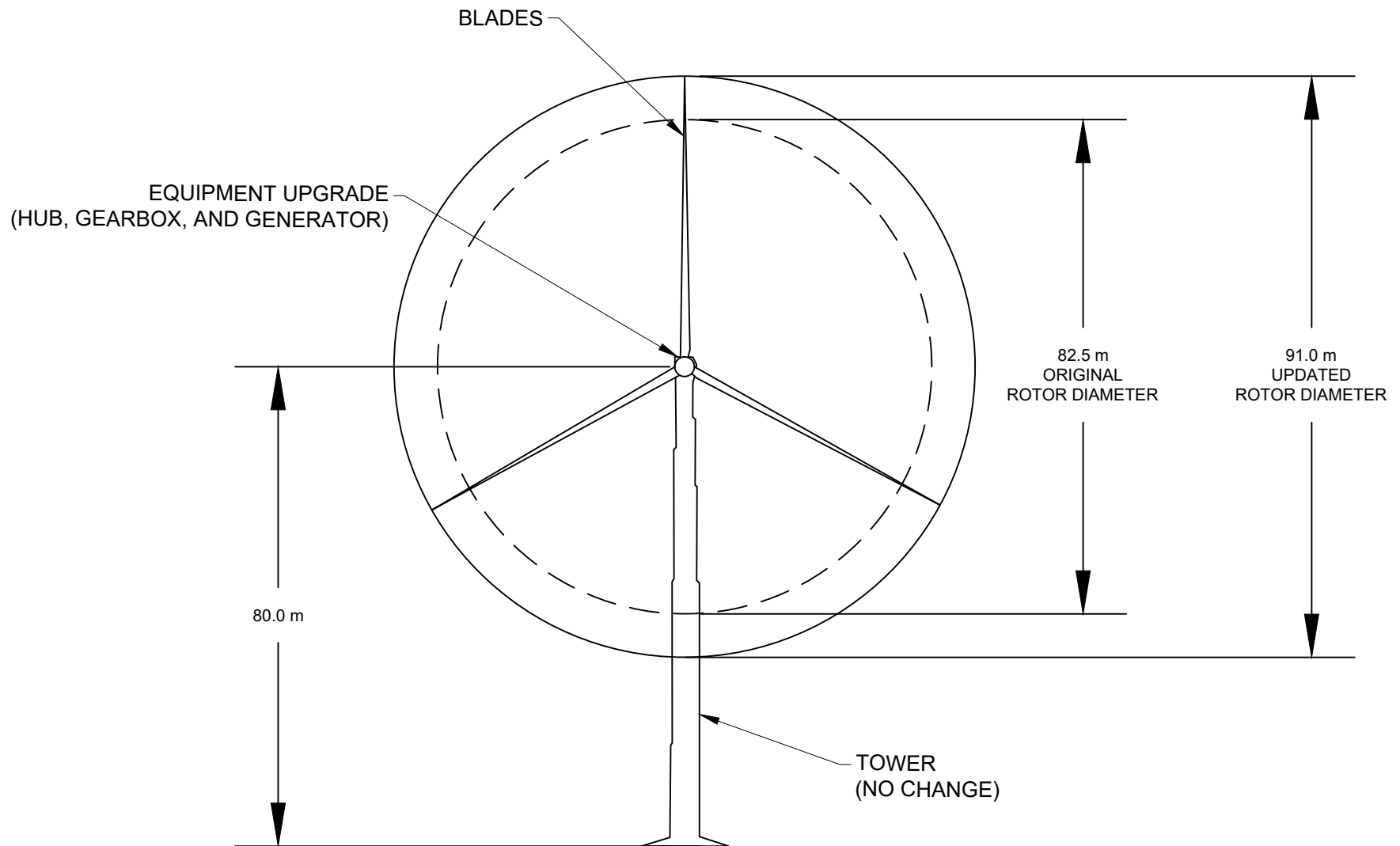
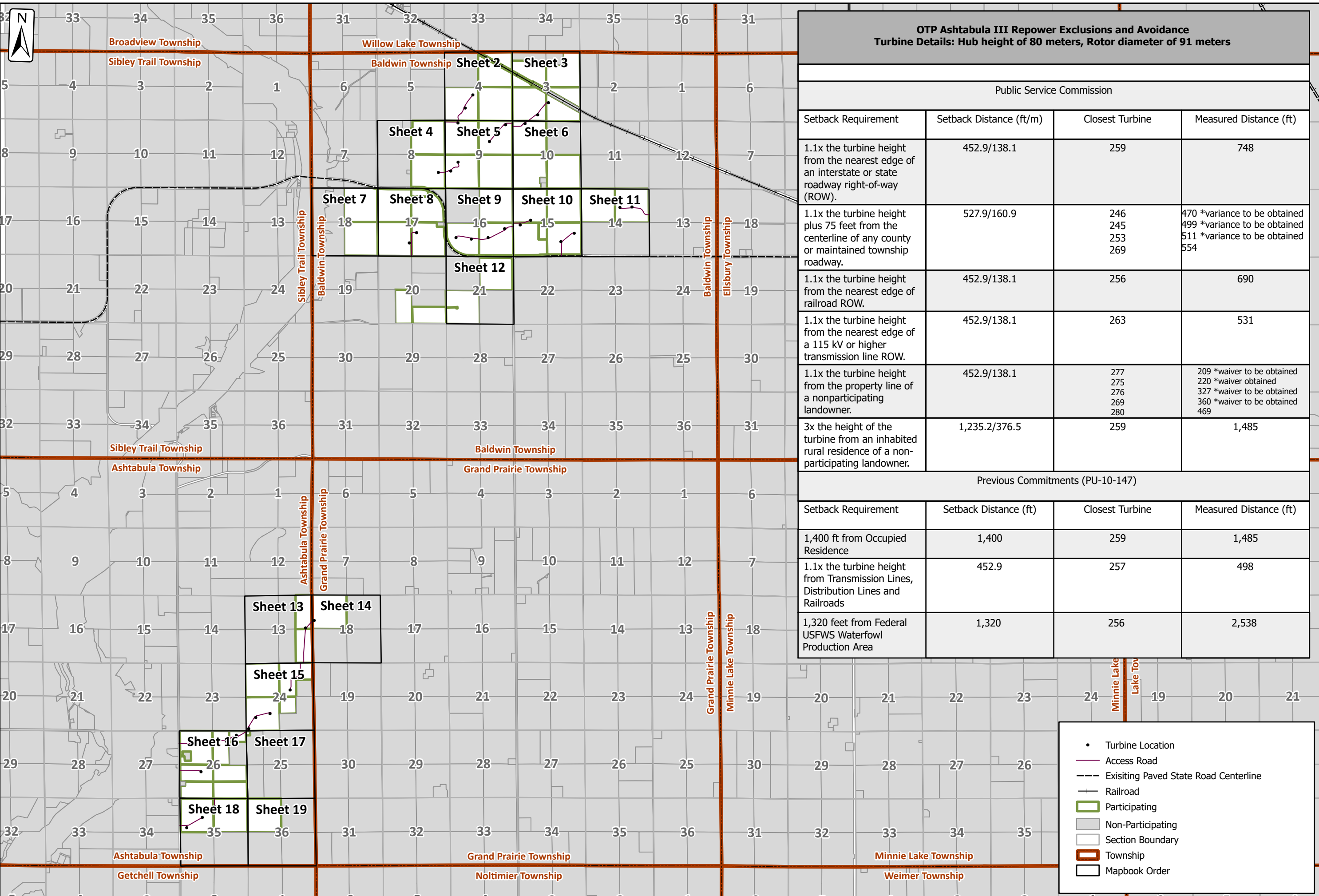


FIGURE 2: PROPOSED TURBINE UPGRADE





OTP Ashtabula III Repower Exclusions and Avoidance Turbine Details: Hub height of 80 meters, Rotor diameter of 91 meters			
Public Service Commission			
Setback Requirement	Setback Distance (ft/m)	Closest Turbine	Measured Distance (ft)
1.1x the turbine height from the nearest edge of an interstate or state roadway right-of-way (ROW).	452.9/138.1	259	748
1.1x the turbine height plus 75 feet from the centerline of any county or maintained township roadway.	527.9/160.9	246 245 253 269	470 *variance to be obtained 499 *variance to be obtained 511 *variance to be obtained 554
1.1x the turbine height from the nearest edge of railroad ROW.	452.9/138.1	256	690
1.1x the turbine height from the nearest edge of a 115 kV or higher transmission line ROW.	452.9/138.1	263	531
1.1x the turbine height from the property line of a nonparticipating landowner.	452.9/138.1	277 275 276 269 280	209 *waiver to be obtained 220 *waiver obtained 327 *waiver to be obtained 360 *waiver to be obtained 469
3x the height of the turbine from an inhabited rural residence of a non-participating landowner.	1,235.2/376.5	259	1,485
Previous Commitments (PU-10-147)			
Setback Requirement	Setback Distance (ft)	Closest Turbine	Measured Distance (ft)
1,400 ft from Occupied Residence	1,400	259	1,485
1.1x the turbine height from Transmission Lines, Distribution Lines and Railroads	452.9	257	498
1,320 feet from Federal USFWS Waterfowl Production Area	1,320	256	2,538

- Turbine Location
- Access Road
- - - Existing Paved State Road Centerline
- + Railroad
- ▭ Participating
- ▭ Non-Participating
- ▭ Section Boundary
- ▭ Township
- ▭ Mapbook Order

ATWELL
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CLIENT: Otter Tail Power Company

SCALE: 0 1,000 2,000 Feet

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SHEET NO: 1 of 19

SECTIONS: 18, 13, 24, 25, 26, 35, 36, 3, 4, 8, 9, 10, 14, 15, 16, 17, 18, 21

TOWNSHIP: T142N R57W, T143N R57W

TOWNSHIPS: Ashtabula, Baldwin and Grand Prairie Townships

COUNTY, STATE: Barnes County, ND

Ashtabula III Wind Upgrade Project
Figure 3: Exclusions and Avoidance



Section 32

Section 5

Section 33 Willow Lake Township

Section 4 Baldwin Township

Section 34

Section 3

Section 5
Section 4

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Section 3

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Section 9

Section 3

Section 10

TREVOR JACOBSEN
040430300

249

MARK G SVENNINGSEN
040920200

248

TREVOR JACOBSEN
040410100

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TREVOR JACOBSEN
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TREVOR JACOBSEN
040410100

TREVOR JACOBSEN
040440400

TREVOR JACOBSEN
040330300

MARK G SVENNINGSEN
040910100

PATRICA NIELSON
041020200

- Turbine Location
- Occupied Residence
- Access Road
- Existing Overhead Transmission Line
- Existing Paved State Road Centerline
- - - Existing Paved County Road Centerline
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- Non-Participating
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COUNTY, STATE	Barnes County, ND

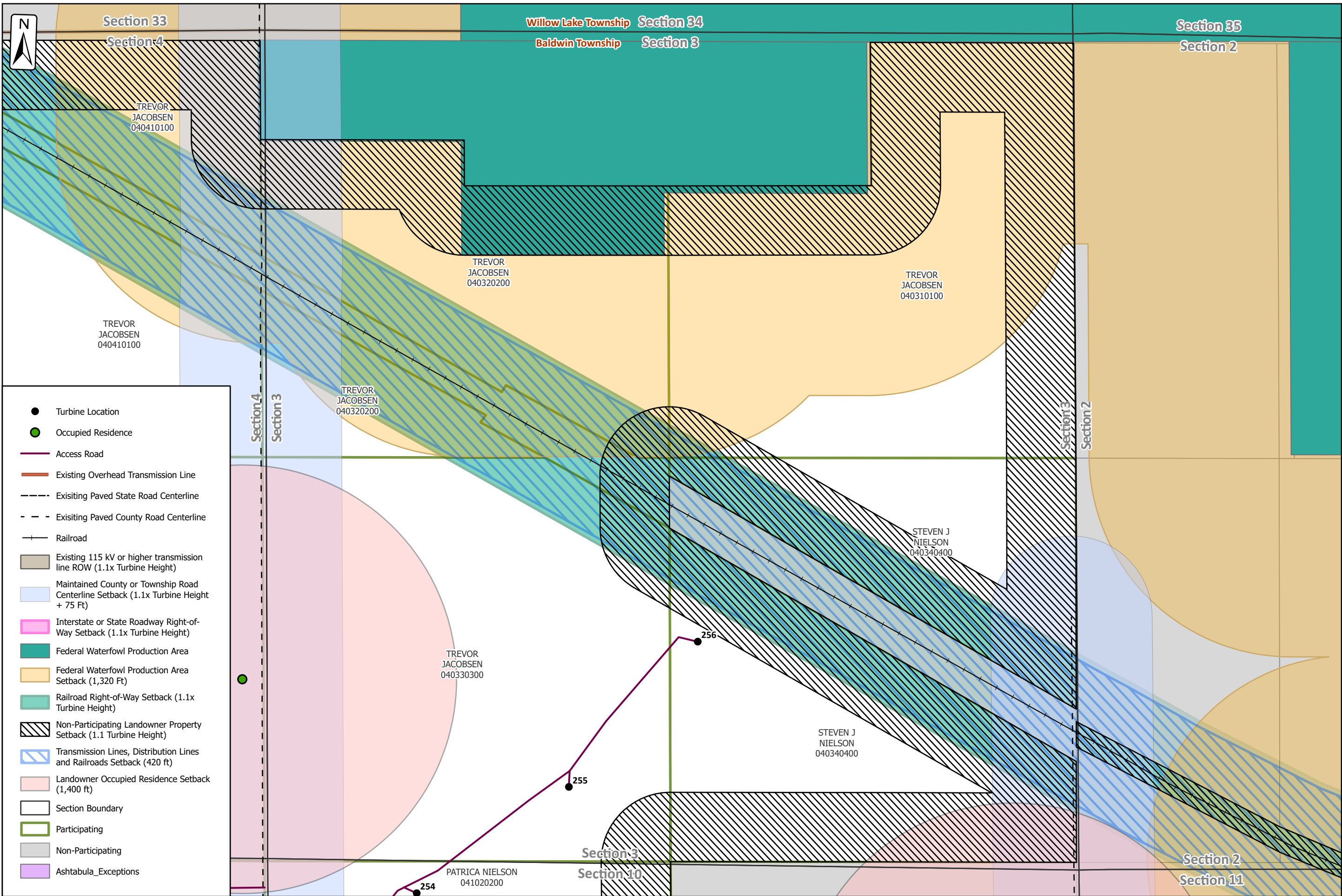
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Ashtabula III Wind Upgrade Project

Figure 3: Exclusions and Avoidance



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- Turbine Location
- Occupied Residence
- Access Road
- Existing Overhead Transmission Line
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Ashtabula III Wind Upgrade Project

Figure 3: Exclusions and Avoidance

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Section 6
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Section 5
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TREVOR JACOBSEN
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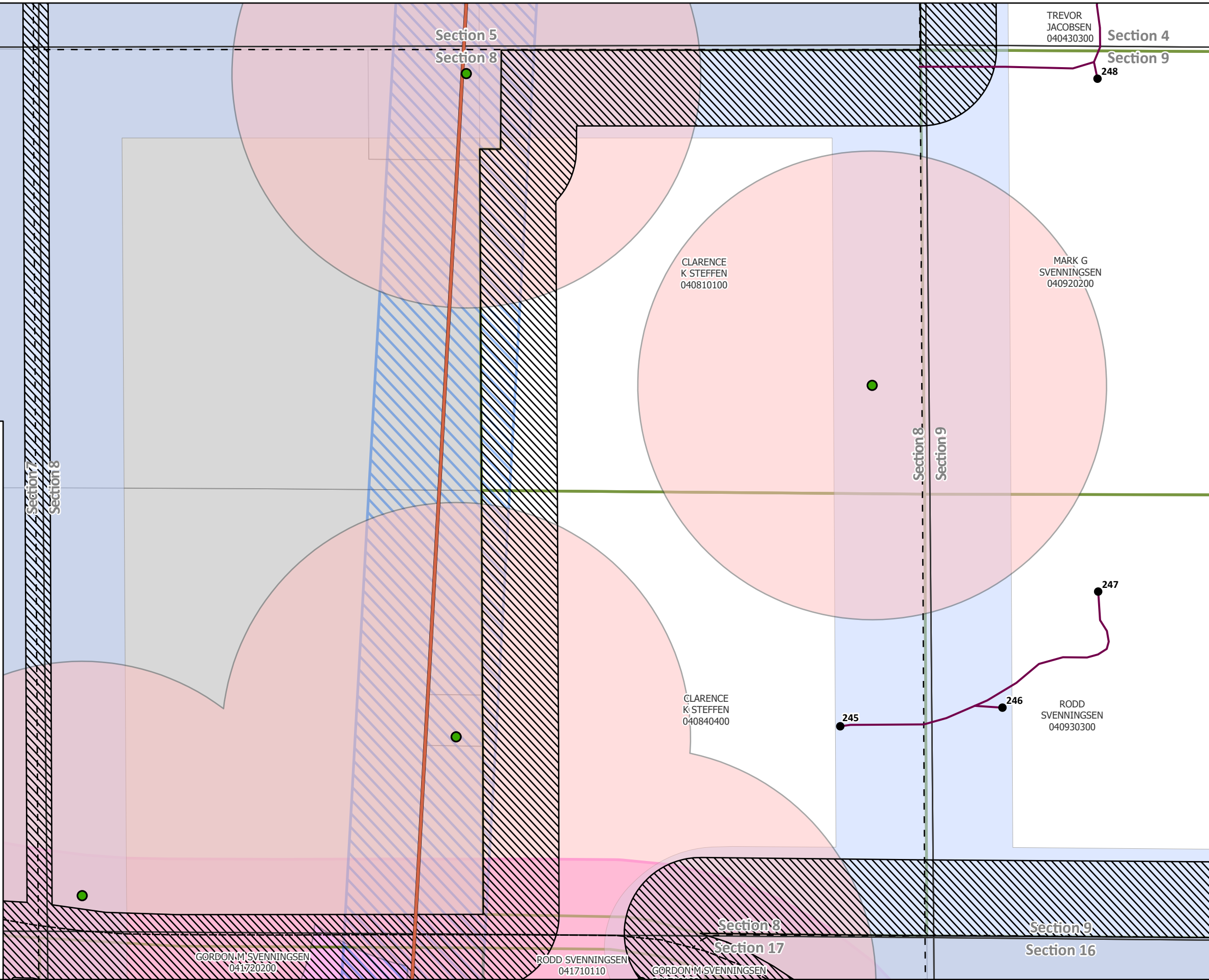
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GORDON M SVENNINGSEN
041720200

RODD SVENNINGSEN
041710110

GORDON M SVENNINGSEN

- Turbine Location
- Occupied Residence
- Access Road
- Existing Overhead Transmission Line
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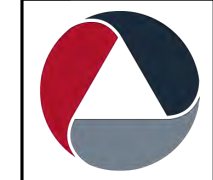
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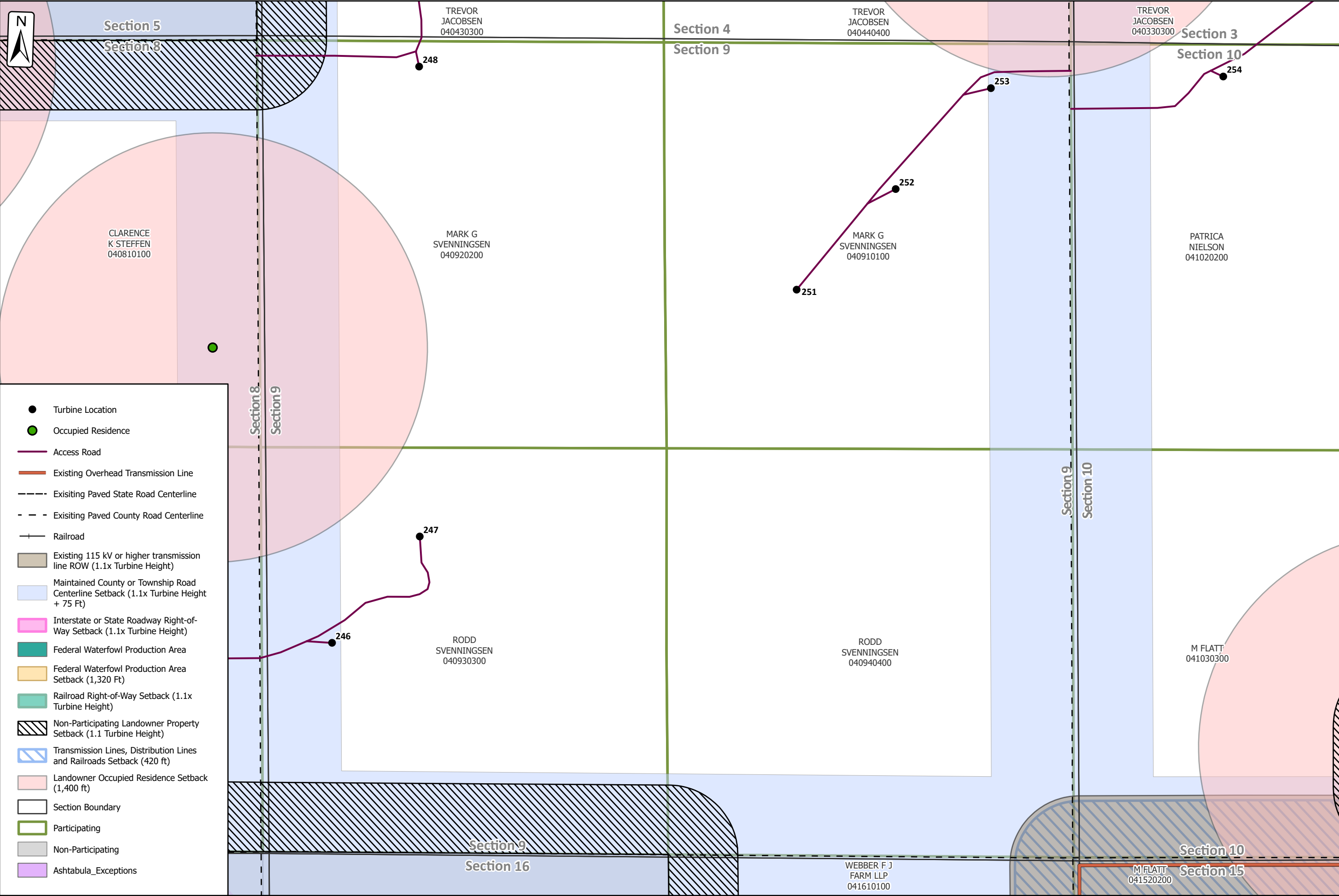
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Ashtabula III Wind Upgrade Project

Figure 3: Exclusions and Avoidance



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- Turbine Location
- Occupied Residence
- Access Road
- Existing Overhead Transmission Line
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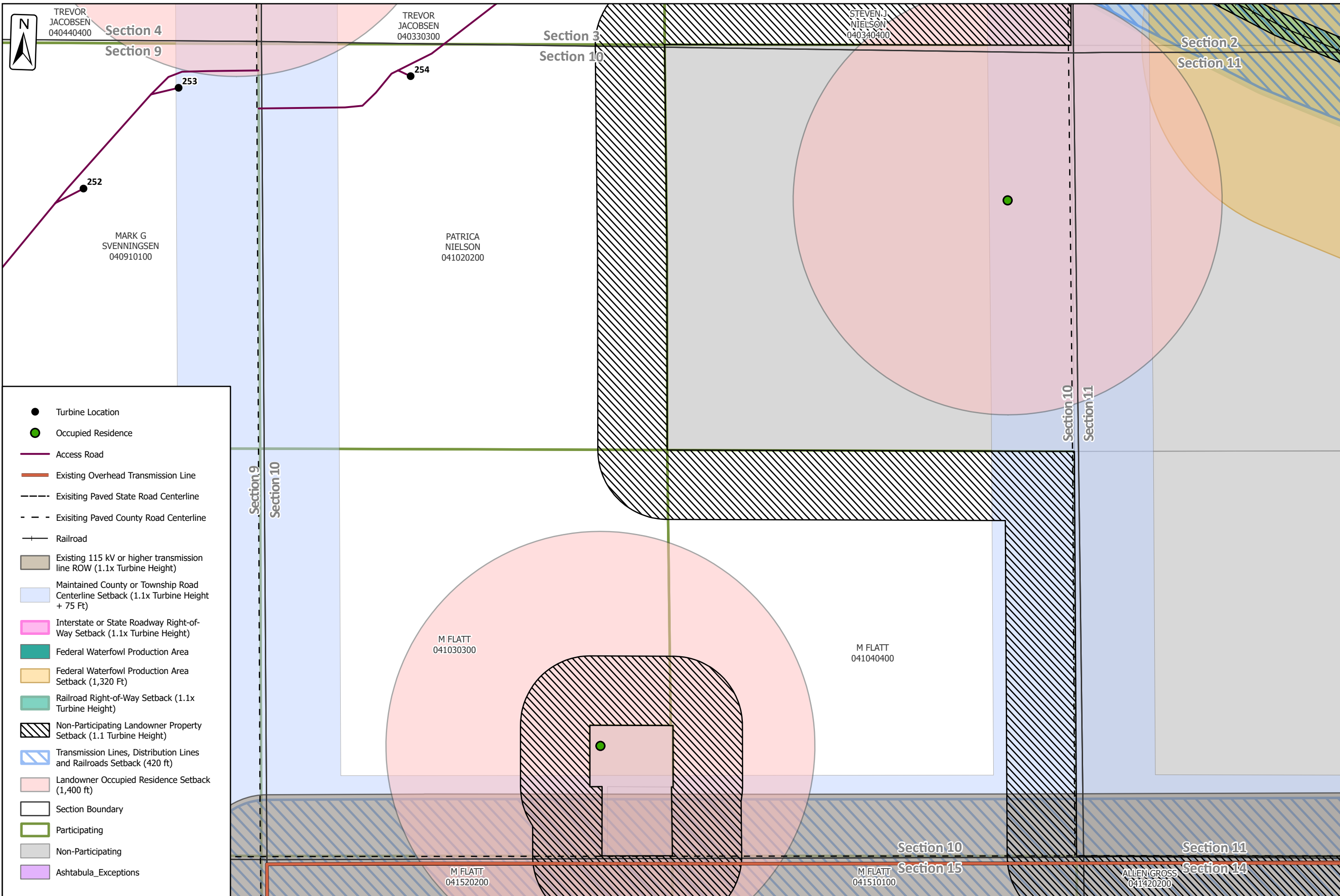
Ashtabula III Wind Upgrade Project

Figure 3: Exclusions and Avoidance



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- Turbine Location
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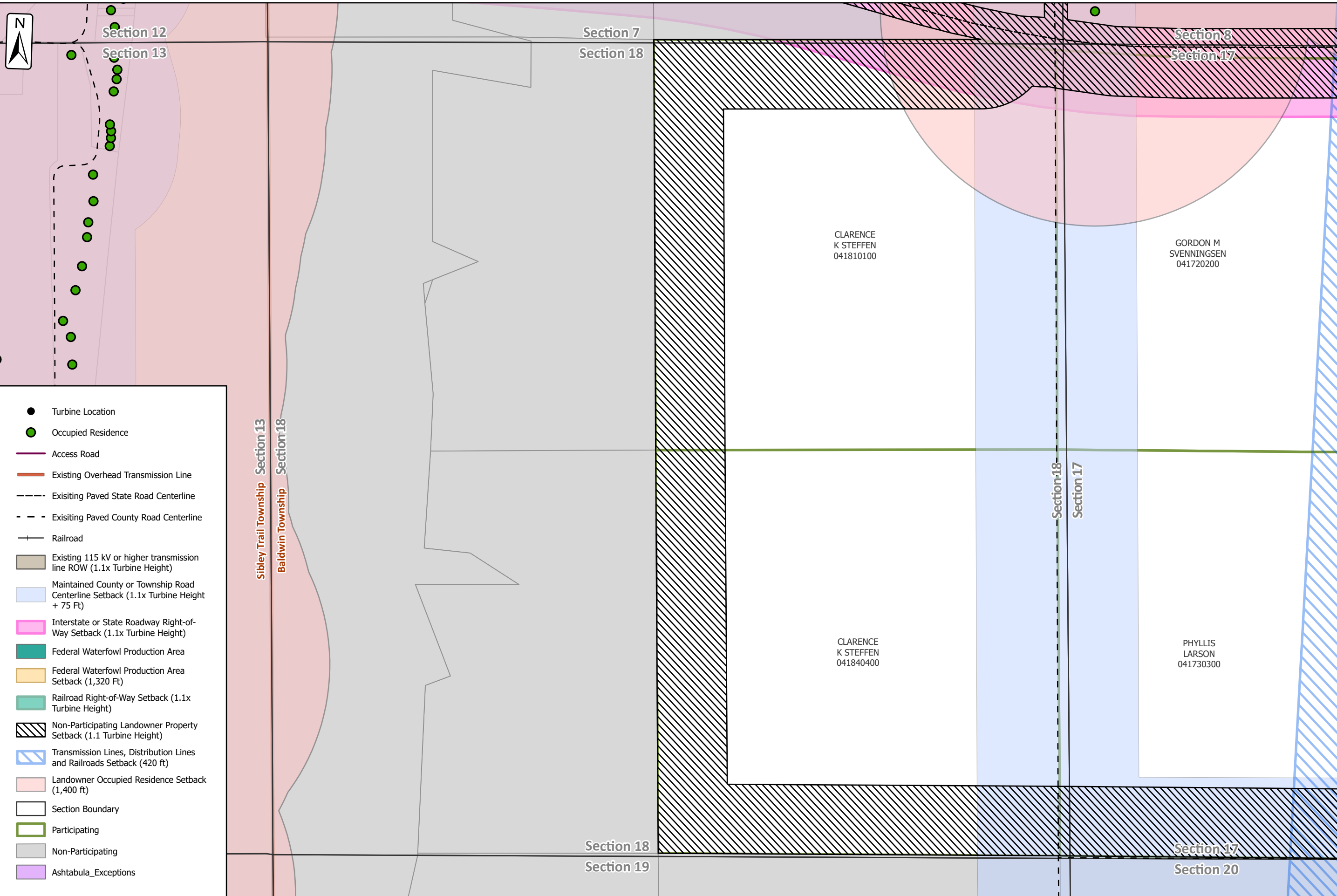
Ashtabula III Wind Upgrade Project

Figure 3: Exclusions and Avoidance



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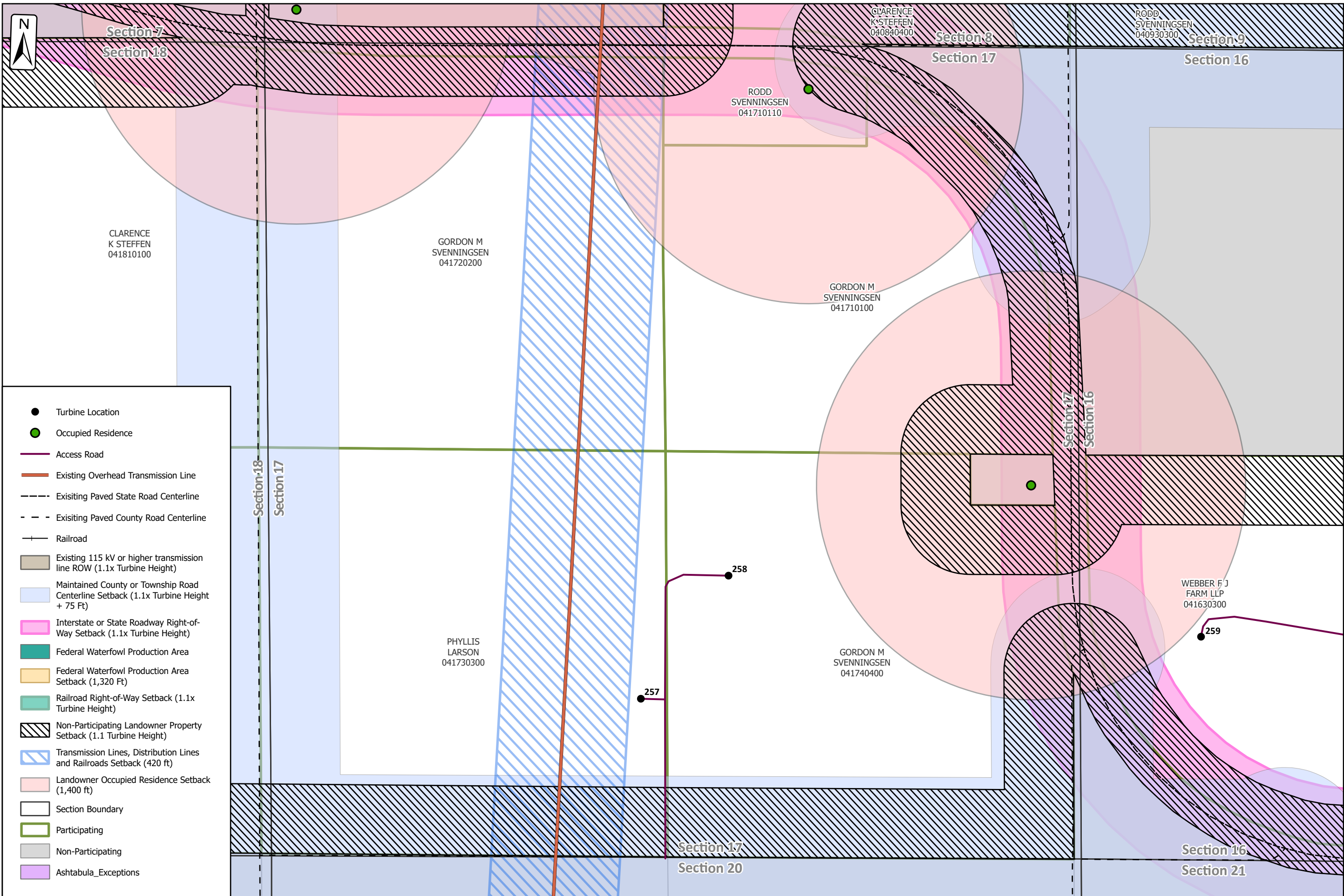
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Ashtabula III Wind Upgrade Project

Figure 3: Exclusions and Avoidance

SCALE: 0 130 260 Feet

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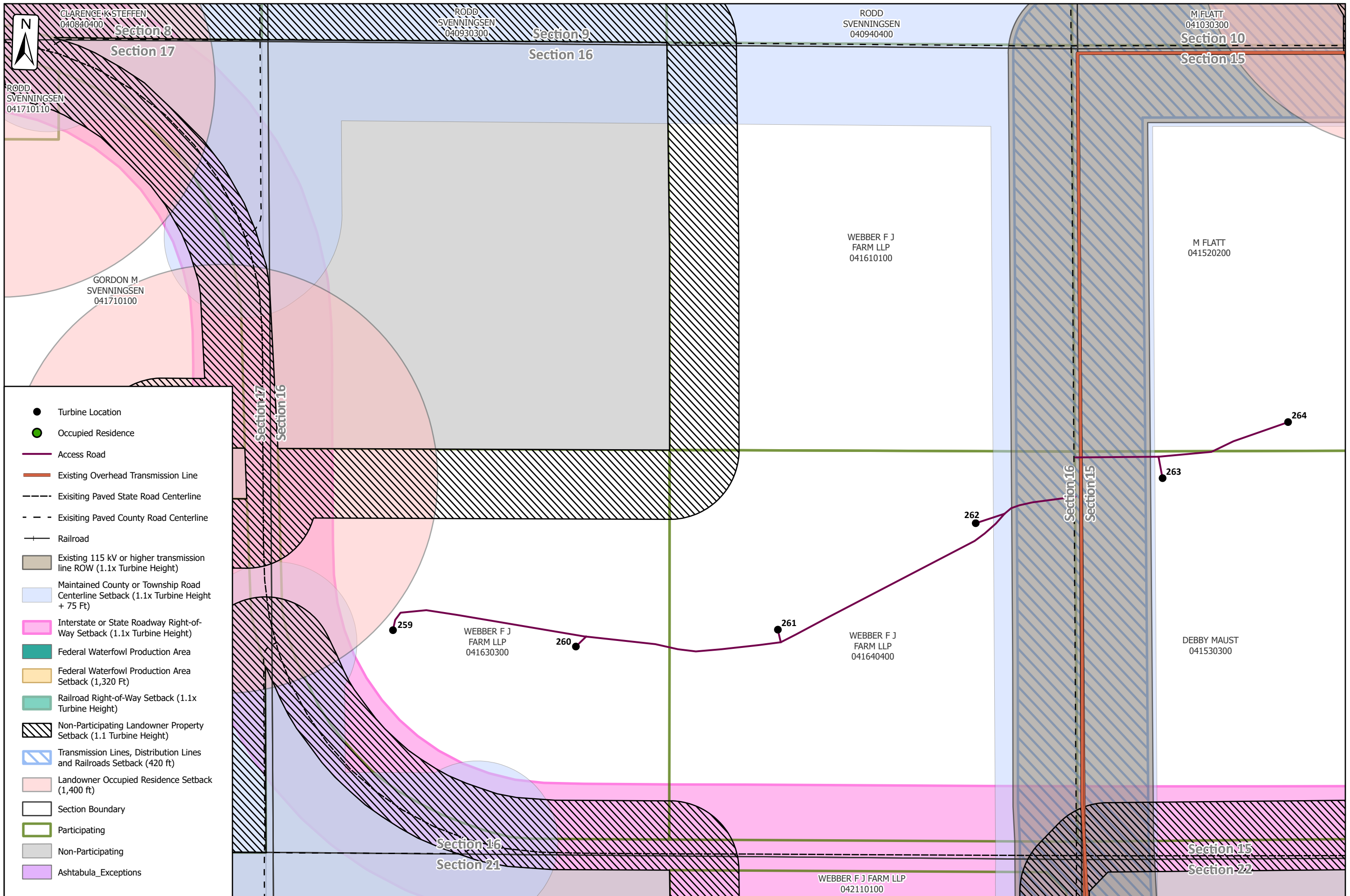
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CLIENT: Otter Tail Power Company
Ashtabula III Wind Upgrade Project
Figure 3: Exclusions and Avoidance

SCALE: 0 130 260 Feet
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RODD SVENNINGSEN
041710110

CLARENCE K STEFFEN
040840400

RODD SVENNINGSEN
040930300

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M FLATT
041030300

GORDON M SVENNINGSEN
041710100

WEBBER F J FARM LLP
041610100

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WEBBER F J FARM LLP
042110100

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Ashtabula III Wind Upgrade Project

Figure 3: Exclusions and Avoidance



SCALE:	0 130 260 Feet
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RODD SVENNINGSEN
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Section 9
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WEBBER F J
FARM LLP
041610100

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ALLEN GROSS
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CAREY B FLATT
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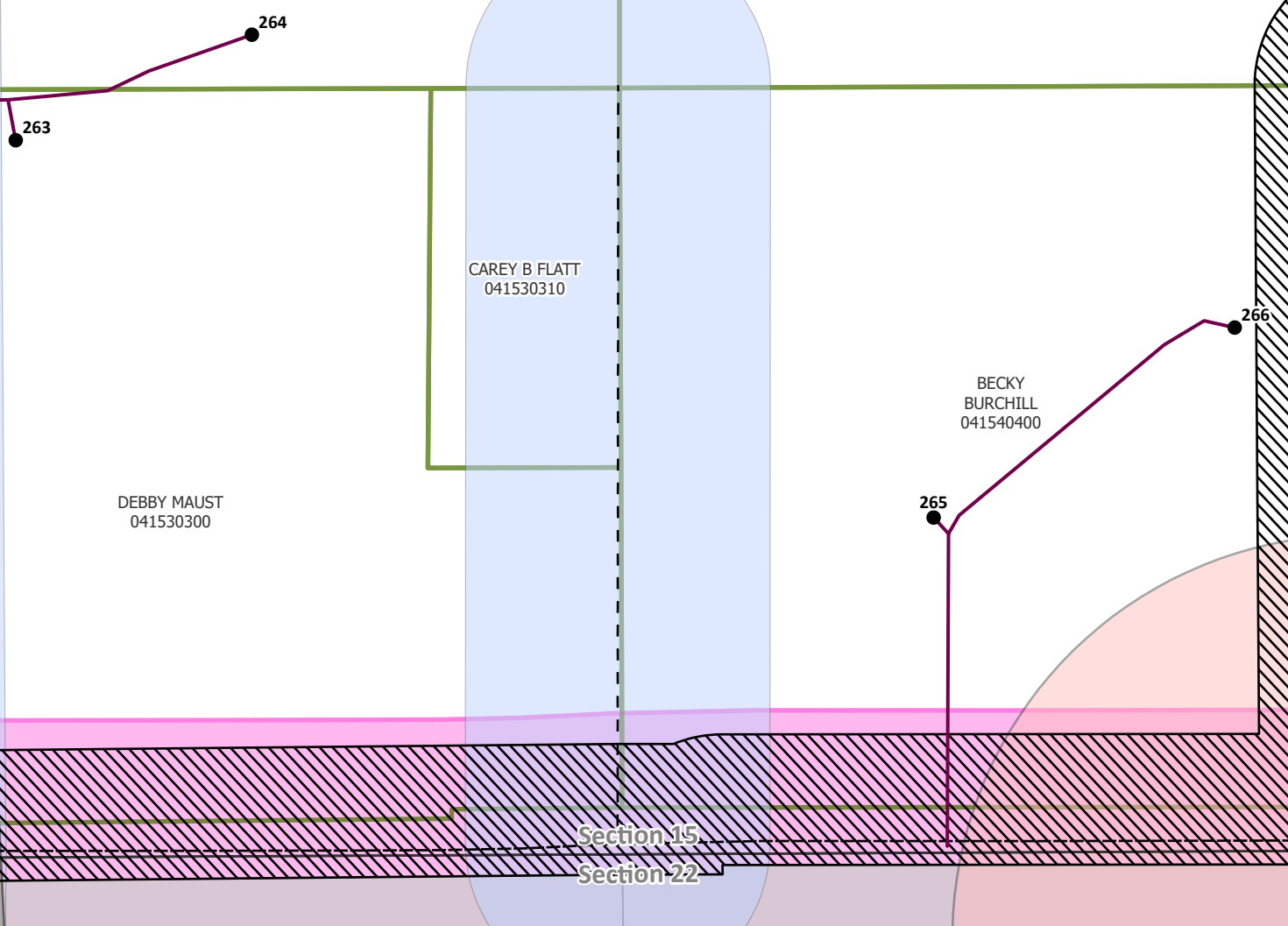
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Section 15
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- Turbine Location
- Occupied Residence
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COUNTY, STATE	Barnes County, ND

CLIENT: Otter Tail Power Company

Ashtabula III Wind Upgrade Project
Figure 3: Exclusions and Avoidance



SCALE: 0 130 260 Feet

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ALLEN GROSS
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MAYNARD
A FLATT
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- Turbine Location
- Occupied Residence
- Access Road
- Existing Overhead Transmission Line
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Section 15

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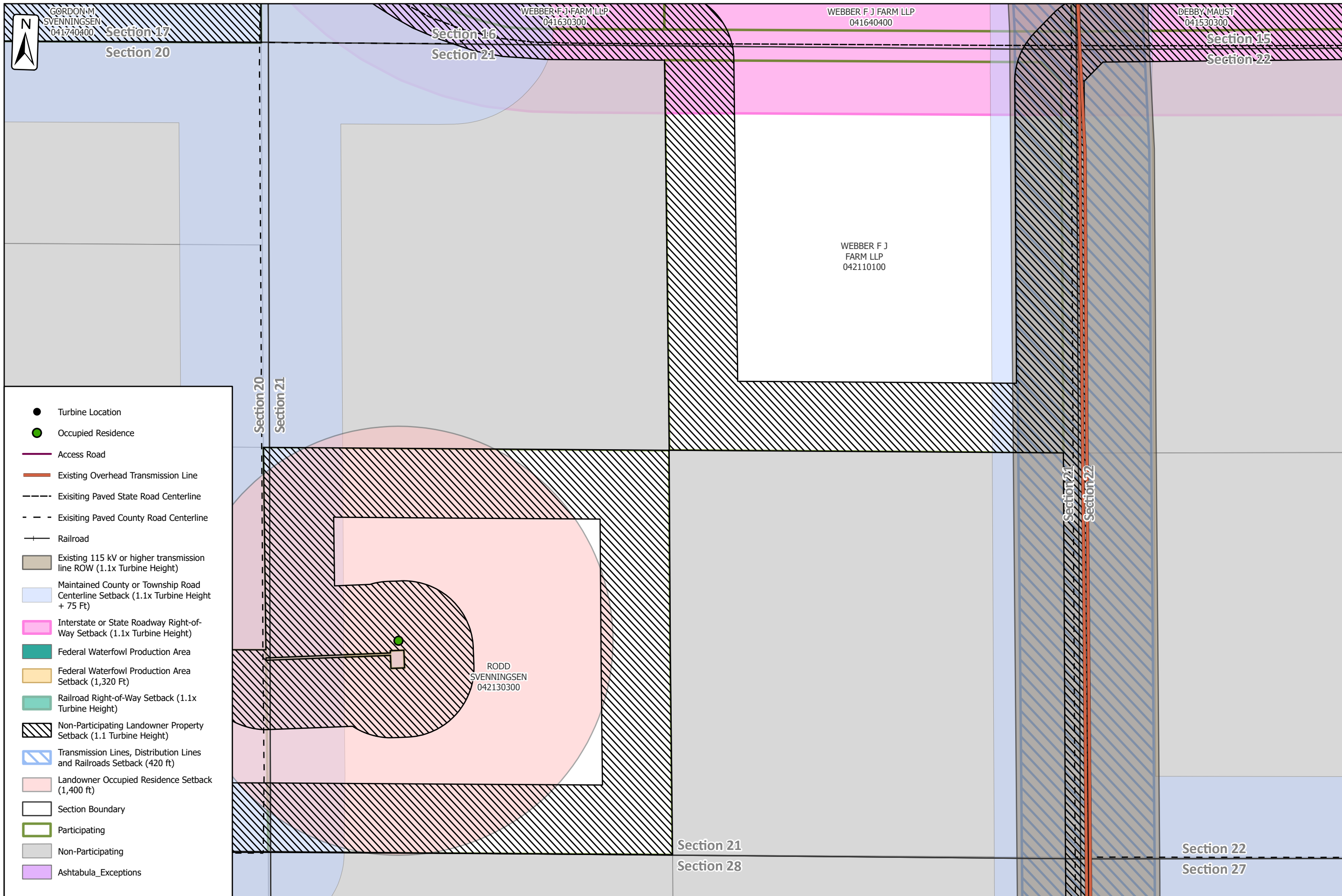
Ashtabula III Wind Upgrade Project Figure 3: Exclusions and Avoidance



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TOWNSHIP	T-142N R-57W, T-143N R-57W
TOWNSHIPS	Ashtabula, Baldwin and Grand Prairie Townships
COUNTY, STATE	Barnes County, ND

CLIENT: Otter Tail Power Company

Ashtabula III Wind Upgrade Project
Figure 3: Exclusions and Avoidance



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Section 11
Section 14

Section 12
Section 13

Section 7
Section 18

JODIE KOCH
SCHERR
031310100

ROCK PILE LLP
131820200

Section 13
Section 18
282
283

JODIE KOCH
SCHERR
031340400

LLOYD R KOCH
032420200

LLOYD KOCH
032410100

Ashtabula Township
Grand Prairie Township

- Turbine Location
- Occupied Residence
- Access Road
- Existing Overhead Transmission Line
- Existing Paved State Road Centerline
- - - Existing Paved County Road Centerline
- Railroad
- Existing 115 kV or higher transmission line ROW (1.1x Turbine Height)
- Maintained County or Township Road Centerline Setback (1.1x Turbine Height + 75 Ft)
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- Federal Waterfowl Production Area
- Federal Waterfowl Production Area Setback (1,320 Ft)
- Railroad Right-of-Way Setback (1.1x Turbine Height)
- Non-Participating Landowner Property Setback (1.1 Turbine Height)
- Transmission Lines, Distribution Lines and Railroads Setback (420 ft)
- Landowner Occupied Residence Setback (1,400 ft)
- Section Boundary
- Participating
- Non-Participating
- Ashtabula_Exceptions



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Ashtabula III Wind Upgrade Project

Figure 3: Exclusions and Avoidance



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Section 12
Section 13

Section 7
Section 18

Section 8
Section 17

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031310100

ROCK PILE LLP
131820200

Section 13
Section 18

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Ashtabula Township
Grand Prairie Township

Section 18
Section 17

Section 18
Section 19

Section 17
Section 20

- Turbine Location
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COUNTY, STATE	Barnes County, ND

CLIENT: Otter Tail Power Company

Ashtabula III Wind Upgrade Project

Figure 3: Exclusions and Avoidance



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Section 14
Section 23

Section 13
Section 24

Section 18
Section 19

JODIE KOCH
SCHERR
031340400

LLOYD KOCH
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032420200

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LLOYD KOCH
032440410

LLOYD R. KOCH
032430300

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MARK
SWANBERG
032520210

Section 24
Section 25

Section 19
Section 30

Ashtabula Township - Section 24
Grand Prairie Township - Section 19

- Turbine Location
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Ashtabula III Wind Upgrade Project

Figure 3: Exclusions and Avoidance



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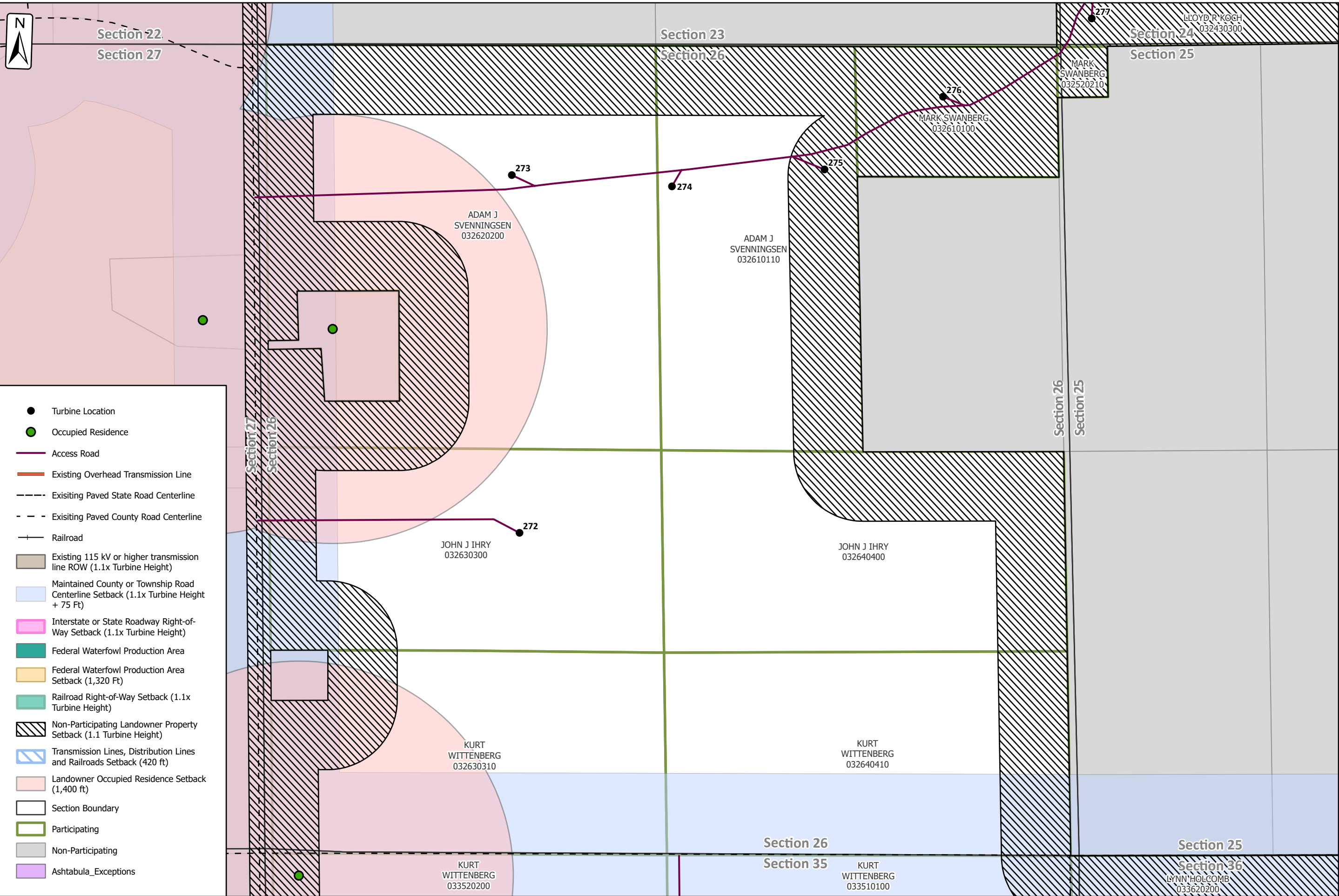
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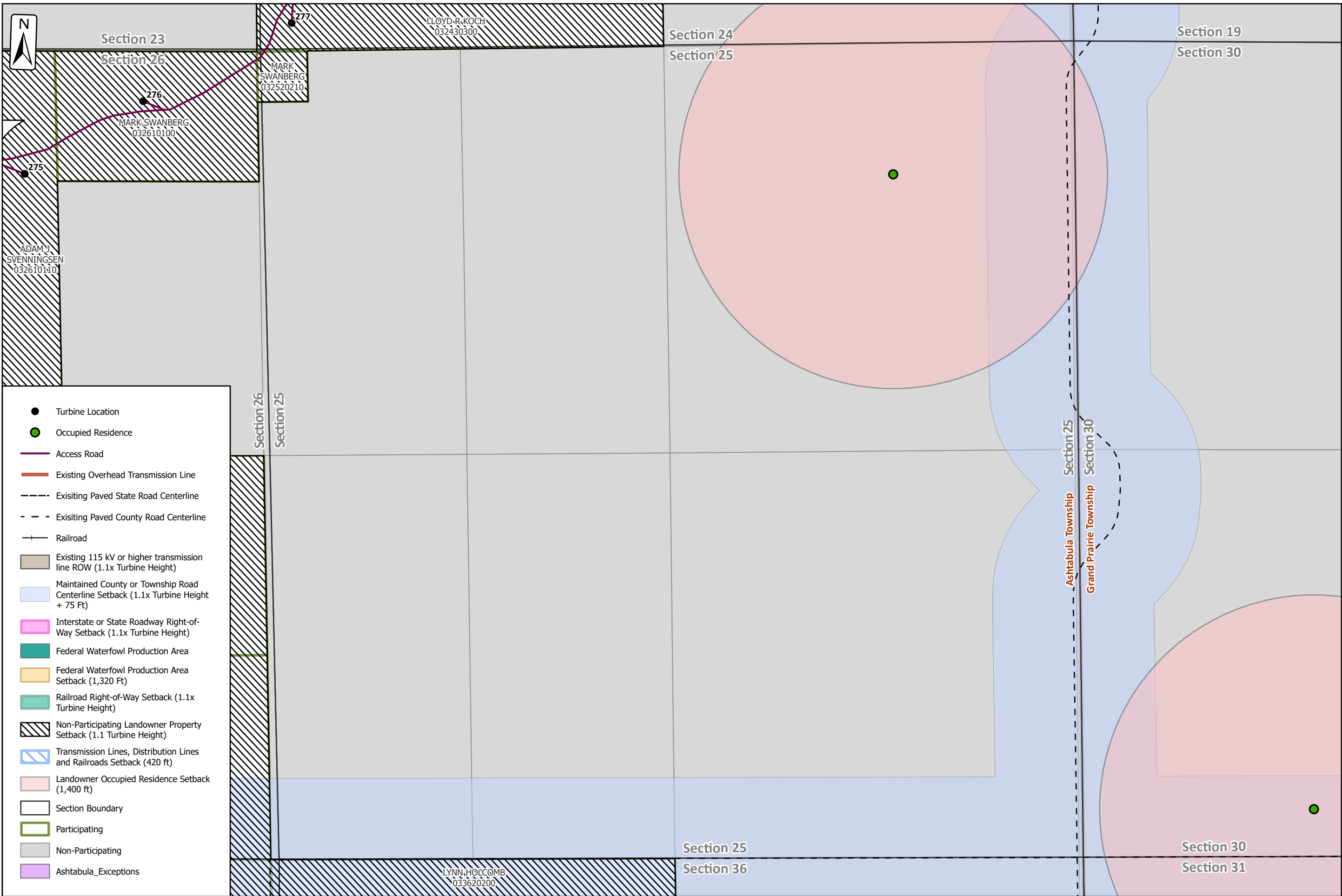
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Ashtabula III Wind Upgrade Project

Figure 3: Exclusions and Avoidance



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Ashtabula III Wind Upgrade Project

Figure 3: Exclusions and Avoidance



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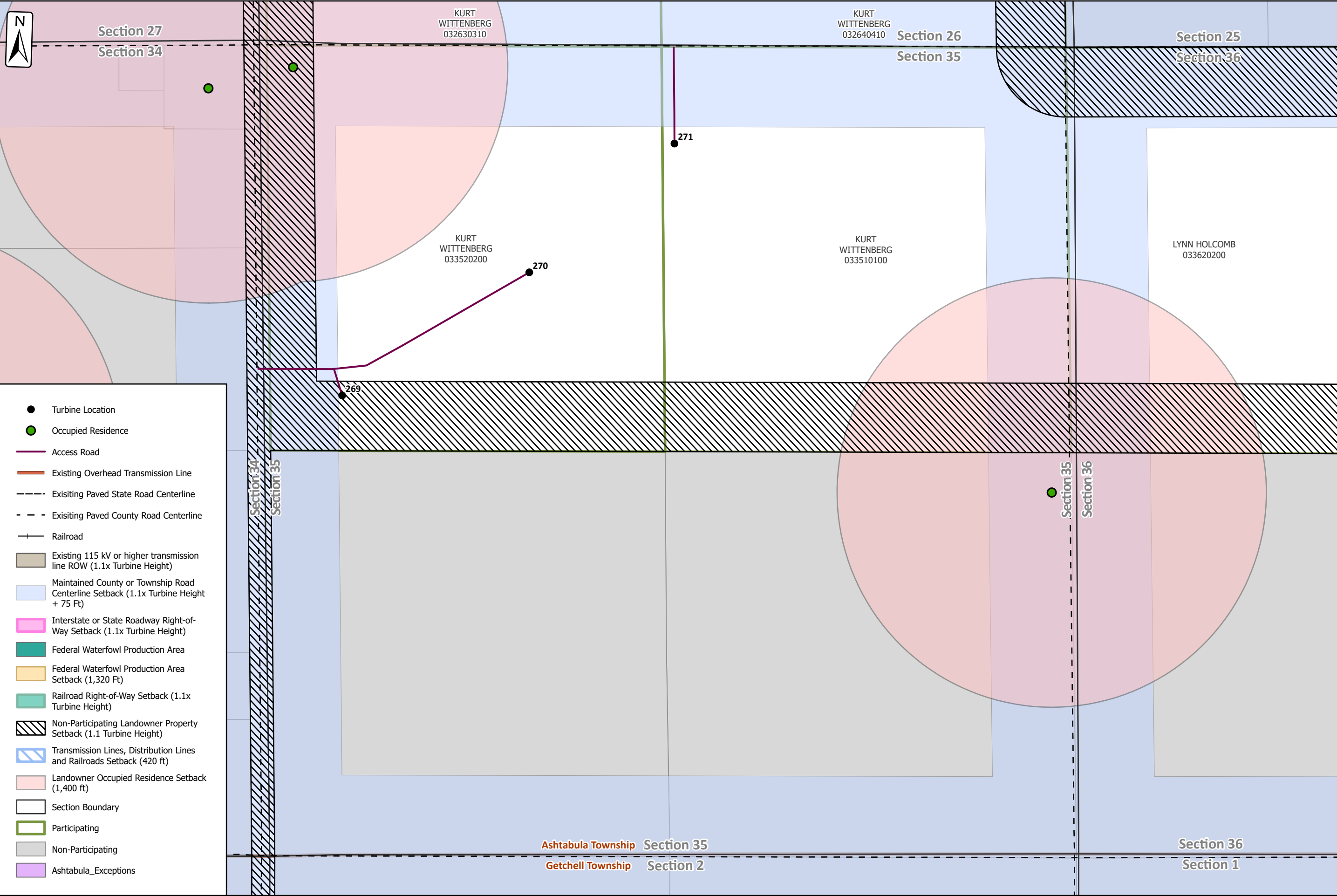
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- Turbine Location
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Ashtabula III Wind Upgrade Project
Figure 3: Exclusions and Avoidance



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Ashtabula Township Section 35
 Getchell Township Section 2



KURT
WITTENBERG
032640410

Section 26
Section 35

Section 25
Section 36

Section 30
Section 31

KURT
WITTENBERG
033510100

LYNN HOLCOMB
033620200

- Turbine Location
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- Ashtabula_Exceptions

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Section 36

Section 36. Ashtabula Township
Section 31 Grand Prairie Township

Ashtabula Township
Getchell Township

Section 36
Section 1

Grand Prairie Township Section 31
Noltmier Township Section 6



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Ashtabula III Wind Upgrade Project

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Appendix A – Acoustic Assessment Results and Sound Waivers

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SOUND LEVEL ASSESSMENT REPORT

Otter Tail Ashtabula III Wind Repower Project Barnes County, North Dakota

Prepared for:

Atwell, LLC
311 North Main
Ann Arbor, Michigan 48104

Prepared by:



Epsilon Associates, Inc.
3 Mill & Main Place, Suite 250
Maynard, MA 01754

June 27, 2023

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1.0 EXECUTIVE SUMMARY

The Ashtabula III Wind Energy Center Repowering Project (the Project) is an existing wind park in Barnes County, North Dakota that is planned to be repowered by Otter Tail Power Company (Otter Tail). Atwell has retained Epsilon Associates, Inc. (Epsilon) to conduct a sound level assessment for this Project. This report presents the results of the sound level modeling from the proposed repower in Barnes County.

This sound level assessment includes computer modeling to predict worst-case future L_{eq} sound levels from the Project, and a comparison of operational sound levels to the North Dakota Administrative Code Energy Conversion Facility Siting Criteria of 45 dBA within 100 feet of an inhabited residence or community building. Additionally, receptors that have signed noise waivers with Otter Tail Power have been compared to the Waiver criterion of 50 dBA within 200 feet of the inhabited residence. Sound level modeling was conducted for all Otter Tail Ashtabula III Wind Repower wind turbines.

The L_{eq} sound levels modeled at receptors in Barnes County ranged from 25 to 49 dBA. The highest L_{eq} sound level modeled at a receptor that has signed a waiver with Otter Tail is 49 dBA. The highest L_{eq} sound level modeled at a receptor that has not signed a waiver with Otter Tail is 45 dBA. Using the mitigation described in this report, the L_{eq} sound levels at all receptors without a signed waiver are at or below the limit of 45 dBA within 100 feet of an inhabited residence. Therefore, the Project meets the State's regulations with respect to sound.

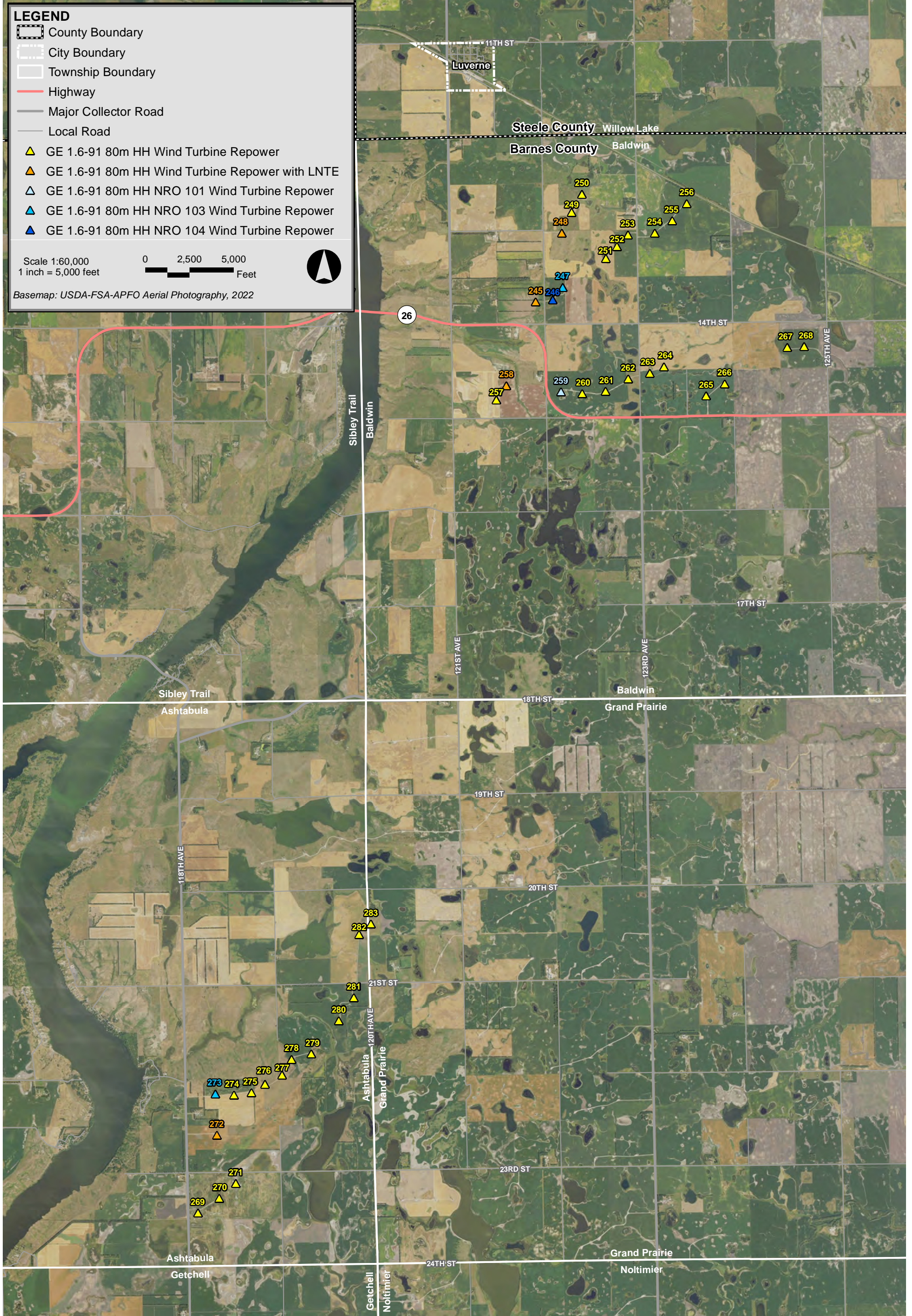
2.0 INTRODUCTION

The proposed repower Project will consist of 39 repowered wind turbines. The proposed wind turbines are all GE 1.6 MW units with a rotor diameter of 91 meters and a hub height of 80 meters. Figure 2-1 shows the locations of the 39 wind turbines in Barnes County over aerial imagery.

A detailed discussion of sound from wind turbines is presented in a white paper prepared by the Renewable Energy Research Laboratory.¹ A few points are repeated herein. Wind turbine sound can originate from two different sources: mechanical sound from the interaction of turbine components, and aerodynamic sound produced by the flow of air over the rotor blades. Prior to the 1990's, both were significant contributors to wind turbine sound. However, recent advances in wind turbine design have greatly reduced the contribution of mechanical sound. Aerodynamic sound has also been reduced from modern wind turbines due to slower rotational speeds and changes in materials of construction. Aerodynamic sound, in general, is broadband (has contributions from a wide range of frequencies). It originates from encounters of the wind turbine blades with localized airflow inhomogeneities and wakes from other turbine blades and from airflow across the surface of the blades, particularly the front and trailing edges. Aerodynamic sound generally increases with increasing wind speed up to a certain point, then typically remains constant, even with higher wind speeds. However, sound levels in general also increase with increasing wind speed with or without the presence of wind turbines.

This report presents the findings of a sound level modeling analysis for the Project. The Project wind turbines were modeled in CadnaA using sound data from GE technical reports. The results of this analysis are found within this report.

¹ Renewable Energy Research Laboratory, Department of Mechanical and Industrial Engineering, University of Massachusetts at Amherst, Wind Turbine Acoustic Noise, June 2002, amended January 2006.



Ashtabula III Repower Barnes County, North Dakota

3.0 SOUND TERMINOLOGY

There are several ways in which sound levels are measured and quantified. All of them use the logarithmic decibel (dB) scale. The following information defines the sound level terminology used in this analysis.

The decibel scale is logarithmic to accommodate the wide range of sound intensities found in the environment. A property of the decibel scale is that the sound pressure levels of two or more separate sounds are not directly additive. For example, if a sound of 50 dB is added to another sound of 50 dB, the total is only a 3-decibel increase (53 dB), which is equal to doubling in sound energy, but not equal to a doubling in decibel quantity (100 dB). Thus, every 3-dB change in sound level represents a doubling or halving of sound energy. The human ear does not perceive changes in the sound pressure level as equal changes in loudness. Scientific research demonstrates that the following general relationships hold between sound level and human perception for two sound levels with the same or very similar frequency characteristics²:

- ◆ 3 dB increase or decrease results in a change in sound that is just perceptible to the average person,
- ◆ 5 dB increase or decrease is described as a clearly noticeable change in sound level, and
- ◆ 10 dB increase or decrease is described as twice or half as loud.

Another mathematical property of decibels is that if one source of sound is at least 10 dB louder than another source, then the total sound level is simply the sound level of the higher-level source. For example, a sound source at 60 dB plus another sound source at 47 dB is equal to 60 dB.

A sound level meter (SLM) that is used to measure sound is a standardized instrument.³ It contains “weighting networks” (e.g., A-, C-, Z-weightings) to adjust the frequency response of the instrument. Frequencies, reported in Hertz (Hz), are detailed characterizations of sounds, often addressed in musical terms as “pitch” or “tone”. The most commonly used weighting network is the A-weighting because it most closely approximates how the human ear responds to sound at various frequencies. The A-weighting network is the accepted scale used for community sound level measurements; therefore, sounds are frequently reported as detected with a sound level meter using this weighting. A-weighted sound levels emphasize middle frequency sounds (i.e., middle pitched – around 1,000 Hz), and de-emphasize low and high frequency sounds. These sound levels are reported in decibels designated as “dBA”. The C-weighting network has a nearly flat response for frequencies between 63 Hz and 4,000 Hz and is noted as dBC. Z-weighted sound levels are measured sound levels without any weighting curve and are otherwise referred

² Bies, David, and Colin Hansen. 2009. *Engineering Noise Control: Theory and Practice*, 4th Edition. New York: Taylor and Francis.

³ *American National Standard Electroacoustics – Sound Level Meters – Part 1: Specifications*, ANSI S1.4-2014 (R2019), published by the Standards Secretariat of the Acoustical Society of America, Melville, NY.

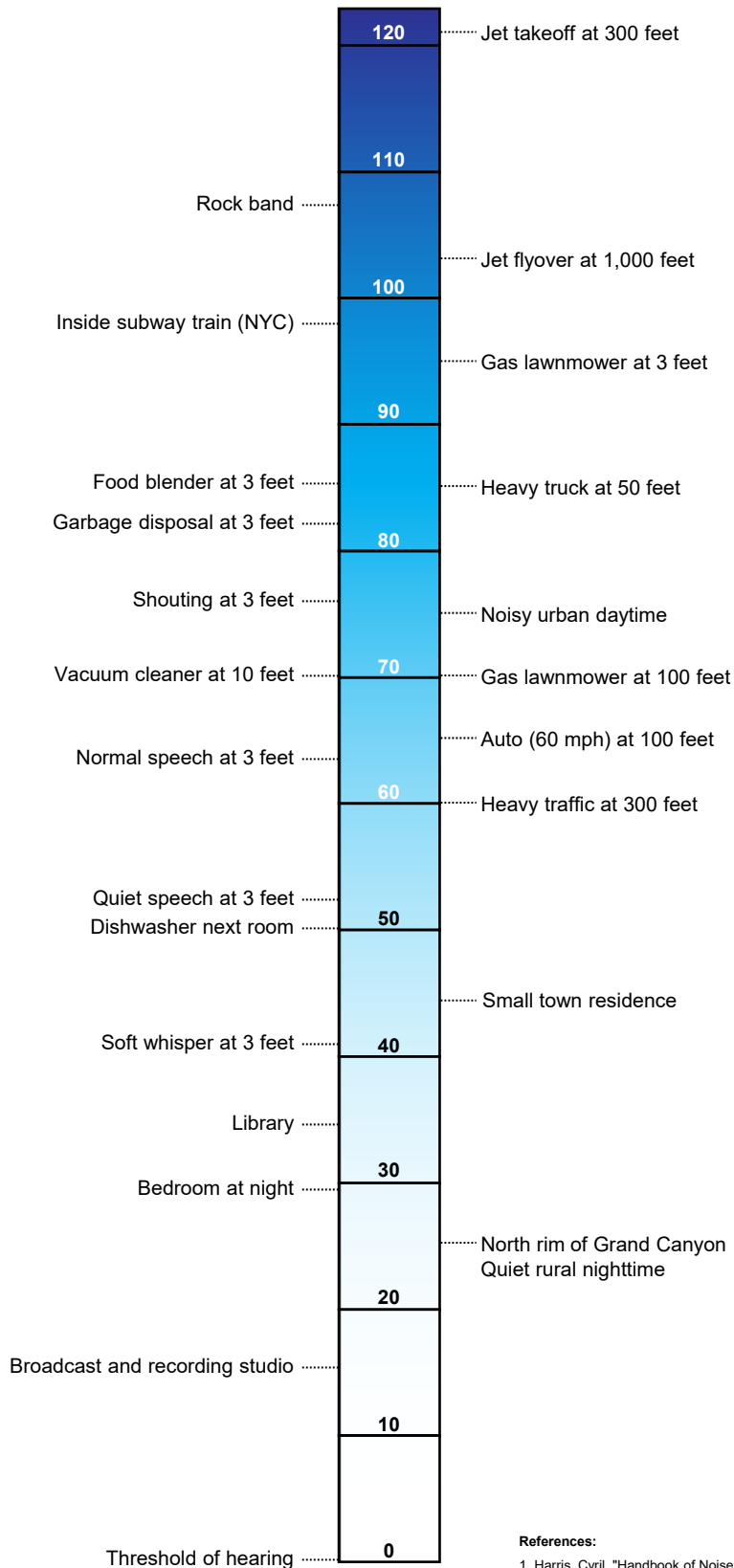
to as “unweighted”. Sound pressure levels for some common indoor and outdoor environments are shown in Figure 3-1.

Because the sounds in our environment vary with time they cannot simply be described with a single number. Two methods are used for describing variable sounds. These are exceedance levels and the equivalent level, both of which are derived from some number of moment-to-moment A-weighted sound level measurements. Exceedance levels are values from the cumulative amplitude distribution of all the sound levels observed during a measurement period. Exceedance levels are designated L_n , where n can have a value between 0 and 100 in terms of percentage. The L_{eq} is a sound level metric that is commonly reported in community sound level monitoring and is utilized in this report. The L_{eq} is described in further detail below.

- ◆ L_{eq} , the equivalent level, is the level of a hypothetical steady sound that would have the same energy (*i.e.*, the same time-averaged mean square sound pressure) as the actual fluctuating sound observed. The equivalent level is designated L_{eq} and is typically A-weighted. The equivalent level represents the time average of the fluctuating sound pressure, but because sound is represented on a logarithmic scale and the averaging is done with linear mean square sound pressure values, the L_{eq} is mostly determined by loud sounds if there are fluctuating sound levels.

Sound Pressure Level, dBA

COMMON INDOOR SOUNDS **COMMON OUTDOOR SOUNDS**



References:

- Harris, Cyril, "Handbook of Noise Acoustical Measurements and Noise Control", p 1-10., 1998
- "Controlling Noise", USAF, AFMC, AFDTIC, Elgin AFB, Fact Sheet, August 1996
- California Dept. of Trans., "Technical Noise Supplement", Oct, 1998

4.0 NOISE REGULATIONS

4.1 Federal Regulations

There are no federal community noise regulations applicable to this Project.

4.2 North Dakota State Regulations

The Project, located in North Dakota, is required to comply with the following sound requirement:

Section 69-06-08-01 Energy Conversion Facility Siting Criteria

4. Additional avoidance areas for wind energy conversion facilities. A wind energy conversion facility site must not include a geographic area where, due to operation of the facility, the sound levels within one hundred feet of an inhabited residence or a community building will exceed forty-five dBA. The sound level avoidance area criteria may be waived in writing by the owner of the occupied residence or the community building.

4.3 Local Regulations

There are no local community noise regulations applicable to this Project.

Therefore, modeling receptors were evaluated in this analysis against the 45 dBA limit.

5.0 MODELED SOUND LEVELS

5.1 Sound Sources

5.1.1 *Project Wind Turbines*

The sound level analysis for the Project includes 39 wind turbines. These 39 wind turbines are depicted in Figure 5-1. The array consists of one (1) wind turbine model: the GE 1.6-91 at a hub height of 80-meters. Wind turbines 245, 248, 258, and 272 will have Low Noise Trailing Edge (LNTE) blades. Wind turbine 246 will be in Noise Reduced Operations (NRO) 104 mode. Wind turbines 247 and 273 will be in NRO 103 mode. Wind turbine 259 will be in NRO 101 mode. The GE 1.6-91 wind turbines have a rotor diameter of 91 meters. Technical reports from GE^{4,5} were provided to Epsilon which documented the expected sound power levels associated with the GE 1.6-91.

5.2 Modeling Methodology

The sound impacts associated with the proposed wind turbines were predicted using the CadnaA sound level calculation software developed by DataKustik GmbH. This software uses the ISO 9613-2 international standard for sound propagation.⁶ The benefits of this software are a more refined set of computations due to the inclusion of topography, ground attenuation, multiple building reflections (if applicable), drop-off with distance, and atmospheric absorption. The CadnaA software allows for octave band calculation of sound from multiple sources as well as computation of diffraction.

Inputs and significant parameters employed in the model are described below and summarized in Table 5-1 below.

- ◆ *Project Array:* This analysis is for the wind turbine array provided to Epsilon on January 26, 2023. The Project array is identified in Figure 5-1. The wind turbine coordinates are provided in Appendix A.
- ◆ *Modeling Receptor Locations:* A modeling receptor dataset dated January 26, 2023 was provided to Epsilon. The dataset included 316 receptors. This dataset was clipped such that only receptors within 1.5 miles of an Otter Tail Ashtabula III wind turbine were included in the analysis. Atwell provided additional information indicating if each receptor was inhabited or uninhabited, the resulting 141 inhabited receptors were input to the CadnaA model. All modeling receptors were input as discrete points at a height of 1.5 meters above ground level to mimic the ears of a typical standing person. In order to provide robust modeling coverage of each inhabited location, additional modeling locations were included offset by 100 feet away (or 200 feet for receptors with

⁴ General Electric Company, Technical Documentation Wind Turbine Generator Systems 1.6-91 – 60 Hz Product Acoustic Specifications, Rev. 03, 2021.

⁵ General Electric Company, Technical Documentation Wind Turbine Generator Systems 1.6-91 RePower with LNTE – 60 Hz Product Acoustic Specifications, Rev. 03, 2021.

⁶ *Acoustics – Attenuation of sound during propagation outdoors – Part 2: General method of calculation*, International Standard ISO 9613-2:1996 (International Organization for Standardization, Geneva, Switzerland, 1996).

signed waivers) from the center point of the receptor in each of the four cardinal directions (north, south, east and west). Therefore, each inhabited location was evaluated at a total of five locations; the center point of the receptor itself, and at the four offset locations on land 100 feet (or 200 feet for receptors with signed waivers) from the receptor. This resulted in a total of 705 receptors. The center points of the modeled locations (receptors) are shown in Figure 5-1. Details of each modeling location are presented in Appendix B.

- ◆ *Modeling Grid:* A modeling grid with 20-meter spacing was calculated for the entire Project Area and the surrounding region. The grid was modeled at a height of 1.5 meters above ground level for consistency with the discrete modeling points. This modeling grid allowed for the creation of sound level isolines.
- ◆ *Terrain Elevation:* Elevation contours for the modeling domain were directly imported into CadnaA which allowed for consideration of terrain shielding where appropriate. The terrain height contour elevations for the modeling domain were generated from elevation information derived from the National Elevation Dataset (NED) developed by the U.S. Geological Survey.
- ◆ *Source Sound Levels:* Sound power levels used in the modeling were described in Section 5.1. Documentation from GE provided levels that represent “worst-case” operational sound level emissions for the Project’s proposed wind turbines were input into the model.
- ◆ *Meteorological Conditions:* A temperature of 10°C (50°F) and a relative humidity of 70% was assumed in the model.
- ◆ *Ground Attenuation:* Spectral ground absorption was calculated using a G-factor of 0 which corresponds to “hard ground” consisting of a hard ground surface. The model, consistent with the standard, allows inputs between 0 (hard ground) and 1 (porous ground). This is a conservative approach as the vast majority of the area is actually agricultural.

Octave band sound power levels corresponding to the highest available wind turbine broadband sound power level for each wind turbine type were input into CadnaA to model wind turbine generated L_{eq} sound pressure levels during conditions when worst-case sound power levels are expected. Sound pressure levels were modeled at 705 receptors representing 141 inhabited locations within the vicinity of the Project. In addition to modeling at discrete points, sound levels were also modeled throughout a large grid of points, each spaced 20 meters apart to allow for the generation of sound level isolines.

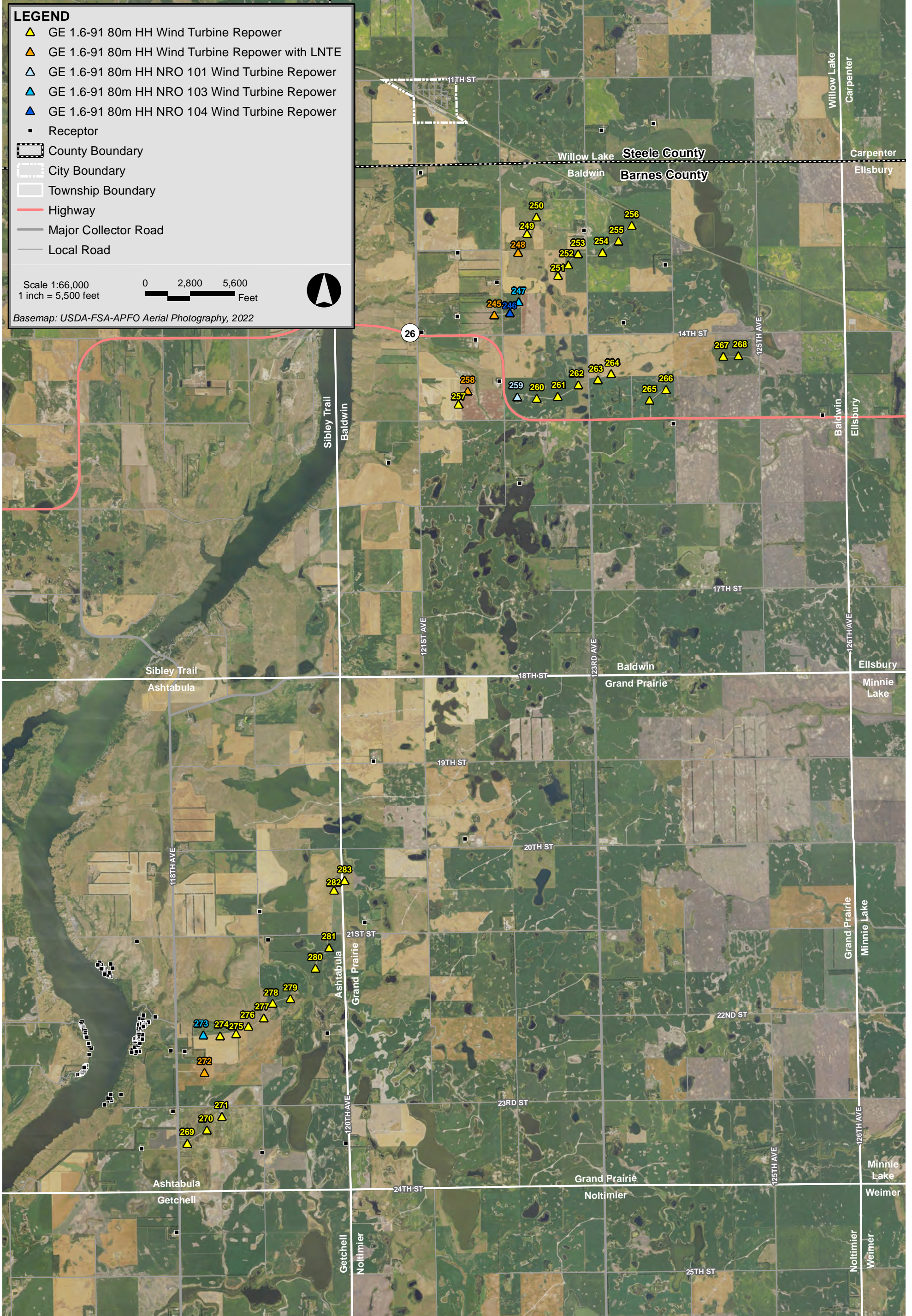
Several modeling assumptions inherent in the ISO 9613-2 calculation methodology, or selected as conditional inputs by Epsilon, were implemented in the CadnaA model to ensure conservative results (i.e., higher sound levels), and are described below:

- ◆ All modeled sources were assumed to be operating simultaneously and at the design wind speed corresponding to the greatest sound level impacts.
- ◆ As per ISO 9613-2, the model assumed favorable conditions for sound propagation, corresponding to a moderate, well-developed ground-based temperature inversion, as might occur on a calm, clear night or equivalently downwind propagation.
- ◆ Meteorological conditions assumed in the model (T=10°C/RH=70%) were selected to minimize atmospheric attenuation in the 500 Hz and 1 kHz octave bands where the human ear is most sensitive.

- ◆ No additional attenuation due to tree shielding, air turbulence, or wind shadow effects was considered in the model.

Table 5-1 Summary of Key Sound Level Modeling Inputs

Modeling Parameter	Description / Value
Wind Turbine Array	Provided by Atwell
Terrain	U.S.G.S. Data
Wind Turbine Sound Power Levels	GE Specifications Documentation
Meteorological Conditions	T=10°C / RH=70%
Ground Absorption Factor	0

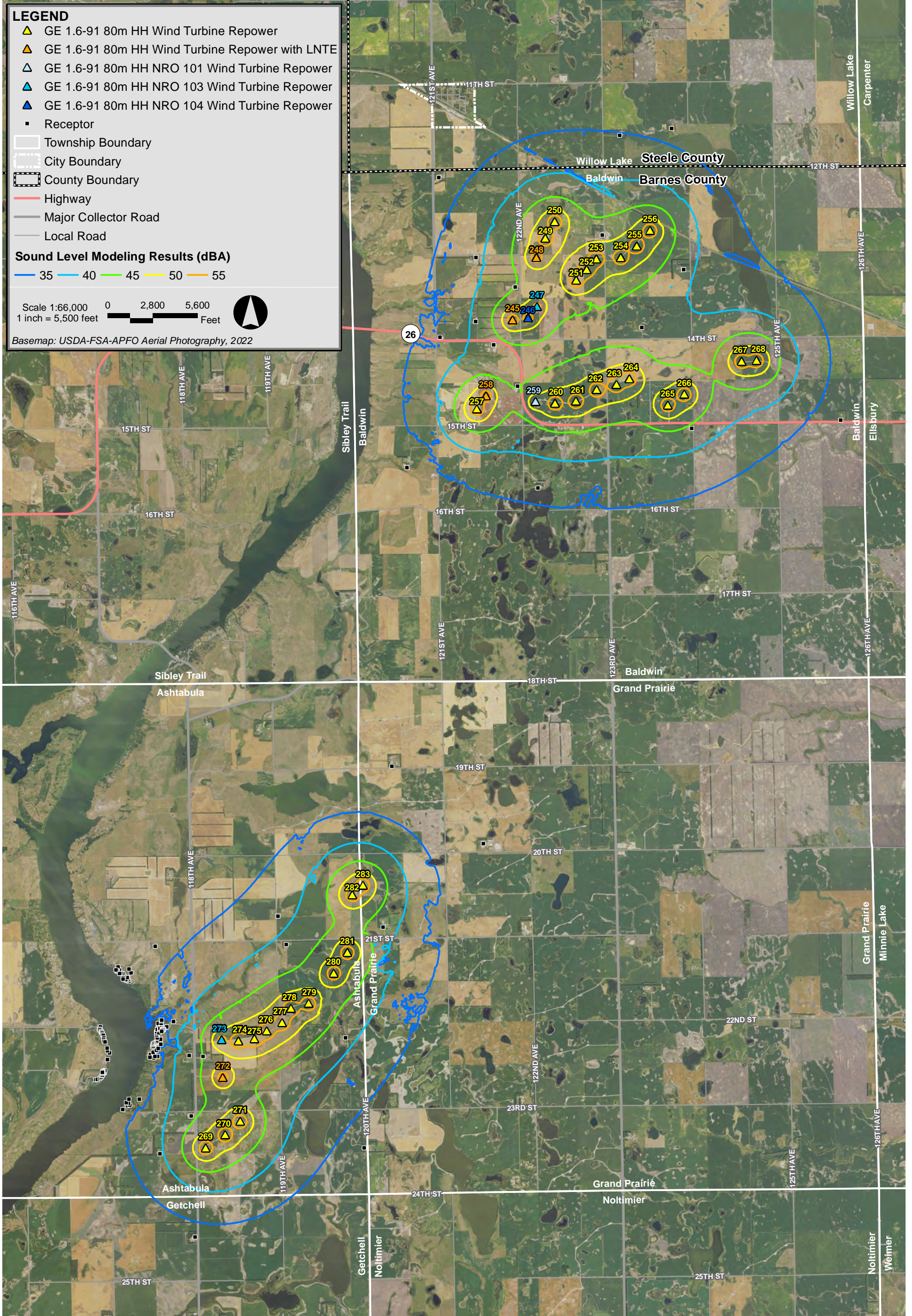


Ashtabula III Repower Barnes County, North Dakota

5.3 Sound Level Modeling Results

All modeled sound levels, as output from CadnaA are A-weighted equivalent sound levels (L_{eq} , dBA). Table B-1.1 in Appendix B shows the predicted broadband (dBA) sound levels at the 141 receptors and their additional offset locations modeled for the Project. The broadband L_{eq} sound levels range from 25 to 49 dBA. These sound levels represent the worst-case future L_{eq} sound levels produced by the Project wind turbines. The maximum modeled sound level of 49 dBA occurs at receptor A265, which has signed a waiver with Otter Tail Power. The highest modeled sound level at a receptor which has not signed a waiver with Otter Tail Power is 45 dBA. This occurs at receptors A268, A269, and A273. Table B-1.2 in Appendix B shows the predicted sound levels sorted from high to low.

In addition to the discrete modeling points, L_{eq} sound level isolines generated from the modeling grid are presented in Figure 5-2.



Ashtabula III Repower Barnes County, North Dakota

6.0 EVALUATION OF SOUND LEVELS

The Project is subject to the requirements contained in the North Dakota Energy Conversion Facility Siting Criteria. Sound levels from operation of the Project are limited by these regulations to 45 dBA within 100 feet of an inhabited residence or community building. Additionally, sound levels from the operation of the Project are limited to 50 dBA within 200 feet of an inhabited residence for any location with a signed Noise Waiver with Otter Tail Power. All modeled sound levels, as output from CadnaA and presented in Appendix B, are A-weighted equivalent sound levels (L_{eq} , dBA). These levels may be used in evaluating measured sound pressure levels over typical averaging durations, (i.e., ten (10) minutes or one (1) hour).

A review of Table B-1.2 in Appendix B shows the highest sound level within 100 feet of an inhabited residence that has not signed a waiver with Otter Tail Power in this analysis to be 45 dBA. This occurs at receptors A268, A 269, and A273. The results also show that the highest sound level within 200 feet of an inhabited residence that has signed a waiver with Otter Tail Power in this analysis to be 49 dBA. This occurs at receptor A265. Therefore, the Project is in compliance with the North Dakota Administrative Code Energy Conversion Facility Siting Criteria with respect to sound.

7.0 CONCLUSIONS

A comprehensive sound level modeling assessment was conducted for the Otter Tail Ashtabula III Wind Repower Project within Barnes County, North Dakota. Sound levels resulting from the operation of all 39 Project wind turbines were calculated at 705 modeling receptors, and isolines were generated from a grid encompassing the area surrounding the wind turbines. The predicted L_{eq} sound levels at all receptors in the study area ranged from 25 to 49 dBA. Predicted sound levels at all receptor locations that have not signed a waiver with Otter Tail Power are all at or below the state limit of 45 dBA within 100 feet of an inhabited residence. Predicted sound levels at all receptor locations that have signed waivers with Otter Tail Power are below the waiver limit of 50 dBA within 200 feet of an inhabited residence. Thus, the Project meets the requirements with respect to sound in the regulations.

Appendix A

Sound Source Coordinates

Table A-1: Wind Turbine Coordinates

Wind Turbine ID	Wind Turbine Type	Hub Height (m)	Coordinates NAD83 UTM Zone 14N (meters)	
			X (Easting)	Y (Northing)
245	GE 1.6-91	80	581717.66	5229598.24
246	GE 1.6-91	80	582012.42	5229635.89
247	GE 1.6-91	80	582183.94	5229849.35
248	GE 1.6-91	80	582170.96	5230782.84
249	GE 1.6-91	80	582339.90	5231140.98
250	GE 1.6-91	80	582517.46	5231454.68
251	GE 1.6-91	80	582926.29	5230349.12
252	GE 1.6-91	80	583120.48	5230551.47
253	GE 1.6-91	80	583307.08	5230754.28
254	GE 1.6-91	80	583768.25	5230783.26
255	GE 1.6-91	80	584068.52	5230998.71
256	GE 1.6-91	80	584321.41	5231291.09
257	GE 1.6-91	80	581043.96	5227910.83
258	GE 1.6-91	80	581215.11	5228157.82
259	GE 1.6-91	80	582155.80	5228048.21
260	GE 1.6-91	80	582519.74	5228020.27
261	GE 1.6-91	80	582920.85	5228058.89
262	GE 1.6-91	80	583311.41	5228275.57
263	GE 1.6-91	80	583681.72	5228369.83
264	GE 1.6-91	80	583929.76	5228484.49
265	GE 1.6-91	80	584656.40	5227983.44
266	GE 1.6-91	80	584971.94	5228188.15
267	GE 1.6-91	80	586053.44	5228815.13
268	GE 1.6-91	80	586340.98	5228830.44
269	GE 1.6-91	80	575905.22	5213915.82
270	GE 1.6-91	80	576273.93	5214165.17
271	GE 1.6-91	80	576559.11	5214424.59
272	GE 1.6-91	80	576229.88	5215253.83
273	GE 1.6-91	80	576205.65	5215965.07
274	GE 1.6-91	80	576524.39	5215946.61
275	GE 1.6-91	80	576827.37	5215984.09
276	GE 1.6-91	80	577061.14	5216131.72
277	GE 1.6-91	80	577355.02	5216291.03
278	GE 1.6-91	80	577518.26	5216559.91
279	GE 1.6-91	80	577857.50	5216654.27
280	GE 1.6-91	80	578329.40	5217226.44
281	GE 1.6-91	80	578589.97	5217618.67
282	GE 1.6-91	80	578681.52	5218709.13
283	GE 1.6-91	80	578883.97	5218889.87

Appendix B

Sound Level Modeling Results - Tabular

Table B-1.1: Sound Level Modeling Results Sorted by Receptor ID

Receptor ID	Signed Waiver	Coordinates		Source Only L _{eq} Sound Level (dBA)
		UTM NAD83 Zone 14N		
		X (m)	Y (m)	
A3	No	575704	5212232	33
A3-E	No	575735	5212232	33
A3-S	No	575704	5212201	33
A3-W	No	575674	5212231	33
A3-N	No	575704	5212262	33
A8	No	575041	5213810	39
A8-E	No	575071	5213811	40
A8-S	No	575041	5213780	39
A8-W	No	575010	5213810	39
A8-N	No	575040	5213841	39
A9	No	578905	5213921	33
A9-E	No	578936	5213922	33
A9-S	No	578906	5213891	33
A9-W	No	578875	5213921	33
A9-N	No	578905	5213952	33
A13	No	575632	5214523	44
A13-E	No	575662	5214523	44
A13-S	No	575632	5214492	44
A13-W	No	575601	5214522	44
A13-N	No	575631	5214553	44
A33	No	573827	5215213	32
A33-E	No	573858	5215214	32
A33-S	No	573828	5215183	32
A33-W	No	573797	5215213	32
A33-N	No	573827	5215244	32
A34	No	573856	5215220	32
A34-E	No	573886	5215220	33
A34-S	No	573856	5215190	32
A34-W	No	573825	5215220	32
A34-N	No	573855	5215251	32
A35	No	573902	5215240	33
A35-E	No	573933	5215241	33
A35-S	No	573903	5215210	33
A35-W	No	573872	5215240	32
A35-N	No	573902	5215271	32
A36	No	573919	5215256	33
A36-E	No	573950	5215256	33
A36-S	No	573920	5215225	33
A36-W	No	573889	5215255	33
A36-N	No	573919	5215286	33
A37	No	573935	5215282	33

Table B-1.1: Sound Level Modeling Results Sorted by Receptor ID

Receptor ID	Signed Waiver	Coordinates		Source Only L _{eq} Sound Level (dBA)
		UTM NAD83 Zone 14N		
		X (m)	Y (m)	
A37-E	No	573965	5215283	33
A37-S	No	573935	5215252	33
A37-W	No	573904	5215282	33
A37-N	No	573934	5215313	33
A38	No	573949	5215296	33
A38-E	No	573979	5215296	33
A38-S	No	573949	5215265	33
A38-W	No	573918	5215295	33
A38-N	No	573948	5215326	33
A39	No	573962	5215322	33
A39-E	No	573993	5215323	33
A39-S	No	573963	5215292	33
A39-W	No	573932	5215322	33
A39-N	No	573962	5215353	33
A40	No	573975	5215339	33
A40-E	No	574006	5215339	33
A40-S	No	573976	5215309	33
A40-W	No	573945	5215339	33
A40-N	No	573975	5215370	33
A41	No	573986	5215353	33
A41-E	No	574017	5215354	33
A41-S	No	573987	5215323	33
A41-W	No	573956	5215353	33
A41-N	No	573986	5215384	33
A42	No	573989	5215363	33
A42-E	No	574020	5215364	33
A42-S	No	573989	5215333	33
A42-W	No	573959	5215363	33
A42-N	No	573989	5215394	33
A43	No	573993	5215386	33
A43-E	No	574024	5215387	33
A43-S	No	573993	5215356	33
A43-W	No	573963	5215386	33
A43-N	No	573993	5215417	33
A44	No	573965	5215371	33
A44-E	No	573995	5215372	33
A44-S	No	573965	5215341	33
A44-W	No	573934	5215371	33
A44-N	No	573964	5215402	33
A45	No	573956	5215363	33
A45-E	No	573987	5215363	33

Table B-1.1: Sound Level Modeling Results Sorted by Receptor ID

Receptor ID	Signed Waiver	Coordinates		Source Only L _{eq} Sound Level (dBA)
		UTM NAD83 Zone 14N		
		X (m)	Y (m)	
A45-S	No	573957	5215332	33
A45-W	No	573926	5215362	33
A45-N	No	573956	5215393	33
A46	No	573952	5215351	33
A46-E	No	573983	5215352	33
A46-S	No	573952	5215321	33
A46-W	No	573922	5215351	33
A46-N	No	573952	5215382	33
A47	No	574044	5215594	33
A47-E	No	574074	5215595	33
A47-S	No	574044	5215564	33
A47-W	No	574013	5215594	33
A47-N	No	574043	5215625	33
A55	No	573911	5216214	32
A55-E	No	573941	5216214	32
A55-S	No	573911	5216183	32
A55-W	No	573880	5216213	32
A55-N	No	573910	5216244	32
A56	No	573890	5216176	32
A56-E	No	573921	5216176	32
A56-S	No	573890	5216145	32
A56-W	No	573860	5216175	32
A56-N	No	573890	5216206	32
A57	No	573900	5216155	32
A57-E	No	573931	5216156	32
A57-S	No	573901	5216125	32
A57-W	No	573870	5216155	32
A57-N	No	573900	5216186	32
A58	No	573921	5216126	32
A58-E	No	573951	5216126	32
A58-S	No	573921	5216096	32
A58-W	No	573890	5216126	32
A58-N	No	573920	5216157	32
A59	No	573934	5216111	32
A59-E	No	573964	5216111	33
A59-S	No	573934	5216081	32
A59-W	No	573903	5216111	32
A59-N	No	573933	5216142	32
A60	No	573946	5216093	32
A60-E	No	573976	5216093	33
A60-S	No	573946	5216062	32

Table B-1.1: Sound Level Modeling Results Sorted by Receptor ID

Receptor ID	Signed Waiver	Coordinates		Source Only L _{eq} Sound Level (dBA)
		UTM NAD83 Zone 14N		
		X (m)	Y (m)	
A60-W	No	573915	5216092	32
A60-N	No	573945	5216123	32
A61	No	573947	5216066	32
A61-E	No	573978	5216066	33
A61-S	No	573948	5216035	33
A61-W	No	573917	5216065	32
A61-N	No	573947	5216096	32
A62	No	573965	5216048	33
A62-E	No	573996	5216048	33
A62-S	No	573965	5216017	33
A62-W	No	573935	5216047	32
A62-N	No	573965	5216078	33
A63	No	573979	5216007	33
A63-E	No	574009	5216007	33
A63-S	No	573979	5215976	33
A63-W	No	573948	5216006	33
A63-N	No	573979	5216037	33
A64	No	573974	5215980	33
A64-E	No	574005	5215981	33
A64-S	No	573975	5215950	33
A64-W	No	573944	5215980	33
A64-N	No	573974	5216011	33
A65	No	573977	5215943	33
A65-E	No	574007	5215943	33
A65-S	No	573977	5215912	33
A65-W	No	573946	5215942	33
A65-N	No	573976	5215973	33
A66	No	574002	5215927	33
A66-E	No	574033	5215927	33
A66-S	No	574003	5215897	33
A66-W	No	573972	5215927	33
A66-N	No	574002	5215958	33
A68	No	574084	5215721	33
A68-E	No	574114	5215721	33
A68-S	No	574084	5215691	33
A68-W	No	574053	5215721	33
A68-N	No	574084	5215752	33
A69	No	574044	5215761	33
A69-E	No	574074	5215761	33
A69-S	No	574044	5215730	33
A69-W	No	574013	5215760	33

Table B-1.1: Sound Level Modeling Results Sorted by Receptor ID

Receptor ID	Signed Waiver	Coordinates		Source Only L _{eq} Sound Level (dBA)
		UTM NAD83 Zone 14N		
		X (m)	Y (m)	
A69-N	No	574043	5215791	33
A70	No	574037	5215810	33
A70-E	No	574067	5215811	33
A70-S	No	574037	5215780	33
A70-W	No	574006	5215810	33
A70-N	No	574036	5215841	33
A71	No	574336	5214645	26
A71-E	No	574367	5214646	25
A71-S	No	574337	5214615	26
A71-W	No	574306	5214645	26
A71-N	No	574336	5214676	26
A72	No	574424	5214718	27
A72-E	No	574454	5214719	27
A72-S	No	574424	5214688	27
A72-W	No	574394	5214718	27
A72-N	No	574424	5214749	27
A73	No	574471	5214730	26
A73-E	No	574501	5214730	26
A73-S	No	574471	5214699	27
A73-W	No	574440	5214729	27
A73-N	No	574471	5214760	27
A74	No	574442	5214766	27
A74-E	No	574472	5214766	27
A74-S	No	574442	5214735	27
A74-W	No	574411	5214765	27
A74-N	No	574441	5214796	26
A75	No	574403	5214774	27
A75-E	No	574434	5214774	26
A75-S	No	574404	5214744	27
A75-W	No	574373	5214774	28
A75-N	No	574403	5214805	26
A76	No	574452	5214843	27
A76-E	No	574482	5214844	27
A76-S	No	574452	5214813	28
A76-W	No	574422	5214843	27
A76-N	No	574452	5214874	27
A77	No	574649	5214843	29
A77-E	No	574680	5214843	30
A77-S	No	574650	5214812	31
A77-W	No	574619	5214842	31
A77-N	No	574649	5214873	29

Table B-1.1: Sound Level Modeling Results Sorted by Receptor ID

Receptor ID	Signed Waiver	Coordinates		Source Only L _{eq} Sound Level (dBA)
		UTM NAD83 Zone 14N		
		X (m)	Y (m)	
A78	No	574860	5215687	29
A78-E	No	574891	5215687	29
A78-S	No	574861	5215656	29
A78-W	No	574830	5215686	29
A78-N	No	574860	5215717	31
A79	No	574922	5215678	33
A79-E	No	574953	5215679	32
A79-S	No	574923	5215648	31
A79-W	No	574892	5215678	29
A79-N	No	574922	5215709	33
A80	No	574994	5215654	30
A80-E	No	575025	5215655	30
A80-S	No	574995	5215624	30
A80-W	No	574964	5215654	32
A80-N	No	574994	5215685	30
A81	No	574924	5215716	31
A81-E	No	574955	5215716	32
A81-S	No	574924	5215686	33
A81-W	No	574894	5215716	29
A81-N	No	574924	5215746	31
A82	No	574921	5215624	30
A82-E	No	574952	5215624	30
A82-S	No	574922	5215593	30
A82-W	No	574891	5215623	29
A82-N	No	574921	5215654	31
A83	No	574848	5215638	29
A83-E	No	574879	5215638	29
A83-S	No	574849	5215608	29
A83-W	No	574818	5215638	29
A83-N	No	574848	5215668	29
A84	No	574942	5215651	31
A84-E	No	574972	5215651	32
A84-S	No	574942	5215620	30
A84-W	No	574911	5215651	31
A84-N	No	574941	5215681	31
A85	No	574913	5215734	31
A85-E	No	574943	5215734	32
A85-S	No	574913	5215703	33
A85-W	No	574882	5215733	31
A85-N	No	574913	5215764	31
A86	No	574974	5215770	35

Table B-1.1: Sound Level Modeling Results Sorted by Receptor ID

Receptor ID	Signed Waiver	Coordinates		Source Only L _{eq} Sound Level (dBA)
		UTM NAD83 Zone 14N		
		X (m)	Y (m)	
A86-E	No	575005	5215771	35
A86-S	No	574975	5215740	32
A86-W	No	574944	5215770	33
A86-N	No	574974	5215801	35
A87	No	574900	5215834	34
A87-E	No	574931	5215834	34
A87-S	No	574901	5215803	34
A87-W	No	574870	5215834	34
A87-N	No	574900	5215864	33
A88	No	575007	5215806	35
A88-E	No	575038	5215807	35
A88-S	No	575008	5215776	36
A88-W	No	574977	5215806	35
A88-N	No	575007	5215837	35
A89	No	574915	5215850	33
A89-E	No	574945	5215851	33
A89-S	No	574915	5215820	34
A89-W	No	574885	5215850	34
A89-N	No	574915	5215881	33
A90	No	574904	5215878	33
A90-E	No	574935	5215878	33
A90-S	No	574905	5215847	34
A90-W	No	574874	5215878	33
A90-N	No	574904	5215908	33
A91	No	574918	5215895	33
A91-E	No	574949	5215895	33
A91-S	No	574918	5215864	33
A91-W	No	574888	5215894	33
A91-N	No	574918	5215925	33
A92	No	574933	5215904	33
A92-E	No	574963	5215904	34
A92-S	No	574933	5215873	33
A92-W	No	574902	5215903	33
A92-N	No	574932	5215934	33
A93	No	574955	5215912	33
A93-E	No	574986	5215913	34
A93-S	No	574956	5215882	33
A93-W	No	574925	5215912	33
A93-N	No	574955	5215943	33
A94	No	574970	5215923	34
A94-E	No	575001	5215923	32

Table B-1.1: Sound Level Modeling Results Sorted by Receptor ID

Receptor ID	Signed Waiver	Coordinates		Source Only L _{eq} Sound Level (dBA)
		UTM NAD83 Zone 14N		
		X (m)	Y (m)	
A94-S	No	574971	5215892	34
A94-W	No	574940	5215923	33
A94-N	No	574970	5215953	32
A95	No	574981	5215931	34
A95-E	No	575012	5215931	32
A95-S	No	574982	5215900	34
A95-W	No	574951	5215931	33
A95-N	No	574981	5215961	32
A96	No	575003	5215950	32
A96-E	No	575034	5215950	32
A96-S	No	575004	5215919	32
A96-W	No	574973	5215949	32
A96-N	No	575003	5215980	30
A97	No	575054	5215884	34
A97-E	No	575085	5215884	33
A97-S	No	575054	5215853	34
A97-W	No	575024	5215883	34
A97-N	No	575054	5215914	32
A98	No	574996	5215987	30
A98-E	No	575026	5215988	33
A98-S	No	574996	5215957	32
A98-W	No	574965	5215987	32
A98-N	No	574995	5216018	29
A99	No	575053	5215978	34
A99-E	No	575084	5215979	34
A99-S	No	575054	5215948	34
A99-W	No	575023	5215978	30
A99-N	No	575053	5216009	34
A100	No	574987	5216008	29
A100-E	No	575017	5216009	29
A100-S	No	574987	5215978	32
A100-W	No	574956	5216008	31
A100-N	No	574987	5216039	29
A101	No	574980	5216052	29
A101-E	No	575010	5216052	32
A101-S	No	574980	5216021	29
A101-W	No	574949	5216051	29
A101-N	No	574979	5216082	29
A102	No	574976	5216077	29
A102-E	No	575007	5216077	32
A102-S	No	574977	5216046	29

Table B-1.1: Sound Level Modeling Results Sorted by Receptor ID

Receptor ID	Signed Waiver	Coordinates		Source Only L _{eq} Sound Level (dBA)
		UTM NAD83 Zone 14N		
		X (m)	Y (m)	
A102-W	No	574946	5216076	29
A102-N	No	574976	5216107	29
A103	No	574975	5216101	29
A103-E	No	575006	5216101	29
A103-S	No	574976	5216070	29
A103-W	No	574945	5216101	29
A103-N	No	574975	5216131	29
A104	No	574981	5216122	29
A104-E	No	575011	5216122	30
A104-S	No	574981	5216091	29
A104-W	No	574950	5216122	29
A104-N	No	574980	5216152	29
A105	No	575017	5216102	30
A105-E	No	575047	5216103	30
A105-S	No	575017	5216072	32
A105-W	No	574986	5216102	29
A105-N	No	575016	5216133	30
A106	No	575010	5216202	29
A106-E	No	575040	5216202	30
A106-S	No	575010	5216171	29
A106-W	No	574979	5216201	29
A106-N	No	575009	5216232	32
A107	No	575000	5216178	29
A107-E	No	575031	5216179	30
A107-S	No	575001	5216148	29
A107-W	No	574970	5216178	29
A107-N	No	575000	5216209	29
A108	No	574987	5216162	29
A108-E	No	575017	5216162	29
A108-S	No	574987	5216132	29
A108-W	No	574956	5216162	29
A108-N	No	574986	5216193	29
A109	No	575028	5216158	30
A109-E	No	575058	5216159	30
A109-S	No	575028	5216128	30
A109-W	No	574997	5216158	29
A109-N	No	575028	5216189	29
A110	No	575036	5216171	30
A110-E	No	575066	5216171	30
A110-S	No	575036	5216140	30
A110-W	No	575005	5216170	29

Table B-1.1: Sound Level Modeling Results Sorted by Receptor ID

Receptor ID	Signed Waiver	Coordinates		Source Only L _{eq} Sound Level (dBA)
		UTM NAD83 Zone 14N		
		X (m)	Y (m)	
A110-N	No	575035	5216201	30
A111	No	575055	5216208	30
A111-E	No	575085	5216208	32
A111-S	No	575055	5216177	30
A111-W	No	575024	5216207	29
A111-N	No	575054	5216238	32
A112	No	575051	5216198	30
A112-E	No	575082	5216198	30
A112-S	No	575052	5216167	30
A112-W	No	575021	5216197	29
A112-N	No	575051	5216228	30
A113	No	575046	5216190	30
A113-E	No	575076	5216190	30
A113-S	No	575046	5216159	30
A113-W	No	575015	5216189	29
A113-N	No	575045	5216220	30
A114	No	575039	5216182	30
A114-E	No	575069	5216182	30
A114-S	No	575039	5216152	30
A114-W	No	575008	5216182	29
A114-N	No	575039	5216212	30
A115	No	575077	5216208	30
A115-E	No	575108	5216208	32
A115-S	No	575078	5216178	30
A115-W	No	575047	5216208	30
A115-N	No	575077	5216238	30
A116	No	575080	5216195	30
A116-E	No	575110	5216195	32
A116-S	No	575080	5216165	30
A116-W	No	575049	5216195	30
A116-N	No	575079	5216225	30
A117	No	575113	5216196	32
A117-E	No	575143	5216197	33
A117-S	No	575113	5216166	31
A117-W	No	575083	5216196	30
A117-N	No	575113	5216227	34
A118	No	575125	5216204	33
A118-E	No	575155	5216205	35
A118-S	No	575125	5216174	31
A118-W	No	575094	5216204	32
A118-N	No	575124	5216235	35

Table B-1.1: Sound Level Modeling Results Sorted by Receptor ID

Receptor ID	Signed Waiver	Coordinates		Source Only L _{eq} Sound Level (dBA)
		UTM NAD83 Zone 14N		
		X (m)	Y (m)	
A119	No	575138	5216208	33
A119-E	No	575168	5216209	35
A119-S	No	575138	5216178	31
A119-W	No	575108	5216208	32
A119-N	No	575138	5216239	37
A120	No	575149	5216209	35
A120-E	No	575180	5216210	35
A120-S	No	575150	5216179	31
A120-W	No	575119	5216209	32
A120-N	No	575149	5216240	37
A121	No	575169	5216210	36
A121-E	No	575200	5216210	37
A121-S	No	575170	5216179	31
A121-W	No	575139	5216210	35
A121-N	No	575169	5216240	37
A122	No	575088	5216166	30
A122-E	No	575118	5216166	31
A122-S	No	575088	5216136	30
A122-W	No	575057	5216166	30
A122-N	No	575087	5216196	30
A123	No	575113	5216170	30
A123-E	No	575144	5216170	31
A123-S	No	575114	5216140	30
A123-W	No	575083	5216170	30
A123-N	No	575113	5216200	32
A124	No	575103	5216160	30
A124-E	No	575133	5216161	31
A124-S	No	575103	5216130	30
A124-W	No	575072	5216160	30
A124-N	No	575103	5216191	30
A125	No	575086	5216145	30
A125-E	No	575117	5216145	30
A125-S	No	575087	5216114	30
A125-W	No	575056	5216144	30
A125-N	No	575086	5216175	30
A126	No	575075	5216127	30
A126-E	No	575105	5216128	30
A126-S	No	575075	5216097	32
A126-W	No	575044	5216127	30
A126-N	No	575074	5216158	30
A127	No	575006	5216281	33

Table B-1.1: Sound Level Modeling Results Sorted by Receptor ID

Receptor ID	Signed Waiver	Coordinates		Source Only L _{eq} Sound Level (dBA)
		UTM NAD83 Zone 14N		
		X (m)	Y (m)	
A127-E	No	575037	5216281	32
A127-S	No	575006	5216250	34
A127-W	No	574976	5216281	33
A127-N	No	575006	5216311	29
A128	No	575060	5216281	32
A128-E	No	575090	5216282	36
A128-S	No	575060	5216251	34
A128-W	No	575029	5216281	32
A128-N	No	575059	5216312	32
A129	No	575070	5216325	32
A129-E	No	575101	5216325	36
A129-S	No	575071	5216294	34
A129-W	No	575040	5216324	32
A129-N	No	575070	5216355	36
A130	No	575071	5216343	36
A130-E	No	575101	5216343	36
A130-S	No	575071	5216313	34
A130-W	No	575040	5216343	32
A130-N	No	575070	5216373	35
A131	No	575299	5216311	38
A131-E	No	575329	5216312	38
A131-S	No	575299	5216281	38
A131-W	No	575268	5216311	38
A131-N	No	575299	5216342	38
A132	No	574451	5217076	33
A132-E	No	574481	5217076	33
A132-S	No	574451	5217045	33
A132-W	No	574420	5217075	32
A132-N	No	574451	5217106	33
A133	No	574438	5217132	32
A133-E	No	574468	5217133	33
A133-S	No	574438	5217102	32
A133-W	No	574407	5217132	32
A133-N	No	574437	5217163	32
A134	No	574434	5217105	32
A134-E	No	574465	5217106	33
A134-S	No	574435	5217075	33
A134-W	No	574404	5217105	32
A134-N	No	574434	5217136	32
A135	No	574409	5217093	32
A135-E	No	574440	5217094	33

Table B-1.1: Sound Level Modeling Results Sorted by Receptor ID

Receptor ID	Signed Waiver	Coordinates		Source Only L _{eq} Sound Level (dBA)
		UTM NAD83 Zone 14N		
		X (m)	Y (m)	
A135-S	No	574410	5217063	32
A135-W	No	574379	5217093	32
A135-N	No	574409	5217124	32
A136	No	574390	5217105	32
A136-E	No	574420	5217106	32
A136-S	No	574390	5217075	32
A136-W	No	574359	5217105	32
A136-N	No	574389	5217136	32
A137	No	574418	5217144	32
A137-E	No	574449	5217145	32
A137-S	No	574419	5217114	32
A137-W	No	574388	5217144	32
A137-N	No	574418	5217175	32
A138	No	574357	5217173	32
A138-E	No	574387	5217174	32
A138-S	No	574357	5217143	32
A138-W	No	574326	5217173	32
A138-N	No	574356	5217204	32
A139	No	574344	5217146	32
A139-E	No	574374	5217147	32
A139-S	No	574344	5217116	32
A139-W	No	574313	5217146	32
A139-N	No	574343	5217177	32
A140	No	574340	5217120	32
A140-E	No	574370	5217120	32
A140-S	No	574340	5217090	32
A140-W	No	574309	5217120	32
A140-N	No	574339	5217150	32
A141	No	574493	5217232	32
A141-E	No	574524	5217233	33
A141-S	No	574494	5217202	32
A141-W	No	574463	5217232	32
A141-N	No	574493	5217263	32
A142	No	574455	5217310	32
A142-E	No	574486	5217310	32
A142-S	No	574456	5217279	32
A142-W	No	574425	5217309	32
A142-N	No	574455	5217340	32
A143	No	574344	5217222	32
A143-E	No	574374	5217223	31
A143-S	No	574344	5217192	32

Table B-1.1: Sound Level Modeling Results Sorted by Receptor ID

Receptor ID	Signed Waiver	Coordinates		Source Only L _{eq} Sound Level (dBA)
		UTM NAD83 Zone 14N		
		X (m)	Y (m)	
A143-W	No	574313	5217222	32
A143-N	No	574343	5217253	32
A144	No	574275	5217292	32
A144-E	No	574305	5217293	32
A144-S	No	574275	5217262	32
A144-W	No	574245	5217292	32
A144-N	No	574275	5217323	32
A145	No	574248	5217347	31
A145-E	No	574278	5217347	32
A145-S	No	574248	5217317	31
A145-W	No	574217	5217347	31
A145-N	No	574247	5217378	31
A146	No	574236	5217260	32
A146-E	No	574266	5217261	32
A146-S	No	574236	5217230	32
A146-W	No	574205	5217260	31
A146-N	No	574235	5217291	31
A147	No	574223	5217281	31
A147-E	No	574254	5217282	32
A147-S	No	574224	5217251	32
A147-W	No	574193	5217281	31
A147-N	No	574223	5217312	31
A148	No	574320	5217219	32
A148-E	No	574350	5217219	32
A148-S	No	574320	5217188	32
A148-W	No	574290	5217218	32
A148-N	No	574320	5217249	32
A149	No	574294	5217228	32
A149-E	No	574324	5217228	32
A149-S	No	574294	5217197	32
A149-W	No	574264	5217227	32
A149-N	No	574294	5217258	32
A150	No	574273	5217224	32
A150-E	No	574303	5217224	32
A150-S	No	574273	5217193	32
A150-W	No	574242	5217224	32
A150-N	No	574272	5217254	32
A151	No	574208	5217292	31
A151-E	No	574238	5217292	31
A151-S	No	574208	5217261	31
A151-W	No	574177	5217291	31

Table B-1.1: Sound Level Modeling Results Sorted by Receptor ID

Receptor ID	Signed Waiver	Coordinates		Source Only L _{eq} Sound Level (dBA)
		UTM NAD83 Zone 14N		
		X (m)	Y (m)	
A151-N	No	574207	5217322	31
A166	No	574951	5217739	33
A166-E	No	574982	5217739	33
A166-S	No	574952	5217709	33
A166-W	No	574921	5217739	33
A166-N	No	574951	5217770	33
A169	No	577273	5218307	39
A169-E	No	577304	5218308	39
A169-S	No	577274	5218277	39
A169-W	No	577243	5218307	39
A169-N	No	577273	5218338	39
A170	Yes	577431	5217769	41
A170-E	Yes	577461	5217769	42
A170-S	Yes	577431	5217738	42
A170-W	Yes	577400	5217768	41
A170-N	Yes	577430	5217799	41
A171	No	579265	5218098	43
A171-E	No	579296	5218099	42
A171-S	No	579266	5218068	42
A171-W	No	579235	5218098	43
A171-N	No	579265	5218129	43
A177	No	581162	5219681	30
A177-E	No	581192	5219681	30
A177-S	No	581162	5219650	30
A177-W	No	581131	5219680	30
A177-N	No	581161	5219711	30
A212	No	579716	5226801	32
A212-E	No	579746	5226802	32
A212-S	No	579716	5226771	32
A212-W	No	579685	5226801	32
A212-N	No	579715	5226832	32
A262	No	582197	5226417	37
A262-E	No	582228	5226417	37
A262-S	No	582198	5226386	36
A262-W	No	582167	5226416	37
A262-N	No	582197	5226447	37
A264	No	584163	5229456	43
A264-E	No	584193	5229457	42
A264-S	No	584163	5229426	43
A264-W	No	584132	5229456	43
A264-N	No	584162	5229487	42

Table B-1.1: Sound Level Modeling Results Sorted by Receptor ID

Receptor ID	Signed Waiver	Coordinates		Source Only L _{eq} Sound Level (dBA)
		UTM NAD83 Zone 14N		
		X (m)	Y (m)	
A265	Yes	583416	5231205	48
A265-E	Yes	583446	5231205	48
A265-S	Yes	583416	5231174	49
A265-W	Yes	583385	5231204	48
A265-N	Yes	583415	5231235	48
A266	No	580319	5232294	33
A266-E	No	580350	5232294	33
A266-S	No	580320	5232263	33
A266-W	No	580289	5232293	33
A266-N	No	580319	5232324	33
A267	No	581022	5230778	39
A267-E	No	581053	5230778	39
A267-S	No	581023	5230747	39
A267-W	No	580992	5230777	39
A267-N	No	581022	5230808	39
A268	No	581768	5230220	45
A268-E	No	581798	5230220	45
A268-S	No	581768	5230189	45
A268-W	No	581738	5230219	45
A268-N	No	581768	5230250	45
A269	No	581814	5228345	45
A269-E	No	581845	5228345	45
A269-S	No	581815	5228315	45
A269-W	No	581784	5228345	45
A269-N	No	581814	5228376	45
A270	No	585108	5227544	44
A270-E	No	585139	5227545	44
A270-S	No	585109	5227514	44
A270-W	No	585078	5227544	44
A270-N	No	585108	5227575	44
A272	No	578556	5216005	41
A272-E	No	578587	5216005	41
A272-S	No	578557	5215975	41
A272-W	No	578526	5216005	42
A272-N	No	578556	5216035	42
A273	No	575853	5215655	45
A273-E	No	575884	5215655	45
A273-S	No	575854	5215624	45
A273-W	No	575823	5215654	45
A273-N	No	575853	5215685	45
A274	No	575595	5215669	42

Table B-1.1: Sound Level Modeling Results Sorted by Receptor ID

Receptor ID	Signed Waiver	Coordinates		Source Only L _{eq} Sound Level (dBA)
		UTM NAD83 Zone 14N		
		X (m)	Y (m)	
A274-E	No	575625	5215669	43
A274-S	No	575595	5215638	42
A274-W	No	575564	5215669	42
A274-N	No	575594	5215699	42
A275	No	587933	5227704	32
A275-E	No	587963	5227704	32
A275-S	No	587933	5227674	32
A275-W	No	587902	5227704	33
A275-N	No	587933	5227734	32
A277	No	581362	5229127	43
A277-E	No	581392	5229128	43
A277-S	No	581362	5229097	43
A277-W	No	581331	5229127	43
A277-N	No	581362	5229158	43
A278	No	583744	5233095	35
A278-E	No	583775	5233095	35
A278-S	No	583745	5233064	35
A278-W	No	583714	5233094	35
A278-N	No	583744	5233125	35
A279	No	584959	5230551	41
A279-E	No	584989	5230552	41
A279-S	No	584959	5230521	41
A279-W	No	584928	5230551	42
A279-N	No	584958	5230582	41
A280	No	577318	5213741	39
A280-E	No	577348	5213741	39
A280-S	No	577318	5213710	39
A280-W	No	577287	5213741	40
A280-N	No	577317	5213771	40
A284	No	579434	5221149	30
A284-E	No	579464	5221149	30
A284-S	No	579434	5221118	30
A284-W	No	579403	5221148	30
A284-N	No	579433	5221179	30
A287	No	581019	5229570	41
A287-E	No	581049	5229571	41
A287-S	No	581019	5229540	41
A287-W	No	580988	5229570	41
A287-N	No	581019	5229601	41
A288	No	580342	5229273	37
A288-E	No	580373	5229273	37

Table B-1.1: Sound Level Modeling Results Sorted by Receptor ID

Receptor ID	Signed Waiver	Coordinates UTM NAD83 Zone 14N		Source Only L _{eq} Sound Level (dBA)
		X (m)	Y (m)	
A288-S	No	580342	5229242	37
A288-W	No	580312	5229272	37
A288-N	No	580342	5229303	37
A316	No	584729	5233224	34
A316-E	No	584760	5233224	34
A316-S	No	584730	5233193	34
A316-W	No	584699	5233223	34
A316-N	No	584729	5233254	34

Table B-1.2: Sound Level Modeling Results Sorted by Sound Level

Receptor ID	Signed Waiver	Coordinates		Source Only L _{eq} Sound Level (dBA)
		UTM NAD83 Zone 14N		
		X (m)	Y (m)	
A265-S	Yes	583416	5231174	49
A265-E	Yes	583446	5231205	48
A265	Yes	583416	5231205	48
A265-W	Yes	583385	5231204	48
A265-N	Yes	583415	5231235	48
A273-E	No	575884	5215655	45
A268-E	No	581798	5230220	45
A268-S	No	581768	5230189	45
A273-S	No	575854	5215624	45
A269-S	No	581815	5228315	45
A268	No	581768	5230220	45
A273-N	No	575853	5215685	45
A273	No	575853	5215655	45
A269-E	No	581845	5228345	45
A268-N	No	581768	5230250	45
A269	No	581814	5228345	45
A269-W	No	581784	5228345	45
A268-W	No	581738	5230219	45
A269-N	No	581814	5228376	45
A273-W	No	575823	5215654	45
A270-N	No	585108	5227575	44
A13-E	No	575662	5214523	44
A270-W	No	585078	5227544	44
A13-S	No	575632	5214492	44
A13	No	575632	5214523	44
A270	No	585108	5227544	44
A13-N	No	575631	5214553	44
A270-E	No	585139	5227545	44
A13-W	No	575601	5214522	44
A270-S	No	585109	5227514	44
A277-E	No	581392	5229128	43
A277-N	No	581362	5229158	43
A277	No	581362	5229127	43
A277-S	No	581362	5229097	43
A171-W	No	579235	5218098	43
A277-W	No	581331	5229127	43
A264-S	No	584163	5229426	43
A264-W	No	584132	5229456	43
A171-N	No	579265	5218129	43
A274-E	No	575625	5215669	43
A264	No	584163	5229456	43

Table B-1.2: Sound Level Modeling Results Sorted by Sound Level

Receptor ID	Signed Waiver	Coordinates		Source Only L _{eq} Sound Level (dBA)
		UTM NAD83 Zone 14N		
		X (m)	Y (m)	
A171	No	579265	5218098	43
A264-N	No	584162	5229487	42
A264-E	No	584193	5229457	42
A171-S	No	579266	5218068	42
A171-E	No	579296	5218099	42
A274	No	575595	5215669	42
A274-S	No	575595	5215638	42
A274-N	No	575594	5215699	42
A274-W	No	575564	5215669	42
A170-S	Yes	577431	5217738	42
A170-E	Yes	577461	5217769	42
A272-W	No	578526	5216005	42
A279-W	No	584928	5230551	42
A272-N	No	578556	5216035	42
A279-N	No	584958	5230582	41
A170	Yes	577431	5217769	41
A272	No	578556	5216005	41
A279	No	584959	5230551	41
A279-S	No	584959	5230521	41
A287-E	No	581049	5229571	41
A272-S	No	578557	5215975	41
A272-E	No	578587	5216005	41
A279-E	No	584989	5230552	41
A170-W	Yes	577400	5217768	41
A170-N	Yes	577430	5217799	41
A287-S	No	581019	5229540	41
A287	No	581019	5229570	41
A287-N	No	581019	5229601	41
A287-W	No	580988	5229570	41
A280-W	No	577287	5213741	40
A8-E	No	575071	5213811	40
A280-N	No	577317	5213771	40
A280	No	577318	5213741	39
A8-N	No	575040	5213841	39
A8	No	575041	5213810	39
A280-S	No	577318	5213710	39
A280-E	No	577348	5213741	39
A267-E	No	581053	5230778	39
A8-S	No	575041	5213780	39
A267-S	No	581023	5230747	39
A267	No	581022	5230778	39

Table B-1.2: Sound Level Modeling Results Sorted by Sound Level

Receptor ID	Signed Waiver	Coordinates		Source Only L _{eq} Sound Level (dBA)
		UTM NAD83 Zone 14N		
		X (m)	Y (m)	
A267-N	No	581022	5230808	39
A8-W	No	575010	5213810	39
A267-W	No	580992	5230777	39
A169-E	No	577304	5218308	39
A169-S	No	577274	5218277	39
A169	No	577273	5218307	39
A169-N	No	577273	5218338	39
A169-W	No	577243	5218307	39
A131-E	No	575329	5216312	38
A131-S	No	575299	5216281	38
A131	No	575299	5216311	38
A131-N	No	575299	5216342	38
A131-W	No	575268	5216311	38
A121-E	No	575200	5216210	37
A288-E	No	580373	5229273	37
A288	No	580342	5229273	37
A288-N	No	580342	5229303	37
A288-S	No	580342	5229242	37
A288-W	No	580312	5229272	37
A121-N	No	575169	5216240	37
A120-N	No	575149	5216240	37
A262-N	No	582197	5226447	37
A119-N	No	575138	5216239	37
A262-E	No	582228	5226417	37
A262	No	582197	5226417	37
A262-W	No	582167	5226416	37
A129-E	No	575101	5216325	36
A262-S	No	582198	5226386	36
A128-E	No	575090	5216282	36
A130-E	No	575101	5216343	36
A130	No	575071	5216343	36
A121	No	575169	5216210	36
A129-N	No	575070	5216355	36
A88-S	No	575008	5215776	36
A118-N	No	575124	5216235	35
A88-E	No	575038	5215807	35
A86-E	No	575005	5215771	35
A278-S	No	583745	5233064	35
A120-E	No	575180	5216210	35
A130-N	No	575070	5216373	35
A278-W	No	583714	5233094	35

Table B-1.2: Sound Level Modeling Results Sorted by Sound Level

Receptor ID	Signed Waiver	Coordinates		Source Only L _{eq} Sound Level (dBA)
		UTM NAD83 Zone 14N		
		X (m)	Y (m)	
A278	No	583744	5233095	35
A119-E	No	575168	5216209	35
A86	No	574974	5215770	35
A88	No	575007	5215806	35
A278-E	No	583775	5233095	35
A278-N	No	583744	5233125	35
A118-E	No	575155	5216205	35
A88-W	No	574977	5215806	35
A120	No	575149	5216209	35
A86-N	No	574974	5215801	35
A121-W	No	575139	5216210	35
A88-N	No	575007	5215837	35
A117-N	No	575113	5216227	34
A97	No	575054	5215884	34
A97-S	No	575054	5215853	34
A87-E	No	574931	5215834	34
A97-W	No	575024	5215883	34
A89-S	No	574915	5215820	34
A128-S	No	575060	5216251	34
A129-S	No	575071	5216294	34
A90-S	No	574905	5215847	34
A87	No	574900	5215834	34
A87-S	No	574901	5215803	34
A99-E	No	575084	5215979	34
A130-S	No	575071	5216313	34
A89-W	No	574885	5215850	34
A316-S	No	584730	5233193	34
A99-S	No	575054	5215948	34
A93-E	No	574986	5215913	34
A87-W	No	574870	5215834	34
A316-W	No	584699	5233223	34
A316	No	584729	5233224	34
A99	No	575053	5215978	34
A95-S	No	574982	5215900	34
A95	No	574981	5215931	34
A94-S	No	574971	5215892	34
A316-E	No	584760	5233224	34
A316-N	No	584729	5233254	34
A99-N	No	575053	5216009	34
A94	No	574970	5215923	34
A92-E	No	574963	5215904	34

Table B-1.2: Sound Level Modeling Results Sorted by Sound Level

Receptor ID	Signed Waiver	Coordinates		Source Only L _{eq} Sound Level (dBA)
		UTM NAD83 Zone 14N		
		X (m)	Y (m)	
A127-S	No	575006	5216250	34
A98-E	No	575026	5215988	33
A93-S	No	574956	5215882	33
A93	No	574955	5215912	33
A93-N	No	574955	5215943	33
A91-E	No	574949	5215895	33
A95-W	No	574951	5215931	33
A127	No	575006	5216281	33
A89-E	No	574945	5215851	33
A86-W	No	574944	5215770	33
A166-E	No	574982	5217739	33
A166-S	No	574952	5217709	33
A3-N	No	575704	5212262	33
A94-W	No	574940	5215923	33
A90-E	No	574935	5215878	33
A92	No	574933	5215904	33
A92-S	No	574933	5215873	33
A92-N	No	574932	5215934	33
A166	No	574951	5217739	33
A9-W	No	578875	5213921	33
A166-N	No	574951	5217770	33
A9-N	No	578905	5213952	33
A3-E	No	575735	5212232	33
A9	No	578905	5213921	33
A93-W	No	574925	5215912	33
A127-W	No	574976	5216281	33
A79-N	No	574922	5215709	33
A81-S	No	574924	5215686	33
A91	No	574918	5215895	33
A91-S	No	574918	5215864	33
A91-N	No	574918	5215925	33
A79	No	574922	5215678	33
A166-W	No	574921	5217739	33
A3	No	575704	5212232	33
A68-E	No	574114	5215721	33
A3-W	No	575674	5212231	33
A9-E	No	578936	5213922	33
A9-S	No	578906	5213891	33
A89	No	574915	5215850	33
A85-S	No	574913	5215703	33
A89-N	No	574915	5215881	33

Table B-1.2: Sound Level Modeling Results Sorted by Sound Level

Receptor ID	Signed Waiver	Coordinates		Source Only L _{eq} Sound Level (dBA)
		UTM NAD83 Zone 14N		
		X (m)	Y (m)	
A90	No	574904	5215878	33
A90-N	No	574904	5215908	33
A68	No	574084	5215721	33
A68-N	No	574084	5215752	33
A69-E	No	574074	5215761	33
A68-S	No	574084	5215691	33
A3-S	No	575704	5212201	33
A87-N	No	574900	5215864	33
A92-W	No	574902	5215903	33
A68-W	No	574053	5215721	33
A70-E	No	574067	5215811	33
A47-E	No	574074	5215595	33
A69-S	No	574044	5215730	33
A69	No	574044	5215761	33
A69-N	No	574043	5215791	33
A70-S	No	574037	5215780	33
A47	No	574044	5215594	33
A266-E	No	580350	5232294	33
A266-S	No	580320	5232263	33
A117-E	No	575143	5216197	33
A91-W	No	574888	5215894	33
A47-N	No	574043	5215625	33
A70	No	574037	5215810	33
A70-N	No	574036	5215841	33
A47-S	No	574044	5215564	33
A43-E	No	574024	5215387	33
A42-E	No	574020	5215364	33
A69-W	No	574013	5215760	33
A41-E	No	574017	5215354	33
A266	No	580319	5232294	33
A266-N	No	580319	5232324	33
A90-W	No	574874	5215878	33
A40-E	No	574006	5215339	33
A47-W	No	574013	5215594	33
A66-E	No	574033	5215927	33
A70-W	No	574006	5215810	33
A39-E	No	573993	5215323	33
A41	No	573986	5215353	33
A41-S	No	573987	5215323	33
A42	No	573989	5215363	33
A42-S	No	573989	5215333	33

Table B-1.2: Sound Level Modeling Results Sorted by Sound Level

Receptor ID	Signed Waiver	Coordinates		Source Only L _{eq} Sound Level (dBA)
		UTM NAD83 Zone 14N		
		X (m)	Y (m)	
A43	No	573993	5215386	33
A43-S	No	573993	5215356	33
A44-E	No	573995	5215372	33
A43-N	No	573993	5215417	33
A266-W	No	580289	5232293	33
A38-E	No	573979	5215296	33
A40-S	No	573976	5215309	33
A41-N	No	573986	5215384	33
A42-N	No	573989	5215394	33
A45-E	No	573987	5215363	33
A46-E	No	573983	5215352	33
A65-E	No	574007	5215943	33
A66	No	574002	5215927	33
A66-S	No	574003	5215897	33
A40	No	573975	5215339	33
A40-N	No	573975	5215370	33
A66-N	No	574002	5215958	33
A63-E	No	574009	5216007	33
A64-E	No	574005	5215981	33
A37-E	No	573965	5215283	33
A39	No	573962	5215322	33
A39-S	No	573963	5215292	33
A39-N	No	573962	5215353	33
A44	No	573965	5215371	33
A44-S	No	573965	5215341	33
A119	No	575138	5216208	33
A132-E	No	574481	5217076	33
A36-E	No	573950	5215256	33
A38-S	No	573949	5215265	33
A41-W	No	573956	5215353	33
A42-W	No	573959	5215363	33
A43-W	No	573963	5215386	33
A44-N	No	573964	5215402	33
A45	No	573956	5215363	33
A45-S	No	573957	5215332	33
A46-S	No	573952	5215321	33
A62-E	No	573996	5216048	33
A63-S	No	573979	5215976	33
A64-S	No	573975	5215950	33
A65	No	573977	5215943	33
A65-S	No	573977	5215912	33

Table B-1.2: Sound Level Modeling Results Sorted by Sound Level

Receptor ID	Signed Waiver	Coordinates		Source Only L _{eq} Sound Level (dBA)
		UTM NAD83 Zone 14N		
		X (m)	Y (m)	
A66-W	No	573972	5215927	33
A132-S	No	574451	5217045	33
A38	No	573949	5215296	33
A38-N	No	573948	5215326	33
A45-N	No	573956	5215393	33
A46	No	573952	5215351	33
A46-N	No	573952	5215382	33
A40-W	No	573945	5215339	33
A63	No	573979	5216007	33
A64	No	573974	5215980	33
A65-N	No	573976	5215973	33
A35-E	No	573933	5215241	33
A35-S	No	573903	5215210	33
A37	No	573935	5215282	33
A37-S	No	573935	5215252	33
A37-N	No	573934	5215313	33
A63-N	No	573979	5216037	33
A64-N	No	573974	5216011	33
A97-E	No	575085	5215884	33
A118	No	575125	5216204	33
A132	No	574451	5217076	33
A134-E	No	574465	5217106	33
A39-W	No	573932	5215322	33
A44-W	No	573934	5215371	33
A60-E	No	573976	5216093	33
A61-E	No	573978	5216066	33
A62-S	No	573965	5216017	33
A65-W	No	573946	5215942	33
A35	No	573902	5215240	33
A62	No	573965	5216048	33
A132-N	No	574451	5217106	33
A133-E	No	574468	5217133	33
A134-S	No	574435	5217075	33
A45-W	No	573926	5215362	33
A36	No	573919	5215256	33
A36-S	No	573920	5215225	33
A36-N	No	573919	5215286	33
A38-W	No	573918	5215295	33
A46-W	No	573922	5215351	33
A62-N	No	573965	5216078	33
A135-E	No	574440	5217094	33

Table B-1.2: Sound Level Modeling Results Sorted by Sound Level

Receptor ID	Signed Waiver	Coordinates		Source Only L _{eq} Sound Level (dBA)
		UTM NAD83 Zone 14N		
		X (m)	Y (m)	
A141-E	No	574524	5217233	33
A34-E	No	573886	5215220	33
A36-W	No	573889	5215255	33
A37-W	No	573904	5215282	33
A59-E	No	573964	5216111	33
A61-S	No	573948	5216035	33
A63-W	No	573948	5216006	33
A64-W	No	573944	5215980	33
A275-W	No	587902	5227704	33
A275-N	No	587933	5227734	32
A116-E	No	575110	5216195	32
A117	No	575113	5216196	32
A120-W	No	575119	5216209	32
A123-N	No	575113	5216200	32
A132-W	No	574420	5217075	32
A133-S	No	574438	5217102	32
A35-N	No	573902	5215271	32
A60-S	No	573946	5216062	32
A61	No	573947	5216066	32
A134	No	574434	5217105	32
A141-S	No	574494	5217202	32
A135-S	No	574410	5217063	32
A61-N	No	573947	5216096	32
A133	No	574438	5217132	32
A137-E	No	574449	5217145	32
A35-W	No	573872	5215240	32
A58-E	No	573951	5216126	32
A60	No	573946	5216093	32
A62-W	No	573935	5216047	32
A136-E	No	574420	5217106	32
A134-N	No	574434	5217136	32
A135	No	574409	5217093	32
A141	No	574493	5217232	32
A33-E	No	573858	5215214	32
A34	No	573856	5215220	32
A34-S	No	573856	5215190	32
A34-N	No	573855	5215251	32
A59-S	No	573934	5216081	32
A60-N	No	573945	5216123	32
A275	No	587933	5227704	32
A115-E	No	575108	5216208	32

Table B-1.2: Sound Level Modeling Results Sorted by Sound Level

Receptor ID	Signed Waiver	Coordinates		Source Only L _{eq} Sound Level (dBA)
		UTM NAD83 Zone 14N		
		X (m)	Y (m)	
A119-W	No	575108	5216208	32
A97-N	No	575054	5215914	32
A136-S	No	574390	5217075	32
A137-S	No	574419	5217114	32
A59	No	573934	5216111	32
A59-N	No	573933	5216142	32
A61-W	No	573917	5216065	32
A57-E	No	573931	5216156	32
A58-S	No	573921	5216096	32
A133-N	No	574437	5217163	32
A134-W	No	574404	5217105	32
A135-N	No	574409	5217124	32
A137	No	574418	5217144	32
A141-N	No	574493	5217263	32
A55-E	No	573941	5216214	32
A58	No	573921	5216126	32
A60-W	No	573915	5216092	32
A133-W	No	574407	5217132	32
A136	No	574390	5217105	32
A141-W	No	574463	5217232	32
A33	No	573827	5215213	32
A33-S	No	573828	5215183	32
A33-N	No	573827	5215244	32
A56-E	No	573921	5216176	32
A58-N	No	573920	5216157	32
A34-W	No	573825	5215220	32
A275-S	No	587933	5227674	32
A275-E	No	587963	5227704	32
A118-W	No	575094	5216204	32
A135-W	No	574379	5217093	32
A57-S	No	573901	5216125	32
A59-W	No	573903	5216111	32
A55-S	No	573911	5216183	32
A137-N	No	574418	5217175	32
A136-N	No	574389	5217136	32
A137-W	No	574388	5217144	32
A57	No	573900	5216155	32
A140-E	No	574370	5217120	32
A142-E	No	574486	5217310	32
A55	No	573911	5216214	32
A58-W	No	573890	5216126	32

Table B-1.2: Sound Level Modeling Results Sorted by Sound Level

Receptor ID	Signed Waiver	Coordinates		Source Only L _{eq} Sound Level (dBA)
		UTM NAD83 Zone 14N		
		X (m)	Y (m)	
A136-W	No	574359	5217105	32
A55-N	No	573910	5216244	32
A56	No	573890	5216176	32
A56-S	No	573890	5216145	32
A57-N	No	573900	5216186	32
A33-W	No	573797	5215213	32
A212-N	No	579715	5226832	32
A111-E	No	575085	5216208	32
A96-E	No	575034	5215950	32
A139-E	No	574374	5217147	32
A140-S	No	574340	5217090	32
A142-S	No	574456	5217279	32
A56-N	No	573890	5216206	32
A138-E	No	574387	5217174	32
A138-S	No	574357	5217143	32
A139-S	No	574344	5217116	32
A140	No	574340	5217120	32
A142	No	574455	5217310	32
A55-W	No	573880	5216213	32
A57-W	No	573870	5216155	32
A129	No	575070	5216325	32
A56-W	No	573860	5216175	32
A139	No	574344	5217146	32
A138	No	574357	5217173	32
A140-N	No	574339	5217150	32
A142-N	No	574455	5217340	32
A142-W	No	574425	5217309	32
A139-N	No	574343	5217177	32
A140-W	No	574309	5217120	32
A138-N	No	574356	5217204	32
A143-S	No	574344	5217192	32
A212-W	No	579685	5226801	32
A95-E	No	575012	5215931	32
A96-S	No	575004	5215919	32
A126-S	No	575075	5216097	32
A139-W	No	574313	5217146	32
A138-W	No	574326	5217173	32
A148-E	No	574350	5217219	32
A143	No	574344	5217222	32
A148-S	No	574320	5217188	32
A212-E	No	579746	5226802	32

Table B-1.2: Sound Level Modeling Results Sorted by Sound Level

Receptor ID	Signed Waiver	Coordinates		Source Only L _{eq} Sound Level (dBA)
		UTM NAD83 Zone 14N		
		X (m)	Y (m)	
A111-N	No	575054	5216238	32
A94-E	No	575001	5215923	32
A96	No	575003	5215950	32
A128	No	575060	5216281	32
A98-S	No	574996	5215957	32
A130-W	No	575040	5216343	32
A143-W	No	574313	5217222	32
A143-N	No	574343	5217253	32
A148	No	574320	5217219	32
A149-E	No	574324	5217228	32
A149-S	No	574294	5217197	32
A148-N	No	574320	5217249	32
A150-E	No	574303	5217224	32
A212	No	579716	5226801	32
A128-N	No	575059	5216312	32
A95-N	No	574981	5215961	32
A86-S	No	574975	5215740	32
A84-E	No	574972	5215651	32
A148-W	No	574290	5217218	32
A149	No	574294	5217228	32
A150-S	No	574273	5217193	32
A149-N	No	574294	5217258	32
A150	No	574273	5217224	32
A212-S	No	579716	5226771	32
A127-E	No	575037	5216281	32
A96-W	No	574973	5215949	32
A94-N	No	574970	5215953	32
A128-W	No	575029	5216281	32
A80-W	No	574964	5215654	32
A100-S	No	574987	5215978	32
A101-E	No	575010	5216052	32
A105-S	No	575017	5216072	32
A144-E	No	574305	5217293	32
A144-S	No	574275	5217262	32
A149-W	No	574264	5217227	32
A150-N	No	574272	5217254	32
A146-E	No	574266	5217261	32
A150-W	No	574242	5217224	32
A129-W	No	575040	5216324	32
A106-N	No	575009	5216232	32
A81-E	No	574955	5215716	32

Table B-1.2: Sound Level Modeling Results Sorted by Sound Level

Receptor ID	Signed Waiver	Coordinates		Source Only L _{eq} Sound Level (dBA)
		UTM NAD83 Zone 14N		
		X (m)	Y (m)	
A79-E	No	574953	5215679	32
A85-E	No	574943	5215734	32
A102-E	No	575007	5216077	32
A144	No	574275	5217292	32
A146-S	No	574236	5217230	32
A147-E	No	574254	5217282	32
A144-N	No	574275	5217323	32
A146	No	574236	5217260	32
A98-W	No	574965	5215987	32
A144-W	No	574245	5217292	32
A145-E	No	574278	5217347	32
A147-S	No	574224	5217251	32
A84-N	No	574941	5215681	31
A84	No	574942	5215651	31
A143-E	No	574374	5217223	31
A145-S	No	574248	5217317	31
A146-N	No	574235	5217291	31
A147	No	574223	5217281	31
A151-E	No	574238	5217292	31
A151-S	No	574208	5217261	31
A146-W	No	574205	5217260	31
A145	No	574248	5217347	31
A147-N	No	574223	5217312	31
A81	No	574924	5215716	31
A81-N	No	574924	5215746	31
A79-S	No	574923	5215648	31
A82-N	No	574921	5215654	31
A100-W	No	574956	5216008	31
A145-N	No	574247	5217378	31
A147-W	No	574193	5217281	31
A151	No	574208	5217292	31
A151-N	No	574207	5217322	31
A145-W	No	574217	5217347	31
A85	No	574913	5215734	31
A85-N	No	574913	5215764	31
A84-W	No	574911	5215651	31
A151-W	No	574177	5217291	31
A85-W	No	574882	5215733	31
A78-N	No	574860	5215717	31
A121-S	No	575170	5216179	31
A120-S	No	575150	5216179	31

Table B-1.2: Sound Level Modeling Results Sorted by Sound Level

Receptor ID	Signed Waiver	Coordinates		Source Only L _{eq} Sound Level (dBA)
		UTM NAD83 Zone 14N		
		X (m)	Y (m)	
A123-E	No	575144	5216170	31
A77-S	No	574650	5214812	31
A119-S	No	575138	5216178	31
A124-E	No	575133	5216161	31
A77-W	No	574619	5214842	31
A118-S	No	575125	5216174	31
A122-E	No	575118	5216166	31
A117-S	No	575113	5216166	31
A284-S	No	579434	5221118	30
A177-W	No	581131	5219680	30
A177-S	No	581162	5219650	30
A284-W	No	579403	5221148	30
A284	No	579434	5221149	30
A177	No	581162	5219681	30
A123-S	No	575114	5216140	30
A125-E	No	575117	5216145	30
A177-N	No	581161	5219711	30
A284-E	No	579464	5221149	30
A177-E	No	581192	5219681	30
A284-N	No	579433	5221179	30
A124-S	No	575103	5216130	30
A126-E	No	575105	5216128	30
A123	No	575113	5216170	30
A80-E	No	575025	5215655	30
A124	No	575103	5216160	30
A125-S	No	575087	5216114	30
A122-S	No	575088	5216136	30
A124-N	No	575103	5216191	30
A125	No	575086	5216145	30
A122	No	575088	5216166	30
A126	No	575075	5216127	30
A80	No	574994	5215654	30
A80-S	No	574995	5215624	30
A125-N	No	575086	5216175	30
A122-N	No	575087	5216196	30
A126-N	No	575074	5216158	30
A116-S	No	575080	5216165	30
A123-W	No	575083	5216170	30
A112-E	No	575082	5216198	30
A116	No	575080	5216195	30
A117-W	No	575083	5216196	30

Table B-1.2: Sound Level Modeling Results Sorted by Sound Level

Receptor ID	Signed Waiver	Coordinates		Source Only L _{eq} Sound Level (dBA)
		UTM NAD83 Zone 14N		
		X (m)	Y (m)	
A124-W	No	575072	5216160	30
A113-E	No	575076	5216190	30
A105-E	No	575047	5216103	30
A115	No	575077	5216208	30
A115-S	No	575078	5216178	30
A116-N	No	575079	5216225	30
A125-W	No	575056	5216144	30
A109-E	No	575058	5216159	30
A110-E	No	575066	5216171	30
A114-E	No	575069	5216182	30
A115-N	No	575077	5216238	30
A122-W	No	575057	5216166	30
A126-W	No	575044	5216127	30
A82-E	No	574952	5215624	30
A112-S	No	575052	5216167	30
A113-S	No	575046	5216159	30
A80-N	No	574994	5215685	30
A111-S	No	575055	5216177	30
A109-S	No	575028	5216128	30
A110-S	No	575036	5216140	30
A111	No	575055	5216208	30
A112	No	575051	5216198	30
A114-S	No	575039	5216152	30
A116-W	No	575049	5216195	30
A84-S	No	574942	5215620	30
A77-E	No	574680	5214843	30
A96-N	No	575003	5215980	30
A110	No	575036	5216171	30
A113	No	575046	5216190	30
A114	No	575039	5216182	30
A115-W	No	575047	5216208	30
A112-N	No	575051	5216228	30
A99-W	No	575023	5215978	30
A98	No	574996	5215987	30
A109	No	575028	5216158	30
A105	No	575017	5216102	30
A106-E	No	575040	5216202	30
A113-N	No	575045	5216220	30
A105-N	No	575016	5216133	30
A107-E	No	575031	5216179	30
A110-N	No	575035	5216201	30

Table B-1.2: Sound Level Modeling Results Sorted by Sound Level

Receptor ID	Signed Waiver	Coordinates		Source Only L _{eq} Sound Level (dBA)
		UTM NAD83 Zone 14N		
		X (m)	Y (m)	
A114-N	No	575039	5216212	30
A82-S	No	574922	5215593	30
A82	No	574921	5215624	30
A104-E	No	575011	5216122	30
A98-N	No	574995	5216018	29
A100	No	574987	5216008	29
A108-E	No	575017	5216162	29
A109-N	No	575028	5216189	29
A100-E	No	575017	5216009	29
A103-E	No	575006	5216101	29
A101-S	No	574980	5216021	29
A111-W	No	575024	5216207	29
A112-W	No	575021	5216197	29
A106-S	No	575010	5216171	29
A113-W	No	575015	5216189	29
A101	No	574980	5216052	29
A77	No	574649	5214843	29
A77-N	No	574649	5214873	29
A100-N	No	574987	5216039	29
A102-S	No	574977	5216046	29
A107-S	No	575001	5216148	29
A110-W	No	575005	5216170	29
A114-W	No	575008	5216182	29
A105-W	No	574986	5216102	29
A101-N	No	574979	5216082	29
A102	No	574976	5216077	29
A103-S	No	574976	5216070	29
A104-S	No	574981	5216091	29
A109-W	No	574997	5216158	29
A106	No	575010	5216202	29
A107	No	575000	5216178	29
A108-S	No	574987	5216132	29
A82-W	No	574891	5215623	29
A102-N	No	574976	5216107	29
A103	No	574975	5216101	29
A104	No	574981	5216122	29
A107-N	No	575000	5216209	29
A108	No	574987	5216162	29
A103-N	No	574975	5216131	29
A104-N	No	574980	5216152	29
A108-N	No	574986	5216193	29

Table B-1.2: Sound Level Modeling Results Sorted by Sound Level

Receptor ID	Signed Waiver	Coordinates		Source Only L _{eq} Sound Level (dBA)
		UTM NAD83 Zone 14N		
		X (m)	Y (m)	
A101-W	No	574949	5216051	29
A106-W	No	574979	5216201	29
A102-W	No	574946	5216076	29
A104-W	No	574950	5216122	29
A107-W	No	574970	5216178	29
A127-N	No	575006	5216311	29
A103-W	No	574945	5216101	29
A108-W	No	574956	5216162	29
A83-E	No	574879	5215638	29
A78	No	574860	5215687	29
A78-S	No	574861	5215656	29
A83-N	No	574848	5215668	29
A81-W	No	574894	5215716	29
A83	No	574848	5215638	29
A78-W	No	574830	5215686	29
A83-W	No	574818	5215638	29
A78-E	No	574891	5215687	29
A83-S	No	574849	5215608	29
A79-W	No	574892	5215678	29
A76-S	No	574452	5214813	28
A75-W	No	574373	5214774	28
A74-E	No	574472	5214766	27
A76-E	No	574482	5214844	27
A73-S	No	574471	5214699	27
A76	No	574452	5214843	27
A76-N	No	574452	5214874	27
A72-S	No	574424	5214688	27
A76-W	No	574422	5214843	27
A72	No	574424	5214718	27
A75-S	No	574404	5214744	27
A72-W	No	574394	5214718	27
A72-N	No	574424	5214749	27
A73-W	No	574440	5214729	27
A74-W	No	574411	5214765	27
A72-E	No	574454	5214719	27
A74-S	No	574442	5214735	27
A74	No	574442	5214766	27
A75	No	574403	5214774	27
A73-N	No	574471	5214760	27
A75-N	No	574403	5214805	26
A71-S	No	574337	5214615	26

Table B-1.2: Sound Level Modeling Results Sorted by Sound Level

Receptor ID	Signed Waiver	Coordinates UTM NAD83 Zone 14N		Source Only L _{eq} Sound Level (dBA)
		X (m)	Y (m)	
A75-E	No	574434	5214774	26
A71-W	No	574306	5214645	26
A73-E	No	574501	5214730	26
A74-N	No	574441	5214796	26
A71-N	No	574336	5214676	26
A71	No	574336	5214645	26
A73	No	574471	5214730	26
A71-E	No	574367	5214646	25

Prepared By and Return To:

Carlos Megias, Esq.
 FPL Energy, LLC
 700 Universe Blvd. (LAW/JB)
 Juno Beach, FL 33408-0420
 Telephone: (561) 694-4678

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ASSIGNMENT OF WIND FARM EASEMENT AGREEMENTS

THIS ASSIGNMENT OF WIND FARM EASEMENT AGREEMENTS (the "*Assignment*") is made and dated as of this 16 day of September, 2008 (the "*Effective Date*") by and between **BOULEVARD ASSOCIATES, LLC**, a Delaware limited liability, a subsidiary of FPL Energy LLC, a Delaware limited liability company, whose address for purposes of notices is: 700 Universe Blvd., Attn: Business Manager, Juno Beach, Florida 33408 ("*Assignor*") and **ASHTABULA WIND LLC**, a Delaware limited liability company, with an address of 700 Universe Blvd., Attn: Business Manager, Juno Beach, Florida 33408 ("*Assignee*").

RECITALS

WHEREAS, Assignor did enter into certain Wind Farm Easement Agreements ("*Agreements*") with various property owners for the purpose of constructing, operating and maintaining wind energy generation projects on which property located in the County of Barnes, State of North Dakota ("**Property**"); and

WHEREAS Assignor desires to assign to Assignee, and Assignee desires to accept from Assignor, an assignment of those Agreements as more specifically set forth herein.

NOW, THEREFORE, in consideration of Ten and NO/100 Dollars (\$10.00), and other good and valuable consideration, the receipt and adequacy of which is hereby acknowledged, the parties agree as follows:

AGREEMENT

1. Assignment. Assignor hereby grants, assigns, transfers and conveys to Assignee, and Assignee hereby accepts, all of Assignee's rights, title and interest in and to the Agreements set forth in the attached Exhibit "A" and more particularly described in the attached Exhibit "B" to this Assignment.

2. Assumption of Obligations. As of the date hereof, Assignee hereby assumes the obligations for the performance of all covenants, agreements and obligations of Assignor with respect to the Agreements. Assignee hereby further covenants, promises and agrees to perform each and all covenants, agreements and obligations of Assignor with respect to the Agreements

(This space reserved for recording information)

in the manner, and in all other respects, as provided for therein as though the Agreements had originally been made, executed and delivered by Assignee.

3. Indemnification. Assignee shall indemnify and hold Assignor free and harmless from any loss, cost, damage, expense, action or causes of action or any other liability (including reasonable attorneys' fees) which it may or might incur under or as a result of or in any way arising from or relating to the Agreements arising from and after the Effective Date. Assignor shall indemnify and hold harmless Assignee from any loss, cost, damage, expense, action or causes of action or any other liability (including reasonable attorneys' fees) which it might incur under or as a result of or in any way arising from or relating to the Agreements which arose prior to the Effective Date.

4. Binding Effect. The matters set forth herein shall be binding upon and inure to the benefit of the parties hereto, and their respective assigns and successors in interest.

5. Additional Documents. The parties hereto agree that they will execute any and all other and further documents that are reasonable and necessary to carry out the full intent and purpose of this Assignment.

6. Severability. If any provision of this Assignment or the application of any such provision to any person or circumstance shall be held invalid, illegal or unenforceable in any respect by a court of competent jurisdiction, such invalidity, illegality or unenforceability shall not affect any other provision hereof.

7. Governing Law. This Assignment shall be governed by and construed in accordance with the laws of the State of North Dakota.

8. Miscellaneous. This Assignment shall be binding upon and inure to the benefit of the parties hereto and their respective successors and assigns and may be executed in counterparts, each of which shall be deemed an original and all of which shall be one and the same instrument.

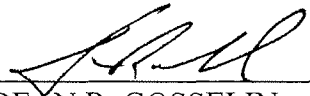
Return To: Cameron D. Sillers
908 3rd St.
LANGDON ND 58249

263828
2 of 24

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IN WITNESS WHEREOF, Assignor and Assignee have executed this Assignment as of the date first above written.

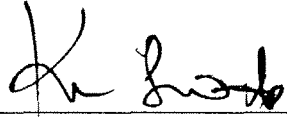
ASSIGNEE:
ASHTABULA WIND LLC, a
Delaware limited liability company,

By: 
DEAN R. GOSSELIN
Vice President

STATE OF FLORIDA)

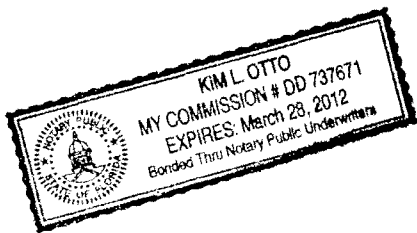
COUNTY OF PALM BEACH)

On this 16 day of September, 2008, before me personally appeared DEAN R. GOSSELIN, as Vice President of ASHTABULA WIND, LLC, a Delaware limited liability company who executed the foregoing instrument for the uses and purposes therein mentioned, and on oath stated that he was authorized to execute said instrument on behalf of said limited liability company.


Notary Public

Notary Public Printed Name

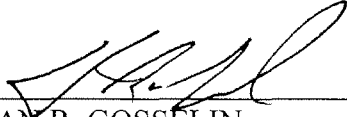
My Commission Expires:



(This space reserved for recording information)

IN WITNESS WHEREOF, Assignor and Assignee have executed this Assignment as of the date first above written.

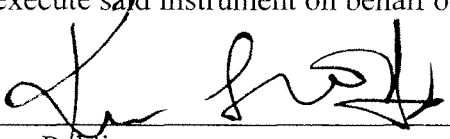
ASSIGNOR:
BOULEVARD ASSOCIATES, LLC, a
Delaware limited liability company,

By: 
DEAN R. GOSSELIN
Vice President

STATE OF FLORIDA)

COUNTY OF PALM BEACH)

On this 16 day of September, 2008, before me personally appeared DEAN R. GOSSELIN, as Vice President of BOULEVARD ASSOCIATES, LLC, a Delaware limited liability company who executed the foregoing instrument for the uses and purposes therein mentioned, and on oath stated that he was authorized to execute said instrument on behalf of said limited liability company.


Notary Public

Notary Public Printed Name

My Commission Expires:



(This space reserved for recording information)

EXHIBIT A

Agreements to be Assigned

1. That certain Wind Farm Easement Agreement by and between Elizabeth J. Anderson, wife and husband (Owner”) and Boulevard Associates, LLC, a Delaware limited liability company (“FPLE”) dated August 10, 2007. Memorandum of Easements recorded as Document No. 260993 in Barnes County, North Dakota. An Option Notice exercising Operator’s Option referenced in the Memorandum of Easement was sent to Owner by Operator in letter dated April 29, 2008 with a Commencement Date declared as June 1, 2008.
2. That certain Wind Farm Easement Agreement by and between Shawn Anderson and Linda Anderson, husband and wife (Owner”) and Boulevard Associates, LLC, a Delaware limited liability company (“FPLE”) dated September 10, 2007. Memorandum of Easements recorded as Document No.261623 in Barnes County, North Dakota. An Option Notice exercising Operator’s Option referenced in the Memorandum of Easement was sent to Owner by Operator in letter dated April 29, 2008 with a Commencement Date declared as June 1, 2008.
3. That certain Wind Farm Easement Agreement by and between Mark C. Askerooth and Frances Karen Askerooth, husband and wife, Scott L. Askerooth, a single person and Cindy Askerooth-Olson and Maurice D. Olson, wife and husband (“Owner”) and Boulevard Associates, LLC, a Delaware limited liability company (“FPLE”) dated October 12, 2007. Memorandum of Easements recorded as Document No. 261624 in Barnes County, North Dakota. An Option Notice exercising Operator’s Option referenced in the Memorandum of Easement was sent to Owner by Operator in letter dated April 29, 2008 with a Commencement Date declared as June 1, 2008.
4. That certain Wind Farm Easement Agreement by and between Casey J. Burchill, husband and wife (“Owner”) and Boulevard Associates, LLC (“Operator”) dated November 7, 2007. Memorandum of Easements recorded as Document Number 261620, Barnes County, North Dakota. An Option Notice exercising Operator’s Option referenced in the Memorandum of Easement was sent to Owner by Operator in letter dated April 29, 2008 with a Commencement Date declared as June 1, 2008.

5. That certain Wind Farm Easement Agreement by and between John C. Burchill II and Linda Burchill, husband and wife, Mary E. Swirzcki and John Swirzcki, wife and husband, Patrick J. Burchill and Lucy Burchill, husband and wife, Anne M. Williams and Brian Williams, wife and husband, Thomas B. Burchill and Paula Burchill husband and wife, as tenants in common, subject to the life estate of John C. Burchill and Frances Colleen Burchill, husband and wife and Boulevard Associates, LLC, a Delaware limited liability company ("FPLE") dated October 4, 2007. Memorandum of Easements recorded as Document No. 261621 in Barnes North Dakota. An Option Notice exercising Operator's Option referenced in the Memorandum of Easement was sent to Owner by Operator in letter dated April 29, 2008 with a Commencement Date declared as June 1, 2008.
6. That certain Wind Farm Easement Agreement by and between Perry J. Burchill and Kathy L. Burchill, husband and wife, (Owner") and Boulevard Associates, LLC, a Delaware limited liability company ("FPLE") dated September 10, 2007. Memorandum of Easements recorded as Document No. 261605 in Barnes County, North Dakota. An Option Notice exercising Operator's Option referenced in the Memorandum of Easement was sent to Owner by Operator in letter dated April 29, 2008 with a Commencement Date declared as June 1, 2008.
7. That certain Wind Farm Easement Agreement by and between Richard Burchill, as his sole and separate property, joined proforma by his wife Jeanette Burchill (Owner") dated October 29, 2008 and Boulevard Associates, LLC, a Delaware limited liability company ("FPLE"). Memorandum of Easements recorded as Document No. 261606 in Barnes County, North Dakota. An Option Notice exercising Operator's Option referenced in the Memorandum of Easement was sent to Owner by Operator in letter dated April 29, 2008 with a Commencement Date declared as June 1, 2008.
8. That certain Wind Farm Easement Agreement by and between Sandra Burchill, a single woman (Owner") and Boulevard Associates, LLC, a Delaware limited liability company ("FPLE") dated August 10, 2007. Memorandum of Easements recorded as Document No. 260994 in Barnes County, North Dakota. An Option Notice exercising Operator's Option referenced in the Memorandum of Easement was sent to Owner by Operator in letter dated April 29, 2008 with a Commencement Date declared as June 1, 2008.
9. That certain Wind Farm Easement Agreement by and between Wayne A. Burdick, subject to a life estate of Doris M. Burdick (Owner") dated April 21, 2008 and Boulevard Associates, LLC, a Delaware limited liability company ("FPLE"). Memorandum of Easements recorded as Document No. 263068 in Barnes County, North Dakota. An Option Notice exercising Operator's Option referenced in the Memorandum of Easement was sent to Owner by Operator in letter dated April 29, 2008 with a Commencement Date declared as June 1, 2008.

10. That certain Wind Farm Easement Agreement by and between Bruce J. Emery and Tamara L. Emery (Owner”) and Boulevard Associates, LLC, a Delaware limited liability company (“FPLE”) dated November 15, 2007. Memorandum of Easements recorded as Document No. 261613 in Barnes County, North Dakota. An Option Notice exercising Operator’s Option referenced in the Memorandum of Easement was sent to Owner by Operator in letter dated April 29, 2008 with a Commencement Date declared as June 1, 2008.
11. That certain Wind Farm Easement Agreement by and between Merle E. Flatt and Marion Flatt, husband and wife (Owner”) and Boulevard Associates, LLC, a Delaware limited liability company (“FPLE”) dated October 29, 2007. Memorandum of Easements recorded as Document No. 261596 in Barnes County, North Dakota. An Option Notice exercising Operator’s Option referenced in the Memorandum of Easement was sent to Owner by Operator in letter dated April 29, 2008 with a Commencement Date declared as June 1, 2008.
12. That certain Wind Farm Easement Agreement by and between Duane D. Haga and Ana Jane Haga, husband and wife (Owner”) and Boulevard Associates, LLC, a Delaware limited liability company (“FPLE”) dated September 4, 2007. Memorandum of Easements recorded as Document No. 260995 in Barnes County, North Dakota. An Option Notice exercising Operator’s Option referenced in the Memorandum of Easement was sent to Owner by Operator in letter dated April 29, 2008 with a Commencement Date declared as June 1, 2008.
13. That certain Wind Farm Easement Agreement by and between Lynn Holcomb and Linda Holcomb, husband and wife (Owner”) and Boulevard Associates, LLC, a Delaware limited liability company (“FPLE”) dated August 10, 2007. Memorandum of Easements recorded as Document No. 260996 in Barnes County, North Dakota. An Option Notice exercising Operator’s Option referenced in the Memorandum of Easement was sent to Owner by Operator in letter dated April 29, 2008 with a Commencement Date declared as June 1, 2008.
14. That certain Wind Farm Easement Agreement by and between John M. Ihry (Owner”) and Boulevard Associates, LLC, a Delaware limited liability company (“FPLE”) dated November 27, 2007. Memorandum of Easements recorded as Document No. 261585 in Barnes County, North Dakota. An Option Notice exercising Operator’s Option referenced in the Memorandum of Easement was sent to Owner by Operator in letter dated April 29, 2008 with a Commencement Date declared as June 1, 2008.
15. That certain Wind Farm Easement Agreement by and between Janet M. Patterson and Robert Patterson, wife and husband, Steven J. Levi and Lisa Levi, husband and wife and Laura C. Porras and Rick Porras, wife and husband, subject to the life estate of Charlotte M. Johns, formerly Charlotte M. Levi (Owner”) and Boulevard Associates, LLC, a Delaware limited liability company (“FPLE”) dated October 2, 2007. Memorandum of Easements recorded as Document No. 261640 in Barnes County, North Dakota. An Option Notice exercising Operator’s Option referenced in the Memorandum of Easement

was sent to Owner by Operator in letter dated April 29, 2008 with a Commencement Date declared as June 1, 2008.

16. That certain Wind Farm Easement Agreement by and between Pamela K. Johnson and Stanley M. Johnson, wife and husband (Owner”) and Boulevard Associates, LLC, a Delaware limited liability company (“FPLE”) dated November 7, 2007. Memorandum of Easements recorded as Document No. 261586 in Barnes County, North Dakota. An Option Notice exercising Operator’s Option referenced in the Memorandum of Easement was sent to Owner by Operator in letter dated April 29, 2008 with a Commencement Date declared as June 1, 2008.
17. That certain Wind Farm Easement Agreement by and between Harriet D. Johnson and Jerome Johnson, wife and husband; Judy A. Anderson, a single person; Joyce M. Saji, a single person, subject to the life estate of Frances M. Jorgenson, a widow (Owner”) and Boulevard Associates, LLC, a Delaware limited liability company (“FPLE”) dated August 10, 2007. Memorandum of Easements recorded as Document No. 260999 in Barnes County, North Dakota. An Option Notice exercising Operator’s Option referenced in the Memorandum of Easement was sent to Owner by Operator in letter dated April 29, 2008 with a Commencement Date declared as June 1, 2008.
18. That certain Wind Farm Easement Agreement by and between Josephine Koch, a one-half interest and Josephine Koch, as Trustee of the Koch Family Trust under Last Will and Testament dated June 9, 1998, a one-half interest (Owner”) and Boulevard Associates, LLC, a Delaware limited liability company (“FPLE”) dated September 10, 2007. Memorandum of Easements recorded as Document No. 261587 in Barnes County, North Dakota. As amended by that certain Amendment to Wind Farm Easement Agreement dated April 21, 2008 recorded as Document No. 262770 in Barnes County, North Dakota. An Option Notice exercising Operator’s Option referenced in the Memorandum of Easement was sent to Owner by Operator in letter dated April 29, 2008 with a Commencement Date declared as June 1, 2008.
19. That certain Wind Farm Easement Agreement by and between Stanley M. Johnson and Pamela K. Johnson, as Co-Trustees of the Howard and Beverly Kunze Family Trust, dated June 5, 1996 (Owner”) and Boulevard Associates, LLC, a Delaware limited liability company (“Operator”) dated December 17, 2007. Memorandum of Easements recorded as Document No. 261570 in Barnes County, North Dakota. An Option Notice exercising Operator’s Option referenced in the Memorandum of Easement was sent to Owner by Operator in letter dated April 29, 2008 with a Commencement Date declared as June 1, 2008.
20. That certain Wind Farm Easement Agreement by and between Edson G. Larson and Margaret Larson, husband and wife (“Owner”) and Boulevard Associates, LLC (“Operator”) dated February 18, 2008. Memorandum of Easements recorded as Document No. 262360, Barnes County, North Dakota. An Option Notice exercising Operator’s Option referenced in the Memorandum of Easement was sent to Owner by

Operator in letter dated April 29, 2008 with a Commencement Date declared as June 1, 2008.

21. That certain Wind Farm Easement Agreement by and between James L. Larson and Lori K. Larson, husband and wife (Owner”) and Boulevard Associates, LLC, a Delaware limited liability company (“FPLE”) dated August 27, 2007. Memorandum of Easements recorded as Document No.260001 in Barnes County, North Dakota. An Option Notice exercising Operator’s Option referenced in the Memorandum of Easement was sent to Owner by Operator in letter dated April 29, 2008 with a Commencement Date declared as June 1, 2008.
22. That certain Wind Farm Easement Agreement by and between Joyce S. Larson, as Trustee of the Joyce S. Larson Revocable Living Trust U/T/A dated September 21, 1994 (Owner”) and Boulevard Associates, LLC, a Delaware limited liability company (“FPLE”) dated October 29, 2007. Memorandum of Easements recorded as Document No. 261573 in Barnes County, North Dakota. An Option Notice exercising Operator’s Option referenced in the Memorandum of Easement was sent to Owner by Operator in letter dated April 29, 2008 with a Commencement Date declared as June 1, 2008.
23. That certain Wind Farm Easement Agreement by and between James H. Leadbetter and Marie Leadbetter, husband and wife, subject to the life estate of James A. Leadbetter and Virginia Leadbetter, husband and wife (“Owner”) and Boulevard Associates, LLC (“Operator”) dated November 7, 2007. Memorandum of Easements recorded as Document Number 261575, Barnes County, North Dakota. An Option Notice exercising Operator’s Option referenced in the Memorandum of Easement was sent to Owner by Operator in letter dated April 29, 2008 with a Commencement Date declared as June 1, 2008.
24. That certain Wind Farm Easement Agreement by and between Janet M. Patterson and Robert Patterson, wife and husband; Steven J. Levi and Lisa Levi, husband and wife and Laura C. Porras and Rick Porras, wife and husband, subject to a first life estate of Hovey E. Molstad, a single person and a second life estate to John A. Moldstad (Owner”) and Boulevard Associates, LLC, a Delaware limited liability company (“FPLE”) dated February 18, 2008. Memorandum of Easements recorded as Document No. 262361 in Barnes County, North Dakota. An Option Notice exercising Operator’s Option referenced in the Memorandum of Easement was sent to Owner by Operator in letter dated April 29, 2008 with a Commencement Date declared as June 1, 2008.
25. That certain Wind Farm Easement Agreement by and between Janet M. Patterson and Robert Patterson, wife and husband; Steven J. Levi and Lisa Levi, husband and wife and Laura C. Porras and Rick Porras, wife and husband, subject to a life estate to John A. Moldstad (Owner”) and Boulevard Associates, LLC, a Delaware limited liability company (“FPLE”) dated February 18, 2008. Memorandum of Easements recorded as Document No. 262363 in Barnes County, North Dakota. An Option Notice exercising Operator’s Option referenced in the Memorandum of Easement was sent to Owner by Operator in letter dated April 29, 2008 with a Commencement Date declared as June 1, 2008.

26. That certain Wind Farm Easement Agreement by and between Evelyn Pedersen (f/k/a Evelyn Pross) and Bruce Pedersen, wife and husband (Owner”) and Boulevard Associates, LLC, a Delaware limited liability company (“FPLE”) dated November 27, 2007. Memorandum of Easements recorded as Document No. 261641 in Barnes County, North Dakota. An Option Notice exercising Operator’s Option referenced in the Memorandum of Easement was sent to Owner by Operator in letter dated April 29, 2008 with a Commencement Date declared as June 1, 2008. An Option Notice exercising Operator’s Option referenced in the Memorandum of Easement was sent to Owner by Operator in letter dated April 29, 2008 with a Commencement Date declared as June 1, 2008.
27. That certain Wind Farm Easement Agreement by and between Julianne Pedersen, a single person (Owner”) and Boulevard Associates, LLC, a Delaware limited liability company (“FPLE”) dated March 10, 2007. Memorandum of Easements recorded as Document No. 262364 in Barnes County, North Dakota. An Option Notice exercising Operator’s Option referenced in the Memorandum of Easement was sent to Owner by Operator in letter dated April 29, 2008 with a Commencement Date declared as June 1, 2008.
28. That certain Wind Farm Easement Agreement by and between Mark Pedersen, a single person (Owner”) and Boulevard Associates, LLC, a Delaware limited liability company (“FPLE”) dated November 15, 2007. Memorandum of Easements recorded as Document No. 261642 in Barnes County, North Dakota. An Option Notice exercising Operator’s Option referenced in the Memorandum of Easement was sent to Owner by Operator in letter dated April 29, 2008 with a Commencement Date declared as June 1, 2008.
29. That certain Wind Farm Easement Agreement by and between Prairie Industries, LLC (Owner”) and Boulevard Associates, LLC, a Delaware limited liability company (“FPLE”) dated March 20, 2008. Memorandum of Easements recorded as Document No. 262775 in Barnes County, North Dakota. An Option Notice exercising Operator’s Option referenced in the Memorandum of Easement was sent to Owner by Operator in letter dated April 29, 2008 with a Commencement Date declared as June 1, 2008.
30. That certain Wind Farm Easement Agreement by and between Julius V. Reitan, a single person (“Owner”) and Boulevard Associates, LLC (“Operator”) dated February 18, 2008. Memorandum of Easements recorded as Document Number 262365, Barnes County, North Dakota. An Option Notice exercising Operator’s Option referenced in the Memorandum of Easement was sent to Owner by Operator in letter dated April 29, 2008 with a Commencement Date declared as June 1, 2008.
31. That certain Wind Farm Easement Agreement by and between Timothy J. Ripplinger and Ann Ripplinger, husband and wife, and Terrance W. Sando and Debra Sando, husband and wife, subject to the life estate of Harold S. Pross, a widower (Owner”) and Boulevard Associates, LLC, a Delaware limited liability company (“FPLE”) dated September 10, 2007. Memorandum of Easements recorded as Document No. 261646 in Barnes County,

North Dakota. An Option Notice exercising Operator's Option referenced in the Memorandum of Easement was sent to Owner by Operator in letter dated April 29, 2008 with a Commencement Date declared as June 1, 2008.

32. That certain Wind Farm Easement Agreement by and between Michael L. Schmidt and Diana Schmidt, husband and wife, an undivided one-half interest; and Joseph L. Schmidt and Melinda Schmidt, husband and wife, an undivided one-half interest, subject to the life estate of Bruce L. Schmidt and Carol J. Schmidt ("Owner") and Boulevard Associates, LLC, a Delaware limited liability company ("FPLE") dated March 20, 2008. Memorandum of Easements recorded as Document No. 262777 in Barnes County, North Dakota. An Option Notice exercising Operator's Option referenced in the Memorandum of Easement was sent to Owner by Operator in letter dated April 29, 2008 with a Commencement Date declared as June 1, 2008.
33. That certain Wind Farm Easement Agreement by and between John S. Svenningsen and Virginia Svenningsen, husband and wife ("Owner") and Boulevard Associates, LLC, a Delaware limited liability company ("FPLE") dated February 18, 2008. Memorandum of Easements recorded as Document No. 262776 in Barnes County, North Dakota. An Option Notice exercising Operator's Option referenced in the Memorandum of Easement was sent to Owner by Operator in letter dated April 29, 2008 with a Commencement Date declared as June 1, 2008.
34. That certain Wind Farm Easement Agreement by and between Larry Svenningsen and Carmen Svenningsen, husband and wife ("Owner") and Boulevard Associates, LLC ("Operator") dated September 10, 2007. Memorandum of Easements recorded as Document Number 261655, Barnes County, North Dakota. An Option Notice exercising Operator's Option referenced in the Memorandum of Easement was sent to Owner by Operator in letter dated April 29, 2008 with a Commencement Date declared as June 1, 2008.
35. That certain Wind Farm Easement Agreement by and between Mark Svenningsen and Jody Svenningsen, husband and wife ("Owner") and Boulevard Associates, LLC ("Operator") dated August 10, 2007. Memorandum of Easements recorded as Document Number 261009, Barnes County, North Dakota. An Option Notice exercising Operator's Option referenced in the Memorandum of Easement was sent to Owner by Operator in letter dated April 29, 2008 with a Commencement Date declared as June 1, 2008.
36. That certain Wind Farm Easement Agreement by and between Charmelle R. Hughes and Jerry Hughes, a/k/a Gerald M. Hughes, wife and husband and Pamela K. Narum and Dave Narum, a/k/a David N. Narum, wife and husband, subject to the life estate of Robert L. Svenningsen and Beverly A. Svenningsen, husband and wife ("Owner") and Boulevard Associates, LLC ("Operator") dated December 17, 2007. Memorandum of Easements recorded as Document Number 261656, Barnes County, North Dakota. An Option Notice exercising Operator's Option referenced in the Memorandum of Easement was sent to Owner by Operator in letter dated April 29, 2008 with a Commencement Date declared as June 1, 2008.

37. That certain Wind Farm Easement Agreement by and between Robin Winter and Steve Winter, wife and husband, subject to the life estate of Shirley Svenningsen (“Owner”) and Boulevard Associates, LLC (“Operator”) dated August 10, 2007. Memorandum of Easements recorded as Document Number 261013, Barnes County, North Dakota. An Option Notice exercising Operator’s Option referenced in the Memorandum of Easement was sent to Owner by Operator in letter dated April 29, 2008 with a Commencement Date declared as June 1, 2008.

38. That certain Wind Farm Easement Agreement by and between Shelly Williams and Kenneth Williams, wife and husband; Holly Newton and Michael Newton, wife and husband and Ann Schommer and Jeffrey Schommer, wife and husband (“Owner”) and Boulevard Associates, LLC (“Operator”) dated January 18, 2008. Memorandum of Easements recorded as Document Number 262174, Barnes County, North Dakota. An Option Notice exercising Operator’s Option referenced in the Memorandum of Easement was sent to Owner by Operator in letter dated April 29, 2008 with a Commencement Date declared as June 1, 2008.

Exhibit B

Land Descriptions

1. **Elizabeth Anderson and Richard Anderson**

The Southeast Quarter (SE $\frac{1}{4}$) of Section 2, in Township 141 North, of Range 57 West of the Fifth-Principal Meridian, Barnes County, North Dakota.

The Northeast Quarter (NE $\frac{1}{4}$), and the North Half of the Southeast Quarter (N $\frac{1}{2}$ SE $\frac{1}{4}$) of Section 11, in Township 141 North, of Range 57 West of the Fifth Principal Meridian, Barnes County, North Dakota.

Government Lots One (1) and Two (2), and the South Half of the Northeast Quarter (S $\frac{1}{2}$ NE $\frac{1}{4}$) of Section Three (3), also described as the Northeast Quarter (NE $\frac{1}{4}$) of Section Three (3), in Township One Hundred Forty-one (141) North, of Range Fifty-seven (57) West of the Fifth Principal Meridian, Barnes County, North Dakota.

2. **Shawn Anderson and Linda Anderson**

The South Half of the North Half of the Southeast Quarter (S $\frac{1}{2}$ N $\frac{1}{2}$ SE $\frac{1}{4}$) of Section 15, Township 141 North of Range 57, West of the Fifth Principal Meridian, Barnes County, North Dakota.

The Southeast Quarter of the Southeast Quarter (SE $\frac{1}{4}$ SE $\frac{1}{4}$) of Section 15, Township 141 North of Range 57 West of the Fifth Principal Meridian, Barnes County, North Dakota.

The Southwest Quarter of the Southeast Quarter (SW $\frac{1}{4}$ SE $\frac{1}{4}$) of Section 15, Township 141 North of Range 57 West of the Fifth Meridian, Barnes County, North Dakota.

The Northwest Quarter (NW $\frac{1}{4}$) of Section 11, Township 141 North of Range 57 West of the Fifth Principal Meridian, Barnes County, North Dakota.

3. **Mark Askerooth, et al**

That part of Section 9, containing 160 acres, more or less, bounded and more particularly described as follows, to wit: Beginning at a point 100 rods W of the SE corner of said Section 9; thence running N 320 rods; thence W 60 rods; thence S 100 rods; thence W 53 1/3 rods; thence S 120 rods; thence E 53 1/3 rods; thence S 100 rods; thence E 60 rods to the point of beginning, in Township 142 North of Range 57 West of the Fifth Principal Meridian, Barnes County, North Dakota

The Southwest Quarter of Section 10, in Township 142 North of Range 57 West of the 5th P.M., Barnes County, North Dakota

4. **Casey Burchill & Debra Burchill**

The Southwest Quarter (SW¹/₄) of Section 32 in Township 143 North of Range 57 West of the Fifth Principal Meridian, Barnes County, North Dakota.

The Northeast Quarter (NE¹/₄) and also the Northeast Quarter of the Southwest Quarter (NE¹/₄SW¹/₄) and Government Lot 3 [comprising the fractional North Half of the Southwest Quarter (N¹/₂SW¹/₄) of Section 7 in Township 142 North of Range 57 West of the Fifth Principal Meridian, Barnes County, North Dakota.

5. **John and Frances Burchill LE**

All of the East Half (E¹/₂) of Section 16, Township 142 North, of Range 57 West of the Fifth Principal Meridian, Barnes County, North Dakota, excepting six acres granted to Grand Prairie School District No. 67 described as beginning at the Southeast corner of said Section 16, thence due North 43 rods 10.5 feet, thence due West 22 rods, thence due South 43 rods 10.5 feet, thence due East 22 rods to the point of beginning.

6. **Perry Burchill and Kathy Burchill**

The Southwest Quarter (SW¹/₄) of Section 16 and the West Half (W¹/₂) of Section 17, all in Township 142 North of Range 57 West of the Fifth Principal Meridian, Barnes County, North Dakota.

The Southeast Quarter (SE¹/₄) of Section 17, Township 142, Range 57, Barnes County, North Dakota.

The South Half (S¹/₂) of Section 8, in Township 142 North of Range 57 West of the Fifth Principal Meridian, Barnes County, North Dakota, subject to that certain agreement dated December 12, 1966 and recorded in Book D-5 of Misc, at page 595.

The North Half (N $\frac{1}{2}$) of the Northeast Quarter (NE $\frac{1}{4}$) and the South Half (S $\frac{1}{2}$) of the Northeast Quarter (NE $\frac{1}{4}$) all in Section 8, Township 142, Range 57, Barnes County, North Dakota.

That portion of the Northwest Quarter (NW $\frac{1}{4}$) of Section 9 in Township 142 North of Range 57 West of the Fifth Principal Meridian, Barnes County, North Dakota, more particularly described as follows: Beginning at a point in the Northwest corner of said Section 9, and thence running East on the section line 160 rods, thence South 100 rods parallel with the West section line of said section on the quarter line, thence West 160 rods parallel with the North section line of said section, thence North 100 rods on the section line of said section to the point of beginning, said tract containing 100 acres.

The South Half (S $\frac{1}{2}$) of Section 32 in Township 142 North of Range 57 West of the Fifth Principal Meridian, Barnes County, North Dakota.

The Northeast Quarter (NE $\frac{1}{4}$) of Section 17, in Township 142 North of Range 57 West of the Fifth Principal Meridian, Barnes County, North Dakota.

The East Half of the Southwest Quarter (E $\frac{1}{2}$ SW $\frac{1}{4}$) of Section 31, in Township 142 North, Range 57 West of the Fifth Principal Meridian, situated in Barnes County, North Dakota.

The Southeast Quarter (SE $\frac{1}{4}$) of Section 31, Township 142 North, Range 57 West of the Fifth Principal Meridian in Barnes County, North Dakota.

The Northwest Quarter (NW $\frac{1}{4}$) of Section 32, Township 143 North, Range 57 West of the Fifth Principal Meridian, Barnes County, North Dakota, Less and except railroad right of way.

7. **Richard Burchill and Jeanette Burchill**

The West One half (W $\frac{1}{2}$) of Section 34, in Township 143 North, of Range 57 West of the Fifth principal Meridian located in Barnes County, North Dakota.

8. **Sandra Burchill**

The Southwest Quarter (SW $\frac{1}{4}$) of Section 28 and the Southeast Quarter (SE $\frac{1}{4}$) of Section 29, all in Township 142 North of Range 57 West of the Fifth Principal Meridian, Barnes County, North Dakota.

The West Half (W $\frac{1}{2}$) and the Northeast Quarter (NE $\frac{1}{4}$) of Section 33, Township 142 North, Range 57 West of the Fifth Principal Meridian, Barnes County, North Dakota

The Northeast Quarter (NE $\frac{1}{4}$) of Section 6, Township 141 North, Range 57 West of the Fifth Principal Meridian, Barnes County, North Dakota.

9. **Doris Burdick LE**

The West One-Half (W $\frac{1}{2}$) of Section 2, in Township One Hundred Forty-one (141) North, of Range Fifty-seven (57) West of the Fifth Principal Meridian, Barnes County, North Dakota, EXCEPT that part of the West One-Half (W $\frac{1}{2}$) more particularly described as Parcel 4 of the

record plat BARNES COUNTY W.A. NO. 8, filed May 20, 1971, in Plat Book F, page 143, Barnes County Records, which part contains 54.51 acres, more or less.

10. **Bruce Emery & Tamara Emery**

The Southeast Quarter (SE $\frac{1}{4}$) of Section 30, Township 143 North of Range 57 West of the Fifth Principal Meridian, Barnes County, North Dakota.

The Southwest Quarter (SW $\frac{1}{4}$) of Section 30, Township 143 North of Range 57 West of the Fifth Principal Meridian, Barnes County, North Dakota.

11. **Merle Flatt and Marion Flatt**

The South Half (S $\frac{1}{2}$) of Section 10, and the North Half (N $\frac{1}{2}$) of Section 15, in Township 143, Range 57, Barnes County, North Dakota, excepting the following described tract containing 5.0 acres:

Part of the South Half (S $\frac{1}{2}$) of Section 10, in Township 143, Range 57 West, Barnes County, North Dakota; described as follows:

Commencing at the Southwest corner of said Section 10, thence North 90 degrees 00'00" East along the South line of said Section 10, 2147.67 feet, thence North 0 degrees 00'00" East, 450.00 feet; to the point of beginning; thence North 0 degrees 00'00" East 400.00 feet; thence North 90 degrees 00'00" East 545.00 feet; thence South 0 degrees 00'00" West 400.00 feet; thence South 90 degrees 00'00" West 545.00 feet; to the point of beginning; said parcel contains 5.00 acres more or less.

A part of the Northwest Quarter (NW $\frac{1}{4}$) of Section 22, in Township 143, Range 57, being particularly described as, commencing at a point on the Northwest (NW) corner; thence due East 35 rods; thence due South 23 rods; thence due West 35 rods; thence due North 23 rods, to place of beginning, less and excepting any and all parcels heretofore deeded for highway right-of-way purposes, containing 2.8 acres, more or less.

The Northeast Quarter (NE $\frac{1}{4}$) and the Northwest Quarter (NW $\frac{1}{4}$) of Section 13, containing 320 acres, the Northeast Quarter (NE $\frac{1}{4}$) of Section 14, containing 160 acres, and the Northwest Quarter (NW $\frac{1}{4}$) of Section 22, less 5.0 acres owned by Baldwin Township and Highway Right of Ways, containing 149.47 acres, all in Township 143 North, Range 57 West, Barnes County, North Dakota.

12. **Duane Haga**

The East Half (E $\frac{1}{2}$) of Section 28, Township 142 North, Range 57 West of the Fifth Principal Meridian, Barnes County, North Dakota. LESS & EXCEPT: Auditor's Lot 1, described as follows:

A tract of land situated in the East Half (E½) of Section 28, Township 142 North, Range 57 West of the Fifth Principal Meridian, Barnes County, North Dakota, more particularly described as follows: Commencing at the Northeast corner of Section 28; thence South 0°00'00" East along the Section line a distance of 2,239.00 feet to an iron pin, the Point of Beginning; thence continuing South 0°00'00" East along the Section line a distance of 445.00 feet to an iron pin; thence South 90°00'00" West a distance of 698.00 feet to an iron pin; thence North 0°0.0'00" West a distance of 445.00 feet to an iron pin; thence North 90°00'00" East a distance of 698.00 feet to the Point of Beginning. Said Tract of land contains 7.13 acres more or less.

13. **Lynn Holcomb and Linda Holcomb**

The Southeast Quarter (SE¼) of Section 33, in Township 142 North of Range 57 West of the Fifth Principal Meridian, Barnes County, North Dakota.

The North Half (N½), and the West Half of the Southwest Quarter (W½SW¼) of Section 31, Township 142 North, 57 West, Barnes County, North Dakota.

The Southeast Quarter (SE¼) and the Northwest Quarter (NW¼) of Section 36, Township 142, of Range 58, West of the Fifth Principal Meridian, Barnes County, North Dakota

14. **John Ihry**

The East Half (E½) of Section 22, Township 143 North, Range 57 West of the Fifth Principal Meridian, Barnes County, North Dakota

15. **Charlotte Johns, LE**

The Northwest Quarter (NW¼) of Section 20, in Township 142 North, Range 57 West of the Fifth Principal Meridian, Barnes County, North Dakota.

16. **Pamela Johnson & Stanley Johnson**

The North Half (N½) of Section 30, in Township 143 North, of Range 57 West to the Fifth Principal Meridian, Barnes County, North Dakota, according to the United States Government Survey thereof.

17. **Frances M. Jorgenson, LE**

The West Half (W½) of Section 33, and the Northeast Quarter (NE¼) of Section 32, all in Township 143 North of Range 57 West of the Fifth Principal Meridian, in Barnes County, North Dakota.

18. **Josephine Koch Trust**

The East Half (E½) of Section 20, Township 142, Range 57 West of the Fifth Principal Meridian, Barnes County, North Dakota, LESS a tract of land containing 10.17 acres, more or less, situated in the North Half of the Northeast Quarter (N½ NE¼) of said Section 20, more particularly described as follows: Commencing at the northeast corner of said Section 20; thence South 66°58'30" West for a distance of 1446.64 feet to the point of beginning of said tract of land to be described; thence East for a distance of 275.00 feet; thence South for a distance of 550.00 feet; thence West for a distance of 395 feet; thence South for a distance of 170.00 feet; thence West for a distance of 400.00 feet; thence North for a distance of 400.00 feet; thence East for a distance of 195.00 feet; thence North for a distance of 320 feet; thence East for a distance of 325.00 feet to the point of beginning

The West Half (W½) of Section 21, Township 142, Range 57 West of the Fifth Principal Meridian, Barnes County, North Dakota.

The Southeast Quarter (SE¼), West Half of the Northeast Quarter (W½NE¼) and the East Half of the Northwest Quarter (E½NW¼) of Section 6, Township 142 North, Range 57 West of the Fifth Principal Meridian, Barnes County, North Dakota.

19. **Kunze Family Trust**

The Southeast Quarter (SE¼), the East Half of the Southwest Quarter (E½SW¼) and Lots 3 and 4, also described as the South Half (S½) of Section 19, in Township 143 North, of Range 57 West of the Fifth Principal Meridian, Barnes County, North Dakota, according to the United States Government Survey thereof, subject to easements and rights of way of record, excepting a strip of land lying in the SW¼ of Section 19, Township 143, Range 57, said strip being 80 feet wide, lying 40 feet on each side of the following described centerline: Beginning at a point 1.84 feet South of the SW corner of said SW¼ of Section 19, and point being on the centerline of the State Highway as surveyed and staked over and across said SW¼ of Section 19, thence running Northeasterly along a 2° curve 103.4 feet; thence N 85° 15'E 2460.5 ft. to the East line of said SW¼ of Section 19, excepting all that portion lying within 33 feet of the section line. Said tract contains 6.96 acres, more or less; and also **excepting** that portion of the SE¼ of Section 19, Township 143 North, Range 57 West, lying within a strip of land, said strip being 80 feet wide, lying 40 feet on each side of the following described centerline: Beginning at the SE corner of said SE¼ of Section 19; thence running N89° 45' W 302.7 ft.; thence along a 4° curve to the right 474.1 feet.; thence N 70° 47'W 548.2 ft.; thence along a 6° curve to the left 399.4 feet.; thence S 85°15' W 969.75 ft. to the West line of said SE¼ of Section 19. Also including all that portion of said SE¼ of Section 19, lying between said strip and the South and West lines of said SE¼ of Section 19, excepting all that portion lying within 33 feet of the Section line. Said strip contains 11.13 acres, more or less; and also excepting a tract of land lying in the SW ¼ of Section 19, Township 143 North, Range 57 West said tract being described as follows: Beginning at a point due North 1804.9 ft. and due East 486.1 ft. from the SW corner of said Section 19, thence running due East 240.0 ft.; thence N 16°17'E 865.7 ft. to the quarter line; thence due West 240.0 feet along the quarter line; thence S 16°17' W 865.7 ft. to the place of beginning. Tract containing 4.58 acres, more or less; and **further subject** to a permanent easement granted to the State of North Dakota described as follows: A strip of land lying in the SW¼

of Section 19, Township 143 North, Range 57 West, said strip being described as follows: Beginning at a point due North 1804.9 ft. due East 33.0 ft. from the SW corner of said Section 19; thence running due East 453.1 ft. to the SW corner of the pit; thence N 16°17'E 52.1 feet; thence due West 467.7 feet.; thence due South 50.0 ft. to the place of beginning. Tract contains 0.53 acres, more or less.

The Northeast Quarter of Section 19, Township 143 North, of Range 57 West of the Fifth Principal Meridian located in Barnes County, North Dakota.

Less and Except a tract of land situated in the East Half (E½) of Section 19, Township 143 North, Range 57 West of the Fifth Principal Meridian located in Barnes County, North Dakota, more particularly described as follows: Commencing at the Northeast corner of said Section 19; thence S00° 20' 11"E along the Section line a distance of 1,262.05 feet to a point, thence S88° 00' 51"W a distance of 1651.17 feet to an iron pin; thence S03° 51' 09"W a distance of 587.16 feet to an iron pin, the Point of Beginning; thence continuing S03° 51' 09"W a distance of 763.04 feet to an iron pin; thence N88° 40' 53"W a distance of 143.31 feet to an iron pin; thence N58° 00' 51"W a distance of 207.43 feet to an-iron pin; thence N47° 44' 21" W a distance of 236.91 feet to an iron pin; thence N 06° 03' 57"W a distance 371.84 feet to an iron pin; thence N85° 09' 54"W a distance of 344.23 feet to an iron pin; thence N 03° 54' 04"E a distance of 147.13 feet to an iron pin; thence S 86° 08' 33" E a distance of 841.17 feet to the point of beginning. Said tract of land contains 9.16 acres more or less, of which 9.06 acres are in the Northeast Quarter (NE ¼) and 0.10 acres are in the Southeast Quarter (SE¼).

20. **Edson Larson & Margaret Larson**

The Southwest Quarter of the Northeast Quarter (SW¼ NE¼) and Lot 2 constituting the West Half of the Northeast Quarter (W½ NE¼) and the South Half of the Northwest (S½ NW¼) and Lots 3 and 4, constituting Northwest Quarter (NW¼), and South Half (S½) of Section 5, Township 142N, Range 57W, excepting therefrom the following described tracts of land; commencing 54 rods east of the southwest corner of Section 5, Township 142N, Range 57W, thence running North 14 rods; thence East 11 rods, thence South 14 rods; thence west to place of beginning, used for school purposes; a strip of land lying in the fractional Northwest quarter (NW¼) of Section 5, Township 142N, Range 57W, said strip being described as follows: a strip of land 40 feet wide lying South of, adjacent to and extending along the entire North line of said fractional Northwest Quarter (NW¼) of Section 5, excepting all that portion lying 33 ft. of the section line; also a strip of land lying in the fractional West half (W½) of the Northeast quarter (NE¼) of Section 5, Township 142N, Range 57W, said strip being described as follows: a strip of land 40 ft. wide lying south of, adjacent to and extending along the entire North line of said fractional West Half (W½) of Northeast quarter (NE¼) of Section 5, excepting all that portion lying within 33 ft. of section line, used for highway purposes, and being the same real estate conveyed to the Union Central Life Insurance Company by Sheriff's Deed

recorded in Book 65 of Deeds, page 405 in office of Register of Deed in Barnes County, North Dakota.

21. **James Larson**

The Southwest Quarter (SW $\frac{1}{4}$) of Section 9; the Northwest Quarter (NW $\frac{1}{4}$) of Section 8; the West One-Half of the Northeast Quarter (W $\frac{1}{2}$ NE $\frac{1}{4}$) of Section Eight 8; all in Township 141, Range 57, Barnes County, North Dakota.

The South One-Half (S $\frac{1}{2}$) of Section 8, and the North One-Half (N $\frac{1}{2}$) of Section 9, all in Township 141, Range 57, Barnes County, North Dakota.

The West One-Half of the Southeast Quarter (W $\frac{1}{2}$ SE $\frac{1}{4}$) of Section 34, Township 142, Range 57, Barnes County, North Dakota

The West Half of the Southeast Quarter (W $\frac{1}{2}$ SE $\frac{1}{4}$), and the East Half of the Southwest Quarter (E $\frac{1}{2}$ SW $\frac{1}{4}$) of Section 4, in Township 141 North of Range 57 West of the Fifth Principal Meridian, Barnes County, North Dakota.

22. **Joyce Larson Trust**

The Southwest Quarter (SW $\frac{1}{4}$) of Section 29, the East One Half of the Southeast Quarter (E $\frac{1}{2}$ SE $\frac{1}{4}$) of Section 34, and the North One Half (N $\frac{1}{2}$) of Section 32, all in Township 142, Range 57, Barnes County, North Dakota.

23. **James A. Leadbetter Life Estate**

The North Half (N $\frac{1}{2}$) of Section 4 in Township 142, Range 57 West of the Fifth Principal Meridian, in Barnes County, North Dakota, subject to easements and rights of way of record.

The East One-Half of the Northwest Quarter (E $\frac{1}{2}$ NW $\frac{1}{4}$), the West One-Half of the Northwest Quarter (W $\frac{1}{2}$ NW $\frac{1}{4}$), the South Half of the Southeast Quarter (S $\frac{1}{2}$ SE $\frac{1}{4}$), the North Half of the Southeast Quarter (N $\frac{1}{2}$ SE $\frac{1}{4}$), in Section 3, Township 141, Range 57 West of the Fifth Principal Meridian, Barnes County, North Dakota.

24. **Hovey Molstad LE**

All of Section 18, in Township 142 North, of Range 57 West of the Fifth Principal Meridian, Barnes County, North Dakota.

The South One-Half of the South One-Half (S $\frac{1}{2}$ S $\frac{1}{2}$) of Section 12 in Township 142 North, of Range 58 West of the Fifth Principal Meridian, Barnes County, North Dakota.

25. **John Molstad LE**

The East One Half of the Northwest Quarter (E $\frac{1}{2}$ NW $\frac{1}{4}$) and the Northeast Quarter (NE $\frac{1}{4}$) of Section 19, and the Southwest Quarter (SW $\frac{1}{4}$) of Section 20, all in Township 142 North Range 57 West of the Fifth Principal Meridian, Barnes County, North Dakota.

26. **Bruce Pedersen & Evelyn Pedersen**

The North one-half of the Northeast Quarter (N $\frac{1}{2}$ NE $\frac{1}{4}$), the Northwest Quarter (NW $\frac{1}{4}$), and the West one-half of the Southwest Quarter (W $\frac{1}{2}$ SW $\frac{1}{4}$), all in Section 20, Township 143 North Range 57 West of the Fifth P.M., Barnes County, North Dakota.

27. **Julianne Pedersen**

The West One Half of the East One Half (W $\frac{1}{2}$ E $\frac{1}{2}$) of Section 34, Township 143 North, Range 57 West of the Fifth Principal Meridian, Barnes County, North Dakota.

The Northeast Quarter (NE $\frac{1}{4}$) and the Southwest Quarter (SW $\frac{1}{4}$) of Section 26, Township 143 North, Range 57 West of the Fifth Principal Meridian, Barnes County, North Dakota.

28. **Mark Pedersen**

The Northwest Quarter (NW $\frac{1}{4}$), the Southwest Quarter (SW $\frac{1}{4}$) and the East Half (E $\frac{1}{2}$) of Section 27, Township 143 North, of Range 57 West of the Fifth Principal Meridian

29. **Prairie Industries**

The East Half of the Southeast Quarter (E $\frac{1}{2}$ SE $\frac{1}{4}$) and the Southwest Quarter of the Southeast Quarter (SW $\frac{1}{4}$ SE $\frac{1}{4}$) of Section 8, Township 141 North, Range 57 West of the Fifth Principal Meridian, Barnes County, North Dakota, less a 4.25 acre tract described as follows: A tract of land in the Southeast Quarter (SE $\frac{1}{4}$) of Section 8, Township 141 North, Range 57 West of the Fifth Principal Meridian, Barnes County, North Dakota, more particularly described as follows: Beginning at the Southeast (SE) corner of the Southeast Quarter (SE $\frac{1}{4}$) of Section 8, Township 141 N, Range 57 W; thence West along the south quarter line a distance of 1,207 feet to the point of beginning; thence North at a 90° angle a distance of 740 feet to a point; thence East at a 90° angle a distance of 250 feet to a point, thence South at a 90° angle a distance of 740 feet to a point; thence West along the south quarter line a distance of 250 feet to the point of beginning. Said tract contains 4.25 acres, more or less.

30. **Harold Pross Life Estate**

The East half ($E\frac{1}{2}$) of Section 33 and the Southeast Quarter ($SE\frac{1}{4}$) of Section 29, Township 143 North, Range 57 West, Barnes County, North Dakota.

31. **Julius Reitan**

The Northwest Quarter ($NW\frac{1}{4}$) also known as the East Half of the Northwest Quarter ($E\frac{1}{2}NW\frac{1}{4}$) and Lots 1 and 2, of Section 7, Township 142 North, Range 57 West of the 5th P.M.; Barnes County, North Dakota,

The North Half of the South Half ($N\frac{1}{2}S\frac{1}{2}$) of Section 12, the Northeast Quarter ($NE\frac{1}{4}$), and Lots 2, 3, 4, and 5 of Section 12, Township 142 North, Range 58 West of the 5th P.M., Barnes County, North Dakota.

32. **Bruce Schmidt & Carol Schmidt LE**

The Northeast Quarter ($NE\frac{1}{4}$) less 2.51 acres right-of-way, 161.90 acres, and the East One Half of the Southeast Quarter ($E\frac{1}{2}SE\frac{1}{4}$) less 2.51 acres right-of-way, 77.49 acres, Section 4, in Township 141 North, Range 57 West of Fifth Principal Meridian in Barnes County, North Dakota.

The Southeast Quarter ($SE\frac{1}{4}$) of Section 15, the Southeast Quarter ($SE\frac{1}{4}$) less 2.51 acres right-of-way, 157.49 acres, in Section 21, the Northeast Quarter ($NE\frac{1}{4}$) and the North Half of the Northwest Quarter ($N\frac{1}{2}NW\frac{1}{4}$) less 1.24 acres right-of-way, 78.76 acres in Section 22, all in Township 142 North, Range 57 West of Fifth Principal Meridian in Barnes County, North Dakota.

33. **John Svenningsen & Virginia Svenningsen**

The Northwest Quarter ($NW\frac{1}{4}$) of Section 6 in Township 141 North, Range 57 West of the Fifth Principal Meridian Barnes County, North Dakota.

34. **Larry Svenningsen & Carmen Svenningsen**

That portion of the West Half ($W\frac{1}{2}$) of Section 9, in Township 142 North of Range 57 West of the Fifth Principal Meridian, in Barnes County, North Dakota, described by metes and bounds as follows: Beginning at a point 160 rods North and 106 and $\frac{2}{3}$ rods East from the Southwest corner of said Section 9; thence running North 60 rods; thence West 106 and $\frac{2}{3}$ rods; thence South 60 rods; thence East 106 and $\frac{2}{3}$ rods to the point of beginning; containing Forty (40) acres, more or less;

Also that portion of said Section 9, in Township 142 North of Range 57 West of the Fifth Principal Meridian, in Barnes County, North Dakota, bounded and particularly described as follows: to-wit: Beginning at point 100 rods North of the Southwest corner of said Section 9; thence East 106 and $\frac{2}{3}$ rods; thence North 60 rods; thence West 106 and $\frac{2}{3}$ rods; thence South 60 rods, to the place of beginning; containing Forty (40) acres, more or less;

Also, all that part of the Southwest Quarter (SW $\frac{1}{4}$) of said Section 9, in Township 142 North of Range 57 West of the Fifth Principal Meridian, in Barnes County, North Dakota; described by metes and bounds as follows, to-wit: Beginning with the Southwest corner of said Section 9; thence running East 160 rods along the South line of said section, to the Southeast corner of the Southwest Quarter (SW $\frac{1}{4}$) of said Section 9; thence running North a distance of 100 rods along the East line of the Southwest Quarter (SW $\frac{1}{4}$) of said Section 9; thence running West 160 rods along a line parallel to the South line of said section to a point on the West line of said Section 9; thence south a distance of 100 rods along the West line of said section to the place of beginning, excepting two acres in the Southwest corner of said tract, still outstanding and held under former conveyance by deed to the Free Methodist Church, the said tract hereby conveyed containing 98 acres, more or less. All of said several measurements being based upon the Government Survey of the said Section 9.

The Southwest Quarter (SW $\frac{1}{4}$) of Section 6, Township 142 North, Range 57 West of the Fifth Principal Meridian, in Barnes County, North Dakota.

The Southeast Quarter (SE $\frac{1}{4}$) of Section 10, Township 142 North, Range 57 West of the Fifth Principal Meridian, in Barnes County, North Dakota. Subject to easements and rights of way.

The Southwest Quarter (SW $\frac{1}{4}$) of Section 1, Township 142, Range 58 West of the Fifth Principal Meridian, in Barnes County, North Dakota.

The West One-Half (W $\frac{1}{2}$) of Section 3, Township 142, Range 57 West of the Fifth Principal Meridian in Barnes County, North Dakota.

35. **Mark Svenningsen & Jody Svenningsen**

The Northwest Quarter (NW $\frac{1}{4}$) of Section 28, in Township 142 North of Range 57 West of the Fifth Principal Meridian, Barnes County, North Dakota, subject to any easements of record in the office of the Register of Deeds in and for Barnes County, North Dakota, for roadways, highways, transmission lines or any other purposes.

The Southwest Quarter (SW $\frac{1}{4}$) of Section 34, Township 142 North, Range 57 West Barnes County, North Dakota.

The North. One-Half (N $\frac{1}{2}$) of Section 9, Township 143, Range 57 West of the Fifth Principal Meridian located in Barnes County, North Dakota, according to the certified plat thereof on file and of record in the office of the Recorder in and for said County and State.

36. **Robert Svenningsen and Beverly Svenningsen LE**

The Southeast Quarter of Section 10 (SE $\frac{1}{4}$), All of Section 11 and the North Half of the Northwest Quarter (N $\frac{1}{2}$ NW $\frac{1}{4}$) of Section 14, all in Township 142 North, Range 58 West of the Fifth Principal Meridian located in Barnes County, North Dakota.

37. **Shirley Svenningsen Life Estate**

The Northwest Quarter (NW $\frac{1}{4}$) of Section 8, in Township 142, Range 57, Barnes County, North Dakota.

38. **Kenneth Williams, et al**

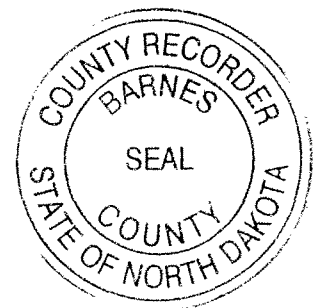
The Southwest Quarter (SW $\frac{1}{4}$) of Section 4, Township 142 North, Range 57 West of the Fifth Principal Meridian located in Barnes County, North Dakota.

The West One-Half (W $\frac{1}{2}$) of Section 7, Township 139 North, Range 57 West of the Fifth Principal Meridian located in Barnes County, North Dakota.

The West One-Half (W $\frac{1}{2}$) of Section 31, Township 140 North, Range 57 West of the Fifth Principal Meridian located in Barnes County, North Dakota.

DOCUMENT NUMBER **263828**

Grantor	J
Grantee	J
Indexed	J
Checked	CKK



Fee: \$ 238.00

263828

OFFICE OF COUNTY RECORDER County of Barnes, North Dakota
I hereby certify that the within instrument was filed in this office
on 10/9/2008 at 2:25 PM and was duly recorded.

Kirstin Cochran County Recorder

By _____ Deputy

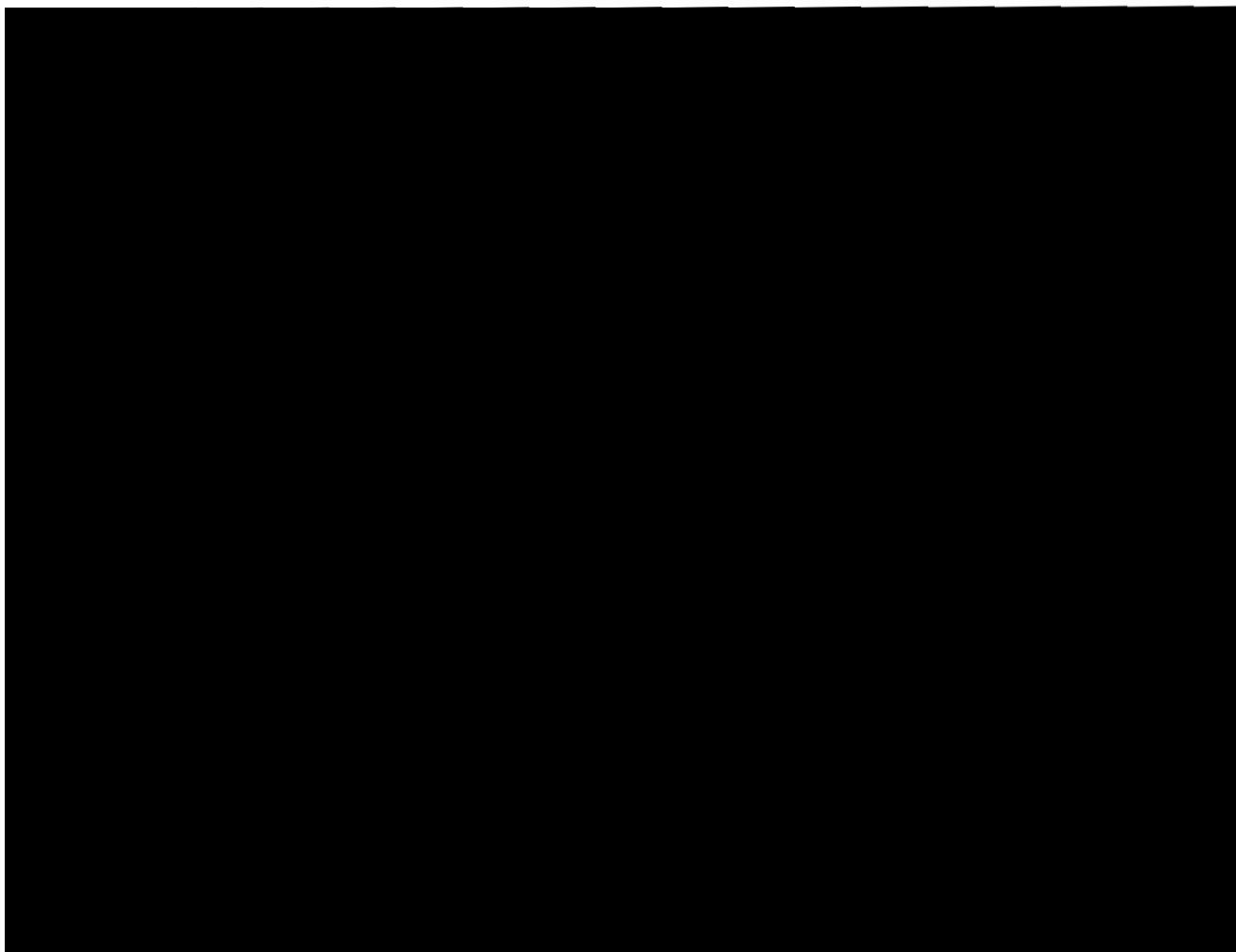
263828
24 of 24

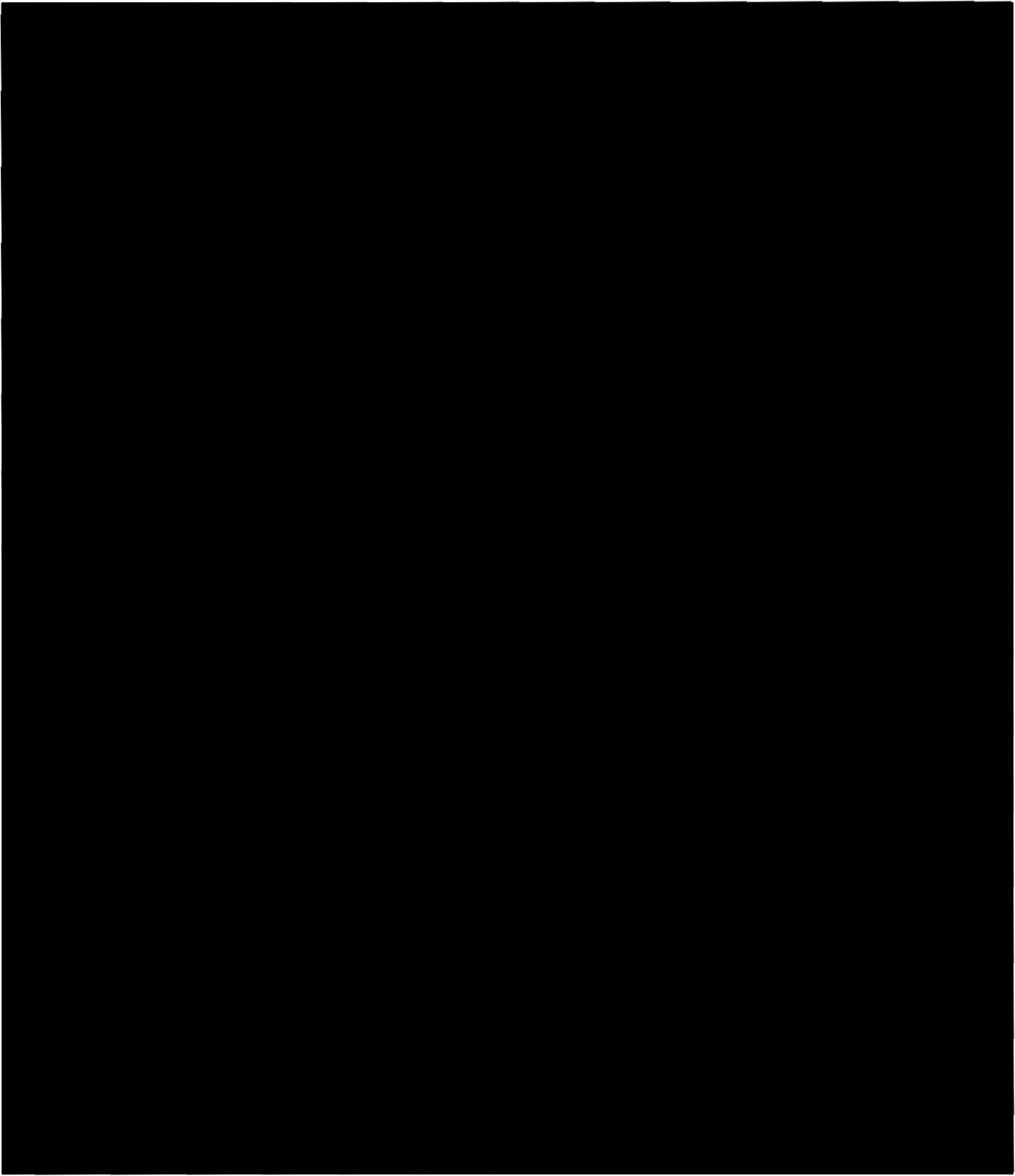
Return To: Cameron D. Sillers
908 3rd St.
LANGDON ND 58249

WIND FARM EASEMENT AGREEMENT

1. **Parties.** This Wind Farm Easement Agreement ("**Agreement**") is made and entered as of the 1 day of July, 2008 ("**Effective Date**"), by and between Trevor Jacobsen and Lisa Jacobsen, husband and wife, an undivided one-half interest, and Thomas Breckheimer and Tricia Breckheimer, husband and wife, an undivided one-half interest ("**Owner**") and Boulevard Associates, LLC, a Delaware limited liability company, an affiliate of FPL Energy, LLC, a Delaware limited liability company ("**Operator**") who are sometimes individually referred to as a "**Party**" and collectively as the "**Parties.**"

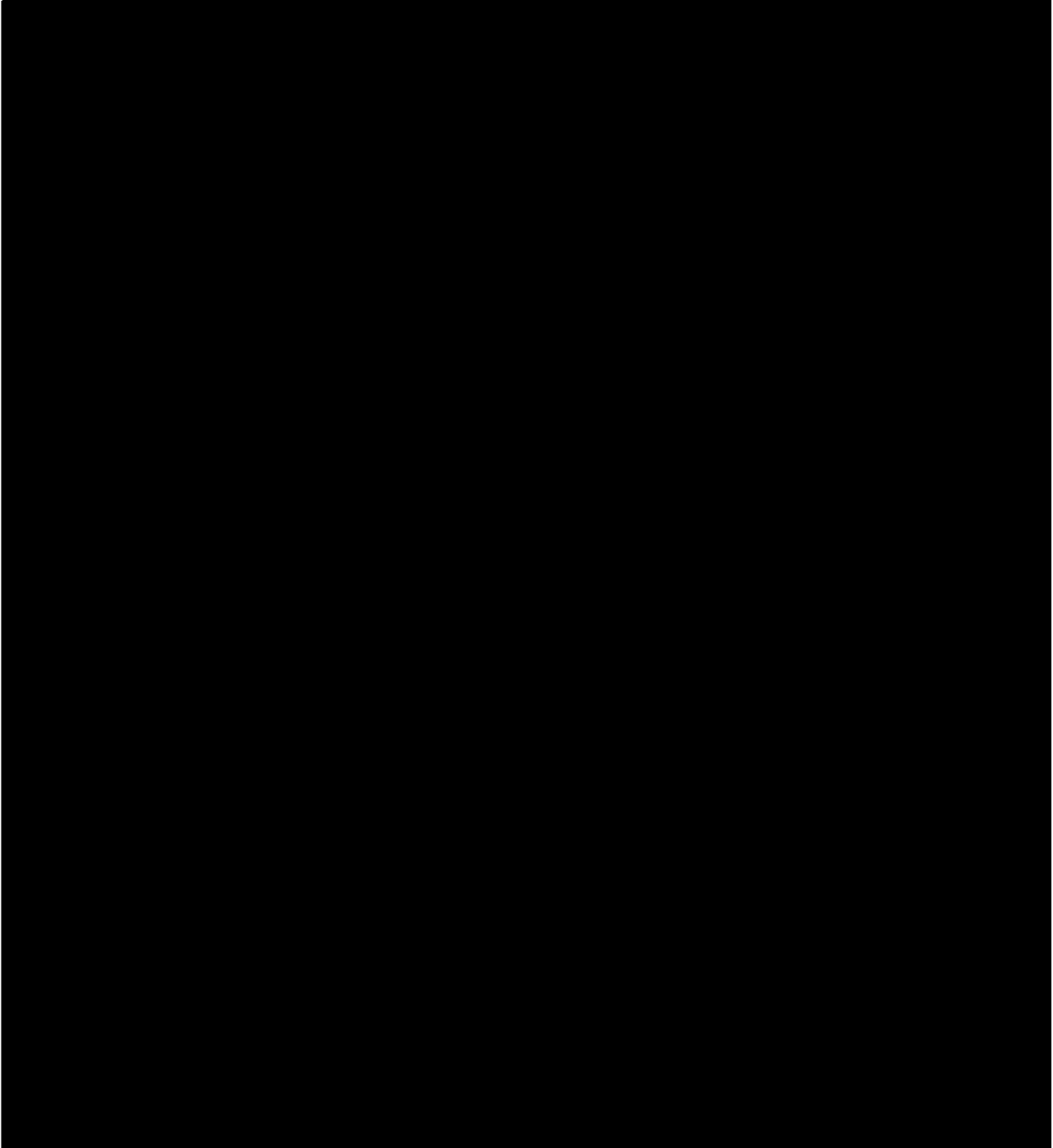
2. **Project.** This Agreement relates to the wind-powered electrical power generation and transmission project known as the "Ashtabula Wind Energy Center" to be located in Barnes County, North Dakota ("**Wind Farm**"), which may be wholly or partially located on the Owner's property legally described on the attached **Exhibit "A"** to this Agreement ("**Owner's Property**"). Upon Operator's exercise of the Option (as defined below), the Wind Farm shall include (i) the Easements referenced in Section 4 that are located on the Owner's Property, and (ii) the Improvements to be constructed on Owner's Property, including the Turbines referenced in Section 7.1. The Easements and Improvements are sometimes collectively referred to as the "**Operator Property.**"



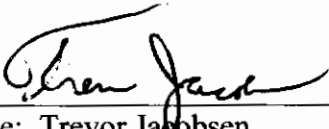


4.7 **Noise Easement.** Owner grants Operator an irrevocable, non-exclusive easement for the right and privilege to generate and maintain audible noise levels in excess of fifty (50) dbA on and above the Noise Easement Property at any or all times of the day or night (“**Noise Easement**”). The “**Noise Easement Property**” shall mean the Owner’s Property except those portions within a 200-foot radius circle (or lesser distance with Owner’s prior written consent) centered on the inside of each presently existing, occupied residence on the Owner’s Property. If noise levels emanating from the Turbines exceed fifty (50) dbA without the Owner’s written

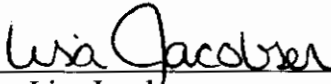
consent as measured within 200 feet (or lesser agreed distance) from the inside of a presently existing residence on Owner's Property by an independent professional applying commonly accepted measurement instruments and standards, Operator shall reduce the noise level to 50 dbA at 200 feet (or lesser agreed distance) from the residence. Measures to be taken by Operator may include installing insulation or sound deadening material in the offending Turbine(s); installing landscaping, insulation, and sound deadening material at the residence; or, changing the operation of the Turbine(s) to reduce noise output.



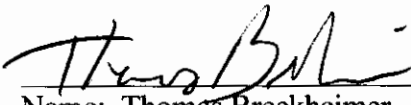
Owner



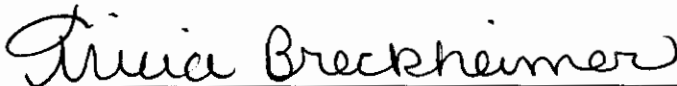
Name: Trevor Jacobsen



Name: Lisa Jacobsen



Name: Thomas Breckheimer



Name: Tricia Breckheimer

Operator

Boulevard Associates, LLC

a Delaware limited liability company

By: 

Name: _____

Title: _____

Dean R. Gosselin

Vice President

EXHIBIT "A"

Legal Description of Owner's Property

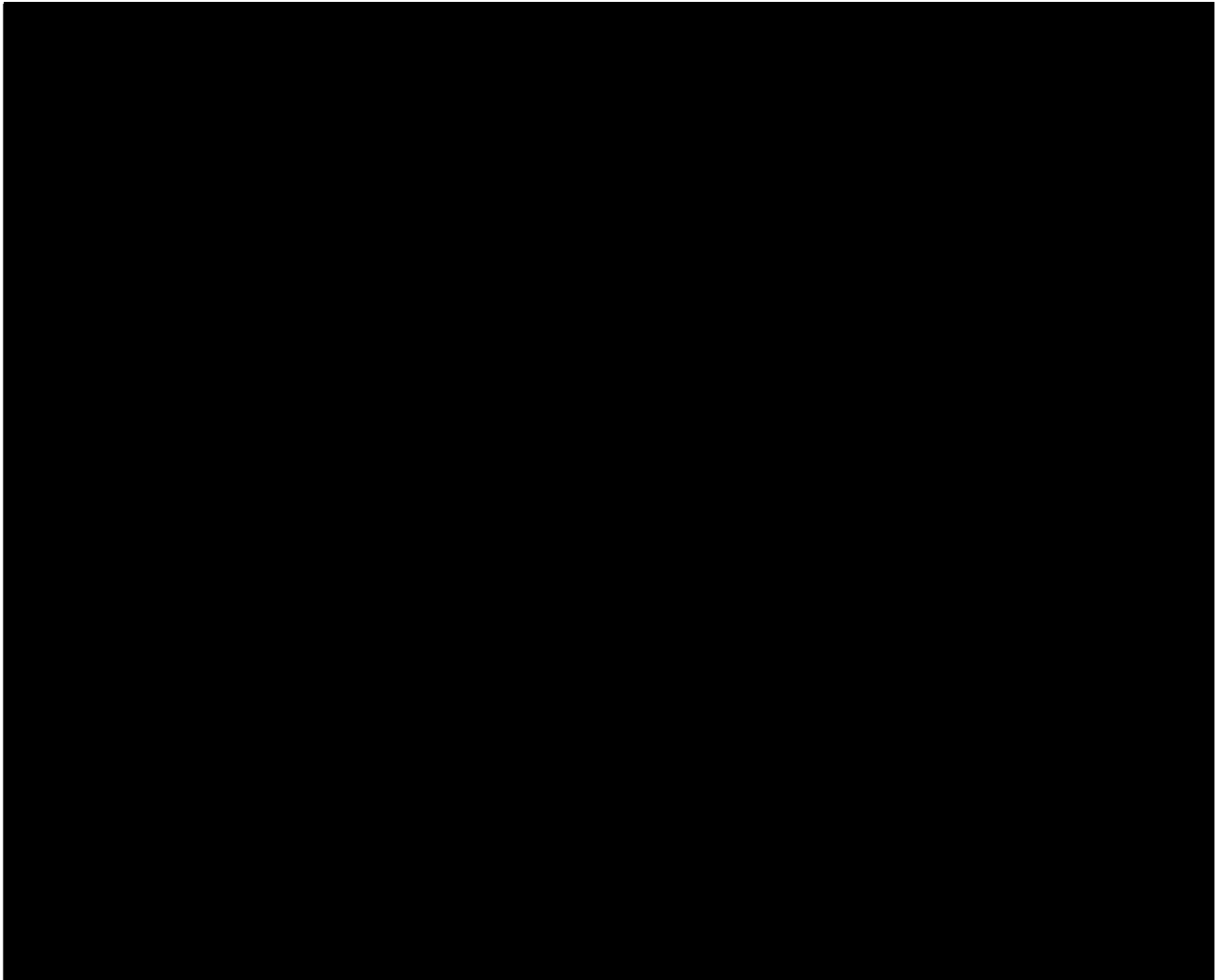
The South Half (S ½) of Section 4 and the Northeast Quarter (NE ¼) of Section 4, Township 143 North, Range 57 West of the 5th P.M., Barnes County, North Dakota, less 14.08 acres Burlington Northern Railway right of way; and

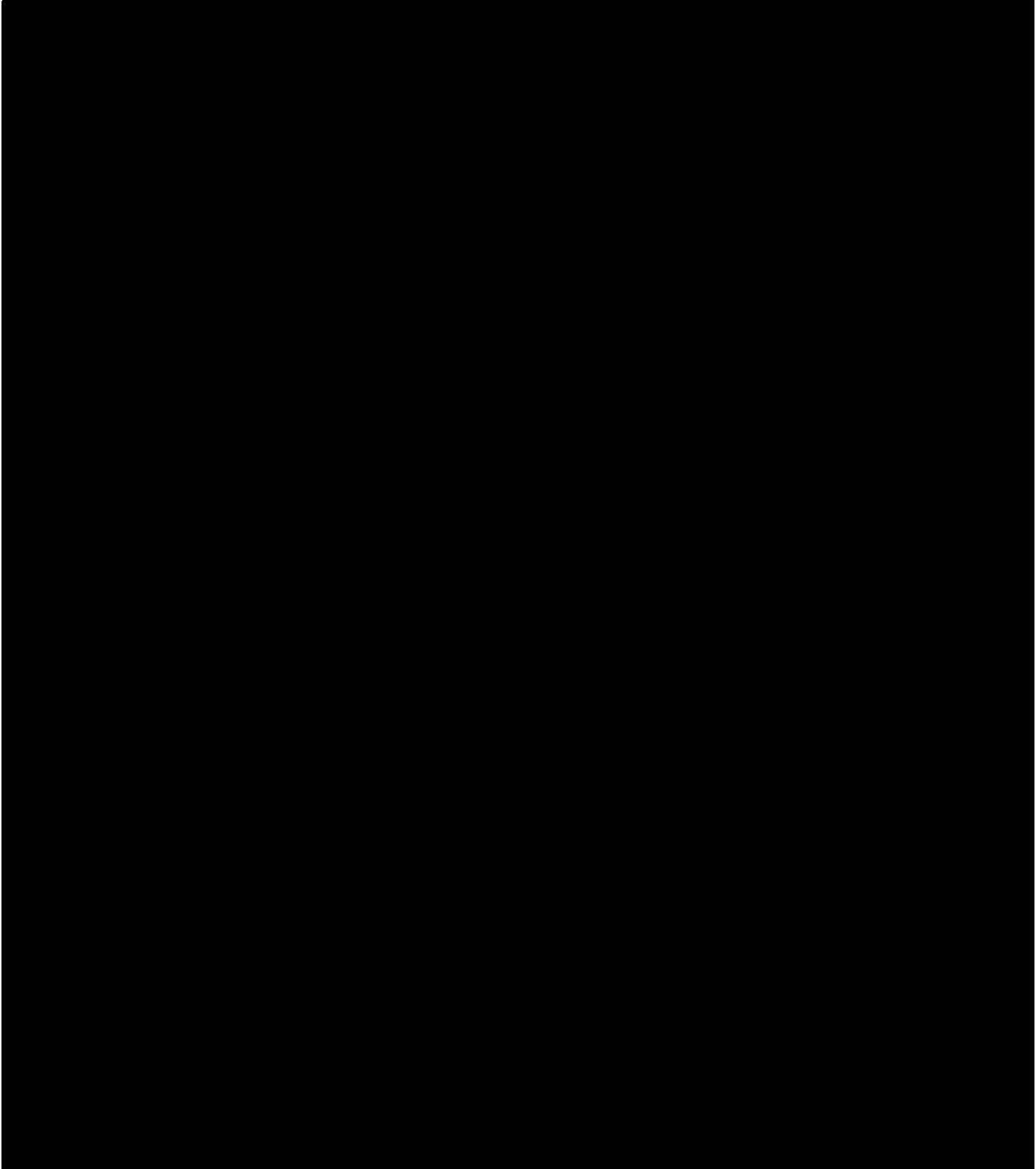
The Southwest Quarter (SW ¼) of Section 3 less 3.90 acres railroad right of way; and the North Half (N ½) of Section 3 less 12.7 acres Burlington Northern Railway Right of Way, and less 92.62 acres conveyed to United States of America described as follows: The N. 15.0 chains of Lots 2 and 3, and the N. 10.0 chains of Lot 4, of Section 3, all in Township 143 North, Range 57 West of the 5th P.M., Barnes County, North Dakota.

WIND FARM EASEMENT AGREEMENT

1. **Parties.** This Wind Farm Easement Agreement (“**Agreement**”) is made and entered as of the 27 day of Nov., 2007 (“**Effective Date**”), by and between Clarence K. Steffen & Mary A. Steffen, husband and wife (“**Owner**”) and Boulevard Associates, LLC, a Delaware limited liability company, an affiliate of FPL Energy, LLC, a Delaware limited liability company (“**Operator**”) who are sometimes individually referred to as a “**Party**” and collectively as the “**Parties.**”

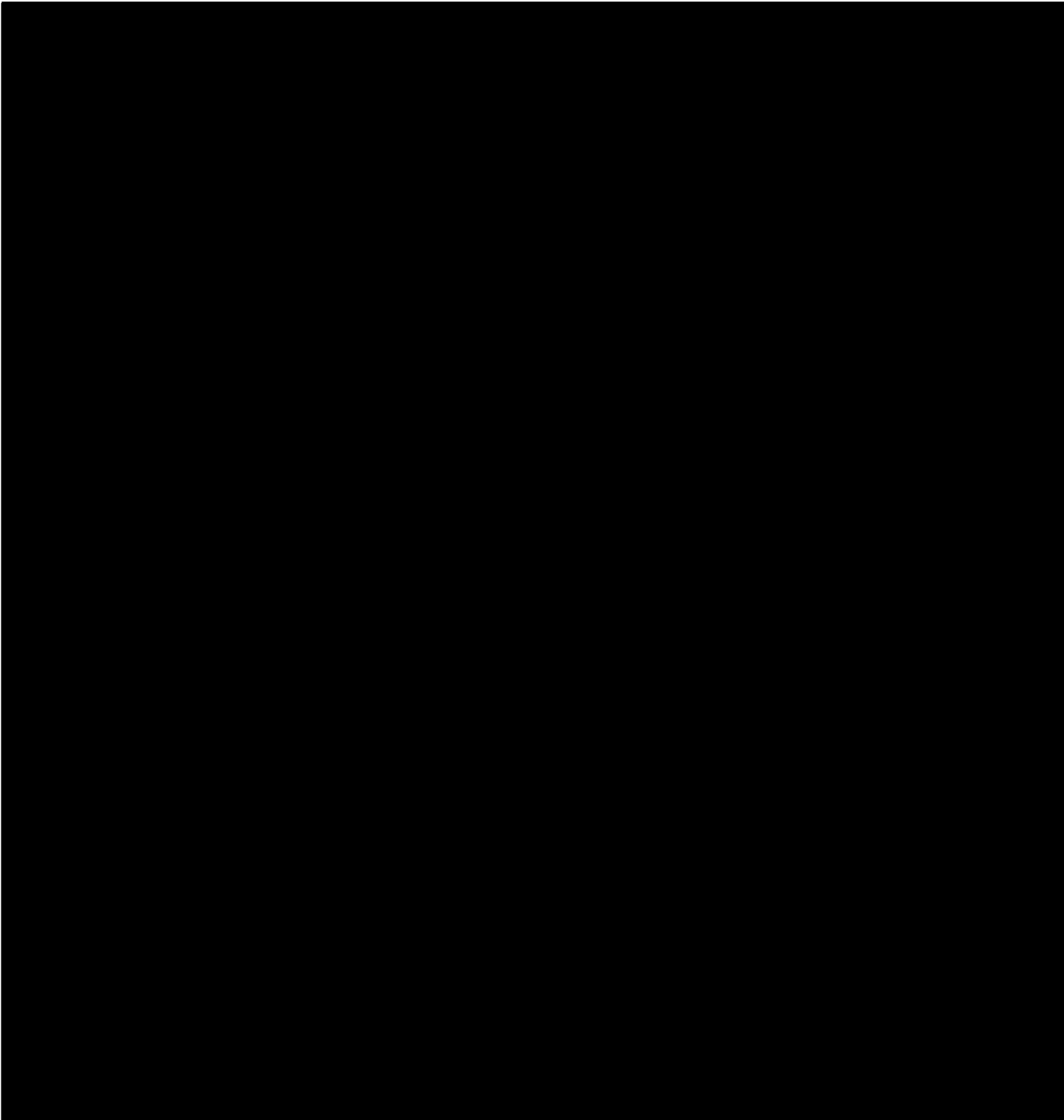
2. **Project.** This Agreement relates to the wind-powered electrical power generation and transmission project known as the “Ashtabula Wind Energy Center” to be located in Barnes County, North Dakota (“**Wind Farm**”), which may be wholly or partially located on the Owner’s property legally described on the attached **Exhibit “A”** to this Agreement (“**Owner’s Property**”). Upon Operator’s exercise of the Option (as defined below), the Wind Farm shall include (i) the Easements referenced in Section 4 that are located on the Owner’s Property, and (ii) the Improvements to be constructed on Owner’s Property, including the Turbines referenced in Section 7.1. The Easements and Improvements are sometimes collectively referred to as the “**Operator Property.**”



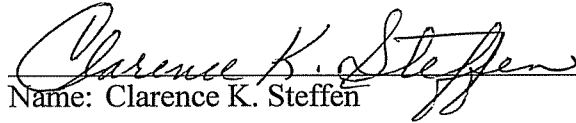


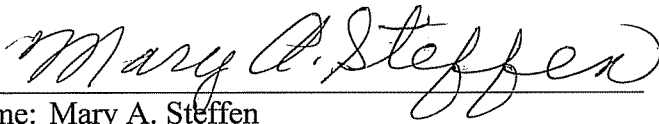
4.7 **Noise Easement.** Owner grants Operator an irrevocable, non-exclusive easement for the right and privilege to generate and maintain audible noise levels in excess of fifty (50) dbA on and above the Noise Easement Property at any or all times of the day or night (“**Noise Easement**”). The “**Noise Easement Property**” shall mean the Owner’s Property except those portions within a 200-foot radius circle (or lesser distance with Owner’s prior written consent) centered on the inside of each presently existing, occupied residence on the Owner’s Property. If noise levels emanating from the Turbines exceed fifty (50) dbA without the Owner’s written

consent as measured within 200 feet (or lesser agreed distance) from the inside of a presently existing residence on Owner's Property by an independent professional applying commonly accepted measurement instruments and standards, Operator shall reduce the noise level to 50 dbA at 200 feet (or lesser agreed distance) from the residence. Measures to be taken by Operator may include installing insulation or sound deadening material in the offending Turbine(s); installing landscaping, insulation, and sound deadening material at the residence; or, changing the operation of the Turbine(s) to reduce noise output.



Owner


Name: Clarence K. Steffen


Name: Mary A. Steffen

Operator

Boulevard Associates, LLC
a Delaware limited liability company


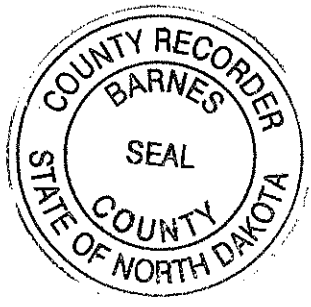
By: 
Name: _____
Title: Dean R. Gosselin
Vice President

EXHIBIT "A"

Legal Description of Owner's Property

The East Half (E ½) of Section 18, and the East Half of Section 8, all in Township 143 North of Range 57 West of the 5th P.M., Barnes County, North Dakota.

Grantor	<i>[Signature]</i>
Grantee	<i>[Signature]</i>
Indexed	<i>[Signature]</i>
Checked	<i>[Signature]</i>



AFTER RECORDING RETURN TO

Orin Shakerdge, Esq.
FPL Energy, LLC
700 Universe Blvd. (LAW/IB)
Juno Beach, FL 33408

Fee: \$ 25.00 269037
 OFFICE OF COUNTY RECORDER County of Barnes, North Dakota
 I hereby certify that the within instrument was filed in this office
 on 11/5/2010 at 12:15 PM and was duly recorded.
 _____ County Recorder
 By *[Signature]* Deputy

AMENDMENT TO WIND FARM EASEMENT

THIS AMENDMENT TO WIND FARM EASEMENT AGREEMENT (the "Amendment") is entered into on the 18th day of October, 2010, between Clarence K. Steffen and Mary A. Steffen, husband and wife (the "Owner"), and Boulevard Associates, LLC a Delaware limited liability company, ("Operator"). Each Owner and Operator shall hereinafter be referred to individually as a "Party" and collectively as the "Parties").

WHEREAS, on November 27, 2007, the Parties entered into that certain Wind Farm Easement Agreement relating to property in Barnes County, North Dakota. A Memorandum of Wind Farm Easement Agreement was recorded on February 4, 2008 in the Office of the Recorder of Barnes County, North Dakota as Document No. 261653. The Wind Farm Easement Agreement and Memorandum of Wind Farm Easement Agreement shall collectively be referred to as "Easement"; and

WHEREAS, the property that is subject to the Easement is defined in Exhibit A of the Easement ("Property"); and

WHEREAS, Owner and Operator desire to correct a scrivener's error in the legal description of the Property; and

NOW, THEREFORE in consideration of Ten Dollars (\$10) and other good and valuable consideration the receipt and adequacy of which is hereby acknowledged, the Parties hereby agree to amend the Agreement as follows:

Return To: NextEra Energy Resources, LLC
700 Universe Blvd. LAW/JB
JUNO BEACH FL 33408

(This space reserved for recording information)

1. **Capitalized Terms**. All capitalized terms used herein and not otherwise defined shall have the meaning given such terms in the Easement.

2. **Property**. Exhibit A of the Easement is hereby deleted in its entirety and replaced with the attached Exhibit A.

3. **Authority**. Owner hereby represents and warrants to FPLE that it owns the Property in fee simple subject and is fully authorized and empowered to grant the rights and benefits granted to FPLE in this Amendment.

4. **Remaining Terms**. All of the terms, conditions and provisions of the Easement not in conflict herewith shall remain in full force and effect.

5. **Counterpart**. This Amendment may be executed simultaneously or in counterparts, each of which together shall constitute one and the same Amendment.

(SIGNATURES ARE ON THE SUCCEEDING PAGES)

Return To: NextEra Energy Resources, LLC
700 Universe Blvd. LAW/JB
JUNO BEACH FL 33408

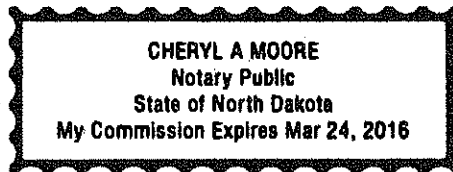
(This space reserved for recording information)

IN WITNESS WHEREOF, the Owner has executed this Memorandum of Easements on the date set forth below:

Owner:

Clarence K. Steffen
Clarence K. Steffen

Mary A. Steffen
Mary A. Steffen



ACKNOWLEDGMENT

STATE OF NORTH DAKOTA

COUNTY OF BARNES

The forgoing instrument was acknowledged before me this 6th day of October, 2010, by Clarence K. Steffen and Mary A. Steffen, husband and wife.

My Commission expires: Mar 24, 2016

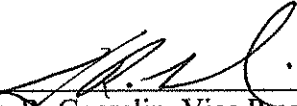
Cheryl A Moore
Notary Public

269037
4 of 6

Return To: NextEra Energy Resources, LLC
700 Universe Blvd. LAW/JB
JUNO BEACH FL 33408


IN WITNESS WHEREOF, the Operator has executed this Memorandum of Easements on the date set forth below:

Operator:
Boulevard Associates, LLC
a Delaware Limited Liability Company

By: 
Dean R. Gosselin, Vice President

STATE OF FLORIDA)
) SS.
COUNTY OF PALM BEACH)

The forgoing instrument was acknowledged before me this 18 day of October 2010, by Dean R. Gosselin, as Vice President of Boulevard Associates, LLC, a Delaware limited liability company, who is personally known to me who subscribed to the foregoing instrument and acknowledged that he executed the same on behalf of said limited liability company and that he was duly authorized to do so.



Name: _____
Notary Public, State of Florida
My Commission Expires: _____

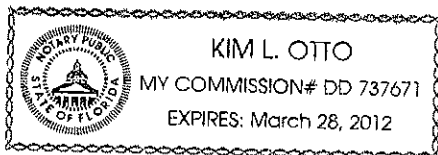
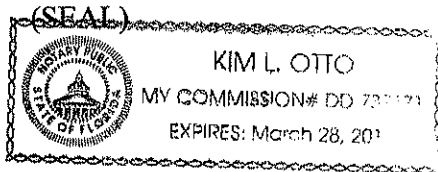


EXHIBIT A

Legal Description of Easement Property

The East Half (E $\frac{1}{2}$) of Section 18 Township 143 North, Range 57 West of the Fifth Principal Meridian located in Barnes County, North Dakota.

The East Half (E $\frac{1}{2}$) of Section 8 Township 143 North, Range 57 West of the Fifth Principal Meridian located in Barnes County, North Dakota, Less and Except the following tracts of land:

- a) A tract of land; Beginning at the Northwest corner of the Northeast Quarter (NE $\frac{1}{4}$) of said Section 8, the point of beginning, thence 132 feet East along the Section line, thence South for a distance of 594 feet, thence due West along the South edge of the tree line which runs East and West for a distance of 132 feet to the quarter-section line, thence North along the quarter-section line for a distance of 594 feet to the point of beginning;
- b) All that portion of the Southeast Quarter (SE $\frac{1}{4}$) of said Section 8, to be used for Right-of-way purposes, lying within a strip of land located on the North side of the South Section line of Section 8. Beginning at a point 2,352.56 feet, more or less, West of the Southeast Section corner of said Section 8, thence North 90 degrees for a distance of 100 feet, thence East and parallel to South Section line of Section 8 a distance of 300 feet, thence southeasterly along a 3 degree curve to a point on the South Section line of Section 8, said point being 1300 feet, more or less, West of Southeast Section corner of Section 8, thence West along the South Section line of Section 8 to the point of beginning
- c) All that portion lying in the Southeast Quarter (SE $\frac{1}{4}$) of said Section 8. Beginning at the Southwest Quarter corner of the Southeast Quarter (SE $\frac{1}{4}$) of Section 8, thence North 100 feet, thence East and parallel with the South Section line of the Southeast Quarter, a distance of 287.44 feet, thence South 100 feet, thence West along the South Section line of the Southeast Quarter (SE $\frac{1}{4}$) of said Section 8 to the point of beginning. Excepting all that portion lying within 33 feet of the Section line.
- d) All that portion lying in the Northeast Quarter (NE $\frac{1}{4}$) of said Section 8. Beginning at the Northeast Section corner of the Northeast Quarter (NE $\frac{1}{4}$) of Section 8, thence West along the North Section line of the Northeast Quarter (NE $\frac{1}{4}$) of said Section 8, a distance of 331 feet, more or less, thence in a southeasterly direction along a one degree curve to a point on the East Section line of the Northeast Quarter (NE $\frac{1}{4}$) of Section 8, said point being 47 feet, more or less South of the Northeast Section corner of the Northeast Quarter (NE $\frac{1}{4}$) of Section 8, thence North to the point of beginning. Excepting all that portion lying within 33 feet of the Section line.

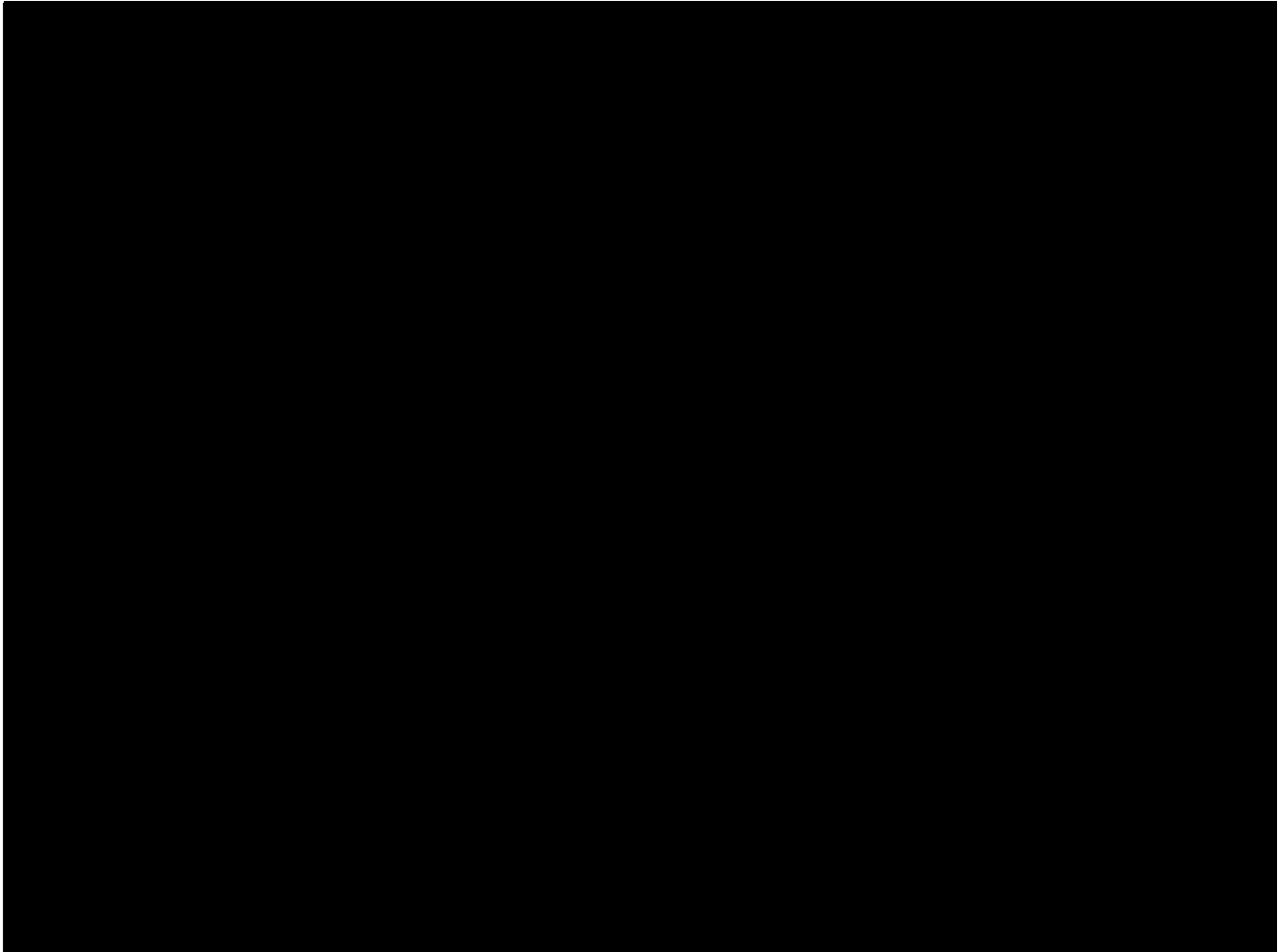
e) All that portion of the Southeast Quarter (SE $\frac{1}{4}$) of said Section 8, lying within a strip of land 100.0 feet wide, measured on the Northerly side of the following described highway centerline: Beginning at a point on the Section line, 2352.56 Feet West of the Southeast corner of said Southeast Quarter (SE $\frac{1}{4}$); thence running East along the Section line a distance of 300.0 feet., thence along a 300 foot spiral of 3 degrees 00 minute curve to the right a distance of 300.0 feet., thence along a 3 degree 00 minute curve to the right until said strip crosses the South line of said Southeast Quarter (SE $\frac{1}{4}$). Excepting all that portion previously acquired for public highway right-of-way and all that portion lying within 33 Feet of the Section line.

f) That part of said Section 18, Township 143, Range 57, Barnes County, North Dakota, described as follows: Commencing at the Southwest corner of Section 7, Township 143, Range 57, said corner also being the Northwest corner of said Section 18; thence S89°42'E along the North line of said Section 18 for a distance of 1,208.1 feet, more or less, to the Southwest corner of the SE $\frac{1}{4}$ SW $\frac{1}{4}$ of said Section 7; thence N00°15'W along the West line of said SE $\frac{1}{4}$ SW $\frac{1}{4}$ for a distance of 154.6 feet; thence S74°54'E for a distance of 605.7 feet to a point on the North line of said Section 18; thence S00°05'W for a distance of 298.1 feet; thence N80°07'W for a distance of 653.9 feet; thence S00°09'E for a distance of 1,106.3 feet; thence S66°29'E for a distance of 327.0 feet; thence S68°49'W for a distance of 386.3. feet to the point of beginning; thence S04°45'00"E for a distance of 132.51 feet; thence N18°04'34"E for a distance of 164.15 feet; thence S68°49'00"W for a distance of 66.39 feet to the point of beginning. Said tract contains 0.10 acres, more or less, and other lands.

WIND FARM EASEMENT AGREEMENT

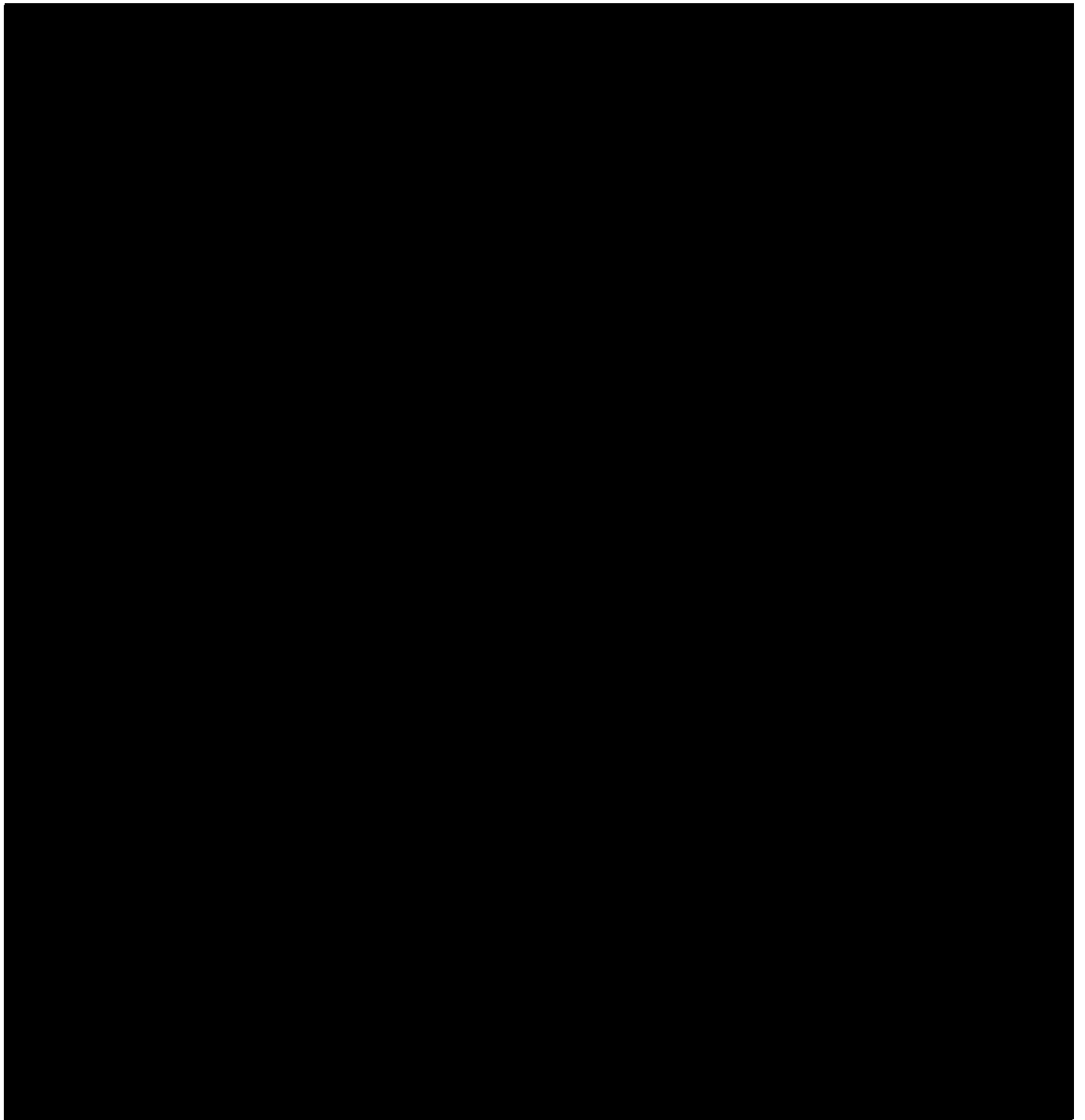
1. **Parties.** This Wind Farm Easement Agreement (“**Agreement**”) is made and entered as of the 12th-day of Nov., 2007 (“**Effective Date**”), by and between Rodd Svenningsen and Deborah Svenningsen, husband and wife (“**Owner**”) and Boulevard Associates, LLC, a Delaware limited liability company, an affiliate of FPL Energy, LLC, a Delaware limited liability company (“**Operator**”) who are sometimes individually referred to as a “**Party**” and collectively as the “**Parties.**”

2. **Project.** This Agreement relates to the wind-powered electrical power generation and transmission project known as the “Ashtabula Wind Energy Center” to be located in Barnes County, North Dakota (“**Wind Farm**”), which may be wholly or partially located on the Owner’s property legally described on the attached **Exhibit “A”** to this Agreement (“**Owner’s Property**”). Upon Operator’s exercise of the Option (as defined below), the Wind Farm shall include (i) the Easements referenced in Section 4 that are located on the Owner’s Property, and (ii) the Improvements to be constructed on Owner’s Property, including the Turbines referenced in Section 7.1. The Easements and Improvements are sometimes collectively referred to as the “**Operator Property.**”

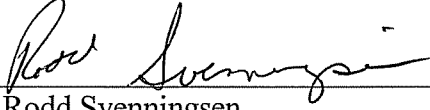


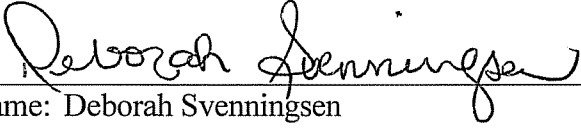
4.7 **Noise Easement**. Owner grants Operator an irrevocable, non-exclusive easement for the right and privilege to generate and maintain audible noise levels in excess of fifty (50) dbA on and above the Noise Easement Property at any or all times of the day or night (“**Noise Easement**”). The “**Noise Easement Property**” shall mean the Owner’s Property except those portions within a 200-foot radius circle (or lesser distance with Owner’s prior written consent) centered on the inside of each presently existing, occupied residence on the Owner’s Property. If

noise levels emanating from the Turbines exceed fifty (50) dbA without the Owner's written consent as measured within 200 feet (or lesser agreed distance) from the inside of a presently existing residence on Owner's Property by an independent professional applying commonly accepted measurement instruments and standards, Operator shall reduce the noise level to 50 dbA at 200 feet (or lesser agreed distance) from the residence. Measures to be taken by Operator may include installing insulation or sound deadening material in the offending Turbine(s); installing landscaping, insulation, and sound deadening material at the residence; or, changing the operation of the Turbine(s) to reduce noise output.



Owner


Name: Rodd Svenningsen


Name: Deborah Svenningsen

Operator

Boulevard Associates, LLC
a Delaware limited liability company

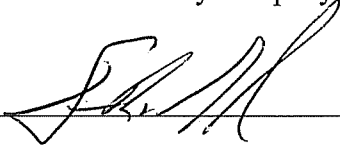
By: 
Name: _____
Title: Dean R. Gosselin
Vice President

EXHIBIT "A"

Legal Description of Owner's Property

The South Half (S ½) of Section 9, in Township 143N, Range 57W, Barnes County, North Dakota.

The Southwest Quarter (SW ¼) of Section 21, less and except, Auditor's Lot Number 1 of the Southwest Quarter (SW ¼) of Section 21, in Township 143N, Range 57W of the 5th P.M, Barnes County, North Dakota, together with the road easement for ingress and egress to said Auditor's Lot Number 1, according to the Plat of Auditor's Lot Number 1 of the SW ¼, Section 21, Township 143, Range 57, Barnes County, North Dakota, recorded on January 22, 1999, in the office of the Register of Deeds, Barnes County, North Dakota, in Book "A" of Auditor's Plat's, Page 46, said Lot 1 containing 0.235 acres, more or less, as noted on said plat.

The North One-Half of the Northwest Quarter (N ½ NW ¼), of the Northeast Quarter (NE ¼) of Section 17, in Township 143N, Range 57W, Barnes County, North Dakota.

Appendix B – Shadow Flicker Assessment Results

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SHADOW FLICKER MODELING REPORT

Ashtabula III Wind Energy Center Repower Project Barnes County, North Dakota

Prepared for:

Atwell, LLC
311 North Main
Ann Arbor, Michigan 48104

Prepared by:



Epsilon Associates, Inc.
3 Mill & Main Place, Suite 250
Maynard, MA 01754

June 27, 2023

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1.0 EXECUTIVE SUMMARY

The Ashtabula III Wind Energy Center Repowering Project (the Project) is an existing wind park in Barnes County, North Dakota that is planned to be repowered by Otter Tail Power Company (Otter Tail). Atwell has retained Epsilon Associates, Inc. (Epsilon) to conduct a shadow flicker assessment for this Project. This report presents results of the shadow flicker modeling from the proposed repower in Barnes County.

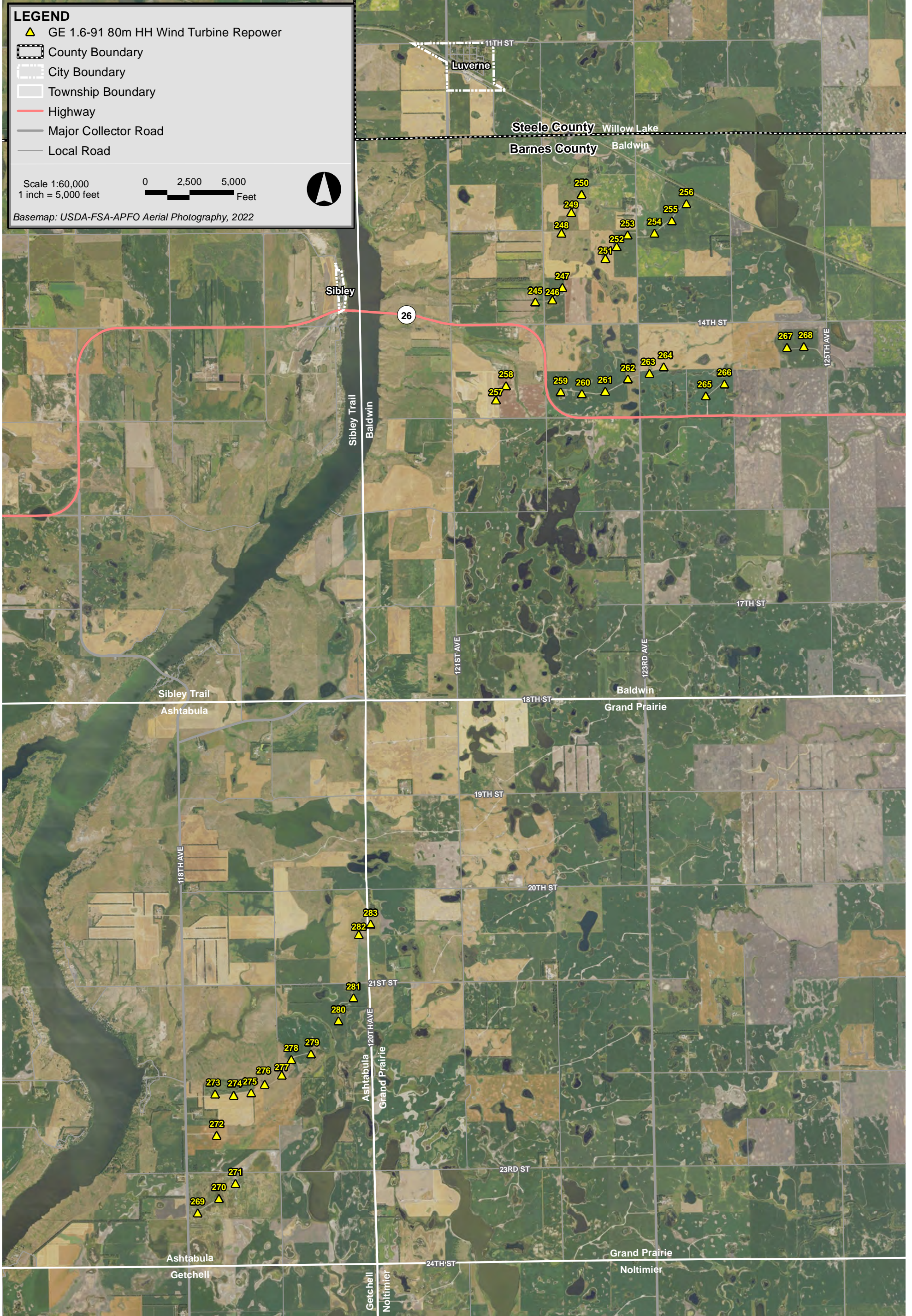
Shadow flicker modeling was conducted for the 39 Otter Tail Ashtabula III General Electric (GE) repowered wind turbines. The purpose of this analysis is to predict the annual durations of wind turbine shadow flicker at nearby receptors. The maximum expected annual duration of shadow flicker at a modeling receptor resulting from the operation of all Otter Tail Ashtabula III wind turbines is 34 hours, 5 minutes per year. The modeling results are conservative in that modeling receptors were treated as “greenhouses” (i.e., having windows on all sides) and the surrounding area was assumed to be without vegetation or structures (“bare earth”).

2.0 INTRODUCTION

The Ashtabula III Wind Energy Center Repower Project will consist of 39 repowered wind turbines. The proposed wind turbines are all GE 1.6 MW units with a rotor diameter of 91 meters and a hub height of 80 meters. Figure 2-1 shows the locations of the 39 wind turbines over aerial imagery.

Shadow flicker can be defined as an intermittent change in the intensity of light in a given area resulting from the operation of a wind turbine due to its interaction with the sun. An indoor observer experiences repeated changes in the brightness of the room as shadows cast from the wind turbine blades briefly pass by windows as the blades rotate. In order for this to occur, the wind turbine must be operating, the sun must be shining, and the window must be within the shadow region of the wind turbine, otherwise there is no shadow flicker. A stationary wind turbine only generates a stationary shadow similar to any other structure.

This report presents the findings of a shadow flicker modeling study for the Project. The wind turbines were modeled with the WindPRO software package using information provided by Atwell. The expected annual duration of shadow flicker was calculated at modeling receptors and shadow flicker isolines for the area surrounding the Project were generated. The results of the modeling are found within this report.



Ashtabula III Repower Barnes County, North Dakota

3.0 SHADOW FLICKER MODELING

3.1 Modeling Methodology

Shadow flicker was modeled using a software package, WindPRO version 3.6. WindPRO is a software suite developed by EMD International A/S and is used for assessing potential environmental impacts from wind turbines. Using the Shadow module within WindPRO, worst-case shadow flicker in the area surrounding the wind turbines was calculated based on data inputs including: location of the wind turbines, location of discrete receptor points, wind turbine dimensions, flicker calculation limits, and terrain data. Based on these data, the model was able to incorporate the appropriate sun angle and maximum daily sunlight for this latitude into the calculations. The resulting worst-case calculations assume that the sun is always shining during daylight hours and that the wind turbine is always operating. The WindPRO Shadow module can be further refined by incorporating sunshine probabilities and wind turbine operational estimates by wind direction over the course of a year. The values produced by this further refinement are known as the “expected” shadow flicker. Both worst-case and expected annual shadow flicker durations are presented in this section.

This analysis is for the wind turbine array sent to Epsilon on January 26, 2023. Locations of the turbines are shown in Figure 3-1 and the coordinates are provided in Appendix A. All 39 wind turbines are GE 1.6-91 wind turbines with a 91-meter rotor diameter and a hub height of 80 meters. Each wind turbine has the following characteristics based on the technical data provided by Atwell:

<u>GE 1.6-91</u>		
◆ Rated Power	=	1,600 kW
◆ Hub Height	=	80 meters
◆ Rotor Diameter	=	91 meters
◆ Cut-in Wind Speed	=	3 m/s
◆ Cut-out Wind Speed	=	25 m/s

To-date, there are no federal, state, or local regulations regarding the maximum radial distance from a wind turbine to which shadow flicker should be analyzed applicable to this Project. In the United States, shadow flicker is commonly evaluated out to a distance of ten times the rotor diameter. For this Project, ten times the largest rotor diameter of the proposed wind turbines corresponds to a distance of 0.6 miles (970 m). Conservatively, this analysis includes shadow flicker calculations out to 1.25 miles (2,012 m) from each wind turbine in the model for the proposed layout and existing wind turbines.

A modeling receptor dataset was provided to Epsilon on January 26, 2023. The dataset included 316 receptors. This dataset was clipped such that only receptors within 1.5 miles of an Otter Tail Ashtabula III wind turbine were included in the analysis. Atwell provided additional information indicating if each receptor was inhabited or uninhabited. The resulting 141 inhabited receptors were input to the model. Each modeling point was assumed to have a window facing all directions (“greenhouse” mode) which yields conservative results. All modeling receptors are identified in Figure 3-2. The model was set to limit calculations to 2,012 meters from a wind turbine, the equivalent of 1.25 miles. Consequently, shadow flicker at any of the modeling receptors greater than the corresponding limitation distance from a wind turbine was zero. In addition to modeling discrete points, shadow flicker was calculated at grid points in

the area surrounding the modeled wind turbines to generate flicker isolines. A 20-meter spacing was used for this grid.

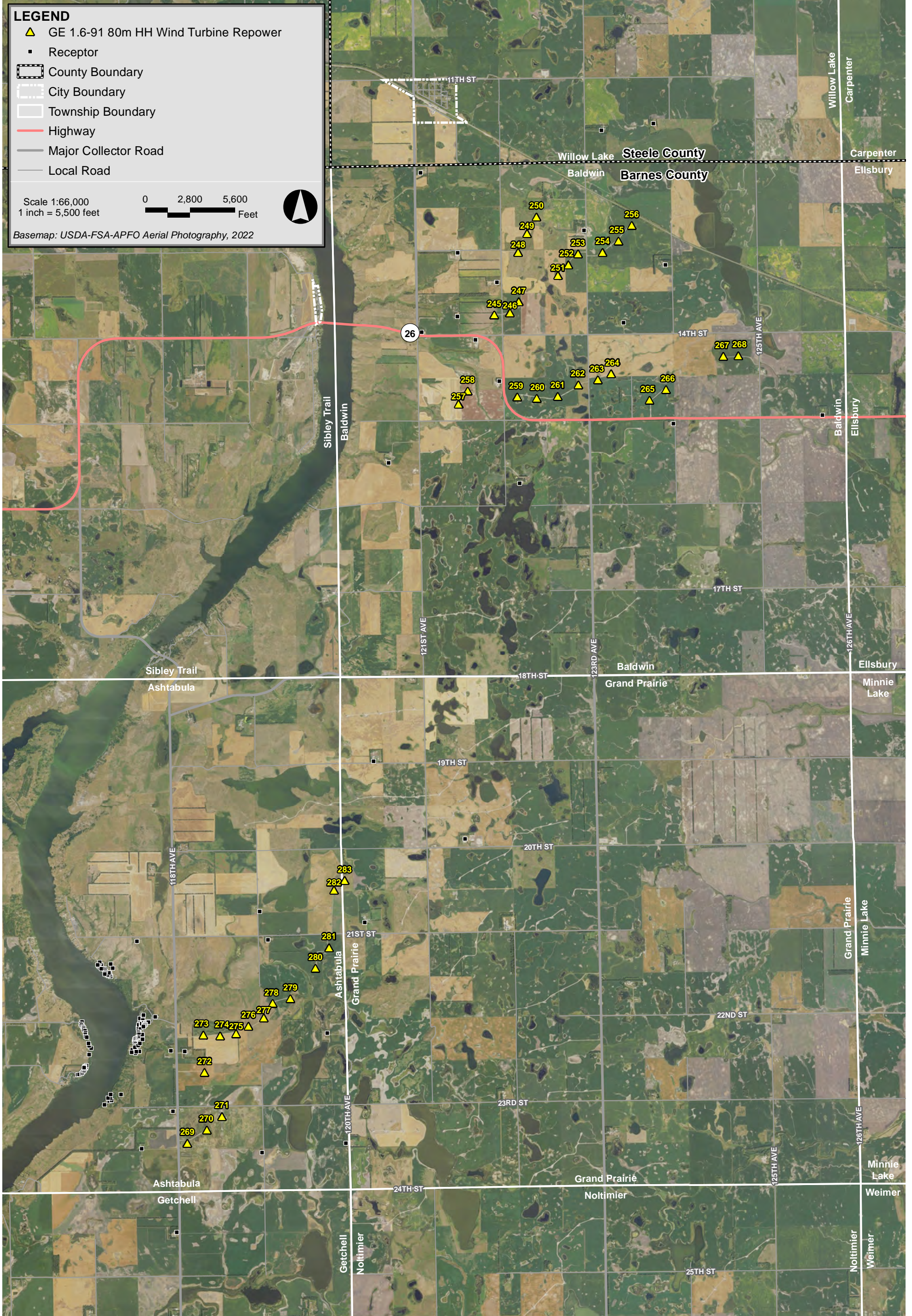
The terrain height contour elevations for the modeling domain were generated from elevation information derived from the National Elevation Dataset (NED) developed by the U.S. Geological Survey. Conservatively, obstacles, i.e., buildings and vegetation, were excluded from the analysis. This is effectively a “bare earth” scenario which is conservative. When accounted for in the shadow flicker calculations, such obstacles may significantly mitigate or eliminate the flicker effect depending on their size, type, and location. In addition, shadow flicker durations were calculated only when the angle of the sun was at least 3° above the horizon.

Monthly sunshine probability values were input for each month from January to December. These numbers were obtained from a publicly available historical dataset for Fargo, North Dakota from the National Oceanic and Atmospheric Administration’s (NOAA) National Centers for Environmental Information (NCEI).¹ Table 3-1 shows the percentage of sunshine hours by month used in the shadow flicker modeling. These values are the percentages that the sun is expected to be shining during daylight hours.

The number of hours the wind turbines are expected to operate for the 16 cardinal wind directions was input into the model. A publicly available dataset² using measured data for a five-year period of hourly wind directions and wind speeds at 3 meters and 10 meters was obtained by Epsilon. Epsilon then scaled this dataset to 80 meters to calculate the typical annual number of operational hours per wind direction sector. These hours per wind direction sector are used by WindPRO to estimate the “wind direction” and “operation time” reduction factors. Based on this dataset, the wind turbines would operate 85% of the year. Table 3-2 shows the distribution of operational hours for the 16 wind directions.

¹ NCEI (formerly NCDC), <https://www1.ncdc.noaa.gov/pub/data/ccd-data/pctpos20.dat>. Accessed in March 2023.

² North Dakota Agricultural Weather Network (NDAWN), 2018-2022, Carrington, ND.



Ashtabula III Repower Barnes County, North Dakota

Table 3-1 Monthly Percent of Possible Sunshine

Month	Possible Sunshine
January	52%
February	54%
March	59%
April	57%
May	60%
June	64%
July	74%
August	71%
September	63%
October	51%
November	39%
December	39%

Table 3-2 Operational Hours per Wind Direction Sector

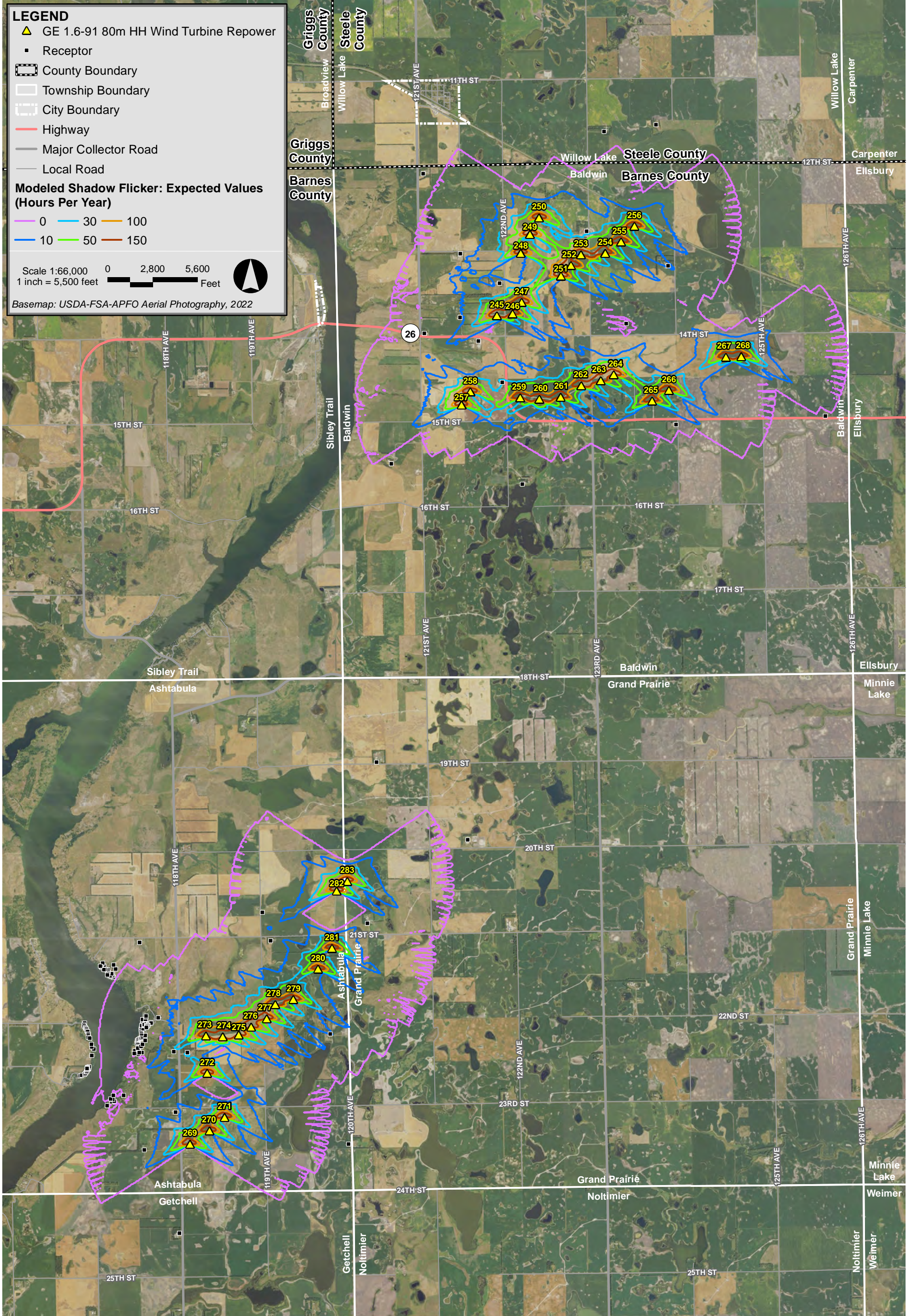
Wind Sector	Operational Hours
N	364
NNE	231
NE	235
ENE	234
E	299
ESE	398
SE	720
SSE	587
S	362
SSW	314
SW	482
WSW	477
W	675
WNW	931
NW	686
NNW	429
Annual	7424

3.2 Results

Following the modeling methodology outlined in Section 3.1, WindPRO was used to calculate shadow flicker at the 141 discrete modeling receptor points. In addition to the discrete modeling points, shadow flicker isolines were generated based on the grid calculations. Table B-1.1 in Appendix B presents the modeling results for the receptors sorted by ID. Table B-1.2 in Appendix B presents the modeling results for the receptors sorted by Expected Flicker. Both worst-case and expected values are presented.

The modeled worst-case annual shadow flicker duration for all 141 receptors ranged from 0 hours, 0 minutes per year to 120 hours, 15 minutes per year. The maximum flicker duration was at receptor A269.

The predicted expected annual shadow flicker duration ranged from 0 hours, 0 minutes per year to 34 hours, 5 minutes per year. The maximum expected flicker duration calculated was at receptor A269. Sixty-eight (68) of the receptors were predicted to experience no annual shadow flicker. Sixty-six (66) of the receptors were predicted to experience some shadow flicker but less than 10 hours per year. The modeling results showed that six (6) of the receptors would be expected to have between 10 hours and 30 hours of shadow flicker per year. One (1) receptor is expected to have over 30 hours of flicker per year. Figure 3-2 displays the modeled flicker isolines (expected hrs/yr) over aerial imagery in relation to modeled wind turbines and modeling receptors.



Ashtabula III Repower Barnes County, North Dakota

Appendix A

Wind Turbine Coordinates

Table A-1: Wind Turbine Coordinates

Wind Turbine ID	Wind Turbine Type	Hub Height (m)	Coordinates NAD83 UTM Zone 14N (meters)	
			X (Easting)	Y (Northing)
245	GE 1.6-91	80	581717.66	5229598.24
246	GE 1.6-91	80	582012.42	5229635.89
247	GE 1.6-91	80	582183.94	5229849.35
248	GE 1.6-91	80	582170.96	5230782.84
249	GE 1.6-91	80	582339.90	5231140.98
250	GE 1.6-91	80	582517.46	5231454.68
251	GE 1.6-91	80	582926.29	5230349.12
252	GE 1.6-91	80	583120.48	5230551.47
253	GE 1.6-91	80	583307.08	5230754.28
254	GE 1.6-91	80	583768.25	5230783.26
255	GE 1.6-91	80	584068.52	5230998.71
256	GE 1.6-91	80	584321.41	5231291.09
257	GE 1.6-91	80	581043.96	5227910.83
258	GE 1.6-91	80	581215.11	5228157.82
259	GE 1.6-91	80	582155.80	5228048.21
260	GE 1.6-91	80	582519.74	5228020.27
261	GE 1.6-91	80	582920.85	5228058.89
262	GE 1.6-91	80	583311.41	5228275.57
263	GE 1.6-91	80	583681.72	5228369.83
264	GE 1.6-91	80	583929.76	5228484.49
265	GE 1.6-91	80	584656.40	5227983.44
266	GE 1.6-91	80	584971.94	5228188.15
267	GE 1.6-91	80	586053.44	5228815.13
268	GE 1.6-91	80	586340.98	5228830.44
269	GE 1.6-91	80	575905.22	5213915.82
270	GE 1.6-91	80	576273.93	5214165.17
271	GE 1.6-91	80	576559.11	5214424.59
272	GE 1.6-91	80	576229.88	5215253.83
273	GE 1.6-91	80	576205.65	5215965.07
274	GE 1.6-91	80	576524.39	5215946.61
275	GE 1.6-91	80	576827.37	5215984.09
276	GE 1.6-91	80	577061.14	5216131.72
277	GE 1.6-91	80	577355.02	5216291.03
278	GE 1.6-91	80	577518.26	5216559.91
279	GE 1.6-91	80	577857.50	5216654.27
280	GE 1.6-91	80	578329.40	5217226.44
281	GE 1.6-91	80	578589.97	5217618.67
282	GE 1.6-91	80	578681.52	5218709.13
283	GE 1.6-91	80	578883.97	5218889.87

Appendix B

Shadow Flicker Modeling Results: Modeling Receptors

Table B-1.1: Shadow Flicker Modeling Results at Discrete Points - Sorted by Receptor ID

Receptor ID	Coordinates UTM NAD83 Zone 14N (meters)		Worst Case Shadow Flicker Hours per Year	Expected Shadow Flicker Hours per Year
	X (Easting)	Y (Northing)	(HH:MM/year)	(HH:MM/year)
A3	575704.05	5212231.60	0:00	0:00
A8	575040.50	5213810.28	14:38	5:14
A9	578905.24	5213921.42	0:00	0:00
A13	575631.87	5214522.75	24:09	7:35
A33	573827.25	5215213.23	0:00	0:00
A34	573855.62	5215220.08	0:00	0:00
A35	573902.19	5215240.25	0:00	0:00
A36	573919.37	5215255.84	0:00	0:00
A37	573934.78	5215282.21	0:00	0:00
A38	573948.57	5215295.71	0:00	0:00
A39	573962.17	5215322.42	0:00	0:00
A40	573975.41	5215339.10	0:00	0:00
A41	573986.48	5215353.17	0:00	0:00
A42	573989.06	5215363.20	0:00	0:00
A43	573993.12	5215386.38	0:00	0:00
A44	573964.80	5215371.42	0:00	0:00
A45	573956.23	5215362.82	0:00	0:00
A46	573952.08	5215351.34	0:00	0:00
A47	574043.59	5215594.39	0:00	0:00
A55	573910.53	5216213.51	0:00	0:00
A56	573890.11	5216175.80	0:00	0:00
A57	573900.41	5216155.39	0:00	0:00
A58	573920.85	5216126.10	0:00	0:00
A59	573933.67	5216111.05	0:00	0:00
A60	573945.56	5216092.76	0:00	0:00
A61	573947.26	5216065.66	0:00	0:00
A62	573965.06	5216047.88	0:00	0:00
A63	573978.94	5216006.86	0:00	0:00
A64	573974.20	5215980.23	0:00	0:00
A65	573976.82	5215942.64	0:00	0:00
A66	574002.48	5215927.06	0:00	0:00
A68	574083.89	5215721.10	0:00	0:00
A69	574043.70	5215760.79	0:00	0:00
A70	574036.74	5215810.47	0:00	0:00
A71	574336.46	5214645.31	0:00	0:00
A72	574424.02	5214718.14	0:00	0:00
A73	574470.90	5214729.61	0:00	0:00
A74	574441.70	5214765.51	0:00	0:00
A75	574403.44	5214774.07	0:00	0:00
A76	574452.01	5214843.49	2:24	0:52
A77	574649.37	5214842.84	2:42	0:58

Table B-1.1: Shadow Flicker Modeling Results at Discrete Points - Sorted by Receptor ID

Receptor ID	Coordinates UTM NAD83 Zone 14N (meters)		Worst Case Shadow Flicker Hours per Year	Expected Shadow Flicker Hours per Year
	X (Easting)	Y (Northing)	(HH:MM/year)	(HH:MM/year)
A78	574860.29	5215686.82	0:00	0:00
A79	574922.13	5215678.13	8:31	3:04
A80	574994.14	5215654.40	9:21	3:23
A81	574924.04	5215716.01	8:12	2:56
A82	574921.47	5215623.71	8:23	3:01
A83	574848.22	5215638.00	4:39	1:40
A84	574941.84	5215650.90	8:33	3:05
A85	574912.89	5215733.82	7:57	2:51
A86	574974.34	5215770.15	12:53	4:28
A87	574900.43	5215833.92	11:05	3:48
A88	575007.44	5215806.39	13:28	4:37
A89	574914.97	5215850.14	11:09	3:48
A90	574904.34	5215877.95	10:42	3:36
A91	574918.03	5215894.77	11:00	3:41
A92	574932.63	5215903.54	11:13	3:44
A93	574955.34	5215912.45	11:35	3:50
A94	574970.33	5215922.91	11:45	3:53
A95	574981.36	5215930.93	11:58	3:56
A96	575003.15	5215949.56	12:28	4:05
A97	575054.11	5215883.67	13:44	4:32
A98	574995.74	5215987.15	11:12	3:38
A99	575053.41	5215978.19	13:31	4:25
A100	574986.94	5216008.13	10:00	3:12
A101	574979.59	5216051.77	10:07	3:14
A102	574976.27	5216076.76	10:09	3:14
A103	574975.12	5216100.90	10:22	3:17
A104	574980.69	5216121.96	10:36	3:21
A105	575016.60	5216102.34	11:14	3:32
A106	575009.69	5216201.85	6:42	2:20
A107	575000.35	5216178.12	6:18	2:14
A108	574986.74	5216162.07	12:30	3:57
A109	575027.95	5216158.34	5:09	1:51
A110	575035.88	5216170.87	5:10	1:50
A111	575054.51	5216207.86	7:13	2:29
A112	575051.38	5216197.51	5:20	1:51
A113	575045.81	5216189.76	5:13	1:49
A114	575038.90	5216181.98	6:49	2:24
A115	575077.19	5216208.00	5:35	1:55
A116	575079.80	5216194.98	5:34	1:55
A117	575113.00	5216196.41	12:23	4:21
A118	575124.54	5216204.40	12:39	4:24

Table B-1.1: Shadow Flicker Modeling Results at Discrete Points - Sorted by Receptor ID

Receptor ID	Coordinates UTM NAD83 Zone 14N (meters)		Worst Case Shadow Flicker Hours per Year	Expected Shadow Flicker Hours per Year
	X (Easting)	Y (Northing)	(HH:MM/year)	(HH:MM/year)
A119	575138.01	5216208.32	12:59	4:30
A120	575149.16	5216209.33	13:11	4:34
A121	575169.22	5216209.90	13:39	4:43
A122	575087.71	5216165.98	5:45	2:02
A123	575113.47	5216170.01	7:43	2:42
A124	575102.95	5216160.29	7:30	2:40
A125	575086.43	5216144.68	7:10	2:35
A126	575074.58	5216127.35	14:56	4:43
A127	575006.10	5216280.96	9:13	3:05
A128	575059.73	5216281.45	21:14	6:24
A129	575070.38	5216324.81	17:51	5:31
A130	575070.76	5216343.00	16:28	5:10
A131	575298.94	5216311.20	18:21	6:08
A132	574450.96	5217075.70	0:00	0:00
A133	574437.55	5217132.24	0:00	0:00
A134	574434.12	5217105.45	0:00	0:00
A135	574409.47	5217093.44	0:00	0:00
A136	574389.81	5217105.13	0:00	0:00
A137	574418.30	5217144.17	0:00	0:00
A138	574356.58	5217173.15	0:00	0:00
A139	574343.65	5217146.23	0:00	0:00
A140	574339.80	5217119.98	0:00	0:00
A141	574493.43	5217232.22	0:00	0:00
A142	574455.43	5217309.77	0:00	0:00
A143	574343.57	5217222.20	0:00	0:00
A144	574275.02	5217292.26	0:00	0:00
A145	574247.51	5217347.05	0:00	0:00
A146	574235.64	5217260.44	0:00	0:00
A147	574223.21	5217281.30	0:00	0:00
A148	574319.99	5217218.59	0:00	0:00
A149	574293.99	5217227.51	0:00	0:00
A150	574272.54	5217223.95	0:00	0:00
A151	574207.73	5217291.66	0:00	0:00
A166	574951.44	5217739.10	0:00	0:00
A169	577273.49	5218307.23	9:01	3:01
A170	577430.75	5217768.83	14:08	4:19
A171	579265.26	5218098.36	22:25	4:58
A177	581161.73	5219680.59	0:00	0:00
A212	579715.72	5226801.23	0:00	0:00
A262	582197.12	5226416.61	0:00	0:00
A264	584162.60	5229456.16	0:00	0:00

Table B-1.1: Shadow Flicker Modeling Results at Discrete Points - Sorted by Receptor ID

Receptor ID	Coordinates UTM NAD83 Zone 14N (meters)		Worst Case Shadow Flicker Hours per Year	Expected Shadow Flicker Hours per Year
	X (Easting)	Y (Northing)	(HH:MM/year)	(HH:MM/year)
A265	583415.79	5231204.85	76:54	23:28
A266	580319.28	5232293.72	0:00	0:00
A267	581022.26	5230777.70	19:35	6:17
A268	581768.01	5230219.58	62:54	17:43
A269	581814.33	5228345.07	120:15	34:05
A270	585108.44	5227544.15	6:46	2:43
A272	578556.16	5216005.02	27:07	10:44
A273	575853.28	5215654.58	94:15	29:53
A274	575594.82	5215668.90	68:31	23:15
A275	587932.95	5227703.98	0:00	0:00
A277	581361.94	5229127.35	1:34	0:25
A278	583744.33	5233094.76	0:00	0:00
A279	584958.76	5230551.29	30:57	12:25
A280	577317.58	5213740.93	9:47	3:55
A284	579433.58	5221148.89	0:00	0:00
A287	581018.95	5229570.32	23:03	8:16
A288	580342.06	5229272.66	5:12	1:52
A316	584729.26	5233223.63	0:00	0:00

Table B-1.2: Shadow Flicker Modeling Results at Discrete Points - Sorted by Expected Flicker

Receptor ID	Coordinates UTM NAD83 Zone 14N (meters)		Worst Case Shadow Flicker Hours per Year	Expected Shadow Flicker Hours per Year
	X (Easting)	Y (Northing)	(HH:MM/year)	(HH:MM/year)
A269	581814	5228345	120:15	34:05
A273	575853	5215655	94:15	29:53
A265	583416	5231205	76:54	23:28
A274	575595	5215669	68:31	23:15
A268	581768	5230220	62:54	17:43
A279	584959	5230551	30:57	12:25
A272	578556	5216005	27:07	10:44
A287	581019	5229570	23:03	8:16
A13	575632	5214523	24:09	7:35
A128	575060	5216281	21:14	6:24
A267	581022	5230778	19:35	6:17
A131	575299	5216311	18:21	6:08
A129	575070	5216325	17:51	5:31
A8	575041	5213810	14:38	5:14
A130	575071	5216343	16:28	5:10
A171	579265	5218098	22:25	4:58
A121	575169	5216210	13:39	4:43
A126	575075	5216127	14:56	4:43
A88	575007	5215806	13:28	4:37
A120	575149	5216209	13:11	4:34
A97	575054	5215884	13:44	4:32
A119	575138	5216208	12:59	4:30
A86	574974	5215770	12:53	4:28
A99	575053	5215978	13:31	4:25
A118	575125	5216204	12:39	4:24
A117	575113	5216196	12:23	4:21
A170	577431	5217769	14:08	4:19
A96	575003	5215950	12:28	4:05
A108	574987	5216162	12:30	3:57
A95	574981	5215931	11:58	3:56
A280	577318	5213741	9:47	3:55
A94	574970	5215923	11:45	3:53
A93	574955	5215912	11:35	3:50
A89	574915	5215850	11:09	3:48
A87	574900	5215834	11:05	3:48
A92	574933	5215904	11:13	3:44
A91	574918	5215895	11:00	3:41
A98	574996	5215987	11:12	3:38
A90	574904	5215878	10:42	3:36
A105	575017	5216102	11:14	3:32
A80	574994	5215654	9:21	3:23

Table B-1.2: Shadow Flicker Modeling Results at Discrete Points - Sorted by Expected Flicker

Receptor ID	Coordinates UTM NAD83 Zone 14N (meters)		Worst Case Shadow Flicker Hours per Year	Expected Shadow Flicker Hours per Year
	X (Easting)	Y (Northing)	(HH:MM/year)	(HH:MM/year)
A104	574981	5216122	10:36	3:21
A103	574975	5216101	10:22	3:17
A102	574976	5216077	10:09	3:14
A101	574980	5216052	10:07	3:14
A100	574987	5216008	10:00	3:12
A84	574942	5215651	8:33	3:05
A127	575006	5216281	9:13	3:05
A79	574922	5215678	8:31	3:04
A82	574921	5215624	8:23	3:01
A169	577273	5218307	9:01	3:01
A81	574924	5215716	8:12	2:56
A85	574913	5215734	7:57	2:51
A270	585108	5227544	6:46	2:43
A123	575113	5216170	7:43	2:42
A124	575103	5216160	7:30	2:40
A125	575086	5216145	7:10	2:35
A111	575055	5216208	7:13	2:29
A114	575039	5216182	6:49	2:24
A106	575010	5216202	6:42	2:20
A107	575000	5216178	6:18	2:14
A122	575088	5216166	5:45	2:02
A116	575080	5216195	5:34	1:55
A115	575077	5216208	5:35	1:55
A288	580342	5229273	5:12	1:52
A109	575028	5216158	5:09	1:51
A112	575051	5216198	5:20	1:51
A110	575036	5216171	5:10	1:50
A113	575046	5216190	5:13	1:49
A83	574848	5215638	4:39	1:40
A77	574649	5214843	2:42	0:58
A76	574452	5214843	2:24	0:52
A277	581362	5229127	1:34	0:25
A3	575704	5212232	0:00	0:00
A9	578905	5213921	0:00	0:00
A33	573827	5215213	0:00	0:00
A34	573856	5215220	0:00	0:00
A35	573902	5215240	0:00	0:00
A36	573919	5215256	0:00	0:00
A37	573935	5215282	0:00	0:00
A38	573949	5215296	0:00	0:00
A39	573962	5215322	0:00	0:00

Table B-1.2: Shadow Flicker Modeling Results at Discrete Points - Sorted by Expected Flicker

Receptor ID	Coordinates UTM NAD83 Zone 14N (meters)		Worst Case Shadow Flicker Hours per Year	Expected Shadow Flicker Hours per Year
	X (Easting)	Y (Northing)	(HH:MM/year)	(HH:MM/year)
A40	573975	5215339	0:00	0:00
A41	573986	5215353	0:00	0:00
A42	573989	5215363	0:00	0:00
A43	573993	5215386	0:00	0:00
A44	573965	5215371	0:00	0:00
A45	573956	5215363	0:00	0:00
A46	573952	5215351	0:00	0:00
A47	574044	5215594	0:00	0:00
A55	573911	5216214	0:00	0:00
A56	573890	5216176	0:00	0:00
A57	573900	5216155	0:00	0:00
A58	573921	5216126	0:00	0:00
A59	573934	5216111	0:00	0:00
A60	573946	5216093	0:00	0:00
A61	573947	5216066	0:00	0:00
A62	573965	5216048	0:00	0:00
A63	573979	5216007	0:00	0:00
A64	573974	5215980	0:00	0:00
A65	573977	5215943	0:00	0:00
A66	574002	5215927	0:00	0:00
A68	574084	5215721	0:00	0:00
A69	574044	5215761	0:00	0:00
A70	574037	5215810	0:00	0:00
A71	574336	5214645	0:00	0:00
A72	574424	5214718	0:00	0:00
A73	574471	5214730	0:00	0:00
A74	574442	5214766	0:00	0:00
A75	574403	5214774	0:00	0:00
A78	574860	5215687	0:00	0:00
A132	574451	5217076	0:00	0:00
A133	574438	5217132	0:00	0:00
A134	574434	5217105	0:00	0:00
A135	574409	5217093	0:00	0:00
A136	574390	5217105	0:00	0:00
A137	574418	5217144	0:00	0:00
A138	574357	5217173	0:00	0:00
A139	574344	5217146	0:00	0:00
A140	574340	5217120	0:00	0:00
A141	574493	5217232	0:00	0:00
A142	574455	5217310	0:00	0:00
A143	574344	5217222	0:00	0:00

Table B-1.2: Shadow Flicker Modeling Results at Discrete Points - Sorted by Expected Flicker

Receptor ID	Coordinates UTM NAD83 Zone 14N (meters)		Worst Case Shadow Flicker Hours per Year	Expected Shadow Flicker Hours per Year
	X (Easting)	Y (Northing)	(HH:MM/year)	(HH:MM/year)
A144	574275	5217292	0:00	0:00
A145	574248	5217347	0:00	0:00
A146	574236	5217260	0:00	0:00
A147	574223	5217281	0:00	0:00
A148	574320	5217219	0:00	0:00
A149	574294	5217228	0:00	0:00
A150	574273	5217224	0:00	0:00
A151	574208	5217292	0:00	0:00
A166	574951	5217739	0:00	0:00
A177	581162	5219681	0:00	0:00
A212	579716	5226801	0:00	0:00
A262	582197	5226417	0:00	0:00
A264	584163	5229456	0:00	0:00
A266	580319	5232294	0:00	0:00
A275	587933	5227704	0:00	0:00
A278	583744	5233095	0:00	0:00
A284	579434	5221149	0:00	0:00
A316	584729	5233224	0:00	0:00

SHADOW - Calendar

Calculation: Points and Grid Shadow receptor: A100 - Shadow Receptor: 1.0 x 1.0 Azimuth: 0.0° Slope: 90.0° (4990)

Assumptions for shadow calculations

Sunshine probability S/S0 (Sun hours/Possible sun hours) []

Reference year for calendar

2023

Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec
 0.52 0.54 0.59 0.57 0.60 0.64 0.74 0.71 0.63 0.51 0.39 0.39

Operational time

N NNE NE ENE E ESE SE SSE S SSW SW WSW W WNW NW NNW Sum
 364 231 235 234 299 398 720 587 362 314 482 477 675 931 686 429 7,424

	January	February	March	April	May	June	
1	08:16 16:50	07:57 17:31	08:29 (89) 18:12	07:12 19:56	07:55 (114) 08:10 (114)	06:17 20:38	05:40 21:16
2	08:16 16:51	07:56 17:32	08:29 (89) 18:14	07:10 19:58	07:56 (114) 08:09 (114)	06:15 20:39	05:39 21:17
3	08:16 16:52	07:55 17:34	08:29 (89) 18:15	07:08 19:59	07:57 (114) 08:07 (114)	06:14 20:40	05:38 21:18
4	08:16 16:53	07:53 17:35	08:30 (89) 18:16	07:06 20:00	06:12 20:42	05:38 21:18	
5	08:16 16:54	07:52 17:37	08:31 (89) 18:18	07:05 20:02	06:11 20:43	05:37 21:19	
6	08:16 16:55	07:51 17:38	08:31 (89) 18:19	07:04 20:03	06:09 20:44	05:37 21:20	
7	08:16 16:56	07:49 17:40	08:33 (89) 18:21	07:02 20:05	06:07 20:46	05:36 21:21	
8	08:16 16:57	07:48 17:41	07:00 18:22	06:58 20:06	06:06 20:47	05:36 21:22	
9	08:15 16:59	07:46 17:43	06:58 18:24	06:57 20:07	06:05 20:48	05:36 21:23	
10	08:15 17:00	07:45 17:45	06:56 18:25	06:55 20:09	06:03 20:50	05:35 21:23	
11	08:15 17:01	07:43 17:46	06:54 18:27	06:53 20:10	06:02 20:51	05:35 21:24	
12	08:14 17:02	07:42 17:48	07:52 18:28	06:51 20:12	06:00 20:52	05:35 21:25	
13	08:14 17:03	07:40 17:49	07:50 19:30	06:49 20:13	05:59 20:54	05:35 21:25	
14	08:13 17:05	07:39 17:51	07:48 19:31	06:47 20:14	05:58 20:55	05:34 21:26	
15	08:13 17:06	07:37 17:52	07:46 19:32	06:45 20:16	05:56 20:56	05:34 21:26	
16	08:12 17:07	07:36 17:54	07:44 19:34	06:43 20:17	05:55 20:58	05:34 21:27	
17	08:12 17:09	07:34 17:55	07:42 19:35	06:41 20:18	05:54 20:59	05:34 21:27	
18	08:11 17:10	07:32 17:57	07:40 19:37	06:39 20:20	05:53 21:00	05:34 21:28	
19	08:10 17:11	07:31 17:58	07:38 19:38	06:38 20:21	05:52 21:01	05:34 21:28	
20	08:09 17:13	07:29 18:00	07:36 19:40	06:36 20:23	05:50 21:02	05:34 21:29	
21	08:09 17:14	07:27 18:00	07:34 19:41	06:34 20:24	05:49 21:04	05:34 21:29	
22	08:08 17:16	07:26 18:01	07:32 19:42	06:32 20:25	05:48 21:05	05:35 21:29	
23	08:07 17:17	07:24 18:03	07:30 19:44	06:30 20:27	05:47 21:06	05:35 21:29	
24	08:06 17:19	07:22 18:05	07:28 19:45	08:04 (114) 20:28	06:29 21:07	05:35 21:30	
25	08:05 17:20	07:20 18:06	07:26 19:47	08:00 (114) 20:30	06:27 21:08	05:35 21:30	
26	08:04 17:22	07:18 18:08	07:24 19:48	07:58 (114) 20:31	06:25 21:09	05:36 21:30	
27	08:03 17:23	08:31 (89) 07:17	07:22 19:49	08:11 (114) 20:32	06:23 21:11	05:36 21:30	
28	08:02 17:25	08:39 (89) 07:15	07:20 19:51	08:12 (114) 20:34	06:22 21:12	05:37 21:30	
29	08:01 17:26	08:41 (89) 18:11	07:18 19:52	07:56 (114) 20:35	06:20 21:13	05:37 21:30	
30	08:00 17:28	08:30 (89) 07:16	07:16 19:54	08:12 (114) 20:36	06:18 21:14	05:37 21:30	
31	07:58 17:29	08:43 (89) 07:15	07:14 19:55	07:55 (114) 20:36	06:18 21:15	05:40 21:30	
Potential sun hours	278	286	367	406	465	475	
Total, worst case	60	91	107				
Sun reduction	0.52	0.54	0.59				38
Oper. time red.	0.85	0.85	0.85				0.57
Wind dir. red.	0.71	0.71	0.71				0.85
Total reduction	0.31	0.33	0.35				0.71
Total, real	19	30	38				0.34

Table layout: For each day in each month the following matrix apply

Day in month	Sun rise (hh:mm)	Sun set (hh:mm)	Minutes with flicker	First time (hh:mm) with flicker	Last time (hh:mm) with flicker	(WTG causing flicker first time)	(WTG causing flicker last time)
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Project: Otter Tail Ashtabula III Wind
 Description: Barnes County, ND

Licensed user:
 Epsilon Associates, Inc
 3 Clock Tower Place, Suite 250
 US-MAYNARD MA 01754
 978 897 7100
 Richard Lampeter / rlampeter@epsilonassociates.com
 Calculated:
 6/18/2023 2:05 PM/3.6.366

SHADOW - Calendar

Calculation: Points and Grid Shadow receptor: A100 - Shadow Receptor: 1.0 x 1.0 Azimuth: 0.0° Slope: 90.0° (4990)
 Assumptions for shadow calculations

Reference year for calendar

2023

Sunshine probability S/S0 (Sun hours/Possible sun hours) []

Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec
 0.52 0.54 0.59 0.57 0.60 0.64 0.74 0.71 0.63 0.51 0.39 0.39

Operational time

N NNE NE ENE E ESE SE SSE S SSW SW WSW W WNW NW NNW Sum
 364 231 235 234 299 398 720 587 362 314 482 477 675 931 686 429 7,424

	July	August	September	October	November	December
1	05:38 21:30	06:08 21:06	06:48 20:15	07:27 19:15	08:11 18:16	07:54 16:43
2	05:39 21:30	06:09 21:05	06:49 20:13	07:28 19:13	08:12 18:15	07:55 16:43
3	05:39 21:29	06:10 21:04	06:50 20:11	07:30 19:11	08:14 18:13	07:56 16:43
4	05:40 21:29	06:11 21:02	06:51 20:09	07:31 19:09	08:15 18:12	07:57 16:42
5	05:40 21:29	06:12 21:01	06:53 20:07	07:32 19:07	07:17 17:10	08:04 (89) 16:42
6	05:41 21:28	06:14 20:59	06:54 20:05	07:34 19:05	07:18 17:09	08:01 (89) 16:41
7	05:42 21:28	06:15 20:58	06:55 20:03	07:35 19:03	07:20 17:07	08:01 (89) 16:41
8	05:43 21:28	06:16 20:56	06:57 20:01	07:37 19:01	07:21 17:06	08:01 (89) 16:41
9	05:43 21:27	06:18 20:55	06:58 19:59	07:38 18:57	07:23 17:04	08:00 (89) 16:41
10	05:44 21:27	06:19 20:53	06:59 19:57	07:39 18:53	07:24 17:03	08:00 (89) 16:41
11	05:45 21:26	06:20 20:52	07:01 19:55	07:40 18:53	07:26 17:02	07:59 (89) 16:41
12	05:46 21:26	06:21 20:50	07:02 19:53	07:42 18:51	07:27 17:01	08:00 (89) 16:41
13	05:47 21:25	06:23 20:49	07:03 19:51	07:44 18:49	07:29 16:59	08:01 (89) 16:41
14	05:48 21:24	06:24 20:47	07:05 19:49	07:46 18:47	07:30 16:58	08:01 (89) 16:41
15	05:49 21:24	06:25 20:45	07:06 19:47	07:48 18:46	07:32 16:57	08:02 (89) 16:41
16	05:50 21:23	06:27 20:44	07:07 19:45	07:49 18:44	07:33 16:56	08:03 (89) 16:41
17	05:51 21:22	06:28 20:42	07:08 19:43	07:49 18:42	07:35 16:55	08:06 (89) 16:41
18	05:52 21:21	06:29 20:40	07:10 19:41	07:51 18:40	07:36 16:54	08:11 16:42
19	05:53 21:21	06:31 20:39	07:11 19:39	07:52 18:38	07:38 16:53	08:11 16:42
20	05:54 21:20	06:32 20:37	07:12 19:37	07:53 18:36	07:39 16:52	08:12 16:42
21	05:55 21:19	06:33 20:35	07:14 19:35	07:55 18:35	07:40 16:51	08:13 16:43
22	05:56 21:18	06:34 20:33	07:15 19:33	07:56 18:33	07:42 16:50	08:13 16:43
23	05:57 21:17	06:36 20:32	07:16 19:31	07:58 18:31	07:43 16:49	08:14 16:44
24	05:58 21:16	06:37 20:30	07:18 19:29	07:59 18:29	07:45 16:48	08:14 16:44
25	05:59 21:15	06:38 20:28	07:19 19:27	08:01 18:28	07:46 16:47	08:15 16:45
26	06:00 21:14	06:40 20:26	07:20 19:25	08:02 18:26	07:47 16:47	08:15 16:45
27	06:02 21:12	06:41 20:24	07:22 19:23	08:04 18:24	07:49 16:46	08:15 16:46
28	06:03 21:11	06:42 20:22	07:23 19:21	08:05 18:23	07:50 16:45	08:16 16:47
29	06:04 21:10	06:44 20:20	07:24 19:19	08:07 18:21	07:51 16:45	08:16 16:47
30	06:05 21:09	06:45 20:19	07:26 19:17	08:08 18:19	07:53 16:44	08:16 16:48
31	06:06 21:08	06:46 20:17		08:10 18:18		08:16 16:49
Potential sun hours	481	442	380	339	283	266
Total, worst case			151		153	
Sun reduction			0.63		0.39	
Oper. time red.			0.85		0.85	
Wind dir. red.			0.71		0.71	
Total reduction			0.38		0.24	
Total, real			57		36	

Table layout: For each day in each month the following matrix apply

Day in month	Sun rise (hh:mm)	Minutes with flicker	First time (hh:mm) with flicker	(WTG causing flicker first time)
	Sun set (hh:mm)		Last time (hh:mm) with flicker	(WTG causing flicker last time)

Project:

Otter Tail Ashtabula III Wind

Description:

Barnes County, ND

Licensed user:

Epsilon Associates, Inc
3 Clock Tower Place, Suite 250
US-MAYNARD MA 01754
978 897 7100
Richard Lampeter / rlampeter@epsilonassociates.com
Calculated:
6/18/2023 2:05 PM/3.6.366

SHADOW - Calendar

Calculation: Points and Grid Shadow receptor: A101 - Shadow Receptor: 1.0 x 1.0 Azimuth: 0.0° Slope: 90.0° (4991)

Assumptions for shadow calculations

Sunshine probability S/S0 (Sun hours/Possible sun hours) []

Reference year for calendar

2023

Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec
0.52 0.54 0.59 0.57 0.60 0.64 0.74 0.71 0.63 0.51 0.39 0.39

Operational time

N NNE NE ENE E ESE SE SSE S SSW SW WSW W WNW NW NNW Sum
364 231 235 234 299 398 720 587 362 314 482 477 675 931 686 429 7,424

Table with columns for months (January to December) and rows for each day of the month, showing sun rise and set times, and a summary row at the bottom for total reduction.

Table layout: For each day in each month the following matrix apply

Matrix with columns: Day in month, Sun rise (hh:mm), Sun set (hh:mm), Minutes with flicker, First time (hh:mm) with flicker, Last time (hh:mm) with flicker, (WTG causing flicker first time), (WTG causing flicker last time)

Project:

Otter Tail Ashtabula III Wind

Description:

Barnes County, ND

Licensed user:

Epsilon Associates, Inc
3 Clock Tower Place, Suite 250
US-MAYNARD MA 01754
978 897 7100
Richard Lampeter / rlampeter@epsilonassociates.com
Calculated:
6/18/2023 2:05 PM/3.6.366

SHADOW - Calendar

Calculation: Points and Grid Shadow receptor: A102 - Shadow Receptor: 1.0 x 1.0 Azimuth: 0.0° Slope: 90.0° (4992)

Assumptions for shadow calculations

Sunshine probability S/S0 (Sun hours/Possible sun hours) []

Reference year for calendar

2023

Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec
0.52 0.54 0.59 0.57 0.60 0.64 0.74 0.71 0.63 0.51 0.39 0.39

Operational time

N NNE NE ENE E ESE SE SSE S SSW SW WSW W WNW NW NNW Sum
364 231 235 234 299 398 720 587 362 614 482 477 675 931 686 429 7,424

Table with columns for months (January to December) and rows for each day of the month, showing sun rise and set times, and a summary section at the bottom for sun hours and reduction.

Table layout: For each day in each month the following matrix apply

Matrix with columns: Day in month, Sun rise (hh:mm), Sun set (hh:mm), Minutes with flicker, First time (hh:mm) with flicker, Last time (hh:mm) with flicker, (WTG causing flicker first time), (WTG causing flicker last time)

Project:

Otter Tail Ashtabula III Wind

Description:

Barnes County, ND

Licensed user:

Epsilon Associates, Inc
3 Clock Tower Place, Suite 250
US-MAYNARD MA 01754
978 897 7100
Richard Lampeter / rlampeter@epsilonassociates.com
Calculated:
6/18/2023 2:05 PM/3.6.366

SHADOW - Calendar

Calculation: Points and Grid Shadow receptor: A103 - Shadow Receptor: 1.0 x 1.0 Azimuth: 0.0° Slope: 90.0° (4993)

Assumptions for shadow calculations

Sunshine probability S/S0 (Sun hours/Possible sun hours) []

Reference year for calendar

2023

Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec
0.52 0.54 0.59 0.57 0.60 0.64 0.74 0.71 0.63 0.51 0.39 0.39

Operational time

N NNE NE ENE E ESE SE SSE S SSW SW WSW W WNW NW NNW Sum
364 231 235 234 299 398 720 587 362 614 482 477 675 931 686 429 7,424

Table with columns for months (January to December) and rows for days (1 to 31). Each cell contains a time range (e.g., 08:16-16:50) and a numerical value in parentheses (e.g., 89). Summary rows at the bottom show 'Potential sun hours', 'Sun reduction', 'Oper. time red.', 'Wind dir. red.', 'Total reduction', and 'Total, real'.

Table layout: For each day in each month the following matrix apply

Matrix with columns: Day in month, Sun rise (hh:mm), Sun set (hh:mm), Minutes with flicker, First time (hh:mm) with flicker, Last time (hh:mm) with flicker, (WTG causing flicker first time), (WTG causing flicker last time)

Project:

Otter Tail Ashtabula III Wind

Description:

Barnes County, ND

Licensed user:

Epsilon Associates, Inc
3 Clock Tower Place, Suite 250
US-MAYNARD MA 01754
978 897 7100
Richard Lampeter / rlampeter@epsilonassociates.com
Calculated:
6/18/2023 2:05 PM/3.6.366

SHADOW - Calendar

Calculation: Points and Grid Shadow receptor: A104 - Shadow Receptor: 1.0 x 1.0 Azimuth: 0.0° Slope: 90.0° (4994)

Assumptions for shadow calculations

Sunshine probability S/S0 (Sun hours/Possible sun hours) []

Reference year for calendar

2023

Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec
0.52 0.54 0.59 0.57 0.60 0.64 0.74 0.71 0.63 0.51 0.39 0.39

Operational time

N NNE NE ENE E ESE SE SSE S SSW SW WSW W WNW NW NNW Sum
364 231 235 234 299 398 720 587 362 314 482 477 675 931 686 429 7,424

Table with columns for months (January to December) and rows for days (1 to 31). Each cell contains start and end times for shadow calculations. Summary rows at the bottom show potential sun hours, total, worst case, and various reduction factors.

Table layout: For each day in each month the following matrix apply

Day in month Sun rise (hh:mm) First time (hh:mm) with flicker (WTG causing flicker first time)
Sun set (hh:mm) Minutes with flicker Last time (hh:mm) with flicker (WTG causing flicker last time)

SHADOW - Calendar

Calculation: Points and Grid Shadow receptor: A105 - Shadow Receptor: 1.0 x 1.0 Azimuth: 0.0° Slope: 90.0° (4995)

Assumptions for shadow calculations

Reference year for calendar

2023

Sunshine probability S/S0 (Sun hours/Possible sun hours) []

Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec
 0.52 0.54 0.59 0.57 0.60 0.64 0.74 0.71 0.63 0.51 0.39 0.39

Operational time

N NNE NE ENE E ESE SE SSE S SSW SW WSW W WNW NW NNW Sum
 364 231 235 234 299 398 720 587 362 314 482 477 675 931 686 429 7,424

	January	February	March	April	May	June	July	August	September	October	November	December
1	08:16 16:50	07:57 17:31	07:13 18:12	07:12 19:56	06:17 20:38	05:40 21:16	05:38 21:30	06:08 21:06	06:48 20:15	07:27 19:15	08:11 18:16	07:54 16:43
2	08:16 16:51	07:56 17:32	07:11 18:14	07:10 19:58	06:15 20:39	05:39 21:17	05:39 21:30	06:09 21:05	06:49 20:13	07:28 19:13	08:12 18:15	07:55 16:43
3	08:16 16:52	07:55 17:34	07:09 18:15	07:08 19:59	06:14 20:40	05:38 21:18	05:39 21:29	06:10 21:04	06:50 20:11	07:30 19:11	08:14 18:13	07:56 16:43
4	08:16 16:53	07:53 17:35	07:07 18:16	07:06 20:00	06:12 20:42	05:38 21:18	05:40 21:29	06:11 21:02	06:51 20:09	07:31 19:09	08:15 18:12	07:57 16:42
5	08:16 16:54	07:52 17:37	07:05 18:18	07:04 20:02	06:10 20:43	05:37 21:19	05:40 21:29	06:12 21:01	06:53 20:07	07:32 19:07	07:17 17:10	07:59 16:42
6	08:16 16:55	07:51 17:38	07:04 18:19	07:02 20:03	06:09 20:44	05:37 21:20	05:41 21:28	06:14 20:59	06:54 20:05	07:34 19:05	07:18 17:09	08:00 16:41
7	08:16 16:56	07:49 17:40	07:02 18:21	07:00 20:05	06:07 20:46	05:36 21:21	05:42 21:28	06:15 20:58	06:55 20:03	07:35 19:03	07:20 17:07	08:01 16:41
8	08:16 16:57	07:48 17:41	07:00 18:22	06:58 20:06	06:06 20:47	05:36 21:22	05:43 21:28	06:16 20:56	06:57 20:01	07:37 19:01	07:21 17:06	08:02 16:41
9	08:15 16:59	07:46 17:43	06:58 18:24	06:57 20:07	06:05 20:48	05:35 21:23	05:43 21:27	06:18 20:55	06:58 19:59	07:38 18:57	07:23 17:04	08:03 16:41
10	08:15 17:00	07:45 17:45	06:56 18:25	06:55 20:09	06:03 20:50	05:35 21:23	05:44 21:27	06:19 20:53	06:59 19:57	07:39 18:55	07:24 17:03	08:04 16:41
11	08:15 17:01	07:43 17:46	06:54 18:27	06:53 20:10	06:02 20:51	05:35 21:24	05:45 21:26	06:20 20:52	07:01 19:55	07:41 18:53	07:26 17:02	08:05 16:41
12	08:14 17:02	07:42 17:48	07:52 18:28	06:51 20:12	06:01 20:52	05:35 21:25	05:46 21:26	06:21 20:50	07:02 19:53	07:42 18:51	07:27 17:01	08:06 16:41
13	08:14 17:03	07:40 17:49	07:50 19:30	06:49 20:13	05:59 20:54	05:35 21:25	05:47 21:25	06:23 20:49	07:03 19:51	07:44 18:49	07:29 16:59	08:07 16:41
14	08:13 17:05	07:39 17:51	07:48 19:31	06:47 20:14	05:58 20:55	05:34 21:26	05:48 21:24	06:24 20:47	07:05 19:49	07:45 18:47	07:30 16:58	08:08 16:41
15	08:13 17:06	07:37 17:52	07:46 19:32	06:45 20:16	05:56 20:56	05:34 21:26	05:49 21:24	06:25 20:45	07:06 19:47	07:46 18:46	07:32 16:57	08:09 16:41
16	08:12 17:07	08:41 (89) 08:45 (89)	07:36 17:54	07:44 19:34	08:18 (114) 08:23 (114)	06:43 20:17	05:55 20:58	05:34 21:27	05:50 21:23	06:27 20:44	07:07 19:45	08:09 16:41
17	08:12 17:09	08:39 (89) 08:49 (89)	07:34 17:55	07:42 19:35	08:15 (114) 08:25 (114)	06:41 20:18	05:54 20:59	05:34 21:27	05:51 21:22	06:28 20:42	07:08 19:43	08:10 16:41
18	08:11 17:10	08:39 (89) 08:50 (89)	07:32 17:57	07:40 19:37	08:13 (114) 08:27 (114)	06:39 20:20	05:53 21:00	05:34 21:28	05:52 21:21	06:29 20:40	07:10 19:41	08:11 16:42
19	08:10 17:11	08:38 (89) 08:51 (89)	07:31 17:58	07:38 19:38	08:12 (114) 08:27 (114)	06:38 20:21	05:52 21:01	05:34 21:28	05:53 21:21	06:31 20:39	07:11 19:39	08:11 16:42
20	08:09 17:13	08:39 (89) 08:52 (89)	07:29 18:00	07:36 19:40	08:11 (114) 08:28 (114)	06:36 20:23	05:50 21:02	05:34 21:29	05:54 21:20	06:32 20:37	07:12 19:37	08:12 16:42
21	08:09 17:14	08:39 (89) 08:53 (89)	07:27 18:00	07:34 19:41	08:10 (114) 08:28 (114)	06:34 20:24	05:49 21:04	05:34 21:29	05:55 21:19	06:33 20:35	07:14 19:35	08:13 16:43
22	08:08 17:16	08:39 (89) 08:54 (89)	07:26 18:01	07:32 19:42	08:10 (114) 08:27 (114)	06:32 20:25	05:48 21:05	05:35 21:29	05:56 21:18	06:34 20:33	07:15 19:33	08:14 16:43
23	08:07 17:17	08:39 (89) 08:54 (89)	07:24 18:03	07:30 19:44	08:10 (114) 08:27 (114)	06:30 20:27	05:47 21:06	05:35 21:29	05:57 21:17	06:36 20:32	07:16 19:31	08:14 16:44
24	08:06 17:19	08:39 (89) 08:54 (89)	07:22 18:05	07:28 19:45	08:10 (114) 08:26 (114)	06:29 20:28	05:46 21:07	05:35 21:30	05:58 21:16	06:37 20:30	07:18 19:29	08:15 16:44
25	08:05 17:20	08:40 (89) 08:54 (89)	07:20 18:06	07:26 19:47	08:11 (114) 08:24 (114)	06:27 20:30	05:45 21:08	05:35 21:30	05:59 21:15	06:38 20:28	07:19 19:27	08:16 16:45
26	08:04 17:22	08:39 (89) 08:53 (89)	07:18 18:08	07:24 19:48	08:13 (114) 08:22 (114)	06:25 20:31	05:44 21:09	06:00 21:30	06:40 21:14	07:20 19:25	08:02 18:26	08:17 16:45
27	08:03 17:23	08:40 (89) 08:53 (89)	07:17 18:09	07:22 19:49	08:13 (114) 08:22 (114)	06:23 20:32	05:44 21:11	06:02 21:30	06:41 21:12	07:22 19:23	08:04 18:24	08:18 16:46
28	08:02 17:25	08:41 (89) 08:53 (89)	07:15 18:11	07:20 19:51	08:13 (114) 08:24 (114)	06:22 20:34	05:43 21:12	06:03 21:30	06:42 21:11	07:23 19:21	08:05 18:23	08:19 16:45
29	08:01 17:26	08:43 (89) 08:52 (89)	07:18 18:11	07:18 19:52	08:13 (114) 08:24 (114)	06:20 20:35	05:42 21:13	06:04 21:30	06:44 21:10	07:24 19:19	08:07 18:21	08:20 16:45
30	08:00 17:28	08:45 (89) 08:51 (89)	07:16 18:08	07:16 19:54	08:13 (114) 08:24 (114)	06:18 20:36	05:41 21:14	06:05 21:30	06:45 20:19	07:26 19:17	08:08 18:19	08:16 16:48
31	07:58 17:29	08:46 (89) 08:51 (89)	07:14 18:05	07:14 19:55	08:13 (114) 08:24 (114)	06:16 20:37	05:40 21:15	06:06 21:30	06:46 20:17	07:27 18:18	08:09 18:18	08:16 16:49
Potential sun hours	278	286	367	406	465	475	481	442	380	339	283	266
Total, worst case	186		151						151		186	
Sun reduction	0.52		0.59						0.63		0.39	
Oper. time red.	0.85		0.85						0.85		0.85	
Wind dir. red.	0.71		0.71						0.71		0.71	
Total reduction	0.31		0.36						0.38		0.23	
Total, real	58		54						57		44	

Table layout: For each day in each month the following matrix apply

Day in month	Sun rise (hh:mm)	First time (hh:mm) with flicker	(WTG causing flicker first time)
	Sun set (hh:mm)	Last time (hh:mm) with flicker	(WTG causing flicker last time)
	Minutes with flicker		

Project: Otter Tail Ashtabula III Wind

Description: Barnes County, ND

Licensed user:
 Epsilon Associates, Inc
 3 Clock Tower Place, Suite 250
 US-MAYNARD MA 01754
 978 897 7100
 Richard Lampeter / rlampeter@epsilonassociates.com
 Calculated:
 6/18/2023 2:05 PM/3.6.366

SHADOW - Calendar

Calculation: Points and Grid Shadow receptor: A106 - Shadow Receptor: 1.0 x 1.0 Azimuth: 0.0° Slope: 90.0° (4996)
 Assumptions for shadow calculations
 Reference year for calendar 2023

Sunshine probability S/S0 (Sun hours/Possible sun hours) []

Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec
 0.52 0.54 0.59 0.57 0.60 0.64 0.74 0.71 0.63 0.51 0.39 0.39

Operational time

N NNE NE ESE SE SSE S SSW SW WSW W WNW NW NNW Sum
 364 231 235 234 299 398 720 587 362 314 482 477 675 931 686 429 7,424

	January	February	March	April	May	June	July	August	September	October	November	December	
1	08:16 16:50	07:57 17:31	07:13 18:12	07:12 19:56	06:17 20:38	05:40 21:16	05:38 21:30	06:08 21:06	06:48 20:15	07:27 19:15	08:00 (118) 08:23 (114)	08:11 18:16	07:54 16:43
2	08:16 16:51	07:56 17:32	07:11 18:14	07:10 19:58	06:15 20:39	05:39 21:17	05:39 21:30	06:09 21:05	06:49 20:13	07:28 19:13	08:00 (118) 08:23 (114)	08:12 18:15	07:55 16:43
3	08:16 16:52	07:55 17:34	07:09 18:15	07:08 19:59	06:14 20:40	05:38 21:18	05:39 21:29	06:10 21:04	06:50 20:11	07:30 19:11	08:00 (118) 08:22 (114)	08:14 18:13	07:56 16:43
4	08:16 16:53	07:53 17:35	07:07 18:16	07:06 20:00	06:12 20:42	05:38 21:18	05:40 21:29	06:11 21:02	06:51 20:09	07:31 19:09	08:01 (118) 08:21 (114)	08:15 18:12	07:57 16:42
5	08:16 16:54	07:52 17:37	07:05 18:18	07:04 20:02	06:10 20:43	05:37 21:19	05:40 21:29	06:12 21:01	06:53 20:07	07:32 19:07	08:04 (118) 08:20 (114)	07:17 17:10	07:59 16:42
6	08:16 16:55	07:51 17:38	07:04 18:19	07:02 20:03	06:09 20:44	05:37 21:20	05:41 21:28	06:14 20:59	06:54 20:05	07:34 19:05	08:09 (114) 08:18 (114)	07:18 17:09	08:00 16:41
7	08:16 16:56	07:49 17:40	07:02 18:21	07:00 20:05	06:07 20:46	05:36 21:21	05:42 21:28	06:15 20:58	06:55 20:03	07:35 19:03	07:20 17:07	08:01 16:41	08:01 16:41
8	08:16 16:57	07:48 17:41	07:00 18:22	06:58 20:06	06:06 20:47	05:36 21:22	05:43 21:28	06:16 20:56	06:57 20:01	07:37 19:01	07:21 17:06	08:02 16:41	08:02 16:41
9	08:15 16:59	07:46 17:43	06:58 18:24	8 07:32 (114) 06:57	06:05 20:07	05:36 20:48	05:43 21:23	06:18 21:27	06:58 20:55	07:38 19:59	07:23 17:04	08:03 16:41	08:03 16:41
10	08:15 17:00	07:45 17:45	06:56 18:25	16 07:26 (118) 06:55	06:03 20:09	05:35 20:50	05:44 21:23	06:19 21:27	06:59 20:53	07:39 19:57	07:24 17:03	08:04 16:41	08:04 16:41
11	08:15 17:01	07:43 17:46	06:54 18:27	16 07:23 (118) 06:53	06:02 20:10	05:35 21:24	05:45 21:26	06:20 20:52	07:01 19:55	07:41 18:53	07:26 17:02	08:05 16:41	08:05 16:41
12	08:14 17:02	07:42 17:48	06:52 18:28	20 08:21 (118) 06:51	06:00 20:12	05:35 20:52	05:46 21:26	06:21 20:50	07:02 19:53	07:42 18:51	07:27 17:01	08:06 16:41	08:06 16:41
13	08:14 17:03	07:40 17:49	06:50 18:30	22 08:43 (114) 06:49	20:12 20:54	21:25 21:25	21:26 21:25	20:50 20:49	19:53 19:51	18:49 18:49	17:01 16:59	16:41 16:41	16:41 16:41
14	08:13 17:05	07:39 17:51	06:48 19:31	24 08:44 (114) 06:47	20:13 20:55	21:25 21:26	21:25 21:24	20:49 20:47	19:51 19:49	18:49 18:47	16:59 16:58	16:41 16:41	16:41 16:41
15	08:13 17:06	07:37 17:52	06:46 19:32	23 08:43 (114) 06:45	20:14 20:56	21:26 21:26	21:24 21:24	20:47 20:45	19:49 19:47	18:47 18:46	16:58 16:57	16:41 16:41	16:41 16:41
16	08:12 17:07	07:36 17:54	06:44 19:34	23 08:43 (114) 06:43	20:16 20:58	21:26 21:27	21:24 21:23	20:45 20:44	19:47 19:45	18:46 18:44	16:57 16:56	16:41 16:41	16:41 16:41
17	08:12 17:09	07:34 17:55	06:42 19:35	22 08:42 (114) 06:41	20:17 20:58	21:27 21:27	21:23 21:22	20:44 20:42	19:45 19:43	18:44 18:42	16:56 16:55	16:41 16:41	16:41 16:41
18	08:11 17:10	07:32 17:57	06:40 19:37	20 08:41 (114) 06:39	20:18 20:20	21:27 21:28	21:22 21:21	20:42 20:40	19:43 19:41	18:42 18:40	16:55 16:54	16:41 16:41	16:41 16:42
19	08:10 17:11	07:31 17:58	06:38 19:38	17 08:39 (114) 06:38	20:20 20:21	21:00 21:01	21:28 21:21	20:40 20:39	19:41 19:39	18:40 18:38	16:54 16:53	16:41 16:42	16:42 16:42
20	08:09 17:13	07:29 18:00	06:36 19:40	4 08:35 (114) 06:36	20:21 21:02	21:01 21:29	21:28 21:20	20:39 20:37	19:39 19:37	18:38 18:36	16:53 16:52	16:42 16:42	16:42 16:42
21	08:09 17:14	07:27 18:00	06:34 19:41	06:34 20:24	05:49 21:04	05:34 21:29	05:55 21:19	06:33 20:35	07:14 19:35	18:36 18:35	16:52 16:51	16:42 16:43	16:43 16:43
22	08:08 17:16	07:26 18:01	06:32 19:42	06:32 20:25	05:48 21:05	05:35 21:29	05:56 21:18	06:34 20:33	07:15 19:33	18:35 18:33	16:50 16:49	16:43 16:43	16:43 16:43
23	08:07 17:17	07:24 18:03	06:30 19:44	06:30 20:27	05:47 21:06	05:35 21:29	05:57 21:17	06:36 20:32	07:16 19:31	18:34 18:31	16:49 16:49	16:43 16:44	16:44 16:44
24	08:06 17:19	07:22 18:05	06:28 19:45	06:29 20:28	05:46 21:07	05:35 21:30	05:58 21:16	06:37 20:30	07:18 19:29	18:33 18:29	16:48 16:48	16:44 16:44	16:44 16:44
25	08:05 17:20	07:20 18:06	06:26 19:47	06:27 20:30	05:45 21:08	05:35 21:30	05:59 21:15	06:38 20:28	07:19 19:27	18:32 18:28	16:47 16:47	16:45 16:45	16:45 16:45
26	08:04 17:22	07:18 18:08	06:24 19:48	06:25 20:31	05:44 21:09	05:36 21:30	06:00 21:14	06:40 20:26	07:20 19:25	18:29 18:26	16:47 16:47	16:45 16:45	16:45 16:45
27	08:03 17:23	07:17 18:09	06:22 19:49	06:23 20:32	05:44 21:11	05:36 21:30	06:02 21:12	06:41 20:24	07:22 19:23	18:28 18:24	16:47 16:46	16:45 16:46	16:45 16:46
28	08:02 17:25	07:15 18:11	06:20 19:50	06:22 20:34	05:43 21:12	05:37 21:30	06:03 21:11	06:42 20:22	07:23 19:21	18:27 18:23	16:46 16:45	16:46 16:46	16:46 16:46
29	08:01 17:26	07:14 19:52	06:18 20:35	06:20 20:35	05:42 21:13	05:37 21:30	06:04 21:10	06:44 20:20	07:24 19:19	18:26 18:21	16:46 16:45	16:46 16:47	16:46 16:47
30	08:00 17:28	07:16 19:54	06:18 20:36	06:18 20:36	05:41 21:14	05:37 21:30	06:05 21:09	06:45 20:19	07:26 19:17	18:25 18:19	16:46 16:44	16:47 16:48	16:47 16:48
31	07:58 17:29	07:14 19:55	06:16 20:37	06:16 20:37	05:40 21:15	05:36 21:30	06:06 21:08	06:46 20:17	07:27 18:18	18:24 18:18	16:47 16:47	16:48 16:49	16:48 16:49
Potential sun hours	278	286	367	406	465	475	481	442	380	339	283	266	
Total, worst case			199						90	113			
Sun reduction			0.59						0.63	0.51			
Oper. time red.			0.85						0.85	0.85			
Wind dir. red.			0.71						0.71	0.71			
Total reduction			0.36						0.38	0.31			
Total, real			71						34	35			

Table layout: For each day in each month the following matrix apply

Day in month	Sun rise (hh:mm)	First time (hh:mm) with flicker	(WTG causing flicker first time)
	Sun set (hh:mm)	Minutes with flicker	Last time (hh:mm) with flicker
			(WTG causing flicker last time)

Project: Otter Tail Ashtabula III Wind

Description: Barnes County, ND

Licensed user:
 Epsilon Associates, Inc
 3 Clock Tower Place, Suite 250
 US-MAYNARD MA 01754
 978 897 7100
 Richard Lampeter / rlampeter@epsilonassociates.com
 Calculated:
 6/18/2023 2:05 PM/3.6.366

SHADOW - Calendar

Calculation: Points and Grid Shadow receptor: A107 - Shadow Receptor: 1.0 x 1.0 Azimuth: 0.0° Slope: 90.0° (4997)

Assumptions for shadow calculations

Sunshine probability S/S0 (Sun hours/Possible sun hours) []

Reference year for calendar

2023

Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec
 0.52 0.54 0.59 0.57 0.60 0.64 0.74 0.71 0.63 0.51 0.39 0.39

Operational time

N NNE NE ENE E ESE SE SSE S SSW SW WSW W WNW NW NNW Sum
 364 231 235 234 299 398 720 587 362 314 482 477 675 931 686 429 7,424

	January	February	March	April	May	June	July	August	September	October	November	December	
1	08:16 16:50	07:57 17:31	07:13 18:12	07:12 19:56	06:17 20:38	05:40 21:16	05:38 21:30	06:08 21:06	06:48 20:15	07:27 19:15	07:58 (118) 08:19 (114)	08:11 18:16	07:54 16:43
2	08:16 16:51	07:56 17:32	07:11 18:14	07:10 19:58	06:15 20:39	05:39 21:17	05:39 21:30	06:09 21:05	06:49 20:13	07:28 19:13	07:59 (118) 08:19 (114)	08:12 18:15	07:55 16:43
3	08:16 16:52	07:55 17:34	07:09 18:15	07:08 19:59	06:14 20:40	05:38 21:18	05:39 21:29	06:10 21:04	06:50 20:11	07:30 19:11	08:00 (118) 08:17 (114)	08:14 18:13	07:56 16:43
4	08:16 16:53	07:53 17:35	07:07 18:16	07:06 20:00	06:12 20:42	05:38 21:18	05:40 21:29	06:11 21:02	06:51 20:09	07:31 19:09	08:06 (114) 08:14 (114)	08:15 18:12	07:57 16:42
5	08:16 16:54	07:52 17:37	07:05 18:18	07:04 20:02	06:10 20:43	05:37 21:19	05:40 21:29	06:12 21:01	06:53 20:07	07:32 19:07		07:17 17:10	07:59 16:42
6	08:16 16:55	07:51 17:38	07:04 18:19	07:02 20:03	06:09 20:44	05:37 21:20	05:41 21:28	06:14 20:59	06:54 20:05	07:34 19:05		07:18 17:09	08:00 16:41
7	08:16 16:56	07:49 17:40	07:02 18:21	07:00 20:05	06:07 20:46	05:36 21:21	05:42 21:28	06:15 20:58	06:55 20:03	07:35 19:03		07:20 17:07	08:01 16:41
8	08:16 16:57	07:48 17:41	07:00 18:22	06:58 20:06	06:06 20:47	05:36 21:22	05:43 21:28	06:16 20:56	06:57 20:01	07:37 19:01		07:21 17:06	08:02 16:41
9	08:15 16:59	07:46 17:43	06:58 18:24	06:57 20:07	06:05 20:48	05:36 21:23	05:43 21:27	06:18 20:55	06:58 19:59	07:38 18:57		07:23 17:04	08:03 16:41
10	08:15 17:00	07:45 17:45	06:56 18:25	06:55 20:09	06:03 20:50	05:35 21:23	05:44 21:27	06:19 20:53	06:59 19:57	07:39 18:55		07:24 17:03	08:04 16:41
11	08:15 17:01	07:43 17:46	06:54 18:27	06:53 07:28 (114)	06:02 06:53	05:35 21:24	05:45 21:26	06:20 20:52	07:01 19:55	07:41 18:53		07:26 17:02	08:05 16:41
12	08:14 17:02	07:42 17:48	07:52 18:28	08:21 (118) 08:38 (114)	06:51 20:12	06:00 20:52	05:35 21:25	05:46 21:26	06:21 20:50	07:02 19:53		07:27 17:01	08:06 16:41
13	08:14 17:03	07:40 17:49	07:50 19:30	08:19 (118) 08:39 (114)	06:49 20:13	05:59 20:54	05:35 21:25	05:47 21:25	06:23 20:49	07:03 19:51		07:29 16:59	08:07 16:41
14	08:13 17:05	07:39 17:51	07:48 19:31	08:18 (118) 08:39 (114)	06:47 20:14	05:58 20:55	05:34 21:26	05:48 21:24	06:24 20:47	07:05 19:49		07:45 16:58	08:08 16:41
15	08:13 17:06	07:37 17:52	07:46 19:32	08:17 (118) 08:39 (114)	06:45 20:16	05:56 20:56	05:34 21:26	05:49 21:24	06:25 20:45	07:06 19:47		07:46 16:57	08:09 16:41
16	08:12 17:07	07:36 17:54	07:44 19:34	08:16 (118) 08:39 (114)	06:43 20:17	05:55 20:58	05:34 21:27	05:50 21:23	06:27 20:44	07:07 19:45		07:48 16:56	08:09 16:41
17	08:12 17:09	07:34 17:55	07:42 19:35	08:16 (118) 08:39 (114)	06:41 20:18	05:54 20:59	05:34 21:27	05:51 21:22	06:28 20:42	07:08 19:43		07:49 16:55	08:10 16:41
18	08:11 17:10	07:32 17:57	07:40 19:37	08:17 (118) 08:38 (114)	06:39 20:20	05:53 21:00	05:34 21:28	05:52 21:21	06:29 20:40	07:10 19:41		07:51 16:54	08:11 16:42
19	08:10 17:11	07:31 17:58	07:38 19:38	08:18 (118) 08:36 (114)	06:38 20:21	05:52 21:01	05:34 21:28	05:53 21:21	06:31 20:39	07:11 19:39		07:52 16:53	08:11 16:42
20	08:09 17:13	07:29 18:00	07:36 19:40	08:21 (118) 08:34 (114)	06:36 20:23	05:50 21:02	05:34 21:29	05:54 21:20	06:32 20:37	07:12 19:37		07:53 16:52	08:12 16:42
21	08:09 17:14	07:27 18:00	07:34 19:41	08:28 (114) 08:30 (114)	06:34 20:24	05:49 21:04	05:34 21:29	05:55 21:19	06:33 20:35	07:14 19:35		07:55 16:51	08:13 16:43
22	08:08 17:16	07:26 18:01	07:32 19:42	08:30 (114)	06:32 20:25	05:48 21:05	05:35 21:29	05:56 21:18	06:34 20:33	07:15 19:33		07:56 16:50	08:14 16:43
23	08:07 17:17	07:24 18:03	07:30 19:44		06:30 20:27	05:47 21:06	05:35 21:29	05:57 21:17	06:36 20:32	07:16 19:31		07:58 16:49	08:14 16:44
24	08:06 17:19	07:22 18:05	07:28 19:45		06:29 20:28	05:46 21:07	05:35 21:30	05:58 21:16	06:37 20:30	07:18 19:29	08:11 (114)	07:59 18:29	08:14 16:44
25	08:05 17:20	07:20 18:06	07:26 19:47		06:27 20:30	05:45 21:08	05:35 21:30	05:59 21:15	06:38 20:28	07:19 19:27	08:04 (118) 08:18 (114)	08:01 18:28	07:46 16:47
26	08:04 17:22	07:18 18:08	07:24 19:48		06:25 20:31	05:44 21:09	05:36 21:30	06:00 21:14	06:40 20:26	07:20 19:25	08:02 (118) 08:20 (114)	08:02 18:26	07:47 16:47
27	08:03 17:23	07:17 18:09	07:22 19:49		06:23 20:32	05:44 21:11	05:36 21:30	06:02 21:12	06:41 20:24	07:22 19:23	08:00 (118) 08:21 (114)	08:04 18:24	07:49 16:46
28	08:02 17:25	07:15 18:11	07:20 19:51		06:22 20:34	05:43 21:12	05:37 21:30	06:03 21:11	06:42 20:22	07:23 19:21	07:58 (118) 08:20 (114)	08:05 18:23	07:50 16:45
29	08:01 17:26		07:18 19:52		06:20 20:35	05:42 21:13	05:37 21:30	06:04 21:10	06:44 20:20	07:24 19:19	08:00 (118) 08:21 (114)	08:07 18:21	07:51 16:45
30	08:00 17:28		07:16 19:54		06:18 20:36	05:41 21:14	05:37 21:30	06:05 21:09	06:45 20:19	07:26 19:17	07:58 (118) 08:20 (114)	08:08 18:19	07:53 16:48
31	07:58 17:29		07:14 19:55		05:40 21:15	05:40 21:15	06:06 21:08	06:46 20:17	06:46 20:17	08:10 18:18		08:10 16:49	08:16 16:49
Potential sun hours	278	286	367	406	465	475	481	442	380	339	283	266	
Total, worst case			187						125		66		
Sun reduction			0.59						0.63		0.51		
Oper. time red.			0.85						0.85		0.85		
Wind dir. red.			0.71						0.71		0.71		
Total reduction			0.36						0.38		0.31		
Total, real			67						48		20		

Table layout: For each day in each month the following matrix apply

Day in month	Sun rise (hh:mm)	First time (hh:mm) with flicker	(WTG causing flicker first time)
	Sun set (hh:mm)	Last time (hh:mm) with flicker	(WTG causing flicker last time)
	Minutes with flicker		

SHADOW - Calendar

Calculation: Points and Grid Shadow receptor: A108 - Shadow Receptor: 1.0 x 1.0 Azimuth: 0.0° Slope: 90.0° (4998)

Assumptions for shadow calculations

Reference year for calendar

2023

Sunshine probability S/S0 (Sun hours/Possible sun hours) []

Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec
 0.52 0.54 0.59 0.57 0.60 0.64 0.74 0.71 0.63 0.51 0.39 0.39

Operational time

N NNE NE ENE E ESE SE SSE S SSW SW WSW W WNW NW NNW Sum
 364 231 235 234 299 398 720 587 362 314 482 477 675 931 686 429 7,424

	January	February	March	April	May	June	
1	08:16 16:50	07:57 17:31	07:13 18:12	07:12 19:56	06:17 20:38	05:40 21:16	
2	08:16 16:51	07:56 17:32	07:11 18:14	07:10 19:58	06:15 20:39	05:39 21:17	
3	08:16 16:52	07:55 17:34	07:09 18:15	07:08 19:59	06:14 20:40	05:38 21:18	
4	08:16 16:53	07:53 17:35	07:07 18:16	07:06 20:00	06:12 20:42	05:38 21:18	
5	08:16 16:54	07:52 17:37	07:05 18:18	07:04 20:02	06:10 20:43	05:37 21:19	
6	08:16 16:55	07:51 17:38	07:04 18:19	07:02 20:03	06:09 20:44	05:37 21:20	
7	08:16 16:56	07:49 17:40	07:02 18:21	07:00 20:05	06:07 20:46	05:36 21:21	
8	08:16 16:57	07:48 17:41	07:00 18:22	06:58 20:06	06:06 20:47	05:36 21:22	
9	08:15 16:59	07:46 17:43	06:58 18:24	06:57 20:07	06:05 20:48	05:36 21:23	
10	08:15 17:00	07:45 17:45	06:56 18:25	06:55 20:09	06:03 20:50	05:35 21:23	
11	08:15 17:01	08:46 (89) 08:47 (89)	07:43 17:46	06:54 18:27	06:53 20:10	05:35 21:24	
12	08:14 17:02	08:43 (89) 08:49 (89)	07:42 17:48	07:52 18:28	08:26 (114) 08:32 (114)	06:51 20:12	06:00 21:25
13	08:14 17:03	08:43 (89) 08:51 (89)	07:40 17:49	07:50 19:30	08:19 (118) 08:35 (114)	06:49 20:13	05:59 21:25
14	08:13 17:05	08:42 (89) 08:52 (89)	07:39 17:51	07:48 19:31	08:17 (118) 08:36 (114)	06:47 20:14	05:58 21:26
15	08:13 17:06	08:42 (89) 08:54 (89)	07:37 17:52	07:46 19:32	08:15 (118) 08:36 (114)	06:45 20:16	05:56 21:26
16	08:12 17:07	08:42 (89) 08:54 (89)	07:36 17:54	07:44 19:34	08:15 (118) 08:36 (114)	06:43 20:17	05:55 21:27
17	08:12 17:09	08:42 (89) 08:55 (89)	07:34 17:55	07:42 19:35	08:14 (118) 08:36 (114)	06:41 20:18	05:54 21:27
18	08:11 17:10	08:41 (89) 08:55 (89)	07:32 17:57	07:40 19:37	08:14 (118) 08:36 (114)	06:39 20:20	05:53 21:28
19	08:10 17:11	08:41 (89) 08:56 (89)	07:31 17:58	07:38 19:38	08:15 (118) 08:35 (114)	06:38 20:21	05:52 21:28
20	08:09 17:13	08:42 (89) 08:57 (89)	07:29 18:00	07:36 19:40	08:16 (118) 08:34 (114)	06:36 20:23	05:50 21:29
21	08:09 17:14	08:43 (89) 08:57 (89)	07:27 18:00	07:34 19:41	08:18 (118) 08:32 (114)	06:34 20:24	05:49 21:29
22	08:08 17:16	08:43 (89) 08:57 (89)	07:26 18:01	07:32 19:42	08:23 (114) 08:29 (114)	06:32 20:25	05:48 21:29
23	08:07 17:17	08:44 (89) 08:57 (89)	07:24 18:03	07:30 19:44	06:30 20:27	05:47 21:06	05:35 21:29
24	08:06 17:19	08:44 (89) 08:57 (89)	07:22 18:05	07:28 19:45	06:29 20:28	05:46 21:07	05:35 21:30
25	08:05 17:20	08:45 (89) 08:57 (89)	07:20 18:06	07:26 19:47	06:27 20:30	05:45 21:08	05:35 21:30
26	08:04 17:22	08:46 (89) 08:55 (89)	07:18 18:08	07:24 19:48	06:25 20:31	05:44 21:09	05:36 21:30
27	08:03 17:23	08:48 (89) 08:54 (89)	07:17 18:09	07:22 19:49	06:23 20:32	05:44 21:11	05:36 21:30
28	08:02 17:25	07:15 18:11	07:20 19:51	06:22 20:34	05:43 21:12	05:37 21:30	05:37 21:30
29	08:01 17:26	07:18 19:52	07:18 19:52	06:20 20:35	05:42 21:13	05:37 21:30	05:37 21:30
30	08:00 17:28	07:16 19:54	07:16 19:54	06:18 20:36	05:41 21:14	05:37 21:30	05:37 21:30
31	07:58 17:29	07:14 19:55	07:14 19:55	07:14 21:15	05:40 21:15	05:40 21:15	05:40 21:15
Potential sun hours	278	286	367	406	465	475	
Total, worst case	187			185			
Sun reduction	0.52			0.59			
Oper. time red.	0.85			0.85			
Wind dir. red.	0.71			0.71			
Total reduction	0.31			0.36			
Total, real	58			66			

Table layout: For each day in each month the following matrix apply

Day in month	Sun rise (hh:mm)	Sun set (hh:mm)	Minutes with flicker	First time (hh:mm) with flicker	Last time (hh:mm) with flicker	(WTG causing flicker first time)	(WTG causing flicker last time)
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SHADOW - Calendar

Calculation: Points and Grid Shadow receptor: A108 - Shadow Receptor: 1.0 x 1.0 Azimuth: 0.0° Slope: 90.0° (4998)

Assumptions for shadow calculations

Sunshine probability S/S0 (Sun hours/Possible sun hours) []

Reference year for calendar

2023

Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec
 0.52 0.54 0.59 0.57 0.60 0.64 0.74 0.71 0.63 0.51 0.39 0.39

Operational time

N NNE NE ENE E ESE SE SSE S SSW SW WSW W WNW NW NNW Sum
 364 231 235 234 299 398 720 587 362 314 482 477 675 931 686 429 7,424

	July	August	September	October	November	December
1	05:38 21:30	06:08 21:06	06:48 20:15	07:27 19:15	07:57 (118) 18:16	07:54 16:43
2	05:39 21:30	06:09 21:05	06:49 20:13	07:28 19:13	07:59 (118) 18:15	07:55 16:43
3	05:39 21:29	06:10 21:04	06:50 20:11	07:30 19:11	08:05 (114) 18:13	07:56 16:43
4	05:40 21:29	06:11 21:02	06:51 20:09	07:31 19:09	08:11 (114) 18:12	07:57 16:42
5	05:40 21:29	06:12 21:01	06:53 20:07	07:32 19:07	08:12 (114) 17:10	07:59 16:42
6	05:41 21:28	06:14 20:59	06:54 20:05	07:34 19:05	07:18 17:09	08:00 16:41
7	05:42 21:28	06:15 20:58	06:55 20:03	07:35 19:03	07:20 17:07	08:01 16:41
8	05:43 21:28	06:16 20:56	06:57 20:01	07:37 19:01	07:21 17:06	08:02 16:41
9	05:43 21:27	06:18 20:55	06:58 19:59	07:38 18:57	07:23 17:04	08:03 16:41
10	05:44 21:27	06:19 20:53	06:59 19:57	07:39 18:55	07:24 17:03	08:04 16:41
11	05:45 21:26	06:20 20:52	07:01 19:55	07:41 18:53	07:26 17:02	08:05 16:41
12	05:46 21:26	06:21 20:50	07:02 19:53	07:42 18:51	07:27 17:01	08:06 16:41
13	05:47 21:25	06:23 20:49	07:03 19:51	07:44 18:49	07:29 16:59	08:07 16:41
14	05:48 21:24	06:24 20:47	07:05 19:49	07:45 18:47	07:30 16:58	08:08 16:41
15	05:49 21:24	06:25 20:45	07:06 19:47	07:46 18:46	07:32 16:57	08:09 16:41
16	05:50 21:23	06:27 20:44	07:07 19:45	07:48 18:44	07:33 16:56	08:09 16:41
17	05:51 21:22	06:28 20:42	07:08 19:43	07:49 18:42	07:35 16:55	08:22 (89) 16:41
18	05:52 21:21	06:29 20:40	07:10 19:41	07:51 18:40	3 08:25 (89) 16:55	08:20 (89) 16:41
19	05:53 21:21	06:31 20:39	07:11 19:39	07:52 18:38	8 08:28 (89) 16:54	08:20 (89) 16:42
20	05:54 21:20	06:32 20:37	07:12 19:37	07:53 18:36	10 08:30 (89) 16:53	08:18 (89) 16:42
21	05:55 21:19	06:33 20:35	07:14 19:35	07:55 18:35	12 08:30 (89) 16:52	08:19 (89) 16:42
22	05:56 21:18	06:34 20:33	07:15 19:33	07:56 18:33	13 08:32 (89) 16:51	08:18 (89) 16:43
23	05:57 21:17	06:36 20:32	07:16 19:31	07:58 18:31	14 08:33 (89) 16:50	08:18 (89) 16:43
24	05:58 21:16	06:37 20:30	07:18 19:29	07:59 18:29	15 08:33 (89) 16:49	08:19 (89) 16:44
25	05:59 21:15	06:38 20:28	07:19 19:27	08:01 18:28	14 08:33 (89) 16:48	08:19 (89) 16:45
26	06:00 21:14	06:40 20:26	07:20 19:25	08:02 18:26	15 08:33 (89) 16:47	08:20 (89) 16:45
27	06:02 21:12	06:41 20:24	07:22 19:23	08:04 18:24	14 08:34 (89) 16:47	08:20 (89) 16:46
28	06:03 21:11	06:42 20:22	07:23 19:21	08:05 18:23	13 08:33 (89) 16:45	08:21 (89) 16:47
29	06:04 21:10	06:44 20:20	07:24 19:19	08:07 18:21	12 08:33 (89) 16:45	08:22 (89) 16:47
30	06:05 21:09	06:45 20:19	07:26 19:17	08:08 18:19	11 08:33 (89) 16:44	08:23 (89) 16:48
31	06:06 21:08	06:46 20:17	07:27 18:18	08:10 18:18	9 08:32 (89) 16:44	08:16 16:49
Potential sun hours	481	442	380	339	283	266
Total, worst case			149	39	177	13
Sun reduction			0.63	0.51	0.39	0.39
Oper. time red.			0.85	0.85	0.85	0.85
Wind dir. red.			0.71	0.71	0.71	0.71
Total reduction			0.38	0.31	0.23	0.23
Total, real			57	12	41	3

Table layout: For each day in each month the following matrix apply

Day in month	Sun rise (hh:mm)	Minutes with flicker	First time (hh:mm) with flicker	(WTG causing flicker first time)
	Sun set (hh:mm)		Last time (hh:mm) with flicker	(WTG causing flicker last time)

Project:
Otter Tail Ashtabula III Wind

Description:
Barnes County, ND

Licensed user:
Epsilon Associates, Inc
3 Clock Tower Place, Suite 250
US-MAYNARD MA 01754
978 897 7100
Richard Lampeter / rlampeter@epsilonassociates.com
Calculated:
6/18/2023 2:05 PM/3.6.366

SHADOW - Calendar

Calculation: Points and Grid Shadow receptor: A109 - Shadow Receptor: 1.0 x 1.0 Azimuth: 0.0° Slope: 90.0° (4999)
Assumptions for shadow calculations
Sunshine probability S/S0 (Sun hours/Possible sun hours) []

Reference year for calendar

2023

Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec
0.52 0.54 0.59 0.57 0.60 0.64 0.74 0.71 0.63 0.51 0.39 0.39

Operational time

N NNE NE E ESE SE SSE S SSW SW WSW W WNW NW NNW Sum
364 231 235 234 299 398 720 587 362 314 482 477 675 931 686 429 7,424

	January	February	March	April	May	June	July	August	September	October	November	December		
1	08:16	07:57	07:13	07:12	06:17	05:40	05:38	06:08	06:48	07:27	08:02 (114)	08:11	07:54	
	16:50	17:31	18:12	19:56	20:38	21:16	21:30	21:06	20:15	19:15	15	08:17 (114)	18:16	16:43
2	08:16	07:56	07:11	07:10	06:15	05:39	05:39	06:09	06:49	07:28	08:03 (114)	08:12	07:55	
	16:51	17:32	18:14	19:58	20:39	21:17	21:30	21:05	20:13	19:13	13	08:16 (114)	18:15	16:43
3	08:16	07:55	07:09	07:08	06:14	05:38	05:39	06:10	06:50	07:30	08:05 (114)	08:14	07:56	
	16:52	17:34	18:15	19:59	20:40	21:18	21:29	21:04	20:11	19:11	8	08:13 (114)	18:13	16:43
4	08:16	07:53	07:07	07:06	06:12	05:38	05:40	06:11	06:51	07:31		08:15	07:57	
	16:53	17:35	18:16	20:00	20:42	21:18	21:29	21:02	20:09	19:09		18:12	16:42	
5	08:16	07:52	07:05	07:04	06:10	05:37	05:40	06:12	06:53	07:32		07:17	07:59	
	16:54	17:37	18:18	20:02	20:43	21:19	21:29	21:01	20:07	19:07		17:10	16:42	
6	08:16	07:51	07:04	07:02	06:09	05:37	05:41	06:14	06:54	07:34		07:18	08:00	
	16:55	17:38	18:19	20:03	20:44	21:20	21:28	20:59	20:05	19:05		17:09	16:41	
7	08:16	07:49	07:02	07:00	06:07	05:36	05:42	06:15	06:55	07:35		07:20	08:01	
	16:56	17:40	18:21	20:05	20:46	21:21	21:28	20:58	20:03	19:03		17:07	16:41	
8	08:16	07:48	07:00	06:58	06:06	05:36	05:43	06:16	06:57	07:37		07:21	08:02	
	16:57	17:41	18:22	20:06	20:47	21:22	21:28	20:56	20:01	19:01		17:06	16:41	
9	08:15	07:46	06:58	06:57	06:05	05:36	05:43	06:18	06:58	07:38		07:23	08:03	
	16:59	17:43	18:24	20:07	20:48	21:23	21:27	20:55	19:59	18:57		17:04	16:41	
10	08:15	07:45	06:56	06:55	06:03	05:35	05:44	06:19	06:59	07:39		07:24	08:04	
	17:00	17:45	18:25	20:09	20:50	21:23	21:27	20:53	19:57	18:55		17:03	16:41	
11	08:15	07:43	06:54	06:53	06:02	05:35	05:45	06:20	07:01	07:41		07:26	08:05	
	17:01	17:46	18:27	20:10	20:51	21:24	21:26	20:52	19:55	18:53		17:02	16:41	
12	08:14	07:42	07:52	8 08:26 (114)	06:51	06:00	05:35	05:46	06:21	07:02		07:42	08:06	
	17:02	17:48	18:28	08:34 (114)	20:12	20:52	21:25	21:26	20:50	19:53		17:01	16:41	
13	08:14	07:40	07:50	08:23 (114)	06:49	05:59	05:35	05:47	06:23	07:03		07:44	08:07	
	17:03	17:49	19:30	13 08:36 (114)	20:13	20:54	21:25	21:25	20:49	19:51		18:49	16:41	
14	08:13	07:39	07:48	08:22 (114)	06:47	05:58	05:34	05:48	06:24	07:05		07:45	08:08	
	17:05	17:51	19:31	15 08:37 (114)	20:14	20:55	21:26	21:24	20:47	19:49		18:47	16:41	
15	08:13	07:37	07:46	08:21 (114)	06:45	05:56	05:34	05:49	06:25	07:06		07:46	08:09	
	17:06	17:52	19:32	16 08:37 (114)	20:16	20:56	21:26	21:24	20:45	19:47		18:46	16:41	
16	08:12	07:36	07:44	08:20 (114)	06:43	05:55	05:34	05:50	06:27	07:07		07:48	08:09	
	17:07	17:54	19:34	17 08:37 (114)	20:17	20:58	21:27	21:23	20:44	19:45		18:44	16:41	
17	08:12	07:34	07:42	08:20 (114)	06:41	05:54	05:34	05:51	06:28	07:08		07:49	08:10	
	17:09	17:55	19:35	17 08:37 (114)	20:18	20:59	21:27	21:22	20:42	19:43		18:42	16:41	
18	08:11	07:32	07:40	08:19 (114)	06:39	05:53	05:34	05:52	06:29	07:10		07:51	08:11	
	17:10	17:57	19:37	18 08:37 (114)	20:20	21:00	21:28	21:21	20:40	19:41		18:40	16:42	
19	08:10	07:31	07:38	08:20 (114)	06:38	05:52	05:34	05:53	06:31	07:11		07:52	08:11	
	17:11	17:58	19:38	16 08:36 (114)	20:21	21:01	21:28	21:21	20:39	19:39		18:38	16:42	
20	08:09	07:29	07:36	08:20 (114)	06:36	05:50	05:34	05:54	06:32	07:12		07:53	08:12	
	17:13	18:00	19:40	15 08:35 (114)	20:23	21:02	21:29	21:20	20:37	19:37		18:36	16:42	
21	08:09	07:27	07:34	08:21 (114)	06:34	05:49	05:34	05:55	06:33	07:14		07:55	08:13	
	17:14	18:00	19:41	12 08:33 (114)	20:24	21:04	21:29	21:19	20:35	19:35		18:35	16:43	
22	08:08	07:26	07:32	08:23 (114)	06:32	05:48	05:35	05:56	06:34	07:15		07:56	08:13	
	17:16	18:01	19:42	7 08:30 (114)	20:25	21:05	21:29	21:18	20:33	19:33		18:33	16:43	
23	08:07	07:24	07:30		06:30	05:47	05:35	05:57	06:36	07:16	7 08:09 (114)	07:58	08:14	
	17:17	18:03	19:44		20:27	21:06	21:29	21:17	20:32	19:31	08:16 (114)	18:31	16:49	
24	08:06	07:22	07:28		06:29	05:46	05:35	05:58	06:37	07:18	08:06 (114)	07:59	08:14	
	17:19	18:05	19:45		20:28	21:07	21:30	21:16	20:30	19:29	08:18 (114)	18:29	16:48	
25	08:05	07:20	07:26		06:27	05:45	05:35	05:59	06:38	07:19	08:04 (114)	08:01	08:15	
	17:20	18:06	19:47		20:30	21:08	21:30	21:15	20:28	19:27	15 08:19 (114)	18:28	16:47	
26	08:04	07:18	07:24		06:25	05:44	05:36	06:00	06:40	07:20	08:03 (114)	08:02	08:15	
	17:22	18:08	19:48		20:31	21:09	21:30	21:14	20:26	19:25	17 08:20 (114)	18:26	16:47	
27	08:03	07:17	07:22		06:23	05:44	05:36	06:02	06:41	07:22	08:02 (114)	08:04	08:15	
	17:23	18:09	19:49		20:32	21:11	21:30	21:12	20:24	19:23	17 08:19 (114)	18:24	16:46	
28	08:02	07:15	07:20		06:22	05:43	05:37	06:03	06:42	07:23	08:01 (114)	08:05	08:16	
	17:25	18:11	19:51		20:34	21:12	21:30	21:11	20:22	19:21	18 08:19 (114)	18:23	16:45	
29	08:01		07:18		06:20	05:42	05:37	06:04	06:44	07:24	08:02 (114)	08:07	08:16	
	17:26		19:52		20:35	21:13	21:30	21:10	20:20	19:19	17 08:19 (114)	18:21	16:45	
30	08:00		07:16		06:18	05:41	05:37	06:05	06:45	07:26	08:02 (114)	08:08	08:16	
	17:28		19:54		20:36	21:14	21:30	21:09	20:19	19:17	16 08:18 (114)	18:19	16:48	
31	07:58		07:14		05:40	05:40	06:06	06:46	06:46	08:10		08:10	08:16	
	17:29		19:55		21:15	21:15	21:08	20:17	20:17	18:18		18:18	16:49	
Potential sun hours	278	286	367	406	465	475	481	442	380	339	283	266		
Total, worst case			154						119			36		
Sun reduction			0.59						0.63			0.51		
Oper. time red.			0.85						0.85			0.85		
Wind dir. red.			0.71						0.71			0.71		
Total reduction			0.36						0.38			0.31		
Total, real			55						45			11		

Table layout: For each day in each month the following matrix apply

Day in month	Sun rise (hh:mm)	First time (hh:mm) with flicker	(WTG causing flicker first time)
	Sun set (hh:mm)	Last time (hh:mm) with flicker	(WTG causing flicker last time)
	Minutes with flicker		

Project:

Otter Tail Ashtabula III Wind

Description:

Barnes County, ND

Licensed user:

Epsilon Associates, Inc
3 Clock Tower Place, Suite 250
US-MAYNARD MA 01754
978 897 7100
Richard Lampeter / rlampeter@epsilonassociates.com
Calculated:
6/18/2023 2:05 PM/3.6.366

SHADOW - Calendar

Calculation: Points and Grid Shadow receptor: A110 - Shadow Receptor: 1.0 x 1.0 Azimuth: 0.0° Slope: 90.0° (5000)

Assumptions for shadow calculations

Sunshine probability S/S0 (Sun hours/Possible sun hours) []

Reference year for calendar

2023

Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec
0.52 0.54 0.59 0.57 0.60 0.64 0.74 0.71 0.63 0.51 0.39 0.39

Operational time

N NNE NE ENE E ESE SE SSE S SSW SW WSW W WNW NW NNW Sum
364 231 235 234 299 398 720 587 362 314 482 477 675 931 686 429 7,424

Table with columns for months (January to December) and rows for days (1 to 31). Includes sunrise/sunset times, shadow reduction percentages, and a summary row for 'Potential sun hours'.

Table layout: For each day in each month the following matrix apply

Matrix with columns: Day in month, Sun rise (hh:mm), Sun set (hh:mm), Minutes with flicker, First time (hh:mm) with flicker, Last time (hh:mm) with flicker, (WTG causing flicker first time), (WTG causing flicker last time)

SHADOW - Calendar

Calculation: Points and Grid Shadow receptor: A111 - Shadow Receptor: 1.0 x 1.0 Azimuth: 0.0° Slope: 90.0° (5001)
 Assumptions for shadow calculations
 Reference year for calendar 2023

Sunshine probability S/S0 (Sun hours/Possible sun hours) []
 Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec
 0.52 0.54 0.59 0.57 0.60 0.64 0.74 0.71 0.63 0.51 0.39 0.39

Operational time

N NNE NE ENE E ESE SE SSE S SSW SW WSW W WNW NW NNW Sum
 364 231 235 234 299 398 720 587 362 314 482 477 675 931 686 429 7,424

	January	February	March	April	May	June	July	August	September	October	November	December	
1	08:16 16:50	07:57 17:31	07:13 18:12	07:12 19:56	06:17 20:38	05:40 21:16	05:38 21:30	06:08 21:06	06:48 20:15	07:27 19:15	08:01 (118) 08:26 (114)	08:11 18:16	07:54 16:43
2	08:16 16:51	07:56 17:32	07:11 18:14	07:10 19:58	06:15 20:39	05:39 21:17	05:39 21:30	06:09 21:05	06:49 20:13	07:28 19:13	08:01 (118) 08:26 (114)	08:12 18:15	07:55 16:43
3	08:16 16:52	07:55 17:34	07:09 18:15	07:08 19:59	06:14 20:40	05:38 21:18	05:39 21:29	06:10 21:04	06:50 20:11	07:30 19:11	08:01 (118) 08:25 (114)	08:14 18:13	07:56 16:43
4	08:16 16:53	07:53 17:35	07:07 18:16	07:06 20:00	06:12 20:42	05:38 21:18	05:40 21:29	06:11 21:02	06:51 20:09	07:31 19:09	08:01 (118) 08:24 (114)	08:15 18:12	07:57 16:42
5	08:16 16:54	07:52 17:37	07:05 18:18	07:04 20:02	06:10 20:43	05:37 21:19	05:40 21:29	06:12 21:01	06:53 20:07	07:32 19:07	08:03 (118) 08:24 (114)	07:17 17:10	07:59 16:42
6	08:16 16:55	07:51 17:38	07:04 18:19	07:02 20:03	06:09 20:44	05:37 21:20	05:41 21:28	06:14 20:59	06:54 20:05	07:34 19:05	08:05 (118) 08:22 (114)	07:18 17:09	08:00 16:41
7	08:16 16:56	07:49 17:40	07:02 18:21	07:00 20:05	06:07 20:46	05:36 21:21	05:42 21:28	06:15 20:58	06:55 20:03	07:35 19:03	08:11 (114) 08:16 (114)	07:20 17:07	08:01 16:41
8	08:16 16:57	07:48 17:41	07:00 18:22	07:00 20:06	06:06 20:47	05:36 21:22	05:43 21:28	06:16 20:56	06:57 20:01	07:37 19:01	08:14 (114) 08:16 (114)	07:21 17:06	08:02 16:41
9	08:15 16:59	07:46 17:43	06:58 18:24	06:57 20:07	06:05 20:48	05:36 21:23	05:43 21:27	06:18 20:55	06:58 19:59	07:38 18:57	07:23 17:04	08:03 16:41	08:03 16:41
10	08:15 17:00	07:45 17:45	06:56 18:25	06:55 20:09	06:03 20:50	05:35 21:23	05:44 21:27	06:19 20:53	06:59 19:57	07:39 18:55	07:24 17:03	08:04 16:41	08:04 16:41
11	08:15 17:01	07:43 17:46	06:54 18:27	06:54 20:10	06:02 20:51	05:35 21:24	05:45 21:26	06:20 20:52	07:01 19:55	07:41 18:53	07:26 17:02	08:05 16:41	08:05 16:41
12	08:14 17:02	07:42 17:48	06:52 18:28	06:51 20:12	06:00 20:52	05:35 21:25	05:46 21:26	06:21 20:50	07:02 19:53	07:42 18:51	07:27 17:01	08:06 16:41	08:06 16:41
13	08:14 17:03	07:40 17:49	06:50 18:30	06:49 20:13	05:59 20:54	05:35 21:25	05:47 21:25	06:23 20:49	07:03 19:51	07:44 18:49	07:29 16:59	08:07 16:41	08:07 16:41
14	08:13 17:05	07:39 17:51	06:48 18:31	06:47 20:14	05:58 20:55	05:34 21:26	05:48 21:24	06:24 20:47	07:05 19:49	07:45 18:47	07:30 16:58	08:08 16:41	08:08 16:41
15	08:13 17:06	07:37 17:52	06:46 18:32	06:45 20:16	05:56 20:56	05:34 21:26	05:49 21:24	06:25 20:45	07:06 19:47	07:46 18:46	07:32 16:57	08:09 16:41	08:09 16:41
16	08:12 17:07	07:36 17:54	06:44 18:34	06:43 20:17	05:55 20:58	05:34 21:27	05:50 21:23	06:27 20:44	07:07 19:45	07:48 18:44	07:33 16:56	08:09 16:41	08:09 16:41
17	08:12 17:09	07:34 17:55	06:42 18:35	06:41 20:18	05:54 20:59	05:34 21:27	05:51 21:22	06:28 20:42	07:08 19:43	07:49 18:42	07:35 16:55	08:10 16:41	08:10 16:41
18	08:11 17:10	07:32 17:57	06:40 18:37	06:39 20:20	05:53 21:00	05:34 21:28	05:52 21:21	06:29 20:40	07:10 19:41	07:51 18:40	07:36 16:54	08:11 16:42	08:11 16:42
19	08:10 17:11	07:31 17:58	06:38 18:38	06:38 20:21	05:52 21:01	05:34 21:28	05:53 21:21	06:31 20:39	07:11 19:39	07:52 18:38	07:38 16:53	08:11 16:42	08:11 16:42
20	08:09 17:13	07:29 18:00	06:36 19:40	06:36 20:23	05:50 21:02	05:34 21:29	05:54 21:20	06:32 20:37	07:12 19:37	07:53 18:36	07:39 16:52	08:12 16:42	08:12 16:42
21	08:09 17:14	07:27 18:00	06:34 19:41	06:34 20:24	05:49 21:04	05:34 21:29	05:55 21:19	06:33 20:35	07:14 19:35	07:55 18:35	07:40 16:51	08:13 16:43	08:13 16:43
22	08:08 17:16	07:26 18:01	06:32 19:42	06:32 20:25	05:48 21:05	05:35 21:29	05:56 21:18	06:34 20:33	07:15 19:33	07:56 18:33	07:42 16:50	08:13 16:43	08:13 16:43
23	08:07 17:17	07:24 18:03	06:30 19:44	06:30 20:27	05:47 21:06	05:35 21:29	05:57 21:17	06:36 20:32	07:16 19:31	07:58 18:31	07:43 16:49	08:14 16:44	08:14 16:44
24	08:06 17:19	07:22 18:05	06:28 19:45	06:29 20:28	05:46 21:07	05:35 21:30	05:58 21:16	06:37 20:30	07:18 19:29	07:59 18:29	07:45 16:48	08:14 16:44	08:14 16:44
25	08:05 17:20	07:20 18:06	06:26 19:47	06:27 20:30	05:45 21:08	05:35 21:30	05:59 21:15	06:38 20:28	07:19 19:27	08:01 18:28	07:46 16:47	08:15 16:45	08:15 16:45
26	08:04 17:22	07:18 18:08	06:24 19:48	06:25 20:31	05:44 21:09	05:36 21:30	06:00 21:14	07:20 20:26	07:20 19:25	08:02 18:26	07:47 16:47	08:15 16:45	08:15 16:45
27	08:03 17:23	07:17 18:09	06:22 19:49	06:23 20:32	05:44 21:11	05:36 21:30	06:02 21:12	06:41 20:24	07:22 19:23	08:04 18:24	07:49 16:46	08:15 16:46	08:15 16:46
28	08:02 17:25	07:15 18:11	06:20 19:50	06:22 20:34	05:43 21:12	05:37 21:30	06:03 21:11	06:42 20:22	07:23 19:19	08:05 (118) 08:24 (114)	08:05 18:23	07:50 16:45	08:16 16:46
29	08:01 17:26	07:14 18:18	06:18 19:52	06:20 20:35	05:42 21:13	05:37 21:30	06:04 21:10	06:44 20:20	07:24 19:19	08:07 (118) 08:26 (114)	08:07 18:21	07:51 16:45	08:16 16:47
30	08:00 17:28	07:14 18:24	06:16 19:54	06:18 20:36	05:41 21:14	05:37 21:30	06:05 21:09	06:45 20:19	07:26 19:17	08:08 (118) 08:26 (114)	08:08 18:19	07:53 16:44	08:16 16:48
31	07:58 17:29	07:14 18:35	06:14 19:55	06:16 20:37	05:40 21:15	05:36 21:30	06:06 21:08	06:46 20:17	07:27 19:18	08:10 18:18	08:10 16:49	08:16 16:49	08:16 16:49
Potential sun hours	278	286	367	406	465	475	481	442	380	339	283	266	
Total, worst case			215						72	146			
Sun reduction			0.59						0.63	0.51			
Oper. time red.			0.85						0.85	0.85			
Wind dir. red.			0.72						0.72	0.72			
Total reduction			0.36						0.38	0.31			
Total, real			77						27	45			

Table layout: For each day in each month the following matrix apply

Day in month	Sun rise (hh:mm)	Sun set (hh:mm)	Minutes with flicker	First time (hh:mm) with flicker	Last time (hh:mm) with flicker	(WTG causing flicker first time)	(WTG causing flicker last time)
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SHADOW - Calendar

Calculation: Points and Grid Shadow receptor: A112 - Shadow Receptor: 1.0 × 1.0 Azimuth: 0.0° Slope: 90.0° (5002)
 Assumptions for shadow calculations
 Reference year for calendar 2023

Sunshine probability S/S0 (Sun hours/Possible sun hours) []
 Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec
 0.52 0.54 0.59 0.57 0.60 0.64 0.74 0.71 0.63 0.51 0.39 0.39

Operational time

N	NNE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW	Sum
364	231	235	234	299	398	720	587	362	314	482	477	675	931	686	429 7,424

	January	February	March	April	May	June	July	August	September	October	November	December	
1	08:16	07:57	07:13	07:12	06:17	05:40	05:38	06:08	06:48	07:27	08:07 (114)	08:11	07:54
	16:50	17:31	18:12	19:56	20:38	21:16	21:30	21:06	20:15	19:15	17 08:24 (114)	18:16	16:43
2	08:16	07:56	07:11	07:10	06:15	05:39	05:39	06:09	06:49	07:28	08:07 (114)	08:12	07:55
	16:51	17:32	18:14	19:58	20:39	21:17	21:30	21:05	20:13	19:13	18 08:25 (114)	18:15	16:43
3	08:16	07:55	07:09	07:08	06:14	05:38	05:39	06:10	06:50	07:30	08:07 (114)	08:14	07:56
	16:52	17:34	18:15	19:59	20:40	21:18	21:29	21:04	20:11	19:11	17 08:24 (114)	18:13	16:43
4	08:16	07:53	07:07	07:06	06:12	05:38	05:40	06:11	06:51	07:31	08:06 (114)	08:15	07:57
	16:53	17:35	18:16	20:00	20:42	21:18	21:29	21:02	20:09	19:09	16 08:22 (114)	18:12	16:42
5	08:16	07:52	07:05	07:04	06:10	05:37	05:40	06:12	06:53	07:32	08:08 (114)	07:17	07:59
	16:54	17:37	18:18	20:02	20:43	21:19	21:29	21:01	20:07	19:07	14 08:22 (114)	17:10	16:42
6	08:16	07:51	07:04	07:02	06:09	05:37	05:41	06:14	06:54	07:34	08:09 (114)	07:18	08:00
	16:55	17:38	18:19	20:03	20:44	21:20	21:28	20:59	20:05	19:05	10 08:19 (114)	17:09	16:41
7	08:16	07:49	07:02	07:00	06:07	05:36	05:42	06:15	06:55	07:35	08:19 (114)	07:20	08:01
	16:56	17:40	18:21	20:05	20:46	21:21	21:28	20:58	20:03	19:03	4 08:16 (114)	17:07	16:41
8	08:16	07:48	07:00	07:36 (114)	06:58	06:06	05:36	05:43	06:16	06:57	07:37	07:21	08:02
	16:57	17:41	18:22	3 07:39 (114)	20:06	20:47	21:22	21:28	20:56	20:01	19:01	17:06	16:41
9	08:15	07:46	06:58	07:32 (114)	06:57	06:05	05:36	05:43	06:18	06:58	07:38	07:23	08:03
	16:59	17:43	18:24	10 07:42 (114)	20:07	20:48	21:23	21:27	20:55	19:59	18:57	17:04	16:41
10	08:15	07:45	06:56	07:30 (114)	06:55	06:03	05:35	05:44	06:19	06:59	07:39	07:24	08:04
	17:00	17:45	18:25	14 07:44 (114)	20:09	20:50	21:23	21:27	20:53	19:57	18:55	17:03	16:41
11	08:15	07:43	06:54	07:28 (114)	06:53	06:02	05:35	05:45	06:20	07:01	07:41	07:26	08:05
	17:01	17:46	18:27	16 07:44 (114)	20:10	20:51	21:24	21:26	20:52	19:55	18:53	17:02	16:41
12	08:14	07:42	07:52	08:28 (114)	06:51	06:00	05:35	05:46	06:21	07:02	07:42	07:27	08:06
	17:02	17:48	18:28	17 08:45 (114)	20:12	20:52	21:25	21:26	20:50	19:53	18:51	17:01	16:41
13	08:14	07:40	07:50	08:27 (114)	06:49	05:59	05:35	05:47	06:23	07:03	07:44	07:29	08:07
	17:03	17:49	19:30	18 08:45 (114)	20:13	20:54	21:25	21:25	20:49	19:51	18:49	16:59	16:41
14	08:13	07:39	07:48	08:27 (114)	06:47	05:58	05:34	05:48	06:24	07:05	07:45	07:30	08:08
	17:05	17:51	19:31	17 08:44 (114)	20:14	20:55	21:26	21:24	20:47	19:49	18:47	16:58	16:41
15	08:13	07:37	07:46	08:27 (114)	06:45	05:56	05:34	05:49	06:25	07:06	07:46	07:32	08:09
	17:06	17:52	19:32	17 08:44 (114)	20:16	20:56	21:26	21:24	20:45	19:47	18:46	16:57	16:41
16	08:12	07:36	07:44	08:27 (114)	06:43	05:55	05:34	05:50	06:27	07:07	07:48	07:33	08:09
	17:07	17:54	19:34	16 08:43 (114)	20:17	20:58	21:27	21:23	20:44	19:45	18:44	16:56	16:41
17	08:12	07:34	07:42	08:28 (114)	06:41	05:54	05:34	05:51	06:28	07:08	07:49	07:35	08:10
	17:09	17:55	19:35	14 08:42 (114)	20:18	20:59	21:27	21:22	20:42	19:43	18:42	16:55	16:41
18	08:11	07:32	07:40	08:29 (114)	06:39	05:53	05:34	05:52	06:29	07:10	07:51	07:36	08:11
	17:10	17:57	19:37	11 08:40 (114)	20:20	21:00	21:28	21:21	20:40	19:41	18:40	16:54	16:42
19	08:10	07:31	07:38	08:32 (114)	06:38	05:52	05:34	05:53	06:31	07:11	07:52	07:38	08:11
	17:11	17:58	19:38	4 08:36 (114)	20:21	21:01	21:28	21:21	20:39	19:39	18:38	16:53	16:42
20	08:09	07:29	07:36	06:36	05:50	05:34	05:54	06:32	07:12	07:53	08:33	07:39	08:12
	17:13	18:00	19:40	20:23	21:02	21:29	21:20	20:37	19:37	18:36	17:35	16:52	16:42
21	08:09	07:27	07:34	06:34	05:49	05:34	05:55	06:33	07:14	07:55	08:36	07:40	08:13
	17:14	18:00	19:41	20:24	21:04	21:29	21:19	20:35	19:35	18:35	17:34	16:51	16:43
22	08:08	07:26	07:32	06:32	05:48	05:35	05:56	06:34	07:15	07:56	08:37	07:42	08:13
	17:16	18:01	19:42	20:25	21:05	21:29	21:18	20:33	19:33	18:33	17:32	16:50	16:43
23	08:07	07:24	07:30	06:30	05:47	05:35	05:57	06:36	07:16	07:58	08:39	07:43	08:14
	17:17	18:03	19:44	20:27	21:06	21:29	21:17	20:32	19:31	18:31	17:30	16:49	16:44
24	08:06	07:22	07:28	06:29	05:46	05:35	05:58	06:37	07:18	07:59	08:40	07:45	08:14
	17:19	18:05	19:45	20:28	21:07	21:30	21:16	20:30	19:29	18:29	17:28	16:48	16:44
25	08:05	07:20	07:26	06:27	05:45	05:35	05:59	06:38	07:19	08:01	08:81	07:46	08:15
	17:20	18:06	19:47	20:30	21:08	21:30	21:15	20:28	19:27	18:28	17:27	16:47	16:45
26	08:04	07:18	07:24	06:25	05:44	05:36	06:00	06:40	07:20	08:02	08:82 (114)	07:47	08:15
	17:22	18:08	19:48	20:31	21:09	21:30	21:14	20:26	19:25	6 08:21 (114)	18:26	16:47	16:45
27	08:03	07:17	07:22	06:23	05:44	05:36	06:02	06:41	07:22	08:04	08:81 (114)	07:49	08:15
	17:23	18:09	19:49	20:32	21:11	21:30	21:12	20:24	19:23	12 08:23 (114)	18:24	16:46	16:46
28	08:02	07:15	07:20	06:22	05:43	05:37	06:03	06:42	07:23	08:05	08:82 (114)	07:50	08:16
	17:25	18:11	19:51	20:34	21:12	21:30	21:11	20:22	19:21	15 08:24 (114)	18:23	16:45	16:47
29	08:01	07:18	07:23	06:20	05:42	05:37	06:04	06:44	07:24	08:07	08:83 (114)	07:51	08:16
	17:26	18:12	19:52	20:35	21:13	21:30	21:10	20:20	19:19	16 08:25 (114)	18:21	16:45	16:47
30	08:00	07:16	07:21	06:18	05:41	05:37	06:05	06:45	07:26	08:08	08:84 (114)	07:53	08:16
	17:28	18:14	19:54	20:36	21:14	21:30	21:09	20:19	19:17	18 08:25 (114)	18:19	16:44	16:48
31	07:58	07:14	07:19	05:40	05:40	05:40	06:06	06:46	07:27	08:10	08:85 (114)	07:54	08:16
	17:29	18:15	19:55	21:15	21:15	21:08	20:17	19:17	18:18	17:19	16:44	16:49	16:49
Potential sun hours	278	286	367	406	465	475	481	442	380	339	283	266	
Total, worst case			157						67		96		
Sun reduction			0.59						0.63		0.51		
Oper. time red.			0.85						0.85		0.85		
Wind dir. red.			0.71						0.71		0.71		
Total reduction			0.36						0.38		0.31		
Total, real			56						26		30		

Table layout: For each day in each month the following matrix apply

Day in month	Sun rise (hh:mm)	First time (hh:mm) with flicker	(WTG causing flicker first time)
	Sun set (hh:mm)	Minutes with flicker	Last time (hh:mm) with flicker
			(WTG causing flicker last time)

Project:

Otter Tail Ashtabula III Wind

Description:

Barnes County, ND

Licensed user:

Epsilon Associates, Inc
3 Clock Tower Place, Suite 250
US-MAYNARD MA 01754
978 897 7100
Richard Lampeter / rlampeter@epsilonassociates.com
Calculated:
6/18/2023 2:05 PM/3.6.366

SHADOW - Calendar

Calculation: Points and Grid Shadow receptor: A113 - Shadow Receptor: 1.0 x 1.0 Azimuth: 0.0° Slope: 90.0° (5003)

Assumptions for shadow calculations

Sunshine probability S/S0 (Sun hours/Possible sun hours) []

Reference year for calendar

2023

Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec
0.52 0.54 0.59 0.57 0.60 0.64 0.74 0.71 0.63 0.51 0.39 0.39

Operational time

N NNE NE ENE E ESE SE SSE S SSW SW WSW W WNW NW NNW Sum
364 231 235 234 299 398 720 587 362 314 482 477 675 931 686 429 7,424

Table with columns for months (January to December) and rows for days (1 to 31). Includes potential sun hours, total worst case sun reduction, and operational time for each day.

Table layout: For each day in each month the following matrix apply

Matrix with columns: Day in month, Sun rise (hh:mm), Sun set (hh:mm), Minutes with flicker, First time (hh:mm) with flicker, Last time (hh:mm) with flicker, (WTG causing flicker first time), (WTG causing flicker last time)

Project:

Otter Tail Ashtabula III Wind

Description:

Barnes County, ND

Licensed user:

Epsilon Associates, Inc
3 Clock Tower Place, Suite 250
US-MAYNARD MA 01754
978 897 7100
Richard Lampeter / rlampeter@epsilonassociates.com
Calculated:
6/18/2023 2:05 PM/3.6.366

SHADOW - Calendar

Calculation: Points and Grid Shadow receptor: A114 - Shadow Receptor: 1.0 x 1.0 Azimuth: 0.0° Slope: 90.0° (5004)

Assumptions for shadow calculations

Sunshine probability S/S0 (Sun hours/Possible sun hours) []

Reference year for calendar

2023

Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec
0.52 0.54 0.59 0.57 0.60 0.64 0.74 0.71 0.63 0.51 0.39 0.39

Operational time

N NNE NE ENE E ESE SE SSE S SSW SW WSW W WNW NW NNW Sum
364 231 235 234 299 398 720 587 362 314 482 477 675 931 686 429 7,424

Table with columns for months (January to December) and rows for days (1 to 31). Includes columns for sun rise/set times, shadow reduction percentages, and potential sun hours. Summary rows at the bottom show total sun hours and reductions.

Table layout: For each day in each month the following matrix apply

Matrix with columns: Day in month, Sun rise (hh:mm), Sun set (hh:mm), Minutes with flicker, First time (hh:mm) with flicker, Last time (hh:mm) with flicker, (WTG causing flicker first time), (WTG causing flicker last time)

SHADOW - Calendar

Calculation: Points and Grid Shadow receptor: A115 - Shadow Receptor: 1.0 x 1.0 Azimuth: 0.0° Slope: 90.0° (5005)

Assumptions for shadow calculations

Sunshine probability S/S0 (Sun hours/Possible sun hours) []

Reference year for calendar

2023

Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec
0.52 0.54 0.59 0.57 0.60 0.64 0.74 0.71 0.63 0.51 0.39 0.39

Operational time

N NNE NE ENE E ESE SE SSE S SSW SW WSW W WNW NW NNW Sum
364 231 235 234 299 398 720 587 362 314 482 477 675 931 686 429 7,424

Table with columns for months (January to December) and rows for days (1 to 31). It includes sunrise/sunset times, shadow reduction percentages, and operational hours. Summary rows at the bottom show total potential sun hours, reduction factors, and real operational hours.

Table layout: For each day in each month the following matrix apply

Matrix with columns: Day in month, Sun rise (hh:mm), Sun set (hh:mm), Minutes with flicker, First time (hh:mm) with flicker, Last time (hh:mm) with flicker, (WTG causing flicker first time), (WTG causing flicker last time)

SHADOW - Calendar

Calculation: Points and Grid Shadow receptor: A116 - Shadow Receptor: 1.0 x 1.0 Azimuth: 0.0° Slope: 90.0° (5006)
 Assumptions for shadow calculations
 Reference year for calendar 2023
 Sunshine probability S/S0 (Sun hours/Possible sun hours) []

Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec
 0.52 0.54 0.59 0.57 0.60 0.64 0.74 0.71 0.63 0.51 0.39 0.39

Operational time

N NNE NE E ESE SE SSE S SSW SW WSW W WNW NW NNW Sum
 364 231 235 234 299 398 720 587 362 314 482 477 675 931 686 429 7,424

	January	February	March	April	May	June	July	August	September	October	November	December			
1	08:16	07:57	07:13	07:12	06:17	05:40	05:38	06:08	06:48	07:27	08:07 (114)	08:11	07:54		
	16:50	17:31	18:12	19:56	20:38	21:16	21:30	21:06	20:15	19:15	18	08:25 (114)	18:16	16:43	
2	08:16	07:56	07:11	07:10	06:15	05:39	05:39	06:09	06:49	07:28	08:07 (114)	08:12	07:55		
	16:51	17:32	18:14	19:58	20:39	21:17	21:30	21:05	20:13	19:13	18	08:25 (114)	18:15	16:43	
3	08:16	07:55	07:09	07:08	06:14	05:38	05:39	06:10	06:50	07:30	08:07 (114)	08:14	07:56		
	16:52	17:34	18:15	19:59	20:40	21:18	21:29	21:04	20:11	19:11	17	08:24 (114)	18:13	16:43	
4	08:16	07:53	07:07	07:06	06:12	05:38	05:40	06:11	06:51	07:31	08:07 (114)	08:15	07:57		
	16:53	17:35	18:16	20:00	20:42	21:18	21:29	21:02	20:09	19:09	16	08:23 (114)	18:12	16:42	
5	08:16	07:52	07:05	07:04	06:10	05:37	05:40	06:12	06:53	07:32	08:08 (114)	07:17	07:59		
	16:54	17:37	18:18	20:02	20:43	21:19	21:29	21:01	20:07	19:07	15	08:23 (114)	17:10	16:42	
6	08:16	07:51	07:04	07:02	06:09	05:37	05:41	06:14	06:54	07:34	08:09 (114)	07:18	08:00		
	16:55	17:38	18:19	20:03	20:44	21:20	21:28	20:59	20:05	19:05	12	08:21 (114)	17:09	16:41	
7	08:16	07:49	07:02	07:00	06:07	05:36	05:42	06:15	06:55	07:35	08:11 (114)	07:20	08:01		
	16:56	17:40	18:21	20:05	20:46	21:21	21:28	20:58	20:03	19:03	7	08:18 (114)	17:07	16:41	
8	08:16	07:48	07:00	07:34 (114)	06:58	06:06	05:36	05:43	06:16	06:57	07:37	07:21	08:02		
	16:57	17:41	18:22	7	07:41 (114)	20:06	20:47	21:22	20:56	20:01	19:01	17:06	16:41		
9	08:15	07:46	06:58	07:32 (114)	06:57	06:05	05:36	05:43	06:18	06:58	07:38	07:23	08:03		
	16:59	17:43	18:24	11	07:43 (114)	20:07	20:48	21:23	20:55	19:59	18:57	17:04	16:41		
10	08:15	07:45	06:56	07:30 (114)	06:55	06:03	05:35	05:44	06:19	06:59	07:39	07:24	08:04		
	17:00	17:45	18:25	15	07:45 (114)	20:09	20:50	21:23	20:53	19:57	18:55	17:03	16:41		
11	08:15	07:43	06:54	07:29 (114)	06:53	06:02	05:35	05:45	06:20	07:01	07:41	07:26	08:05		
	17:01	17:46	18:27	16	07:45 (114)	20:10	20:51	21:24	20:52	19:55	18:53	17:02	16:41		
12	08:14	07:42	07:52	08:28 (114)	06:51	06:00	05:35	05:46	06:21	07:02	07:42	07:27	08:06		
	17:02	17:48	18:28	18	08:46 (114)	20:12	20:52	21:25	20:50	19:53	18:51	17:01	16:41		
13	08:14	07:40	07:50	08:27 (114)	06:49	05:59	05:35	05:47	06:23	07:03	07:44	07:29	08:07		
	17:03	17:49	19:30	18	08:45 (114)	20:13	20:54	21:25	20:49	19:51	18:49	16:59	16:41		
14	08:13	07:39	07:48	08:27 (114)	06:47	05:58	05:34	05:48	06:24	07:05	07:45	07:30	08:08		
	17:05	17:51	19:31	18	08:45 (114)	20:14	20:55	21:26	20:47	19:49	18:47	16:58	16:41		
15	08:13	07:37	07:46	08:27 (114)	06:45	05:56	05:34	05:49	06:25	07:06	07:46	07:32	08:09		
	17:06	17:52	19:32	18	08:45 (114)	20:16	20:56	21:26	20:45	19:47	18:46	16:57	16:41		
16	08:12	07:36	07:44	08:27 (114)	06:43	05:55	05:34	05:50	06:27	07:07	07:48	07:33	08:09		
	17:07	17:54	19:34	17	08:44 (114)	20:17	20:58	21:27	20:44	19:45	18:44	16:56	16:41		
17	08:12	07:34	07:42	08:28 (114)	06:41	05:54	05:34	05:51	06:28	07:08	07:49	07:35	08:10		
	17:09	17:55	19:35	14	08:42 (114)	20:18	20:59	21:27	20:42	19:43	18:42	16:55	16:41		
18	08:11	07:32	07:40	08:29 (114)	06:39	05:53	05:34	05:52	06:29	07:10	07:51	07:36	08:11		
	17:10	17:57	19:37	11	08:40 (114)	20:20	21:00	21:28	20:40	19:41	18:40	16:54	16:42		
19	08:10	07:31	07:38	08:33 (114)	06:38	05:52	05:34	05:53	06:31	07:11	07:52	07:38	08:11		
	17:11	17:58	19:38	4	08:37 (114)	20:21	21:01	21:28	20:39	19:39	18:38	16:53	16:42		
20	08:09	07:29	07:36	06:36	05:50	05:34	05:54	06:32	07:12	07:53	07:39	08:12			
	17:13	18:00	19:40	20:23	21:02	21:29	21:20	20:37	19:37	18:36	17:36	16:52	16:42		
21	08:09	07:27	07:34	06:34	05:49	05:34	05:55	06:33	07:14	07:55	07:40	08:13			
	17:14	18:00	19:41	20:24	21:04	21:29	21:19	20:35	19:35	18:35	17:35	16:51	16:43		
22	08:08	07:26	07:32	06:32	05:48	05:35	05:56	06:34	07:15	07:56	07:42	08:13			
	17:16	18:01	19:42	20:25	21:05	21:29	21:18	20:33	19:33	18:33	17:33	16:50	16:43		
23	08:07	07:24	07:30	06:30	05:47	05:35	05:57	06:36	07:16	07:58	07:43	08:14			
	17:17	18:03	19:44	20:27	21:06	21:29	21:17	20:32	19:31	18:31	17:31	16:49	16:44		
24	08:06	07:22	07:28	06:29	05:46	05:35	05:58	06:37	07:18	07:59	07:45	08:14			
	17:19	18:05	19:45	20:28	21:07	21:30	21:16	20:30	19:29	18:29	17:29	16:48	16:44		
25	08:05	07:20	07:26	06:27	05:45	05:35	05:59	06:38	07:19	08:01	07:46	08:15			
	17:20	18:06	19:47	20:30	21:08	21:30	21:15	20:28	19:27	18:28	17:28	16:47	16:45		
26	08:04	07:18	07:24	06:25	05:44	05:36	06:00	06:40	07:20	08:02	07:47	08:15			
	17:22	18:08	19:48	20:31	21:09	21:30	21:14	20:26	19:25	5	08:21 (114)	18:26	16:47	16:45	
27	08:03	07:17	07:22	06:23	05:44	05:36	06:02	06:41	07:22	08:04	08:12 (114)	08:04	07:49	08:15	
	17:23	18:09	19:49	20:32	21:11	21:30	21:12	20:24	19:23	11	08:23 (114)	18:24	16:46	16:46	
28	08:02	07:15	07:20	06:22	05:43	05:37	06:03	06:42	07:23	08:05	08:10 (114)	08:05	07:50	08:16	
	17:25	18:11	19:51	20:34	21:12	21:30	21:11	20:22	19:21	14	08:24 (114)	18:23	16:45	16:47	
29	08:01		07:18	06:20	05:42	05:37	06:04	06:44	07:24	08:07	08:09 (114)	08:07	07:51	08:16	
	17:26		19:52	20:35	21:13	21:30	21:10	20:20	19:19	17	08:26 (114)	18:21	16:45	16:47	
30	08:00		07:16	06:18	05:41	05:37	06:05	06:45	07:26	08:08	08:08 (114)	08:08	07:53	08:16	
	17:28		19:54	20:36	21:14	21:30	21:09	20:19	19:17	17	08:25 (114)	18:19	16:44	16:48	
31	07:58		07:14		05:40		06:06	06:46				08:10		08:16	
	17:29		19:55		21:15		21:08	20:17				18:18		16:49	
Potential sun hours	278	286	367	406	465	475	481	442	380	339		283		266	
Total, worst case									64			103			
Sun reduction									0.63			0.51			
Oper. time red.									0.85			0.85			
Wind dir. red.									0.71			0.71			
Total reduction									0.38			0.31			
Total, real									24			32			

Table layout: For each day in each month the following matrix apply

Day in month	Sun rise (hh:mm)	First time (hh:mm) with flicker	(WTG causing flicker first time)
	Sun set (hh:mm)	Last time (hh:mm) with flicker	(WTG causing flicker last time)
	Minutes with flicker		

Project:

Otter Tail Ashtabula III Wind

Description:

Barnes County, ND

Licensed user:

Epsilon Associates, Inc
3 Clock Tower Place, Suite 250
US-MAYNARD MA 01754
978 897 7100
Richard Lampeter / rlampeter@epsilonassociates.com
Calculated:
6/18/2023 2:05 PM/3.6.366

SHADOW - Calendar

Calculation: Points and Grid Shadow receptor: A117 - Shadow Receptor: 1.0 x 1.0 Azimuth: 0.0° Slope: 90.0° (5007)

Assumptions for shadow calculations

Sunshine probability S/S0 (Sun hours/Possible sun hours) []

Reference year for calendar

2023

Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec
0.52 0.54 0.59 0.57 0.60 0.64 0.74 0.71 0.63 0.51 0.39 0.39

Operational time

N NNE NE ENE E ESE SE SSE S SSW SW WSW W WNW NW NNW Sum
364 231 235 234 299 398 720 587 362 314 482 477 675 931 686 429 7,424

Table with columns for months (January to December) and rows for days (1 to 31). Includes columns for sun rise/set times, shadow reduction (Total, Oper. time, Wind dir., Total, Total, real), and potential sun hours.

Table layout: For each day in each month the following matrix apply

Matrix with columns: Day in month, Sun rise (hh:mm), Sun set (hh:mm), Minutes with flicker, First time (hh:mm) with flicker, Last time (hh:mm) with flicker, (WTG causing flicker first time), (WTG causing flicker last time)

Project:

Otter Tail Ashtabula III Wind

Description:

Barnes County, ND

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978 897 7100
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Calculated:
6/18/2023 2:05 PM/3.6.366

SHADOW - Calendar

Calculation: Points and Grid Shadow receptor: A118 - Shadow Receptor: 1.0 x 1.0 Azimuth: 0.0° Slope: 90.0° (5008)

Assumptions for shadow calculations

Sunshine probability S/S0 (Sun hours/Possible sun hours) []

Reference year for calendar

2023

Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec
0.52 0.54 0.59 0.57 0.60 0.64 0.74 0.71 0.63 0.51 0.39 0.39

Operational time

N NNE NE ENE E ESE SE SSE S SSW SW WSW W WNW NW NNW Sum
364 231 235 234 299 398 720 587 362 314 482 477 675 931 686 429 7,424

Table with columns for months (January to December) and rows for days (1 to 31). Each cell contains sun rise and set times, and a 'Potential sun hours' row at the bottom.

Table layout: For each day in each month the following matrix apply

Matrix with columns: Day in month, Sun rise (hh:mm), Sun set (hh:mm), Minutes with flicker, First time (hh:mm) with flicker, Last time (hh:mm) with flicker, (WTG causing flicker first time), (WTG causing flicker last time)

Project:

Otter Tail Ashtabula III Wind

Description:

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Licensed user:

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Calculated:
6/18/2023 2:05 PM/3.6.366

SHADOW - Calendar

Calculation: Points and Grid Shadow receptor: A119 - Shadow Receptor: 1.0 x 1.0 Azimuth: 0.0° Slope: 90.0° (5009)

Assumptions for shadow calculations

Sunshine probability S/S0 (Sun hours/Possible sun hours) []

Reference year for calendar

2023

Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec
0.52 0.54 0.59 0.57 0.60 0.64 0.74 0.71 0.63 0.51 0.39 0.39

Operational time

N NNE NE ENE E ESE SE SSE S SSW SW WSW W WNW NW NNW Sum
364 231 235 234 299 398 720 587 362 314 482 477 675 931 686 429 7,424

Table with columns for months (January-December) and rows for days (1-31). Includes sunrise/sunset times, shadow reduction percentages, and total reduction values.

Table layout: For each day in each month the following matrix apply

Day in month Sun rise (hh:mm) Sun set (hh:mm) Minutes with flicker First time (hh:mm) with flicker Last time (hh:mm) with flicker (WTG causing flicker first time) (WTG causing flicker last time)

Project:

Otter Tail Ashtabula III Wind

Description:

Barnes County, ND

Licensed user:

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Calculated:
6/18/2023 2:05 PM/3.6.366

SHADOW - Calendar

Calculation: Points and Grid Shadow receptor: A120 - Shadow Receptor: 1.0 x 1.0 Azimuth: 0.0° Slope: 90.0° (5010)

Assumptions for shadow calculations

Sunshine probability S/S0 (Sun hours/Possible sun hours) []

Reference year for calendar

2023

Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec
0.52 0.54 0.59 0.57 0.60 0.64 0.74 0.71 0.63 0.51 0.39 0.39

Operational time

N NNE NE ENE E ESE SE SSE S SSW SW WSW W WNW NW NNW Sum
364 231 235 234 299 398 720 587 362 314 482 477 675 931 686 429 7,424

Table with columns for months (January to December) and rows for days (1 to 31). Each cell contains sun rise/set times and shadow reduction values. Summary rows at the bottom show total sun hours and reduction for each month.

Table layout: For each day in each month the following matrix apply

Matrix with columns: Day in month, Sun rise (hh:mm), Sun set (hh:mm), Minutes with flicker, First time (hh:mm) with flicker, Last time (hh:mm) with flicker, (WTG causing flicker first time), (WTG causing flicker last time)

Project:

Otter Tail Ashtabula III Wind

Description:

Barnes County, ND

Licensed user:

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Calculated:
6/18/2023 2:05 PM/3.6.366

SHADOW - Calendar

Calculation: Points and Grid Shadow receptor: A121 - Shadow Receptor: 1.0 x 1.0 Azimuth: 0.0° Slope: 90.0° (5011)

Assumptions for shadow calculations

Sunshine probability S/S0 (Sun hours/Possible sun hours) []

Reference year for calendar

2023

Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec
0.52 0.54 0.59 0.57 0.60 0.64 0.74 0.71 0.63 0.51 0.39 0.39

Operational time

N NNE NE ENE E ESE SE SSE S SSW SW WSW W WNW NW NNW Sum
364 231 235 234 299 398 720 587 362 314 482 477 675 931 686 429 7,424

Table with columns for months (January to December) and rows for days (1 to 31). Includes potential sun hours, total reduction, and operational time data.

Table layout: For each day in each month the following matrix apply

Day in month Sun rise (hh:mm) Sun set (hh:mm) Minutes with flicker First time (hh:mm) with flicker Last time (hh:mm) with flicker (WTG causing flicker first time) (WTG causing flicker last time)

Project:

Otter Tail Ashtabula III Wind

Description:

Barnes County, ND

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Calculated:
6/18/2023 2:05 PM/3.6.366

SHADOW - Calendar

Calculation: Points and Grid Shadow receptor: A122 - Shadow Receptor: 1.0 x 1.0 Azimuth: 0.0° Slope: 90.0° (5012)

Assumptions for shadow calculations

Sunshine probability S/S0 (Sun hours/Possible sun hours) []

Reference year for calendar

2023

Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec
0.52 0.54 0.59 0.57 0.60 0.64 0.74 0.71 0.63 0.51 0.39 0.39

Operational time

N NNE NE ENE E ESE SE SSE S SSW SW WSW W WNW NW NNW Sum
364 231 235 234 299 398 720 587 362 314 482 477 675 931 686 429 7,424

Table with columns for months (January-December) and rows for days (1-31). Includes potential sun hours, total reduction, and wind direction reduction data.

Table layout: For each day in each month the following matrix apply

Day in month Sun rise (hh:mm) Sun set (hh:mm) Minutes with flicker First time (hh:mm) with flicker Last time (hh:mm) with flicker (WTG causing flicker first time) (WTG causing flicker last time)

Project:

Otter Tail Ashtabula III Wind

Description:

Barnes County, ND

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978 897 7100
Richard Lampeter / rlampeter@epsilonassociates.com
Calculated:
6/18/2023 2:05 PM/3.6.366

SHADOW - Calendar

Calculation: Points and Grid Shadow receptor: A123 - Shadow Receptor: 1.0 x 1.0 Azimuth: 0.0° Slope: 90.0° (5013)

Assumptions for shadow calculations

Sunshine probability S/S0 (Sun hours/Possible sun hours) []

Reference year for calendar

2023

Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec
0.52 0.54 0.59 0.57 0.60 0.64 0.74 0.71 0.63 0.51 0.39 0.39

Operational time

N NNE NE ENE E ESE SE SSE S SSW SW WSW W WNW NW NNW Sum
364 231 235 234 299 398 720 587 362 314 482 477 675 931 686 429 7,424

Table with columns for months (January to December) and rows for days (1 to 31). Includes potential sun hours, total worst case sun reduction, and operational time for each day.

Table layout: For each day in each month the following matrix apply

Matrix with columns: Day in month, Sun rise (hh:mm), Sun set (hh:mm), Minutes with flicker, First time (hh:mm) with flicker, Last time (hh:mm) with flicker, (WTG causing flicker first time), (WTG causing flicker last time)

Project:

Otter Tail Ashtabula III Wind

Description:

Barnes County, ND

Licensed user:

Epsilon Associates, Inc
3 Clock Tower Place, Suite 250
US-MAYNARD MA 01754
978 897 7100
Richard Lampeter / rlampeter@epsilonassociates.com
Calculated:
6/18/2023 2:05 PM/3.6.366

SHADOW - Calendar

Calculation: Points and Grid Shadow receptor: A124 - Shadow Receptor: 1.0 x 1.0 Azimuth: 0.0° Slope: 90.0° (5014)

Assumptions for shadow calculations

Sunshine probability S/S0 (Sun hours/Possible sun hours) []

Reference year for calendar

2023

Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec
0.52 0.54 0.59 0.57 0.60 0.64 0.74 0.71 0.63 0.51 0.39 0.39

Operational time

N NNE NE ENE E ESE SE SSE S SSW SW WSW W WNW NW NNW Sum
364 231 235 234 299 398 720 587 362 314 482 477 675 931 686 429 7,424

Table with columns for months (January-December) and rows for days (1-31) showing sun rise/set times and shadow reduction metrics.

Table layout: For each day in each month the following matrix apply

Day in month Sun rise (hh:mm) Sun set (hh:mm) Minutes with flicker First time (hh:mm) with flicker Last time (hh:mm) with flicker (WTG causing flicker first time) (WTG causing flicker last time)

Project:

Otter Tail Ashtabula III Wind

Description:

Barnes County, ND

Licensed user:

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3 Clock Tower Place, Suite 250
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978 897 7100
Richard Lampeter / rlampeter@epsilonassociates.com
Calculated:
6/18/2023 2:05 PM/3.6.366

SHADOW - Calendar

Calculation: Points and Grid Shadow receptor: A125 - Shadow Receptor: 1.0 x 1.0 Azimuth: 0.0° Slope: 90.0° (5015)

Assumptions for shadow calculations

Sunshine probability S/S0 (Sun hours/Possible sun hours) []

Reference year for calendar

2023

Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec
0.52 0.54 0.59 0.57 0.60 0.64 0.74 0.71 0.63 0.51 0.39 0.39

Operational time

N NNE NE ENE E ESE SE SSE S SSW SW WSW W WNW NW NNW Sum
364 231 235 234 299 398 720 587 362 314 482 477 675 931 686 429 7,424

Table with columns for months (January to December) and rows for days (1 to 31). Includes sunrise/sunset times, shadow reduction percentages, and potential sun hours.

Table layout: For each day in each month the following matrix apply

Matrix with columns: Day in month, Sun rise (hh:mm), Sun set (hh:mm), Minutes with flicker, First time (hh:mm) with flicker, Last time (hh:mm) with flicker, (WTG causing flicker first time), (WTG causing flicker last time)

SHADOW - Calendar

Calculation: Points and Grid Shadow receptor: A126 - Shadow Receptor: 1.0 x 1.0 Azimuth: 0.0° Slope: 90.0° (5016)
 Assumptions for shadow calculations Sunshine probability S/S0 (Sun hours/Possible sun hours) []

Reference year for calendar

2023

Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec
 0.52 0.54 0.59 0.57 0.60 0.64 0.74 0.71 0.63 0.51 0.39 0.39

Operational time

N NNE NE ENE E ESE SE SSE S SSW SW WSW W WNW NW NNW Sum
 364 231 235 234 299 398 720 587 362 314 482 477 675 931 686 429 7,424

	January	February	March	April	May	June	
1	08:16 16:50	07:57 17:31	07:13 18:12	07:12 19:56	06:17 20:38	05:40 21:16	
2	08:16 16:51	07:56 17:32	07:11 18:14	07:10 19:58	06:15 20:39	05:39 21:17	
3	08:16 16:52	07:55 17:34	07:09 18:15	07:08 19:59	06:14 20:40	05:38 21:18	
4	08:16 16:53	07:53 17:35	07:07 18:16	07:06 20:00	06:12 20:42	05:38 21:18	
5	08:16 16:54	08:45 (89) 08:48 (89)	07:52 17:37	07:05 18:18	07:04 20:02	06:10 20:43	05:37 21:19
6	08:16 16:55	3 08:45 (89) 5 08:50 (89)	07:51 17:38	07:04 18:19	07:02 20:03	06:09 20:44	05:37 21:20
7	08:16 16:56	08:45 (89) 7 08:52 (89)	07:49 17:40	07:02 18:21	07:00 20:05	06:07 20:46	05:36 21:21
8	08:16 16:57	8 08:44 (89) 8 08:52 (89)	07:48 17:41	07:00 18:22	06:58 20:06	06:06 20:47	05:36 21:22
9	08:15 16:59	08:44 (89) 10 08:54 (89)	07:46 17:43	06:58 18:24	06:57 20:07	06:05 20:48	05:36 21:23
10	08:15 17:00	08:43 (89) 11 08:54 (89)	07:45 17:45	06:56 18:25	06:55 20:09	06:03 20:50	05:35 21:23
11	08:15 17:01	08:43 (89) 12 08:55 (89)	07:43 17:46	06:54 18:27	06:53 20:10	06:02 20:51	05:35 21:24
12	08:14 17:02	08:42 (89) 14 08:56 (89)	07:42 17:48	07:52 18:28	06:51 20:12	06:00 20:52	05:35 21:25
13	08:14 17:03	08:43 (89) 14 08:57 (89)	07:40 17:49	07:50 19:30	06:49 5 08:23 (114) 20:13	05:59 20:54	05:35 21:25
14	08:13 17:05	08:42 (89) 15 08:57 (89)	07:39 17:51	07:48 19:31	5 08:16 (118) 15 08:31 (114) 20:14	06:47 20:55	05:34 21:26
15	08:13 17:06	08:42 (89) 16 08:58 (89)	07:37 17:52	07:46 19:32	19 08:13 (118) 19 08:32 (114) 20:16	06:45 20:56	05:34 21:26
16	08:12 17:07	08:43 (89) 16 08:59 (89)	07:36 17:54	07:44 19:34	21 08:12 (118) 21 08:33 (114) 20:17	06:43 20:57	05:34 21:27
17	08:12 17:09	08:43 (89) 16 08:59 (89)	07:34 17:55	07:42 19:35	22 08:11 (118) 22 08:33 (114) 20:18	06:41 20:58	05:34 21:27
18	08:11 17:10	08:43 (89) 16 08:59 (89)	07:32 17:57	07:40 19:37	22 08:11 (118) 22 08:33 (114) 20:20	06:39 21:00	05:34 21:28
19	08:10 17:11	08:44 (89) 15 08:59 (89)	07:31 17:58	07:38 19:38	22 08:11 (118) 22 08:33 (114) 20:21	06:38 21:01	05:34 21:28
20	08:09 17:13	08:45 (89) 15 09:00 (89)	07:29 18:00	07:36 19:40	22 08:11 (118) 22 08:33 (114) 20:23	06:36 21:02	05:34 21:29
21	08:09 17:14	08:46 (89) 14 09:00 (89)	07:27 18:00	07:34 19:41	21 08:11 (118) 21 08:32 (114) 20:24	06:34 21:04	05:34 21:29
22	08:08 17:16	08:47 (89) 12 08:59 (89)	07:26 18:01	07:32 19:42	18 08:13 (118) 18 08:31 (114) 20:25	06:32 21:05	05:35 21:29
23	08:07 17:17	08:48 (89) 11 08:59 (89)	07:24 18:03	07:30 19:44	12 08:17 (114) 12 08:29 (114) 20:27	06:30 21:06	05:35 21:29
24	08:06 17:19	08:49 (89) 9 08:58 (89)	07:22 18:05	07:28 19:45	7 08:19 (114) 7 08:26 (114) 20:28	06:29 21:07	05:35 21:30
25	08:05 17:20	08:52 (89) 4 08:56 (89)	07:20 18:06	07:26 19:47	06:27 20:30	05:45 21:08	05:35 21:30
26	08:04 17:22	08:52 (89) 07:18	07:20 19:48	07:24 19:48	06:25 20:31	05:44 21:09	05:36 21:30
27	08:03 17:23	07:17 18:09	07:22 19:49	07:22 19:49	06:23 20:32	05:44 21:11	05:36 21:30
28	08:02 17:25	07:15 18:11	07:20 19:51	07:20 19:51	06:22 20:34	05:43 21:12	05:37 21:30
29	08:01 17:26	07:18 19:52	07:18 19:52	07:18 19:52	06:20 20:35	05:42 21:13	05:37 21:30
30	08:00 17:28	07:16 19:54	07:16 19:54	07:16 19:54	06:18 20:36	05:41 21:14	05:37 21:30
31	07:58 17:29	07:14 19:55	07:14 19:55	07:14 19:55	05:40 21:15	05:40 21:15	05:37 21:30
Potential sun hours	278	286	367	406	465	475	
Total, worst case	243			206			
Sun reduction	0.52			0.59			
Oper. time red.	0.85			0.85			
Wind dir. red.	0.71			0.71			
Total reduction	0.31			0.36			
Total, real	76			74			

Table layout: For each day in each month the following matrix apply

Day in month	Sun rise (hh:mm)	First time (hh:mm) with flicker	(WTG causing flicker first time)
	Sun set (hh:mm)	Minutes with flicker	Last time (hh:mm) with flicker
			(WTG causing flicker last time)

SHADOW - Calendar

Calculation: Points and Grid Shadow receptor: A126 - Shadow Receptor: 1.0 x 1.0 Azimuth: 0.0° Slope: 90.0° (5016)

Assumptions for shadow calculations

Sunshine probability S/S0 (Sun hours/Possible sun hours) []

Reference year for calendar

2023

Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec
 0.52 0.54 0.59 0.57 0.60 0.64 0.74 0.71 0.63 0.51 0.39 0.39

Operational time

N NNE NE ENE E ESE SE SSE S SSW SW WSW W WNW NW NNW Sum
 364 231 235 234 299 398 720 587 362 314 482 477 675 931 686 429 7,424

	July	August	September	October	November	December
1	05:38	06:08	06:48	07:27	07:56 (118)	08:11
	21:30	21:06	20:15	19:15	15 08:11 (114)	18:16
2	05:39	06:09	06:49	07:28	08:04 (114)	08:12
	21:30	21:05	20:13	19:13	4 08:08 (114)	18:15
3	05:39	06:10	06:50	07:30		08:14
	21:29	21:04	20:11	19:11		18:13
4	05:40	06:11	06:51	07:31		08:15
	21:29	21:02	20:09	19:09		18:12
5	05:40	06:12	06:53	07:32		07:17
	21:29	21:01	20:07	19:07		17:10
6	05:41	06:14	06:54	07:34		07:18
	21:28	20:59	20:05	19:05		17:09
7	05:42	06:15	06:55	07:35		07:20
	21:28	20:58	20:03	19:03		17:07
8	05:43	06:16	06:57	07:37		07:21
	21:28	20:56	20:01	19:01		17:06
9	05:43	06:18	06:58	07:38		07:23
	21:27	20:55	19:59	18:57		17:04
10	05:44	06:19	06:59	07:39		07:24
	21:27	20:53	19:57	18:55		17:03
11	05:45	06:20	07:01	07:41		07:26
	21:26	20:52	19:55	18:53		17:02
12	05:46	06:21	07:02	07:42		07:27
	21:26	20:50	19:53	18:51		17:01
13	05:47	06:23	07:03	07:44		07:29
	21:25	20:49	19:51	18:49		16:59
14	05:48	06:24	07:05	07:45		07:30
	21:24	20:47	19:49	18:47		16:58
15	05:49	06:25	07:06	07:46		07:32
	21:24	20:45	19:47	18:46		16:57
16	05:50	06:27	07:07	07:48		07:33
	21:23	20:44	19:45	18:44		16:56
17	05:51	06:28	07:08	07:49		07:35
	21:22	20:42	19:43	18:42		16:55
18	05:52	06:29	07:10	07:51		07:36
	21:21	20:40	19:41	18:40		16:54
19	05:53	06:31	07:11	07:52		07:38
	21:21	20:39	19:39	18:38		16:53
20	05:54	06:32	07:12	07:53		07:39
	21:20	20:37	19:37	18:36		16:52
21	05:55	06:33	07:14	08:05 (114)		07:40
	21:19	20:35	19:35	18:35		16:51
22	05:56	06:34	07:15	08:02 (114)		07:42
	21:18	20:33	19:33	18:33		16:50
23	05:57	06:36	07:16	07:58 (118)		07:43
	21:17	20:32	19:31	18:31		16:49
24	05:58	06:37	07:18	07:56 (118)		07:45
	21:16	20:30	19:29	18:29		16:48
25	05:59	06:38	07:19	07:54 (118)		07:46
	21:15	20:28	19:27	18:28		16:47
26	06:00	06:40	07:20	07:54 (118)		07:47
	21:14	20:26	19:25	18:26		16:47
27	06:02	06:41	07:22	07:53 (118)		07:49
	21:12	20:24	19:23	18:24		16:46
28	06:03	06:42	07:23	07:53 (118)		07:50
	21:11	20:22	19:21	18:23		16:45
29	06:04	06:44	07:24	07:54 (118)		07:51
	21:10	20:20	19:19	18:21		16:45
30	06:05	06:45	07:26	07:54 (118)		07:53
	21:09	20:19	19:17	18:19		16:44
31	06:06	06:46		08:10		08:16
	21:08	20:17		18:18		16:49
Potential sun hours	481	442	380	339	283	266
Total, worst case			190	19	160	78
Sun reduction			0.63	0.51	0.39	0.39
Oper. time red.			0.85	0.85	0.85	0.85
Wind dir. red.			0.71	0.71	0.71	0.71
Total reduction			0.38	0.31	0.23	0.23
Total, real			72	6	37	18

Table layout: For each day in each month the following matrix apply

Day in month	Sun rise (hh:mm)	Minutes with flicker	First time (hh:mm) with flicker	(WTG causing flicker first time)
	Sun set (hh:mm)		Last time (hh:mm) with flicker	(WTG causing flicker last time)

Project:

Otter Tail Ashtabula III Wind

Description:

Barnes County, ND

Licensed user:

Epsilon Associates, Inc
3 Clock Tower Place, Suite 250
US-MAYNARD MA 01754
978 897 7100
Richard Lampeter / rlampeter@epsilonassociates.com
Calculated:
6/18/2023 2:05 PM/3.6.366

SHADOW - Calendar

Calculation: Points and Grid Shadow receptor: A127 - Shadow Receptor: 1.0 x 1.0 Azimuth: 0.0° Slope: 90.0° (5017)

Assumptions for shadow calculations

Sunshine probability S/S0 (Sun hours/Possible sun hours) []

Reference year for calendar

2023

Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec
0.52 0.54 0.59 0.57 0.60 0.64 0.74 0.71 0.63 0.51 0.39 0.39

Operational time

N NNE NE ENE E ESE SE SSE S SSW SW WSW W WNW NW NNW Sum
364 231 235 234 299 398 720 587 362 314 482 477 675 931 686 429 7,424

Table with columns for months (January to December) and rows for days (1-31) showing sun rise/set times, shadow reduction percentages, and potential sun hours.

Table layout: For each day in each month the following matrix apply

Matrix with columns: Day in month, Sun rise (hh:mm), Sun set (hh:mm), Minutes with flicker, First time (hh:mm) with flicker, Last time (hh:mm) with flicker, (WTG causing flicker first time), (WTG causing flicker last time)

Project:

Otter Tail Ashtabula III Wind

Description:

Barnes County, ND

Licensed user:

Epsilon Associates, Inc
3 Clock Tower Place, Suite 250
US-MAYNARD MA 01754
978 897 7100
Richard Lampeter / rlampeter@epsilonassociates.com
Calculated:
6/18/2023 2:05 PM/3.6.366

SHADOW - Calendar

Calculation: Points and Grid Shadow receptor: A128 - Shadow Receptor: 1.0 x 1.0 Azimuth: 0.0° Slope: 90.0° (5018)

Assumptions for shadow calculations

Sunshine probability S/S0 (Sun hours/Possible sun hours) []

Reference year for calendar

2023

Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec
0.52 0.54 0.59 0.57 0.60 0.64 0.74 0.71 0.63 0.51 0.39 0.39

Operational time

N NNE NE ESE SE SSE S SSW SW WSW W WNW NW NNW Sum
364 231 235 234 299 398 720 587 362 314 482 477 675 931 686 429 7,424

Calendar grid showing shadow calculations for each day from January to December. Columns include month, day, and various time points (sunrise, sunset, etc.).

Table layout: For each day in each month the following matrix apply

Day in month Sun rise (hh:mm) Sun set (hh:mm) First time (hh:mm) with flicker Last time (hh:mm) with flicker (WTG causing flicker first time) (WTG causing flicker last time)



SHADOW - Calendar

Calculation: Points and Grid Shadow receptor: A129 - Shadow Receptor: 1.0 x 1.0 Azimuth: 0.0° Slope: 90.0° (5019)

Assumptions for shadow calculations

Reference year for calendar

2023

Sunshine probability S/S0 (Sun hours/Possible sun hours) []

Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec
 0.52 0.54 0.59 0.57 0.60 0.64 0.74 0.71 0.63 0.51 0.39 0.39

Operational time

N NNE NE ENE E ESE SE SSE S SSW SW WSW W WNW NW NNW Sum
 364 231 235 234 299 398 720 587 362 314 482 477 675 931 686 429 7,424

	January	February	March	April	May	June
1	08:16 16:50	08:59 (89) 09:10 (89)	07:57 17:31	07:13 18:12	07:12 19:56	05:40 21:16
2	08:16 16:51	09:00 (89) 09:10 (89)	07:56 17:32	07:11 18:14	07:10 19:58	05:39 21:17
3	08:16 16:52	09:00 (89) 09:09 (89)	07:55 17:34	07:09 18:15	07:08 19:59	05:38 21:18
4	08:16 16:53	09:01 (89) 09:10 (89)	07:53 17:35	07:07 18:16	07:06 20:00	05:38 21:18
5	08:16 16:54	09:03 (89) 09:09 (89)	07:52 17:37	07:05 18:18	07:04 20:02	05:37 21:19
6	08:16 16:55	09:04 (89) 09:09 (89)	07:51 17:38	07:04 18:19	07:02 20:03	05:37 21:20
7	08:16 16:56	09:09 (89) 17:40	07:49 17:40	07:02 18:21	07:00 20:05	05:36 21:21
8	08:16 16:57	07:48 17:41	07:48 17:41	07:00 18:22	06:58 20:06	05:36 21:22
9	08:15 16:59	07:46 17:43	06:58 18:24	07:24 (104) 18:24	06:57 20:07	05:36 21:23
10	08:15 17:00	07:45 17:45	06:56 18:25	07:23 (104) 15 07:44 (118)	06:55 20:09	05:35 21:23
11	08:15 17:01	07:43 17:46	06:54 18:27	07:23 (104) 11 07:34 (104)	06:53 20:10	05:35 21:24
12	08:14 17:02	07:42 17:48	07:52 18:28	08:24 (104) 9 08:33 (104)	06:51 20:12	05:35 21:25
13	08:14 17:03	07:40 17:49	07:50 19:30	08:25 (104) 6 08:31 (104)	06:49 20:13	05:35 21:25
14	08:13 17:05	07:39 17:51	07:48 19:31	06:47 20:14	05:58 20:55	05:34 21:26
15	08:13 17:06	07:37 17:52	07:46 19:32	06:45 20:16	05:56 20:56	05:34 21:26
16	08:12 17:07	07:36 17:54	07:44 19:34	08:07 (100) 7 08:14 (100)	06:43 20:17	05:55 20:58
17	08:12 17:09	07:34 17:55	07:42 19:35	08:05 (100) 10 08:15 (100)	06:41 20:18	05:54 20:59
18	08:11 17:10	07:32 17:57	07:40 19:37	08:05 (100) 10 08:15 (100)	06:39 20:20	05:53 21:00
19	08:10 17:11	07:31 17:58	07:38 19:38	08:04 (100) 11 08:15 (100)	06:38 20:21	05:52 21:01
20	08:09 17:13	07:29 18:00	07:36 19:40	08:05 (100) 9 08:14 (100)	06:36 20:23	05:50 21:03
21	08:09 17:14	07:27 18:00	07:34 19:41	08:06 (100) 6 08:12 (100)	06:34 20:24	05:49 21:04
22	08:08 17:16	07:26 18:01	07:32 19:42	06:32 20:25	05:48 21:05	05:35 21:29
23	08:07 17:17	07:24 18:03	07:30 19:44	06:30 20:27	05:47 21:06	05:35 21:29
24	08:06 17:19	07:22 18:05	07:28 19:45	06:29 20:28	05:46 21:07	05:35 21:30
25	08:05 17:20	07:20 18:06	07:26 2 07:56 (114)	06:27 20:30	05:45 21:08	05:35 21:30
26	08:04 17:22	07:18 18:08	07:24 10 08:03 (114)	06:25 20:31	05:44 21:09	05:36 21:30
27	08:03 17:23	07:17 18:09	07:22 13 08:04 (114)	06:23 20:32	05:44 21:11	05:36 21:30
28	08:02 17:25	07:15 18:11	07:20 15 08:05 (114)	06:22 20:34	05:43 21:12	05:37 21:30
29	08:01 17:26	07:14 18:11	07:18 19:51	06:20 20:35	05:42 21:13	05:37 21:30
30	08:00 17:28	07:13 18:10	07:16 19:54	06:18 20:36	05:41 21:14	05:37 21:30
31	07:58 17:29	07:12 18:09	07:14 19:55	06:17 20:37	05:40 21:15	05:37 21:30
Potential sun hours	278	286	367	406	465	475
Total, worst case	50	40	327			
Sun reduction	0.52	0.54	0.59			
Oper. time red.	0.85	0.85	0.85			
Wind dir. red.	0.70	0.72	0.72			
Total reduction	0.31	0.33	0.36			
Total, real	16	13	117			

Table layout: For each day in each month the following matrix apply

Day in month	Sun rise (hh:mm)	Sun set (hh:mm)	Minutes with flicker	First time (hh:mm) with flicker	Last time (hh:mm) with flicker	(WTG causing flicker first time)	(WTG causing flicker last time)
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SHADOW - Calendar

Calculation: Points and Grid Shadow receptor: A129 - Shadow Receptor: 1.0 x 1.0 Azimuth: 0.0° Slope: 90.0° (5019)

Assumptions for shadow calculations

Sunshine probability S/S0 (Sun hours/Possible sun hours) []

Reference year for calendar

2023

Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec
 0.52 0.54 0.59 0.57 0.60 0.64 0.74 0.71 0.63 0.51 0.39 0.39

Operational time

N NNE NE ENE E ESE SE SSE S SSW SW WSW W WNW NW NNW Sum
 364 231 235 234 299 398 720 587 362 314 482 477 675 931 686 429 7,424

	July	August	September	October	November	December
1	05:38 21:30	06:08 21:06	06:48 20:15	07:27 19:15		08:11 18:16
2	05:39 21:30	06:09 21:05	06:49 20:13	07:28 19:13	6 08:05 (104)	08:12 18:15
3	05:39 21:29	06:10 21:04	06:50 20:11	07:30 19:11	9 08:03 (104)	08:14 18:13
4	05:40 21:29	06:11 21:02	06:51 20:09	07:31 19:09	11 08:12 (104)	08:15 18:12
5	05:40 21:29	06:12 21:01	06:53 20:07	07:32 19:07	15 08:22 (118)	07:17 17:10
6	05:41 21:28	06:14 20:59	06:54 20:05	07:34 19:05	20 08:01 (104)	07:18 17:09
7	05:42 21:28	06:15 20:58	06:55 20:03	07:35 19:03	29 08:02 (104)	07:20 17:07
8	05:43 21:28	06:16 20:56	06:57 20:01	07:37 19:01	32 08:36 (114)	07:21 17:06
9	05:43 21:27	06:18 20:55	06:58 19:59	07:38 18:57	27 08:02 (104)	07:23 17:04
10	05:44 21:27	06:19 20:53	06:59 19:57	07:39 18:55	27 08:05 (104)	07:24 17:03
11	05:45 21:26	06:20 20:52	07:01 19:55	07:41 18:53	27 08:39 (114)	07:26 17:02
12	05:46 21:26	06:21 20:50	07:02 19:53	07:42 18:51	27 08:12 (118)	07:27 17:01
13	05:47 21:25	06:23 20:49	07:03 19:51	07:44 18:49	26 08:13 (118)	07:29 16:59
14	05:48 21:24	06:24 20:47	07:05 19:49	07:45 18:47	20 08:39 (114)	07:30 16:58
15	05:49 21:24	06:25 20:45	07:06 19:47	07:46 18:46	16 08:22 (114)	07:32 16:57
16	05:50 21:23	06:27 20:44	07:07 19:45	07:48 18:44	14 08:23 (114)	07:33 16:56
17	05:51 21:22	06:28 20:42	07:08 19:43	07:49 18:42	11 08:37 (114)	07:35 16:55
18	05:52 21:21	06:29 20:40	07:10 19:41	07:51 18:40	5 08:35 (114)	07:36 16:54
19	05:53 21:21	06:31 20:39	07:11 19:39	07:52 18:38		07:38 16:53
20	05:54 21:20	06:32 20:37	07:12 19:37	07:53 18:36		08:12 16:52
21	05:55 21:19	06:33 20:35	07:14 19:35	07:55 18:35		08:13 16:43
22	05:56 21:18	06:34 20:33	07:15 19:33	07:56 18:33		08:13 16:43
23	05:57 21:17	06:36 20:32	07:16 19:31	07:58 18:31		08:14 16:44
24	05:58 21:16	06:37 20:30	07:18 19:29	07:59 18:29	7 07:50 (100)	08:14 16:44
25	05:59 21:15	06:38 20:28	07:19 19:27	08:01 18:28	7 07:57 (100)	08:15 16:45
26	06:00 21:14	06:40 20:26	07:20 19:25	08:02 18:26	10 07:48 (100)	08:15 16:45
27	06:02 21:12	06:41 20:24	07:22 19:23	08:04 18:24	10 07:58 (100)	08:15 16:46
28	06:03 21:11	06:42 20:22	07:23 19:21	08:05 18:23	11 07:47 (100)	08:16 16:47
29	06:04 21:10	06:44 20:20	07:24 19:19	08:07 18:21	10 07:57 (100)	08:16 16:47
30	06:05 21:09	06:45 20:19	07:26 19:17	08:08 18:19	7 07:56 (100)	08:16 16:48
31	06:06 21:08	06:46 20:17		08:10 18:18		08:16 16:49
Potential sun hours	481	442	380	339	283	266
Total, worst case			55	322		277
Sun reduction			0.63	0.51		0.39
Oper. time red.			0.85	0.85		0.85
Wind dir. red.			0.71	0.72		0.70
Total reduction			0.38	0.31		0.23
Total, real			21	100		64

Table layout: For each day in each month the following matrix apply

Day in month	Sun rise (hh:mm)	Sun set (hh:mm)	Minutes with flicker	First time (hh:mm) with flicker	Last time (hh:mm) with flicker	(WTG causing flicker first time)	(WTG causing flicker last time)
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SHADOW - Calendar

Calculation: Points and Grid Shadow receptor: A13 - Shadow Receptor: 1.0 × 1.0 Azimuth: 0.0° Slope: 90.0° (4903)

Assumptions for shadow calculations

Sunshine probability S/S0 (Sun hours/Possible sun hours) []

Reference year for calendar

2023

Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec
 0.52 0.54 0.59 0.57 0.60 0.64 0.74 0.71 0.63 0.51 0.39 0.39

Operational time

N NNE NE ENE E ESE SE SSE S SSW SW WSW W WNW NW NNW Sum
 364 231 235 234 299 398 720 587 362 314 482 477 675 931 686 429 7,424

	January	February	March	April	May	June
1	08:16 16:50	07:57 17:31 20	08:23 (102) 08:43 (102)	07:13 18:12	07:12 19:56	06:17 20:38
2	08:16 16:51	07:56 17:32 22	08:22 (102) 08:44 (102)	07:11 18:13	07:10 19:58	06:15 20:39
3	08:16 16:52	07:55 17:34 25	08:20 (102) 08:45 (102)	07:09 18:15	07:08 19:59	06:14 20:40
4	08:16 16:53	07:53 17:35 27	08:19 (102) 08:46 (102)	07:07 18:16	07:06 20:00	06:12 20:42
5	08:16 16:54	07:52 17:37 28	08:17 (102) 08:45 (102)	07:05 18:18	07:04 20:02	06:11 20:43
6	08:16 16:55	07:51 17:38 29	08:17 (102) 08:46 (102)	07:04 18:19	07:02 20:03	06:09 20:44
7	08:16 16:56	07:49 17:40 30	08:17 (102) 08:47 (102)	07:02 18:21	07:00 20:05	06:07 20:46
8	08:16 16:57	07:48 17:41 30	08:17 (102) 08:47 (102)	07:00 18:22	06:58 20:06	06:06 20:47
9	08:15 16:59	07:46 17:43 29	08:18 (102) 08:47 (102)	06:58 18:24	06:57 20:07	06:05 20:48
10	08:15 17:00	07:45 17:45 30	08:17 (102) 08:47 (102)	06:56 18:25	06:55 20:09	06:03 20:50
11	08:15 17:01	07:43 17:46 29	08:17 (102) 08:46 (102)	06:54 18:27	06:53 20:10	06:02 20:51
12	08:14 17:02	07:42 17:48 28	08:18 (102) 08:46 (102)	07:52 18:28	08:15 (90) 08:20 (90)	06:00 20:52
13	08:14 17:03	07:40 17:49 26	08:19 (102) 08:45 (102)	07:50 19:30	08:13 (90) 08:22 (90)	06:49 20:54
14	08:13 17:05	07:39 17:51 25	08:20 (102) 08:45 (102)	07:48 19:31	08:11 (90) 08:23 (90)	05:58 20:55
15	08:13 17:06	07:37 17:52 22	08:21 (102) 08:43 (102)	07:46 19:32	08:09 (90) 08:23 (90)	05:56 20:56
16	08:12 17:07	07:36 17:54 20	08:22 (102) 08:42 (102)	07:44 19:34	08:07 (90) 08:24 (90)	05:55 20:57
17	08:11 17:09	07:34 17:55 17	08:24 (102) 08:41 (102)	07:42 19:35	08:05 (90) 08:24 (90)	05:54 20:59
18	08:11 17:10	07:32 17:57 11	08:27 (102) 08:38 (102)	07:40 19:37	08:03 (90) 08:24 (90)	06:39 21:00
19	08:10 17:11	07:31 17:58	07:38 19:38	21 08:24 (90)	20:20 21:01	21:28 05:52
20	08:09 17:13	07:29 18:00	07:36 19:39	22 08:23 (90)	20:21 21:02	21:28 05:50
21	08:09 17:14	07:27 18:00	07:34 19:41	21 08:22 (90)	20:23 21:04	21:28 05:49
22	08:08 17:16	07:25 18:01	07:32 19:42	19 08:21 (90)	20:24 21:05	21:29 05:48
23	08:07 17:17	07:24 18:03	07:30 19:44	16 08:20 (90)	20:25 21:06	21:29 05:47
24	08:06 17:19	07:22 18:05	07:28 19:45	13 08:19 (90)	20:27 21:07	21:29 05:46
25	08:05 17:20	07:20 18:06	07:26 19:47	6 08:18 (90)	20:28 21:08	21:30 05:45
26	08:04 17:22	07:18 18:08	07:24 19:48		20:29 21:09	21:30 05:44
27	08:03 17:23	08:29 (102) 08:34 (102)	07:17 18:09		20:31 21:10	21:30 05:43
28	08:02 17:25	08:28 (102) 08:37 (102)	07:15 18:11		20:32 21:12	21:30 05:42
29	08:01 17:26	08:27 (102) 08:39 (102)	07:18 19:52		20:34 21:13	21:30 05:41
30	08:00 17:28	08:26 (102) 08:41 (102)	07:16 19:53		20:35 21:14	21:30 05:40
31	07:58 17:29	08:24 (102) 08:42 (102)	07:14 19:55		20:36 21:15	21:30 05:39
Potential sun hours	278	286	367	406	465	475
Total, worst case	59	448	216			
Sun reduction	0.52	0.54	0.59			
Oper. time red.	0.85	0.85	0.85			
Wind dir. red.	0.72	0.72	0.71			
Total reduction	0.32	0.33	0.36			
Total, real	19	147	77			

Table layout: For each day in each month the following matrix apply

Day in month	Sun rise (hh:mm)	First time (hh:mm) with flicker	(WTG causing flicker first time)
	Sun set (hh:mm)	Minutes with flicker	Last time (hh:mm) with flicker
			(WTG causing flicker last time)

SHADOW - Calendar

Calculation: Points and Grid Shadow receptor: A13 - Shadow Receptor: 1.0 x 1.0 Azimuth: 0.0° Slope: 90.0° (4903)

Assumptions for shadow calculations

Sunshine probability S/S0 (Sun hours/Possible sun hours) []

Reference year for calendar

2023

Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec
 0.52 0.54 0.59 0.57 0.60 0.64 0.74 0.71 0.63 0.51 0.39 0.39

Operational time

N NNE NE ENE E ESE SE SSE S SSW SW WSW W WNW NW NNW Sum
 364 231 235 234 299 398 720 587 362 314 482 477 675 931 686 429 7,424

	July	August	September	October	November	December
1	05:38	06:08	06:48	07:27	07:51 (90)	08:11
	21:30	21:06	20:15	19:15	11 08:02 (90)	18:16
2	05:39	06:09	06:49	07:28	07:53 (90)	08:12
	21:29	21:05	20:13	19:13	8 08:01 (90)	18:15
3	05:39	06:10	06:50	07:30	07:54 (90)	08:14
	21:29	21:04	20:11	19:11	5 07:59 (90)	18:13
4	05:40	06:11	06:51	07:31	08:15	30 09:16 (102)
	21:29	21:02	20:09	19:09	18:12	29 09:16 (102)
5	05:40	06:12	06:53	07:32	07:17	29 09:16 (102)
	21:29	21:01	20:07	19:07	17:10	30 08:17 (102)
6	05:41	06:14	06:54	07:34	07:18	30 08:17 (102)
	21:28	20:59	20:05	19:05	17:09	29 08:16 (102)
7	05:42	06:15	06:55	07:35	07:20	29 08:16 (102)
	21:28	20:58	20:03	19:03	17:07	29 08:16 (102)
8	05:43	06:16	06:57	07:37	07:21	29 08:16 (102)
	21:28	20:56	20:01	19:01	17:06	27 08:15 (102)
9	05:43	06:18	06:58	07:38	07:23	27 08:15 (102)
	21:27	20:55	19:59	18:57	17:04	25 08:15 (102)
10	05:44	06:19	06:59	07:39	07:24	25 08:15 (102)
	21:27	20:53	19:57	18:55	17:03	23 08:15 (102)
11	05:45	06:20	07:01	07:41	07:26	23 08:15 (102)
	21:26	20:52	19:55	18:53	17:02	21 08:14 (102)
12	05:46	06:21	07:02	07:42	07:27	21 08:14 (102)
	21:26	20:50	19:53	18:51	17:01	19 08:14 (102)
13	05:47	06:23	07:03	07:43	07:29	19 08:14 (102)
	21:25	20:49	19:51	18:49	16:59	16 08:13 (102)
14	05:48	06:24	07:05	07:45	07:30	16 08:13 (102)
	21:24	20:47	19:49	18:47	16:58	14 08:12 (102)
15	05:49	06:25	07:06	07:46	07:32	14 08:12 (102)
	21:24	20:45	19:47	18:46	16:57	11 08:11 (102)
16	05:50	06:27	07:07	07:48	07:33	11 08:11 (102)
	21:23	20:44	19:45	18:44	16:56	7 08:08 (102)
17	05:51	06:28	07:08	07:49	07:35	7 08:08 (102)
	21:22	20:42	19:43	18:42	16:55	1 08:04 (102)
18	05:52	06:29	07:10	07:51	07:36	1 08:04 (102)
	21:21	20:40	19:41	18:40	16:54	08:11
19	05:53	06:31	07:11	07:52	07:37	08:11
	21:20	20:39	19:39	18:38	16:53	16:42
20	05:54	06:32	07:12	07:53	07:39	16:42
	21:20	20:37	19:37	18:36	16:52	08:12
21	05:55	06:33	07:14	07:55	07:40	16:42
	21:19	20:35	19:35	18:35	16:51	08:13
22	05:56	06:34	07:15	07:56	07:42	16:43
	21:18	20:33	19:33	18:33	16:50	08:13
23	05:57	06:36	07:16	07:58	07:43	16:43
	21:17	20:31	19:31	18:31	16:49	08:14
24	05:58	06:37	07:18	07:59	07:45	16:44
	21:16	20:30	19:29	18:29	16:48	08:14
25	05:59	06:38	07:19	08:01	08:57 (102)	16:44
	21:15	20:28	19:27	18:28	9 09:06 (102)	08:15
26	06:00	06:40	07:20	08:02	08:54 (102)	16:45
	21:14	20:26	19:25	18:26	15 09:09 (102)	08:15
27	06:02	06:41	07:22	08:04	08:52 (102)	16:45
	21:12	20:24	19:23	18:24	19 09:11 (102)	08:15
28	06:03	06:42	07:23	08:05	08:51 (102)	16:46
	21:11	20:22	19:21	18:23	22 09:13 (102)	08:16
29	06:04	06:44	07:24	08:06	08:49 (102)	16:47
	21:10	20:20	19:19	18:21	24 09:13 (102)	08:16
30	06:05	06:45	07:26	08:08	08:49 (102)	16:47
	21:09	20:19	19:17	18:19	25 09:14 (102)	08:16
31	06:06	06:46	07:27	08:09	08:48 (102)	16:48
	21:08	20:17	19:16	18:18	27 09:15 (102)	08:16
Potential sun hours	481	442	380	339	283	266
Total, worst case			193	165	368	
Sun reduction			0.63	0.51	0.39	
Oper. time red.			0.85	0.85	0.85	
Wind dir. red.			0.71	0.72	0.72	
Total reduction			0.38	0.31	0.24	
Total, real			74	51	87	

Table layout: For each day in each month the following matrix apply

Day in month	Sun rise (hh:mm)	Minutes with flicker	First time (hh:mm) with flicker	(WTG causing flicker first time)
	Sun set (hh:mm)		Last time (hh:mm) with flicker	(WTG causing flicker last time)

SHADOW - Calendar

Calculation: Points and Grid Shadow receptor: A130 - Shadow Receptor: 1.0 x 1.0 Azimuth: 0.0° Slope: 90.0° (5020)

Assumptions for shadow calculations

Reference year for calendar

2023

Sunshine probability S/S0 (Sun hours/Possible sun hours) []

Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec
 0.52 0.54 0.59 0.57 0.60 0.64 0.74 0.71 0.63 0.51 0.39 0.39

Operational time

N NNE NE ENE E ESE SE SSE S SSW SW WSW W WNW NW NNW Sum
 364 231 235 234 299 398 720 587 362 314 482 477 675 931 686 429 7,424

	January	February	March	April	May	June
1	08:16	09:03 (89)	07:57	07:13	07:43 (118)	07:12
	16:50	09:11 (89)	17:31	18:12	08:09 (114)	19:56
2	08:16	09:04 (89)	07:56	07:11	07:41 (118)	07:10
	16:51	09:10 (89)	17:32	18:14	08:08 (114)	19:58
3	08:16	09:04 (89)	07:55	07:09	07:40 (118)	07:08
	16:52	09:09 (89)	17:34	18:15	08:08 (114)	19:59
4	08:16	09:06 (89)	07:53	07:07	07:39 (118)	07:06
	16:53	09:08 (89)	17:35	18:16	08:07 (114)	20:00
5	08:16		07:52	07:05	07:39 (118)	07:04
	16:54		17:37	18:18	08:05 (114)	20:02
6	08:16		07:51	07:04	07:28 (104)	07:02
	16:55		17:38	18:19	08:04 (114)	20:03
7	08:16		07:49	07:02	07:27 (104)	07:00
	16:56		17:40	18:21	08:00 (114)	20:05
8	08:16		07:48	07:00	07:26 (104)	06:58
	16:57		17:41	18:22	07:49 (118)	20:06
9	08:15		07:46	06:58	07:25 (104)	06:57
	16:59		17:43	18:24	07:37 (104)	20:07
10	08:15		07:45	06:56	07:25 (104)	06:55
	17:00		17:45	18:25	07:37 (104)	20:09
11	08:15		07:43	06:54	07:26 (104)	06:53
	17:01		17:46	18:27	07:35 (104)	20:10
12	08:14		07:42	07:52	08:27 (104)	06:51
	17:02		17:48	18:28	08:34 (104)	20:12
13	08:14		07:40	07:50		06:49
	17:03		17:49	19:30		20:13
14	08:13		07:39	07:48		06:47
	17:05		17:51	19:31		20:14
15	08:13		07:37	07:46	08:09 (100)	06:45
	17:06		17:52	19:32	08:16 (100)	20:16
16	08:12		07:36	07:44	08:07 (100)	06:43
	17:07		17:54	19:34	08:17 (100)	20:17
17	08:12		07:34	07:42	08:06 (100)	06:41
	17:09		17:55	19:35	08:17 (100)	20:18
18	08:11		07:32	07:40	08:06 (100)	06:39
	17:10		17:57	19:37	08:17 (100)	20:20
19	08:10		07:31	07:38	08:06 (100)	06:38
	17:11		17:58	19:38	08:16 (100)	20:21
20	08:09		07:29	07:36	08:07 (100)	06:36
	17:13		18:00	19:40	08:14 (100)	20:23
21	08:09		07:27	07:34		06:34
	17:14		18:00	19:41		20:24
22	08:08		07:26	07:32		06:32
	17:16		18:01	19:42		20:25
23	08:07		07:24	07:30		06:30
	17:17		18:03	19:44		20:27
24	08:06		07:22	07:57 (114)	07:28	06:29
	17:19		18:05	08:04 (114)	19:45	20:28
25	08:05		07:20	07:54 (114)	07:26	06:27
	17:20		18:06	08:06 (114)	19:47	20:30
26	08:04		07:18	07:54 (114)	07:24	06:25
	17:22		18:08	08:08 (114)	19:48	20:31
27	08:03		07:17	07:52 (114)	07:22	06:23
	17:23		18:09	08:08 (114)	19:49	20:32
28	08:02		07:15	07:46 (118)	07:20	06:22
	17:25		18:11	08:09 (114)	19:51	20:34
29	08:01				07:18	06:20
	17:26				19:52	20:35
30	08:00				07:16	06:18
	17:28				19:54	20:36
31	07:58				07:14	05:40
	17:29				19:55	21:15
Potential sun hours	278	286	367	406	465	475
Total, worst case	21	69	307			
Sun reduction	0.52	0.54	0.59			
Oper. time red.	0.85	0.85	0.85			
Wind dir. red.	0.70	0.72	0.72			
Total reduction	0.31	0.33	0.36			
Total, real	7	23	110			

Table layout: For each day in each month the following matrix apply

Day in month	Sun rise (hh:mm)	Minutes with flicker	First time (hh:mm) with flicker	Last time (hh:mm) with flicker	(WTG causing flicker first time)	(WTG causing flicker last time)
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SHADOW - Calendar

Calculation: Points and Grid Shadow receptor: A130 - Shadow Receptor: 1.0 x 1.0 Azimuth: 0.0° Slope: 90.0° (5020)

Assumptions for shadow calculations

Reference year for calendar

2023

Sunshine probability S/S0 (Sun hours/Possible sun hours) []

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
0.52	0.54	0.59	0.57	0.60	0.64	0.74	0.71	0.63	0.51	0.39	0.39

Operational time

N	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW	Sum
364	231	235	234	299	398	720	587	362	314	482	477	675	931	686	429	7,424

	July	August	September	October	November	December
1	05:38 21:30	06:08 21:06	06:48 20:15	07:27 19:15	08:11 18:16	07:54 16:43
2	05:39 21:30	06:09 21:05	06:49 20:13	07:28 19:13	08:12 18:15	07:55 16:43
3	05:39 21:29	06:10 21:04	06:50 20:11	07:30 19:11	08:06 (104) 08:13 (104)	07:56 18:13
4	05:40 21:29	06:11 21:02	06:51 20:09	07:31 19:09	08:04 (104) 08:13 (104)	07:57 18:12
5	05:40 21:29	06:12 21:01	06:53 20:07	07:32 19:07	08:03 (104) 08:15 (104)	07:59 17:10
6	05:41 21:28	06:14 20:59	06:54 20:05	07:34 19:05	08:02 (104) 08:14 (104)	07:18 17:09
7	05:42 21:28	06:15 20:58	06:55 20:03	07:35 19:03	08:03 (104) 08:26 (118)	07:20 17:07
8	05:43 21:28	06:16 20:56	06:57 20:01	07:37 19:01	08:03 (104) 08:36 (114)	07:21 17:06
9	05:43 21:27	06:18 20:55	06:58 19:59	07:38 18:57	08:03 (104) 08:39 (114)	07:23 17:04
10	05:44 21:27	06:19 20:53	06:59 19:57	07:39 18:55	08:14 (118) 08:41 (114)	07:24 17:03
11	05:45 21:26	06:20 20:52	07:01 19:55	07:41 18:53	08:13 (118) 08:41 (114)	07:26 17:02
12	05:46 21:26	06:21 20:50	07:02 19:53	07:42 18:51	08:14 (118) 08:42 (114)	07:27 17:01
13	05:47 21:25	06:23 20:49	07:03 19:51	07:44 18:49	08:14 (118) 08:41 (114)	07:29 16:59
14	05:48 21:24	06:24 20:47	07:05 19:49	07:45 18:47	08:16 (118) 08:42 (114)	07:30 16:58
15	05:49 21:24	06:25 20:45	07:06 19:47	07:46 18:46	08:17 (118) 08:41 (114)	07:32 16:57
16	05:50 21:23	06:27 20:44	07:07 19:45	07:48 18:44	08:25 (114) 08:41 (114)	07:33 16:56
17	05:51 21:22	06:28 20:42	07:08 19:43	07:49 18:42	08:25 (114) 08:39 (114)	07:35 16:55
18	05:52 21:21	06:29 20:40	07:10 19:41	07:51 18:40	08:26 (114) 08:38 (114)	07:36 16:54
19	05:53 21:21	06:31 20:39	07:11 19:39	07:52 18:38	08:28 (114) 08:36 (114)	07:38 16:53
20	05:54 21:20	06:32 20:37	07:12 19:37	07:53 18:36	07:39 16:52	08:12 16:42
21	05:55 21:19	06:33 20:35	07:14 19:35	07:55 18:35	07:40 16:51	08:13 16:43
22	05:56 21:18	06:34 20:33	07:15 19:33	07:56 18:33	07:42 16:50	08:13 16:43
23	05:57 21:17	06:36 20:32	07:16 19:31	07:58 18:31	07:43 16:49	08:14 16:44
24	05:58 21:16	06:37 20:30	07:18 19:29	07:59 18:29	07:45 16:48	08:14 16:44
25	05:59 21:15	06:38 20:28	07:19 19:27	08:01 18:28	07:46 16:47	08:15 16:45
26	06:00 21:14	06:40 20:26	07:20 19:25	08:02 18:26	07:47 16:47	08:15 16:45
27	06:02 21:12	06:41 20:24	07:22 19:23	08:04 18:24	07:49 16:46	08:15 16:46
28	06:03 21:11	06:42 20:22	07:23 19:21	08:05 18:23	07:50 16:45	08:16 16:47
29	06:04 21:10	06:44 20:20	07:24 19:19	08:07 18:21	07:51 16:45	08:16 16:47
30	06:05 21:09	06:45 20:19	07:26 19:17	08:08 18:19	07:53 16:44	08:16 16:48
31	06:06 21:08	06:46 20:17	07:27 18:18	08:10 18:18	07:54 16:49	08:17 09:11 (89)
Potential sun hours	481	442	380	339	283	266
Total, worst case			53	323		215
Sun reduction			0.63	0.51		0.39
Oper. time red.			0.85	0.85		0.85
Wind dir. red.			0.71	0.72		0.70
Total reduction			0.38	0.31		0.23
Total, real			20	101		50

Table layout: For each day in each month the following matrix apply

Day in month	Sun rise (hh:mm)	Minutes with flicker	First time (hh:mm) with flicker	(WTG causing flicker first time)
	Sun set (hh:mm)		Last time (hh:mm) with flicker	(WTG causing flicker last time)

Project:

Otter Tail Ashtabula III Wind

Description:

Barnes County, ND

Licensed user:

Epsilon Associates, Inc
3 Clock Tower Place, Suite 250
US-MAYNARD MA 01754
978 897 7100
Richard Lampeter / rlampeter@epsilonassociates.com
Calculated:
6/18/2023 2:05 PM/3.6.366

SHADOW - Calendar

Calculation: Points and Grid Shadow receptor: A131 - Shadow Receptor: 1.0 x 1.0 Azimuth: 0.0° Slope: 90.0° (5021)

Assumptions for shadow calculations

Sunshine probability S/S0 (Sun hours/Possible sun hours) []

Reference year for calendar

2023

Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec
0.52 0.54 0.59 0.57 0.60 0.64 0.74 0.71 0.63 0.51 0.39 0.39

Operational time

N NNE NE ENE E ESE SE SSE S SSW SW WSW W WNW NW NNW Sum
364 231 235 234 299 398 720 587 362 314 482 477 675 931 686 429 7,424

Table with columns for months (January to December) and rows for each day of the month, showing sun rise and set times, and a summary section for potential sun hours and various reductions.

Table layout: For each day in each month the following matrix apply

Day in month Sun rise (hh:mm) Sun set (hh:mm) First time (hh:mm) with flicker Last time (hh:mm) with flicker (WTG causing flicker first time) (WTG causing flicker last time)

Project:

Otter Tail Ashtabula III Wind

Description:

Barnes County, ND

Licensed user:

Epsilon Associates, Inc
3 Clock Tower Place, Suite 250
US-MAYNARD MA 01754
978 897 7100
Richard Lampeter / rlampeter@epsilonassociates.com
Calculated:
6/18/2023 2:05 PM/3.6.366

SHADOW - Calendar

Calculation: Points and Grid Shadow receptor: A169 - Shadow Receptor: 1.0 x 1.0 Azimuth: 0.0° Slope: 90.0° (5059)

Assumptions for shadow calculations

Sunshine probability S/S0 (Sun hours/Possible sun hours) []

Reference year for calendar

2023

Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec
0.52 0.54 0.59 0.57 0.60 0.64 0.74 0.71 0.63 0.51 0.39 0.39

Operational time

N NNE NE ENE E ESE SE SSE S SSW SW WSW W WNW NW NNW Sum
364 231 235 234 299 398 720 587 362 314 482 477 675 931 686 429 7,424

Calendar table with columns for months (January to December) and rows for days (1 to 31). Each cell contains sun rise and set times (hh:mm) and potential sun hours. Includes summary rows for 'Total, worst case', 'Sun reduction', 'Oper. time red.', 'Wind dir. red.', 'Total reduction', and 'Total, real'.

Table layout: For each day in each month the following matrix apply

Matrix with columns: Day in month, Sun rise (hh:mm), Sun set (hh:mm), First time (hh:mm) with flicker, Last time (hh:mm) with flicker, (WTG causing flicker first time), (WTG causing flicker last time)

SHADOW - Calendar

Calculation: Points and Grid Shadow receptor: A170 - Shadow Receptor: 1.0 x 1.0 Azimuth: 0.0° Slope: 90.0° (5060)

Assumptions for shadow calculations

Sunshine probability S/S0 (Sun hours/Possible sun hours) []

Reference year for calendar

2023

Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec
 0.52 0.54 0.59 0.57 0.60 0.64 0.74 0.71 0.63 0.51 0.39 0.39

Operational time

N NNE NE ENE E ESE SE SSE S SSW SW WSW W WNW NW NNW Sum
 364 231 235 234 299 398 720 587 362 314 482 477 675 931 686 429 7,424

	January	February	March	April	May	June
1	08:16 16:50	07:57 17:30	08:25 (103) 08:46 (103)	07:13 18:12	07:12 19:56	06:17 20:38
2	08:16 16:51	07:56 17:32	08:25 (103) 08:46 (103)	07:11 18:13	07:10 19:58	06:15 20:39
3	08:16 16:52	07:55 17:34	08:25 (103) 08:46 (103)	07:09 18:15	07:08 19:59	06:13 20:40
4	08:16 16:53	07:53 17:35	08:26 (103) 08:46 (103)	07:07 18:16	07:06 20:00	06:12 20:42
5	08:16 16:54	07:52 17:37	08:26 (103) 08:45 (103)	07:05 18:18	07:04 20:02	06:10 20:43
6	08:16 16:55	07:51 17:38	08:27 (103) 08:45 (103)	07:03 18:19	07:02 20:03	06:09 20:44
7	08:16 16:56	07:49 17:40	08:28 (103) 08:45 (103)	07:02 18:21	07:00 20:05	06:07 20:46
8	08:16 16:57	07:48 17:41	08:29 (103) 08:43 (103)	07:00 18:22	06:58 20:06	06:06 20:47
9	08:15 16:58	07:46 17:43	08:32 (103) 08:42 (103)	06:58 18:24	06:56 20:07	06:04 20:48
10	08:15 17:00	07:45 17:44	08:36 (103) 08:37 (103)	06:56 18:25	06:54 20:09	06:03 20:50
11	08:15 17:01	07:43 17:46	06:54 18:27	07:17 (105) 07:23 (105)	06:53 20:10	06:02 20:51
12	08:14 17:02	07:42 17:47	07:52 18:28	08:15 (105) 08:25 (105)	06:51 20:11	06:00 20:52
13	08:14 17:03	07:40 17:49	07:50 19:29	08:13 (105) 08:25 (105)	06:49 20:13	05:59 20:54
14	08:13 17:05	07:39 17:51	07:48 19:31	08:11 (105) 08:26 (105)	06:47 20:14	05:58 20:55
15	08:13 17:06	07:37 17:52	07:46 19:32	08:09 (105) 08:26 (105)	06:45 20:16	05:56 20:56
16	08:12 17:07	07:36 17:54	07:44 19:34	08:08 (105) 08:26 (105)	06:43 20:17	05:55 20:57
17	08:11 17:08	07:34 17:55	07:42 19:35	08:08 (105) 08:25 (105)	06:41 20:18	05:54 20:59
18	08:11 17:10	07:32 17:57	07:40 19:37	08:08 (105) 08:25 (105)	06:39 20:20	05:53 21:00
19	08:10 17:11	07:31 17:58	07:38 19:38	08:08 (105) 08:23 (105)	06:37 20:21	05:51 21:01
20	08:09 17:13	07:29 18:00	07:36 19:39	08:09 (105) 08:22 (105)	06:36 20:22	05:50 21:02
21	08:09 17:14	07:27 18:00	07:34 19:41	08:11 (105) 08:19 (105)	06:34 20:24	05:49 21:04
22	08:08 17:16	07:25 18:01	07:32 19:42	06:32 20:25	05:48 21:05	05:34 21:29
23	08:07 17:17	07:24 18:03	07:30 19:44	06:30 20:27	05:47 21:06	05:35 21:29
24	08:06 17:18	08:33 (103) 08:39 (103)	07:22 18:04	07:28 19:45	06:29 20:28	05:46 21:07
25	08:05 17:20	08:31 (103) 08:40 (103)	07:20 18:06	07:26 19:46	06:27 20:29	05:45 21:08
26	08:04 17:21	08:30 (103) 08:41 (103)	07:18 18:07	07:24 19:48	06:25 20:31	05:44 21:09
27	08:03 17:23	08:29 (103) 08:42 (103)	07:16 18:09	07:22 19:49	06:23 20:32	05:43 21:10
28	08:02 17:24	08:28 (103) 08:44 (103)	07:15 18:10	07:20 19:51	06:22 20:34	05:42 21:12
29	08:01 17:26	08:27 (103) 08:45 (103)	07:18 18:10	07:18 19:52	06:20 20:35	05:42 21:13
30	08:00 17:27	08:26 (103) 08:46 (103)	07:16 18:10	07:16 19:53	06:18 20:36	05:41 21:14
31	07:58 17:29	08:25 (103) 08:45 (103)	07:14 19:55	07:14 19:55	05:40 21:15	05:40 21:15
Potential sun hours	278	286	367	406	465	475
Total, worst case	113	162	148			
Sun reduction	0.52	0.54	0.59			
Oper. time red.	0.85	0.85	0.85			
Wind dir. red.	0.71	0.71	0.71			
Total reduction	0.31	0.33	0.36			
Total, real	36	53	53			

Table layout: For each day in each month the following matrix apply

Day in month	Sun rise (hh:mm)	Sun set (hh:mm)	Minutes with flicker	First time (hh:mm) with flicker	Last time (hh:mm) with flicker	(WTG causing flicker first time)	(WTG causing flicker last time)
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SHADOW - Calendar

Calculation: Points and Grid Shadow receptor: A170 - Shadow Receptor: 1.0 x 1.0 Azimuth: 0.0° Slope: 90.0° (5060)

Assumptions for shadow calculations

Sunshine probability S/S0 (Sun hours/Possible sun hours) []

Reference year for calendar

2023

Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec
 0.52 0.54 0.59 0.57 0.60 0.64 0.74 0.71 0.63 0.51 0.39 0.39

Operational time

N NNE NE ENE E ESE SE SSE S SSW SW WSW W WNW NW NNW Sum
 364 231 235 234 299 398 720 587 362 314 482 477 675 931 686 429 7,424

	July	August	September	October	November	December
1	05:38	06:07	06:47	07:27	07:51 (105)	08:11
	21:30	21:06	20:15	19:15	15 08:06 (105)	18:16
2	05:38	06:09	06:49	07:28	07:52 (105)	08:12
	21:29	21:05	20:13	19:13	12 08:04 (105)	18:14
3	05:39	06:10	06:50	07:30	07:54 (105)	08:14
	21:29	21:04	20:11	19:11	9 08:03 (105)	18:13
4	05:40	06:11	06:51	07:31	07:55 (105)	08:15
	21:29	21:02	20:09	19:09	6 08:01 (105)	18:11
5	05:40	06:12	06:53	07:32	07:17	12 09:12 (103)
	21:29	21:01	20:07	19:07	15 08:14 (103)	16:42
6	05:41	06:14	06:54	07:34	07:18	15 08:14 (103)
	21:28	20:59	20:05	19:05	17 08:14 (103)	16:41
7	05:42	06:15	06:55	07:35	07:20	17 08:14 (103)
	21:28	20:58	20:03	19:03	19 08:16 (103)	16:41
8	05:42	06:16	06:57	07:36	07:21	20 08:16 (103)
	21:28	20:56	20:01	19:01	20 08:16 (103)	16:41
9	05:43	06:17	06:58	07:38	07:23	20 08:16 (103)
	21:27	20:55	19:59	18:57	20 08:16 (103)	16:41
10	05:44	06:19	06:59	07:39	07:24	21 08:17 (103)
	21:27	20:53	19:57	18:55	21 08:17 (103)	16:41
11	05:45	06:20	07:00	07:41	07:26	21 08:17 (103)
	21:26	20:52	19:55	18:53	21 08:17 (103)	16:40
12	05:46	06:21	07:02	07:42	07:27	21 08:17 (103)
	21:26	20:50	19:53	18:51	21 08:17 (103)	16:40
13	05:47	06:23	07:03	07:43	07:29	21 08:17 (103)
	21:25	20:49	19:51	18:49	20 08:17 (103)	16:40
14	05:47	06:24	07:04	07:45	07:30	20 08:17 (103)
	21:24	20:47	19:49	18:47	19 08:17 (103)	16:41
15	05:48	06:25	07:06	07:46	07:32	19 08:17 (103)
	21:24	20:45	19:47	18:45	17 08:17 (103)	16:41
16	05:49	06:26	07:07	07:48	07:33	17 08:17 (103)
	21:23	20:44	19:45	18:44	15 08:16 (103)	16:41
17	05:50	06:28	07:08	07:49	07:35	15 08:16 (103)
	21:22	20:42	19:43	18:42	12 08:15 (103)	16:41
18	05:51	06:29	07:10	07:50	07:36	12 08:15 (103)
	21:21	20:40	19:41	18:40	10 08:14 (103)	16:41
19	05:52	06:30	07:11	07:52	07:37	10 08:14 (103)
	21:20	20:39	19:39	18:38	7 08:13 (103)	16:42
20	05:53	06:32	07:12	07:53	07:39	7 08:13 (103)
	21:20	20:37	19:37	18:36	4 08:12 (103)	16:42
21	05:55	06:33	07:14	07:55	07:40	4 08:12 (103)
	21:19	20:35	19:35	18:34	16:51	08:13
22	05:56	06:34	07:15	07:56	07:42	16:51
	21:18	20:33	19:33	18:33	07:42	08:13
23	05:57	06:36	07:16	07:58	07:43	16:50
	21:17	20:31	19:31	18:31	16:50	08:14
24	05:58	06:37	07:18	07:59	07:45	16:49
	21:16	20:30	19:29	8 07:56 (105)	07:45	16:49
25	05:59	06:38	07:19	07:53 (105)	08:01	08:14
	21:15	20:28	19:27	13 08:06 (105)	18:27	16:44
26	06:00	06:40	07:20	07:51 (105)	08:02	16:44
	21:14	20:26	19:25	15 08:06 (105)	18:26	08:15
27	06:01	06:41	07:22	07:51 (105)	08:04	16:45
	21:12	20:24	19:23	17 08:08 (105)	18:24	16:45
28	06:03	06:42	07:23	07:50 (105)	08:05	07:49
	21:11	20:22	19:21	17 08:07 (105)	18:22	16:46
29	06:04	06:43	07:24	07:49 (105)	08:06	16:45
	21:10	20:20	19:19	18 08:07 (105)	18:21	07:51
30	06:05	06:45	07:26	07:50 (105)	08:08	16:44
	21:09	20:18	19:17	17 08:07 (105)	18:19	07:52
31	06:06	06:46	07:27	08:09	16:44	08:16
	21:08	20:17	19:16	18:18	16:44	16:48
Potential sun hours	481	442	380	339	283	266
Total, worst case			105	42	278	
Sun reduction			0.63	0.51	0.39	
Oper. time red.			0.85	0.85	0.85	
Wind dir. red.			0.71	0.71	0.71	
Total reduction			0.38	0.31	0.24	
Total, real			40	13	66	

Table layout: For each day in each month the following matrix apply

Day in month	Sun rise (hh:mm)	Minutes with flicker	First time (hh:mm) with flicker	(WTG causing flicker first time)
	Sun set (hh:mm)		Last time (hh:mm) with flicker	(WTG causing flicker last time)

SHADOW - Calendar

Calculation: Points and Grid Shadow receptor: A171 - Shadow Receptor: 1.0 x 1.0 Azimuth: 0.0° Slope: 90.0° (5061)

Assumptions for shadow calculations

Reference year for calendar

2023

Sunshine probability S/S0 (Sun hours/Possible sun hours) []

Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec
 0.52 0.54 0.59 0.57 0.60 0.64 0.74 0.71 0.63 0.51 0.39 0.39

Operational time

N NNE NE ENE E ESE SE SSE S SSW SW WSW W WNW NW NNW Sum
 364 231 235 234 299 398 720 587 362 314 482 477 675 931 686 429 7,424

	January	February	March	April	May	June	July	August	September	October	November	December
1	08:16 16:50	16:05 (103) 17:30	07:57 24	16:32 (105) 18:12	07:13 19:56	06:17 20:38	05:39 21:30	05:38 21:06	06:07 20:15	06:47 19:15	07:27 18:16	08:11 16:43
2	08:16 16:51	16:06 (103) 17:32	07:56 23	16:33 (105) 18:13	07:11 19:57	06:15 20:39	05:39 21:16	05:38 21:29	06:08 21:05	06:49 20:13	07:28 19:13	08:12 18:14
3	08:16 16:52	16:07 (103) 17:33	07:55 22	16:33 (105) 18:15	07:09 19:59	06:13 20:40	05:38 21:17	05:39 21:29	06:10 21:03	06:50 20:11	07:30 19:11	08:14 18:13
4	08:16 16:53	16:08 (103) 17:35	07:53 19	16:35 (105) 18:16	07:07 20:00	06:12 20:42	05:38 21:18	05:39 21:29	06:11 21:02	06:51 20:09	07:31 19:09	08:15 18:11
5	08:16 16:54	16:09 (103) 17:37	07:52 17	16:36 (105) 18:18	07:05 20:02	06:10 20:43	05:37 21:19	05:40 21:29	06:12 21:01	06:53 20:07	07:32 19:07	08:16 17:10
6	08:16 16:55	16:11 (103) 17:39	07:51 13	16:38 (105) 18:19	07:03 20:03	06:09 20:44	05:37 21:20	05:41 21:28	06:13 20:59	06:54 20:05	07:34 19:05	08:18 17:08
7	08:16 16:56	16:13 (103) 17:40	07:49 8	16:40 (105) 18:21	07:01 20:04	06:07 20:46	05:36 21:21	05:42 21:28	06:15 20:58	06:55 20:03	07:35 19:03	08:20 17:07
8	08:16 16:57	16:15 (103) 17:41	07:48 7	16:42 (105) 18:22	07:00 20:06	06:06 20:47	05:36 21:22	05:42 21:28	06:16 20:56	06:56 20:01	07:36 19:01	08:21 17:06
9	08:15 16:58	16:16 (103) 17:43	07:46 6	16:44 (105) 18:24	06:58 20:07	06:04 20:48	05:35 21:22	05:43 21:27	06:17 20:55	06:58 19:59	07:38 18:57	08:23 17:04
10	08:15 16:59	16:17 (103) 17:44	07:45 5	16:45 (105) 18:25	06:56 20:09	06:03 20:50	05:35 21:23	05:44 21:27	06:19 20:53	06:59 19:57	07:39 18:55	08:24 17:03
11	08:15 17:01	16:18 (103) 17:46	07:43 4	16:46 (105) 18:26	06:54 20:10	06:03 20:51	05:35 21:24	05:45 21:26	06:20 20:52	07:00 19:55	07:41 18:53	08:25 17:02
12	08:14 17:02	16:19 (103) 17:47	07:42 3	16:47 (105) 18:27	06:52 20:11	06:00 20:52	05:34 21:24	05:46 21:26	06:21 20:50	07:02 19:53	07:42 18:51	08:26 17:00
13	08:14 17:03	16:20 (103) 17:48	07:41 2	16:48 (105) 18:28	06:51 20:12	06:00 20:53	05:34 21:25	05:46 21:25	06:22 20:48	07:03 19:51	07:43 18:49	08:27 16:59
14	08:13 17:04	16:21 (103) 17:49	07:39 1	16:49 (105) 18:29	06:49 20:13	05:59 20:54	05:34 21:25	05:46 21:25	06:22 20:48	07:03 19:51	07:43 18:49	08:27 16:59
15	08:13 17:06	16:22 (103) 17:50	07:37 0	16:50 (105) 18:30	06:47 20:14	05:57 20:55	05:34 21:26	05:47 21:24	06:24 20:47	07:04 19:49	07:45 18:47	08:28 16:58
16	08:12 17:07	16:23 (103) 17:51	07:35 0	16:51 (105) 18:31	06:46 20:15	05:56 20:56	05:34 21:26	05:48 21:24	06:25 20:45	07:06 19:47	07:46 18:45	08:29 16:57
17	08:11 17:08	16:24 (103) 17:52	07:33 0	16:52 (105) 18:32	06:45 20:16	05:55 20:57	05:34 21:27	05:49 21:23	06:26 20:44	07:07 19:45	07:48 18:43	08:30 16:56
18	08:11 17:10	16:25 (103) 17:53	07:31 0	16:53 (105) 18:33	06:44 20:17	05:54 20:58	05:34 21:28	05:50 21:22	06:28 20:42	07:08 19:43	07:49 18:42	08:31 16:54
19	08:10 17:11	16:26 (103) 17:54	07:29 0	16:54 (105) 18:34	06:43 20:18	05:53 20:59	05:34 21:29	05:51 21:22	06:30 20:42	07:11 19:43	07:50 18:42	08:32 16:53
20	08:09 17:13	16:27 (103) 17:55	07:27 0	16:55 (105) 18:35	06:42 20:19	05:52 21:00	05:34 21:30	05:52 21:21	06:30 20:49	07:11 19:41	07:52 18:40	08:33 16:53
21	08:08 17:14	16:28 (103) 17:56	07:25 0	16:56 (105) 18:36	06:41 20:20	05:51 21:01	05:34 21:31	05:52 21:20	06:30 20:38	07:11 19:39	07:52 18:38	08:34 16:52
22	08:08 17:15	16:29 (103) 17:57	07:23 0	16:57 (105) 18:37	06:40 20:21	05:50 21:02	05:34 21:32	05:56 21:19	06:30 20:36	07:12 19:37	07:53 18:36	08:35 16:51
23	08:07 17:17	16:30 (103) 17:58	07:21 0	16:58 (105) 18:38	06:39 20:22	05:49 21:03	05:34 21:33	05:57 21:18	06:30 20:33	07:16 19:33	07:58 18:33	08:36 16:50
24	08:06 17:18	16:31 (103) 17:59	07:19 0	16:59 (105) 18:39	06:38 20:23	05:48 21:04	05:34 21:34	05:58 21:17	06:37 20:31	07:18 19:31	07:59 18:31	08:37 16:49
25	08:05 17:20	16:32 (103) 18:00	07:17 0	17:00 (105) 18:40	06:37 20:24	05:47 21:05	05:34 21:35	05:59 21:16	06:38 20:30	07:19 19:29	08:01 18:29	08:38 16:48
26	08:04 17:21	16:33 (103) 18:01	07:15 0	17:01 (105) 18:41	06:36 20:25	05:46 21:06	05:34 21:36	05:59 21:16	06:38 20:28	07:19 19:27	08:01 18:27	08:39 16:47
27	08:03 17:22	16:34 (103) 18:02	07:13 0	17:02 (105) 18:42	06:35 20:26	05:45 21:07	05:34 21:37	05:59 21:16	06:39 20:26	07:19 19:25	08:01 18:26	08:40 16:46
28	08:02 17:23	16:35 (103) 18:03	07:11 0	17:03 (105) 18:43	06:34 20:27	05:44 21:08	05:34 21:38	05:59 21:16	06:39 20:24	07:19 19:23	08:01 18:24	08:41 16:46
29	08:01 17:24	16:36 (103) 18:04	07:09 0	17:04 (105) 18:44	06:33 20:28	05:43 21:09	05:34 21:39	05:59 21:16	06:39 20:22	07:19 19:21	08:01 18:22	08:42 16:45
30	07:59 17:25	16:37 (103) 18:05	07:07 0	17:05 (105) 18:45	06:32 20:29	05:42 21:10	05:34 21:40	05:59 21:16	06:39 20:20	07:19 19:19	08:01 18:21	08:43 16:44
31	07:58 17:29	16:38 (103) 18:06	07:05 0	17:06 (105) 18:46	06:31 20:30	05:41 21:11	05:34 21:41	05:59 21:16	06:39 20:18	07:19 19:17	08:01 18:19	08:44 16:44
Potential sun hours	278	286		367	406	465	475	481	442	380	339	283
Total, worst case	409	409	126								474	336
Sun reduction	0.52	0.52	0.54								0.39	0.39
Oper. time red.	0.85	0.85	0.85								0.85	0.85
Wind dir. red.	0.59	0.59	0.59								0.59	0.58
Total reduction	0.26	0.27									0.20	0.19
Total, real	107	34									93	65

Table layout: For each day in each month the following matrix apply

Day in month	Sun rise (hh:mm)	Sun set (hh:mm)	Minutes with flicker	First time (hh:mm) with flicker	Last time (hh:mm) with flicker	(WTG causing flicker first time)	(WTG causing flicker last time)
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SHADOW - Calendar

Calculation: Points and Grid Shadow receptor: A265 - Shadow Receptor: 1.0 x 1.0 Azimuth: 0.0° Slope: 90.0° (5155)

Assumptions for shadow calculations

Reference year for calendar

2023

Sunshine probability S/S0 (Sun hours/Possible sun hours) []

Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec
 0.52 0.54 0.59 0.57 0.60 0.64 0.74 0.71 0.63 0.51 0.39 0.39

Operational time

N NNE NE ENE E ESE SE SSE S SSW SW WSW W WNW NW NNW Sum
 364 231 235 234 299 398 720 587 362 314 482 477 675 931 686 429 7,424

	January	February	March	April	May	June
1	08:17 16:49	09:21 (113) 10:01 (113)	07:57 17:30	07:13 18:11	07:41 (86) 17:47 (83)	06:16 20:38
2	08:17 16:50	09:22 (113) 10:01 (113)	07:56 17:31	07:11 18:13	07:40 (86) 17:45 (83)	06:14 20:39
3	08:17 16:51	09:23 (113) 10:02 (113)	07:55 17:33	07:09 18:14	07:40 (86) 08:11 (86)	06:13 20:40
4	08:17 16:52	09:23 (113) 10:02 (113)	07:53 17:34	07:07 18:16	07:40 (86) 08:10 (86)	06:11 20:42
5	08:16 16:53	09:23 (113) 10:02 (113)	07:52 17:36	07:05 18:17	07:40 (86) 08:10 (86)	06:10 20:43
6	08:16 16:54	09:24 (113) 10:02 (113)	07:51 17:38	07:03 18:19	07:41 (86) 08:09 (86)	06:08 20:44
7	08:16 16:55	09:25 (113) 10:02 (113)	07:49 17:39	07:01 18:20	07:41 (86) 08:08 (86)	06:07 20:46
8	08:16 16:56	09:25 (113) 10:02 (113)	07:48 17:41	06:59 18:22	07:42 (86) 08:06 (86)	06:05 20:47
9	08:16 16:58	09:26 (113) 10:02 (113)	07:46 17:42	06:57 18:23	07:43 (86) 08:05 (86)	06:04 20:48
10	08:15 16:59	09:27 (113) 10:03 (113)	07:45 17:44	06:55 18:25	07:44 (86) 08:03 (86)	06:02 20:50
11	08:15 17:00	09:28 (113) 10:02 (113)	07:43 17:45	06:54 18:26	07:47 (86) 08:00 (86)	06:01 20:51
12	08:14 17:01	09:29 (113) 10:03 (113)	07:42 17:47	07:52 18:28	06:50 20:11	05:59 20:52
13	08:14 17:02	09:29 (113) 10:02 (113)	07:40 17:48	07:50 19:29	06:48 20:13	05:58 20:54
14	08:13 17:04	09:30 (113) 10:02 (113)	07:39 17:50	07:48 19:30	06:46 20:14	05:57 20:55
15	08:13 17:05	09:32 (113) 10:02 (113)	07:37 17:52	07:46 19:32	06:44 20:15	05:56 20:56
16	08:12 17:06	09:33 (113) 10:01 (113)	07:35 17:53	07:44 19:33	06:43 20:17	05:54 20:58
17	08:12 17:08	09:34 (113) 10:00 (113)	07:34 17:55	07:42 19:35	06:41 20:18	05:53 20:59
18	08:11 17:09	09:35 (113) 09:59 (113)	07:32 17:56	07:40 19:36	06:39 20:20	05:52 21:00
19	08:10 17:11	09:36 (113) 09:58 (113)	07:30 17:58	07:38 19:38	19:17 (101) 19:18 (101)	06:37 20:21
20	08:09 17:12	09:39 (113) 09:58 (113)	07:29 17:59	07:36 19:39	19:14 (101) 19:19 (101)	06:35 20:22
21	08:09 17:13	09:41 (113) 09:56 (113)	07:27 18:01	07:34 19:40	19:12 (101) 19:20 (101)	06:33 20:24
22	08:08 17:15	09:45 (113) 09:52 (113)	07:25 18:01	07:32 19:42	19:11 (101) 19:22 (101)	06:32 20:25
23	08:07 17:16	09:45 (113) 18:02	07:24 18:02	07:30 19:43	19:10 (101) 19:23 (101)	06:30 20:27
24	08:06 17:18	09:45 (113) 18:04	07:24 18:04	07:28 19:45	19:09 (101) 19:25 (101)	06:28 20:28
25	08:05 17:19	09:45 (113) 18:05	07:24 18:05	07:26 19:46	19:09 (101) 19:26 (101)	06:26 20:29
26	08:04 17:21	09:45 (113) 18:07	07:24 18:07	07:24 19:48	19:09 (101) 19:27 (101)	06:24 20:31
27	08:03 17:22	09:45 (113) 18:08	07:22 18:08	07:22 19:49	19:09 (101) 19:27 (101)	06:23 20:32
28	08:02 17:24	09:45 (113) 18:10	07:21 18:10	07:20 19:50	19:09 (101) 19:26 (101)	06:21 20:33
29	08:01 17:25	09:45 (113) 19:52	07:18 19:52	07:18 19:52	19:10 (101) 19:24 (101)	06:19 20:35
30	08:00 17:27	09:45 (113) 19:53	07:16 19:53	07:16 19:53	19:12 (101) 19:22 (101)	06:18 20:36
31	07:58 17:28	09:45 (113) 19:55	07:14 19:55	07:14 19:55	07:37 (116) 19:17 (101)	05:39 21:15
Potential sun hours	277	286	367	406	466	475
Total, worst case	684	271	460	347	166	
Sun reduction	0.52	0.54	0.59	0.57	0.60	
Oper. time red.	0.85	0.85	0.85	0.85	0.85	
Wind dir. red.	0.69	0.70	0.71	0.70	0.72	
Total reduction	0.30	0.32	0.35	0.34	0.37	
Total, real	207	87	163	117	61	

Table layout: For each day in each month the following matrix apply

Day in month	Sun rise (hh:mm)	First time (hh:mm) with flicker	(WTG causing flicker first time)
	Sun set (hh:mm)	Minutes with flicker	Last time (hh:mm) with flicker
			(WTG causing flicker last time)

SHADOW - Calendar

Calculation: Points and Grid Shadow receptor: A265 - Shadow Receptor: 1.0 x 1.0 Azimuth: 0.0° Slope: 90.0° (5155)

Assumptions for shadow calculations

Sunshine probability S/S0 (Sun hours/Possible sun hours) []

Reference year for calendar

2023

Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec
 0.52 0.54 0.59 0.57 0.60 0.64 0.74 0.71 0.63 0.51 0.39 0.39

Operational time

N NNE NE ENE E ESE SE SSE S SSW SW WSW W WNW NW NNW Sum
 364 231 235 234 299 398 720 587 362 314 482 477 675 931 686 429 7,424

	July	August	September	October	November	December
1	05:37 21:30	06:07 21:06	06:47 20:14	07:22 (116) 19:14	08:11 18:15	07:54 16:43
2	05:37 21:30	06:08 21:05	06:48 20:13	07:20 (116) 19:12	08:12 18:14	07:55 16:42
3	05:38 21:29	06:09 21:04	06:50 20:11	07:20 (116) 19:10	08:14 18:12	07:56 16:42
4	05:39 21:29	06:10 21:02	06:51 20:09	07:18 (116) 19:08	08:15 18:11	07:57 16:41
5	05:39 21:29	06:12 21:01	20:10 (85) 20:07	06:52 20:07	07:17 (116) 19:06	07:32 17:09
6	05:40 21:29	06:13 20:59	20:17 (85) 20:05	20:07 20:05	23 07:40 (116) 19:04	19 08:40 (86) 17:08
7	05:41 21:28	06:14 20:58	20:19 (85) 20:03	20:05 20:03	22 07:40 (116) 19:02	22 08:42 (86) 17:06
8	05:42 21:28	06:15 20:56	20:21 (85) 20:01	20:03 20:01	20 07:40 (116) 19:00	24 08:42 (86) 17:05
9	05:42 21:27	06:17 20:55	20:04 (85) 20:22 (85)	06:56 19:59	18 07:39 (116) 18:56	27 08:44 (86) 17:04
10	05:43 21:27	06:18 20:53	20:02 (85) 20:23 (85)	06:59 19:57	16 07:38 (116) 18:54	28 08:44 (86) 17:02
11	05:43 21:26	06:18 20:52	20:02 (85) 20:23 (85)	06:59 19:55	14 07:37 (116) 18:53	30 08:45 (86) 17:01
12	05:44 21:26	06:19 20:52	20:02 (85) 20:23 (85)	07:00 19:53	12 07:37 (116) 18:53	31 08:45 (86) 17:01
13	05:44 21:26	06:21 20:50	20:01 (85) 20:23 (85)	07:01 19:53	9 07:35 (116) 18:51	31 08:44 (86) 17:00
14	05:44 21:25	06:22 20:49	20:00 (85) 20:23 (85)	07:03 19:51	9 07:27 (116) 18:49	31 08:14 (86) 16:59
15	05:47 21:25	06:23 20:47	20:01 (85) 20:23 (85)	07:04 19:49	6 07:28 (116) 18:47	39 18:18 (83) 16:57
16	05:47 21:24	06:23 20:45	20:01 (85) 20:21 (85)	07:04 19:47	7 19:10 (101) 18:45	43 08:13 (86) 16:56
17	05:48 21:24	06:25 20:45	20:00 (85) 20:21 (85)	07:05 19:47	11 19:02 (101) 18:45	45 08:13 (86) 16:56
18	05:49 21:23	06:26 20:44	20:00 (85) 20:19 (85)	07:07 19:45	15 18:59 (101) 18:43	45 08:13 (86) 16:55
19	05:50 21:22	06:27 20:42	20:00 (85) 20:17 (85)	07:08 19:43	15 19:14 (101) 18:43	45 08:14 (86) 16:55
20	05:51 21:21	06:28 20:40	20:00 (85) 20:16 (85)	07:09 19:41	17 19:15 (101) 18:41	42 08:18 (83) 16:54
21	05:51 21:21	06:28 20:40	20:01 (85) 20:16 (85)	07:09 19:41	17 18:57 (101) 18:39	42 08:15 (86) 16:53
22	05:52 21:21	06:30 20:38	20:01 (85) 20:14 (85)	07:11 19:39	19 18:56 (101) 18:38	38 08:17 (86) 16:52
23	05:52 21:21	06:30 20:38	20:01 (85) 20:14 (85)	07:11 19:39	19 18:56 (101) 18:38	38 08:17 (86) 16:52
24	05:53 21:20	06:31 20:37	20:02 (85) 20:12 (85)	07:12 19:37	19 18:55 (101) 18:36	35 08:18 (86) 16:51
25	05:54 21:19	06:32 20:35	20:02 (85) 20:10 (85)	07:13 19:35	17 19:12 (101) 18:36	29 18:12 (83) 16:51
26	05:54 21:19	06:32 20:35	20:03 (85) 20:10 (85)	07:13 19:35	17 18:56 (101) 18:36	29 18:12 (83) 16:51
27	05:55 21:18	06:34 20:33	20:05 (85) 20:09 (85)	07:15 19:33	14 18:55 (101) 18:32	17 08:21 (86) 16:49
28	05:55 21:18	06:34 20:33	20:05 (85) 20:09 (85)	07:15 19:33	14 18:55 (101) 18:32	17 08:21 (86) 16:49
29	05:56 21:17	06:35 20:31	07:16 19:30	18:55 (101) 18:30	9 08:23 (86) 16:48	11 09:19 (113) 16:42
30	05:57 21:16	06:36 20:30	07:17 19:28	18:56 (101) 18:29	16 09:32 (113) 16:43	16 09:32 (113) 16:43
31	05:58 21:15	06:38 20:28	07:19 19:26	18:58 (101) 18:27	20 09:35 (113) 16:43	20 09:35 (113) 16:43
Potential sun hours	482	443	380	339	282	266
Total, worst case		304	374	590	214	1204
Sun reduction		0.71	0.63	0.51	0.39	0.39
Oper. time red.		0.85	0.85	0.85	0.85	0.85
Wind dir. red.		0.72	0.69	0.71	0.69	0.69
Total reduction		0.43	0.37	0.31	0.23	0.23
Total, real		131	138	181	49	274

Table layout: For each day in each month the following matrix apply

Day in month	Sun rise (hh:mm)	First time (hh:mm) with flicker	(WTG causing flicker first time)
	Sun set (hh:mm)	Last time (hh:mm) with flicker	(WTG causing flicker last time)
	Minutes with flicker		

SHADOW - Calendar

Calculation: Points and Grid Shadow receptor: A267 - Shadow Receptor: 1.0 x 1.0 Azimuth: 0.0° Slope: 90.0° (5157)

Assumptions for shadow calculations

Reference year for calendar

2023

Sunshine probability S/S0 (Sun hours/Possible sun hours) []

Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec
 0.52 0.54 0.59 0.57 0.60 0.64 0.74 0.71 0.63 0.51 0.39 0.39

Operational time

N NNE NE ENE E ESE SE SSE S SSW SW WSW W WNW NW NNW Sum
 364 231 235 234 299 398 720 587 362 314 482 477 675 931 686 429 7,424

	January	February	March	April	May	June			
1	08:17	08:46 (98)	07:57	07:13	07:12	07:42 (83)	06:16	05:39	
	16:49	9 08:55 (98)	17:30	18:12		19:56	16 07:58 (83)	20:38	
2	08:17	08:46 (98)	07:56	07:11	07:35 (84)	07:10	07:43 (83)	06:15	05:38
	16:50	9 08:55 (98)	17:32	18:13	2 07:37 (84)	19:57	13 07:56 (83)	20:39	21:17
3	08:17	08:46 (98)	07:55	07:09	07:33 (84)	07:08	07:44 (83)	06:13	05:38
	16:51	10 08:56 (98)	17:33	18:15	4 07:37 (84)	19:59	10 07:54 (83)	20:40	21:18
4	08:17	08:46 (98)	07:53	07:07	07:31 (84)	07:06		06:11	05:37
	16:52	11 08:57 (98)	17:35	18:16	6 07:37 (84)	20:00		20:42	21:19
5	08:17	08:45 (98)	07:52	07:05	07:29 (84)	07:04		06:10	05:36
	16:53	11 08:56 (98)	17:36	18:17	7 07:36 (84)	20:02		20:43	21:20
6	08:16	08:45 (98)	07:51	07:03	07:27 (84)	07:02		06:08	05:36
	16:54	12 08:57 (98)	17:38	18:19	8 07:35 (84)	20:03		20:45	21:20
7	08:16	08:45 (98)	07:49	07:01	07:30 (84)	07:00		06:07	05:35
	16:55	13 08:58 (98)	17:39	18:20	1 07:31 (84)	20:04		20:46	21:21
8	08:16	08:45 (98)	07:48	06:59		06:58		06:05	05:35
	16:57	13 08:58 (98)	17:41	18:22		20:06		20:47	21:22
9	08:16	08:44 (98)	07:46	06:58		06:56		06:04	05:35
	16:58	14 08:58 (98)	17:42	18:23		20:07	1 06:29 (85)	06:30 (85)	21:23
10	08:15	08:44 (98)	07:45	06:56		06:54		06:02	05:34
	16:59	15 08:59 (98)	17:44	18:25		20:09	3 06:31 (85)	06:28 (85)	21:23
11	08:15	08:44 (98)	07:43	06:54		06:52		06:01	05:34
	17:00	14 08:58 (98)	17:45	18:26		20:10	4 06:30 (85)	06:26 (85)	21:24
12	08:15	08:46 (98)	07:42	07:52		06:50		06:00	05:34
	17:01	13 08:59 (98)	17:47	18:28		20:11	6 06:31 (85)	06:25 (85)	21:25
13	08:14	08:46 (98)	07:40	07:50		06:48		05:58	05:34
	17:03	12 08:58 (98)	17:49	19:29		20:13	7 06:31 (85)	06:24 (85)	21:25
14	08:14	08:47 (98)	07:39	07:48		06:46		05:57	05:33
	17:04	10 08:57 (98)	17:50	19:31		20:14	8 06:22 (85)	06:22 (85)	21:26
15	08:13	08:49 (98)	07:37	07:46		06:45		05:56	05:33
	17:05	8 08:57 (98)	17:52	19:32		20:16	9 06:30 (85)	06:21 (85)	21:27
16	08:12	08:50 (98)	07:36	07:44		06:43		05:54	05:33
	17:07	6 08:56 (98)	17:53	19:33		20:17	9 06:29 (85)	06:20 (85)	21:27
17	08:12		07:34	07:42		06:41		05:53	05:33
	17:08		17:55	19:35		20:18	8 06:28 (85)	06:20 (85)	21:28
18	08:11		07:32	07:40		06:39		05:52	05:33
	17:09		17:56	19:36		20:20	6 06:27 (85)	06:21 (85)	21:28
19	08:10		07:31	07:38		06:37		05:51	05:33
	17:11		17:58	19:38		20:21		06:27 (85)	21:28
20	08:10		07:29	07:36		06:35		05:50	05:33
	17:12		17:59	19:39		20:23	4 06:59 (101)	06:20 (85)	21:29
21	08:09		07:27	07:34		06:33		05:49	05:34
	17:14		18:01	19:41		20:24	6 07:03 (101)	06:57 (101)	21:29
22	08:08		07:25	07:32		06:32		05:47	05:34
	17:15		18:01	19:42		20:25	8 07:03 (101)	06:55 (101)	21:29
23	08:07		07:24	07:30		06:30		05:46	05:34
	17:16		18:02	19:43		20:27	10 07:04 (101)	06:54 (101)	21:30
24	08:06		07:22	07:28	07:51 (83)	06:28		05:45	05:34
	17:18		18:04	19:45	6 07:57 (83)	20:28	12 07:04 (101)	06:52 (101)	21:30
25	08:05		07:20	07:26	07:49 (83)	06:26		05:44	05:34
	17:19		18:06	19:46	10 07:59 (83)	20:29	13 07:03 (101)	06:50 (101)	21:30
26	08:04		07:18	07:24	07:47 (83)	06:25		05:43	05:35
	17:21		18:07	19:48	13 08:00 (83)	20:31	14 07:03 (101)	06:49 (101)	21:30
27	08:03		07:16	07:22	07:45 (83)	06:23		05:42	05:35
	17:22		18:09	19:49	15 08:00 (83)	20:32	13 07:02 (101)	06:49 (101)	21:30
28	08:02		07:15	07:20	07:43 (83)	06:21		05:41	05:36
	17:24		18:10	19:50	17 08:00 (83)	20:34	11 07:00 (101)	06:49 (101)	21:30
29	08:01			07:18	07:42 (83)	06:19		05:40	05:36
	17:25			19:52	18 08:00 (83)	20:35	8 06:51 (101)	06:59 (101)	21:30
30	08:00			07:16	07:41 (83)	06:18		05:40	05:37
	17:27			19:53	19 08:00 (83)	20:36		21:14	21:30
31	07:58			07:14	07:42 (83)			05:40	
	17:28			19:55	17 07:59 (83)			21:15	
Potential sun hours	277	286	367	406		466		475	
Total, worst case	180			143		138		61	
Sun reduction	0.52			0.59		0.57		0.60	
Oper. time red.	0.85			0.85		0.85		0.85	
Wind dir. red.	0.71			0.71		0.67		0.64	
Total reduction	0.31			0.35		0.33		0.33	
Total, real	56			51		45		20	

Table layout: For each day in each month the following matrix apply

Day in month	Sun rise (hh:mm)	Sun set (hh:mm)	Minutes with flicker	First time (hh:mm) with flicker	Last time (hh:mm) with flicker	(WTG causing flicker first time)	(WTG causing flicker last time)
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Project:

Otter Tail Ashtabula III Wind

Description:

Barnes County, ND

Licensed user:

Epsilon Associates, Inc
3 Clock Tower Place, Suite 250
US-MAYNARD MA 01754
978 897 7100
Richard Lampeter / rlampeter@epsilonassociates.com
Calculated:
6/18/2023 2:05 PM/3.6.366

SHADOW - Calendar

Calculation: Points and Grid Shadow receptor: A267 - Shadow Receptor: 1.0 x 1.0 Azimuth: 0.0° Slope: 90.0° (5157)

Assumptions for shadow calculations

Sunshine probability S/S0 (Sun hours/Possible sun hours) []

Reference year for calendar

2023

Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec
0.52 0.54 0.59 0.57 0.60 0.64 0.74 0.71 0.63 0.51 0.39 0.39

Operational time

N NNE NE ENE E ESE SE SSE S SSW SW WSW W WNW NW NNW Sum
364 231 235 234 299 398 720 587 362 314 482 477 675 931 686 429 7,424

Table with columns for months (July-December) and rows for days (1-31) showing sun rise/set times, shadow reduction percentages, and operational time. Includes summary rows for potential sun hours and various reduction factors.

Table layout: For each day in each month the following matrix apply

Matrix with columns: Day in month, Sun rise (hh:mm), Sun set (hh:mm), Minutes with flicker, First time (hh:mm) with flicker, Last time (hh:mm) with flicker, (WTG causing flicker first time), (WTG causing flicker last time)

SHADOW - Calendar

Calculation: Points and Grid Shadow receptor: A268 - Shadow Receptor: 1.0 x 1.0 Azimuth: 0.0° Slope: 90.0° (5158)

Assumptions for shadow calculations

Reference year for calendar

2023

Sunshine probability S/S0 (Sun hours/Possible sun hours) []

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
0.52	0.54	0.59	0.57	0.60	0.64	0.74	0.71	0.63	0.51	0.39	0.39

Operational time

N	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW	Sum
364	231	235	234	299	398	720	587	362	314	482	477	675	931	686	429	7,424

	January	February	March	April	May	June
1	08:17 16:49	08:54 (98) 09:26 (98)	07:57 17:30	09:04 (98) 09:35 (98)	07:13 18:12	07:12 19:56
2	08:17 16:50	08:54 (98) 09:27 (98)	07:56 17:31	09:06 (98) 09:35 (98)	07:11 18:13	07:10 19:57
3	08:17 16:51	08:55 (98) 09:28 (98)	07:55 17:33	09:07 (98) 09:33 (98)	07:09 18:14	07:08 19:59
4	08:17 16:52	08:55 (98) 09:29 (98)	07:53 17:35	09:09 (98) 09:32 (98)	07:07 18:16	07:06 20:00
5	08:16 16:53	08:54 (98) 09:28 (98)	07:52 17:36	09:11 (98) 09:30 (98)	07:05 18:17	07:04 20:02
6	08:16 16:54	08:55 (98) 09:29 (98)	07:51 17:38	09:13 (98) 09:27 (98)	07:03 18:19	07:02 20:03
7	08:16 16:55	08:55 (98) 09:30 (98)	07:49 17:39	09:20 (98) 09:22 (98)	07:01 18:20	07:00 20:04
8	08:16 16:57	08:55 (98) 09:30 (98)	07:48 17:41	06:59 18:22	06:58 20:06	07:21 (84) 20:07
9	08:16 16:58	08:55 (98) 09:32 (98)	07:46 17:42	06:58 18:23	06:56 20:07	07:20 (84) 20:48
10	08:15 16:59	08:56 (98) 09:33 (98)	07:45 17:44	06:56 18:25	06:54 20:09	07:20 (84) 20:50
11	08:15 17:00	08:55 (98) 09:33 (98)	07:43 17:45	06:54 18:26	06:52 20:10	07:20 (84) 20:51
12	08:14 17:01	08:56 (98) 09:34 (98)	07:42 17:47	07:52 18:28	06:50 20:11	07:21 (84) 20:52
13	08:14 17:03	08:56 (98) 09:34 (98)	07:40 17:49	07:50 19:29	06:48 20:13	07:22 (84) 20:54
14	08:13 17:04	08:56 (98) 09:34 (98)	07:39 17:50	07:48 19:31	06:46 20:14	07:23 (84) 20:55
15	08:13 17:05	08:57 (98) 09:36 (98)	07:37 17:52	07:46 19:32	06:45 20:16	05:56 20:56
16	08:12 17:07	08:56 (98) 09:36 (98)	07:36 17:53	07:44 19:33	06:43 20:17	05:54 20:58
17	08:12 17:08	08:56 (98) 09:36 (98)	07:34 17:55	07:42 19:35	06:41 20:18	07:04 (115) 20:59
18	08:11 17:09	08:56 (98) 09:36 (98)	07:32 17:56	07:40 19:36	06:39 20:20	07:02 (115) 21:00
19	08:10 17:11	08:58 (98) 09:38 (98)	07:31 17:58	07:38 19:38	06:37 20:21	07:01 (115) 21:01
20	08:09 17:12	08:58 (98) 09:38 (98)	07:29 17:59	07:36 19:39	06:35 20:22	06:59 (115) 21:03
21	08:09 17:13	08:58 (98) 09:38 (98)	07:27 18:01	07:34 19:41	06:33 20:24	06:57 (115) 21:04
22	08:08 17:15	08:58 (98) 09:38 (98)	07:25 18:01	07:32 19:42	06:32 20:25	06:55 (115) 21:05
23	08:07 17:16	08:59 (98) 09:38 (98)	07:24 18:02	07:30 19:43	06:30 20:27	06:54 (115) 21:06
24	08:06 17:18	08:59 (98) 09:38 (98)	07:22 18:04	07:28 19:45	06:28 20:28	06:55 (115) 21:07
25	08:05 17:19	09:00 (98) 09:38 (98)	07:20 18:05	07:26 19:46	06:26 20:29	06:55 (115) 21:08
26	08:04 17:21	09:00 (98) 09:39 (98)	07:18 18:07	07:24 19:48	06:25 20:31	06:58 (115) 21:10
27	08:03 17:22	09:00 (98) 09:38 (98)	07:16 18:09	07:22 19:49	06:23 20:32	05:43 21:11
28	08:02 17:24	09:01 (98) 09:37 (98)	07:15 18:10	07:20 19:50	06:21 20:34	06:45 (81) 21:12
29	08:01 17:25	09:02 (98) 09:37 (98)		07:18 19:52	06:19 20:35	06:44 (81) 21:13
30	08:00 17:27	09:03 (98) 09:37 (98)		07:16 19:53	06:18 20:36	06:42 (81) 21:14
31	07:58 17:28	09:03 (98) 09:36 (98)		07:14 19:55	05:39 21:15	05:39 21:15
Potential sun hours	277	286	367	406	466	475
Total, worst case	1146	144		268		47
Sun reduction	0.52	0.54		0.57		0.60
Oper. time red.	0.85	0.85		0.85		0.85
Wind dir. red.	0.71	0.71		0.68		0.65
Total reduction	0.31	0.32		0.33		0.33
Total, real	358	47		88		16

Table layout: For each day in each month the following matrix apply

Day in month	Sun rise (hh:mm)	Minutes with flicker	First time (hh:mm) with flicker	Last time (hh:mm) with flicker	(WTG causing flicker first time)	(WTG causing flicker last time)
	Sun set (hh:mm)					

Project:

Otter Tail Ashtabula III Wind

Description:

Barnes County, ND

Licensed user:

Epsilon Associates, Inc
3 Clock Tower Place, Suite 250
US-MAYNARD MA 01754
978 897 7100
Richard Lampeter / rlampeter@epsilonassociates.com
Calculated:
6/18/2023 2:05 PM/3.6.366

SHADOW - Calendar

Calculation: Points and Grid Shadow receptor: A268 - Shadow Receptor: 1.0 x 1.0 Azimuth: 0.0° Slope: 90.0° (5158)

Assumptions for shadow calculations

Sunshine probability S/S0 (Sun hours/Possible sun hours) []

Reference year for calendar

2023

Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec
0.52 0.54 0.59 0.57 0.60 0.64 0.74 0.71 0.63 0.51 0.39 0.39

Operational time

N NNE NE ENE E ESE SE SSE S SSW SW WSW W WNW NW NNW Sum
364 231 235 234 299 398 720 587 362 314 482 477 675 931 686 429 7,424

Table with columns for months (July-December) and rows for each day of the month, showing sun rise/set times, potential sun hours, and reduction factors.

Table layout: For each day in each month the following matrix apply

Matrix with columns: Day in month, Sun rise (hh:mm), Sun set (hh:mm), Minutes with flicker, First time (hh:mm) with flicker, Last time (hh:mm) with flicker, (WTG causing flicker first time), (WTG causing flicker last time)

SHADOW - Calendar

Calculation: Points and Grid Shadow receptor: A269 - Shadow Receptor: 1.0 x 1.0 Azimuth: 0.0° Slope: 90.0° (5159)

Assumptions for shadow calculations

Sunshine probability S/S0 (Sun hours/Possible sun hours) []

Reference year for calendar

2023

Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec
 0.52 0.54 0.59 0.57 0.60 0.64 0.74 0.71 0.63 0.51 0.39 0.39

Operational time

N NNE NE ENE E ESE SE SSE S SSW SW WSW W WNW NW NNW Sum
 364 231 235 234 299 398 720 587 362 314 482 477 675 931 686 429 7,424

	January	February	March	April	May	June
1	08:17 16:49	08:55 (87) 09:27 (87)	07:57 17:30	08:57 (87) 17:05 (82)	07:13 18:12	07:37 (97) 19:56
2	08:17 16:50	08:55 (87) 09:28 (87)	07:56 17:32	08:58 (87) 17:07 (82)	07:11 18:13	07:35 (97) 19:57
3	08:17 16:51	08:55 (87) 09:29 (87)	07:55 17:33	08:58 (87) 17:08 (82)	07:09 18:15	07:33 (97) 19:59
4	08:16 16:52	08:54 (87) 09:29 (87)	07:53 17:35	08:59 (87) 17:10 (82)	07:07 18:16	07:31 (97) 20:00
5	08:16 16:53	08:54 (87) 09:30 (87)	07:52 17:36	09:00 (87) 17:12 (82)	07:05 18:17	07:31 (97) 20:02
6	08:16 16:54	08:55 (87) 09:31 (87)	07:51 17:38	09:01 (87) 17:13 (82)	07:03 18:19	07:32 (97) 20:03
7	08:16 16:55	08:55 (87) 09:32 (87)	07:49 17:39	08:15 (94) 17:16 (82)	07:01 18:20	07:33 (97) 20:04
8	08:16 16:57	08:54 (87) 09:32 (87)	07:48 17:41	08:13 (94) 17:17 (82)	06:59 18:22	07:36 (97) 20:06
9	08:16 16:58	08:55 (87) 09:34 (87)	07:46 17:42	08:12 (94) 17:18 (82)	06:57 18:23	07:35 (97) 20:07
10	08:15 16:59	08:55 (87) 09:35 (87)	07:45 17:44	08:10 (94) 17:17 (82)	06:56 18:25	07:34 (97) 20:09
11	08:15 17:00	08:55 (87) 09:35 (87)	07:43 17:45	08:08 (94) 17:17 (82)	06:54 18:26	17:20 (107) 20:10
12	08:14 17:01	08:54 (87) 09:36 (87)	07:42 17:47	08:07 (94) 17:17 (82)	07:52 18:28	18:21 (107) 20:11
13	08:14 17:03	08:55 (87) 09:37 (87)	07:40 17:49	08:05 (94) 17:16 (82)	07:50 19:29	18:22 (107) 20:13
14	08:13 17:04	08:54 (87) 09:37 (87)	07:39 17:50	08:05 (94) 17:15 (82)	07:48 19:31	18:24 (107) 20:14
15	08:13 17:05	08:55 (87) 09:39 (87)	07:37 17:52	08:05 (94) 17:14 (82)	07:46 19:32	18:26 (107) 20:15
16	08:12 17:07	08:55 (87) 09:39 (87)	07:35 17:53	08:04 (94) 17:11 (82)	07:44 19:33	18:30 (107) 20:17
17	08:12 17:08	08:54 (87) 09:40 (87)	07:34 17:55	08:04 (94) 17:07 (82)	07:42 19:35	18:37 (107) 20:18
18	08:11 17:09	08:54 (87) 09:40 (87)	07:32 17:56	08:05 (94) 08:32 (94)	07:40 19:36	06:39 20:20
19	08:10 17:11	08:54 (87) 09:40 (87)	07:30 17:58	08:05 (94) 08:32 (94)	07:38 19:38	08:01 (93) 20:21
20	08:09 17:12	08:55 (87) 09:42 (87)	07:29 17:59	08:05 (94) 08:31 (94)	07:36 19:39	07:59 (93) 20:22
21	08:09 17:14	08:55 (87) 09:42 (87)	07:27 18:01	08:05 (94) 08:30 (94)	07:34 19:41	07:57 (93) 20:24
22	08:08 17:15	08:55 (87) 09:43 (87)	07:25 18:01	08:07 (94) 08:30 (94)	07:32 19:42	07:55 (93) 20:25
23	08:07 17:16	08:55 (87) 09:43 (87)	07:24 18:02	08:08 (94) 17:42 (107)	07:30 19:43	07:53 (93) 20:27
24	08:06 17:18	08:55 (87) 09:44 (87)	07:22 18:04	08:09 (94) 17:43 (107)	07:28 19:45	07:51 (93) 20:28
25	08:05 17:19	08:56 (87) 09:44 (87)	07:20 18:06	07:44 (97) 17:45 (107)	07:26 19:46	07:49 (106) 20:29
26	08:04 17:21	08:55 (87) 09:43 (87)	07:18 18:07	07:42 (97) 17:46 (107)	07:24 19:48	07:47 (106) 20:31
27	08:03 17:22	08:55 (87) 09:44 (87)	07:16 18:09	07:40 (97) 17:47 (107)	07:22 19:49	07:45 (106) 20:32
28	08:02 17:24	08:56 (87) 09:44 (87)	07:15 18:10	07:39 (97) 17:50 (107)	07:20 19:50	07:43 (106) 20:34
29	08:01 17:25	08:56 (87) 09:44 (87)		07:18 19:52	07:18 19:52	07:41 (106) 20:35
30	08:00 17:27	08:57 (87) 17:02 (82)		07:16 19:53	07:16 20:36	06:18 21:14
31	07:58 17:28	08:57 (87) 17:03 (82)		07:14 19:55	07:14 19:55	05:40 21:15
Potential sun hours	277	286	367	406	466	475
Total, worst case	1338	1353	630			
Sun reduction	0.52	0.54	0.59			
Oper. time red.	0.85	0.85	0.85			
Wind dir. red.	0.71	0.69	0.67			
Total reduction	0.31	0.32	0.34			
Total, real	417	426	213			

Table layout: For each day in each month the following matrix apply

Day in month	Sun rise (hh:mm)	Minutes with flicker	First time (hh:mm) with flicker	Last time (hh:mm) with flicker	(WTG causing flicker first time)	(WTG causing flicker last time)
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Project:

Otter Tail Ashtabula III Wind

Description:

Barnes County, ND

Licensed user:

Epsilon Associates, Inc
3 Clock Tower Place, Suite 250
US-MAYNARD MA 01754
978 897 7100

Richard Lampeter / rlampeter@epsilonassociates.com

Calculated:

6/18/2023 2:05 PM/3.6.366

SHADOW - Calendar

Calculation: Points and Grid Shadow receptor: A269 - Shadow Receptor: 1.0 x 1.0 Azimuth: 0.0° Slope: 90.0° (5159)

Assumptions for shadow calculations

Sunshine probability S/S0 (Sun hours/Possible sun hours) []

Reference year for calendar

2023

Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec
0.52 0.54 0.59 0.57 0.60 0.64 0.74 0.71 0.63 0.51 0.39 0.39

Operational time

N NNE NE ENE E ESE SE SSE S SSW SW WSW W WNW NW NNW Sum
364 231 235 234 299 398 720 587 362 314 482 477 675 931 686 429 7,424

Table with columns for months (July-December) and rows for each day of the month, showing sun rise/set times, potential sun hours, and reduction factors.

Table layout: For each day in each month the following matrix apply

Matrix with columns: Day in month, Sun rise (hh:mm), Sun set (hh:mm), Minutes with flicker, First time (hh:mm) with flicker, Last time (hh:mm) with flicker, (WTG causing flicker first time), (WTG causing flicker last time)

Project: Otter Tail Ashtabula III Wind

Description: Barnes County, ND

Licensed user: Epsilon Associates, Inc
3 Clock Tower Place, Suite 250
US-MAYNARD MA 01754
978 897 7100
Richard Lampeter / rlampeter@epsilonassociates.com
Calculated: 6/18/2023 2:05 PM/3.6.366

SHADOW - Calendar

Calculation: Points and Grid Shadow receptor: A270 - Shadow Receptor: 1.0 x 1.0 Azimuth: 0.0° Slope: 90.0° (5160)

Assumptions for shadow calculations

Sunshine probability S/S0 (Sun hours/Possible sun hours) []

Reference year for calendar

2023

Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec
0.52 0.54 0.59 0.57 0.60 0.64 0.74 0.71 0.63 0.51 0.39 0.39

Operational time

N NNE NE ENE E ESE SE SSE S SSW SW WSW W WNW NW NNW Sum
364 231 235 234 299 398 720 587 362 314 482 477 675 931 686 429 7,424

Table with 13 columns for months (January-December) and rows for each day of the year (1-31). Columns contain start and end times for shadow calculations. Summary rows at the bottom show total sun hours and various reduction factors.

Table layout: For each day in each month the following matrix apply

Day in month Sun rise (hh:mm) Sun set (hh:mm) First time (hh:mm) with flicker Last time (hh:mm) with flicker (WTG causing flicker first time) (WTG causing flicker last time)

SHADOW - Calendar

Calculation: Points and Grid Shadow receptor: A272 - Shadow Receptor: 1.0 x 1.0 Azimuth: 0.0° Slope: 90.0° (5162)

Assumptions for shadow calculations

Reference year for calendar

2023

Sunshine probability S/S0 (Sun hours/Possible sun hours) []

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
0.52	0.54	0.59	0.57	0.60	0.64	0.74	0.71	0.63	0.51	0.39	0.39

Operational time

N	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW	Sum
364	231	235	234	299	398	720	587	362	314	482	477	675	931	686	429	7,424

	January	February	March	April	May	June
1	08:16 16:50	07:57 17:30	07:13 18:12	07:12 19:56	19:23 (104) 19:28 (104)	06:17 20:38
2	08:16 16:51	07:56 17:32	07:11 18:13	07:10 19:58	06:15 20:39	14 19:50 (99)
3	08:16 16:52	07:55 17:34	07:09 18:15	07:08 19:59	06:13 20:40	11 19:52 (99)
4	08:16 16:53	07:53 17:35	07:07 18:16	07:06 20:00	19:37 (100) 19:40 (100)	7 20:42
5	08:16 16:54	07:52 17:37	07:05 18:18	07:04 20:02	19:34 (100) 19:41 (100)	3 20:43
6	08:16 16:55	07:51 17:38	07:03 18:19	07:02 20:03	19:32 (100) 19:42 (100)	7 20:44
7	08:16 16:56	07:49 17:40	07:01 18:21	07:00 20:04	19:31 (100) 19:43 (100)	10 20:46
8	08:16 16:57	07:48 17:41	07:00 18:22	06:58 20:06	19:30 (100) 19:44 (100)	12 20:47
9	08:15 16:58	07:46 17:43	06:58 18:24	06:56 20:07	19:31 (100) 19:45 (100)	14 20:48
10	08:15 17:00	07:45 17:44	06:56 18:25	06:54 20:09	19:31 (100) 19:44 (100)	14 20:50
11	08:15 17:01	07:43 17:46	06:54 18:26	06:52 20:10	19:31 (100) 19:43 (100)	13 20:51
12	08:14 17:02	07:42 17:47	06:52 18:27	06:51 20:11	19:32 (100) 19:41 (100)	12 20:52
13	08:14 17:03	07:40 17:49	07:50 19:29	06:49 20:13	19:35 (100) 19:38 (100)	9 20:54
14	08:13 17:05	07:39 17:51	07:48 19:31	06:47 20:14	05:58 20:55	3 20:55
15	08:13 17:06	07:37 17:52	07:46 19:32	06:45 20:15	05:56 20:56	05:34 20:56
16	08:12 17:07	07:35 17:54	07:44 19:34	06:43 20:17	05:55 20:57	05:34 20:57
17	08:11 17:08	07:34 17:55	07:42 19:35	06:41 20:18	05:54 20:59	05:34 20:59
18	08:11 17:10	07:32 17:57	07:40 19:36	06:39 20:20	05:53 21:00	05:34 21:00
19	08:10 17:11	07:30 17:58	07:38 19:38	06:37 20:21	05:51 21:01	05:34 21:01
20	08:09 17:13	07:29 18:00	07:36 19:39	06:36 20:22	05:50 21:02	05:34 21:02
21	08:08 17:14	07:27 18:00	07:34 19:41	06:34 20:24	19:53 (99) 20:01 (99)	05:49 21:04
22	08:08 17:16	07:25 18:01	07:32 19:42	06:32 20:25	19:52 (99) 20:04 (99)	05:48 21:05
23	08:07 17:17	07:24 18:03	07:30 19:44	06:30 20:27	19:50 (99) 20:04 (99)	05:47 21:06
24	08:06 17:18	07:22 18:04	07:28 19:45	06:28 20:28	19:49 (99) 20:05 (99)	05:46 21:07
25	08:05 17:20	07:20 18:06	07:26 19:46	06:27 20:29	19:49 (99) 20:06 (99)	2 20:43 (119)
26	08:04 17:21	07:18 18:07	07:24 19:48	06:25 20:31	19:48 (99) 20:05 (99)	5 20:44 (119)
27	08:03 17:23	07:16 18:09	07:22 19:49	06:23 20:32	19:47 (99) 20:05 (99)	7 20:45 (119)
28	08:02 17:24	07:15 18:10	07:20 19:51	06:22 20:33	19:48 (99) 20:05 (99)	9 20:46 (119)
29	08:01 17:26	07:18 19:52	07:18 19:32 (104)	06:20 20:35	19:48 (99) 20:04 (99)	10 20:46 (119)
30	07:59 17:27	07:16 19:53	07:16 19:21 (104)	06:18 20:36	19:49 (99) 20:04 (99)	12 20:48 (119)
31	07:58 17:29	07:14 19:55	07:14 19:30 (104)	06:18 20:36	19:49 (99) 20:04 (99)	14 20:49 (119)
Potential sun hours	278	286	367	406	465	475
Total, worst case			55	252		559
Sun reduction			0.59	0.57		0.64
Oper. time red.			0.85	0.85		0.85
Wind dir. red.			0.70	0.72		0.72
Total reduction			0.35	0.35		0.39
Total, real			19	87		218

Table layout: For each day in each month the following matrix apply

Day in month	Sun rise (hh:mm)	First time (hh:mm) with flicker	(WTG causing flicker first time)
	Sun set (hh:mm)	Minutes with flicker	Last time (hh:mm) with flicker
			(WTG causing flicker last time)

Project:

Otter Tail Ashtabula III Wind

Description:

Barnes County, ND

Licensed user:

Epsilon Associates, Inc
3 Clock Tower Place, Suite 250
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978 897 7100
Richard Lampeter / rlampeter@epsilonassociates.com
6/18/2023 2:05 PM/3.6.366

SHADOW - Calendar

Calculation: Points and Grid Shadow receptor: A272 - Shadow Receptor: 1.0 x 1.0 Azimuth: 0.0° Slope: 90.0° (5162)

Assumptions for shadow calculations

Sunshine probability S/S0 (Sun hours/Possible sun hours) []

Reference year for calendar

2023

Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec
0.52 0.54 0.59 0.57 0.60 0.64 0.74 0.71 0.63 0.51 0.39 0.39

Operational time

N NNE NE ENE E ESE SE SSE S SSW SW WSW W WNW NW NNW Sum
364 231 235 234 299 398 720 587 362 314 482 477 675 931 686 429 7,424

Table with columns for months (July to December) and rows for each day of the month, showing sun rise/set times, shadow reduction, and potential sun hours.

Table layout: For each day in each month the following matrix apply

Matrix with columns: Day in month, Sun rise (hh:mm), Sun set (hh:mm), Minutes with flicker, First time (hh:mm) with flicker, Last time (hh:mm) with flicker, (WTG causing flicker first time), (WTG causing flicker last time)

Project:

Otter Tail Ashtabula III Wind

Description:

Barnes County, ND

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978 897 7100
Richard Lampeter / rlampeter@epsilonassociates.com
Calculated:
6/18/2023 2:05 PM/3.6.366

SHADOW - Calendar

Calculation: Points and Grid Shadow receptor: A273 - Shadow Receptor: 1.0 x 1.0 Azimuth: 0.0° Slope: 90.0° (5163)

Assumptions for shadow calculations

Sunshine probability S/S0 (Sun hours/Possible sun hours) []

Reference year for calendar

2023

Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec
0.52 0.54 0.59 0.57 0.60 0.64 0.74 0.71 0.63 0.51 0.39 0.39

Operational time

N NNE NE ENE E ESE SE SSE S SSW SW WSW W WNW NW NNW Sum
364 231 235 234 299 398 720 587 362 314 482 477 675 931 686 429 7,424

Table with columns for months (January to June) and rows for each day of the month, showing sun rise/set times, potential sun hours, and reduction factors.

Table layout: For each day in each month the following matrix apply

Matrix with columns: Day in month, Sun rise (hh:mm), Sun set (hh:mm), Minutes with flicker, First time (hh:mm) with flicker, Last time (hh:mm) with flicker, (WTG causing flicker first time), (WTG causing flicker last time)

SHADOW - Calendar

Calculation: Points and Grid Shadow receptor: A273 - Shadow Receptor: 1.0 x 1.0 Azimuth: 0.0° Slope: 90.0° (5163)

Assumptions for shadow calculations

Sunshine probability S/S0 (Sun hours/Possible sun hours) []

Reference year for calendar

2023

Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec
 0.52 0.54 0.59 0.57 0.60 0.64 0.74 0.71 0.63 0.51 0.39 0.39

Operational time

N NNE NE ENE E ESE SE SSE S SSW SW WSW W WNW NW NNW Sum
 364 231 235 234 299 398 720 587 362 314 482 477 675 931 686 429 7,424

	July	August	September	October	November	December
1	05:38	06:35 (118)	06:07	06:48	07:27	08:11
	21:30	07:01 (118)	21:06	07:07 (104)	20:15	19:15
2	05:39	06:36 (118)	06:09	06:36 (99)	06:49	07:28
	21:29	07:02 (118)	21:05	07:08 (104)	20:13	19:13
3	05:39	06:36 (118)	06:10	06:37 (99)	06:50	07:30
	21:29	07:03 (118)	21:04	07:08 (104)	20:11	19:11
4	05:40	06:35 (118)	06:11	06:38 (99)	06:51	07:31
	21:29	07:02 (118)	21:02	07:09 (104)	20:09	19:09
5	05:40	06:36 (118)	06:12	06:39 (99)	06:53	07:32
	21:29	07:03 (118)	21:01	07:09 (104)	20:07	19:07
6	05:41	06:36 (118)	06:14	06:41 (99)	06:54	07:34
	21:28	07:04 (118)	20:59	07:10 (104)	20:05	19:05
7	05:42	06:35 (118)	06:15	06:42 (99)	06:55	07:35
	21:28	07:03 (118)	20:58	07:10 (104)	20:03	19:03
8	05:43	06:36 (118)	06:16	06:43 (99)	06:57	07:37
	21:28	07:04 (118)	20:56	07:10 (104)	20:01	19:01
9	05:43	06:36 (118)	06:18	06:44 (100)	06:58	07:38
	21:27	07:05 (118)	20:55	07:10 (104)	19:59	18:57
10	05:44	06:35 (118)	06:19	06:45 (100)	06:59	07:39
	21:27	07:04 (118)	20:53	07:09 (104)	19:57	18:55
11	05:45	06:35 (118)	06:20	06:47 (100)	07:01	07:41
	21:26	07:05 (118)	20:52	07:10 (104)	19:55	18:53
12	05:46	06:36 (118)	06:21	06:49 (104)	07:02	07:42
	21:26	07:05 (118)	20:50	07:09 (104)	19:53	18:51
13	05:47	06:36 (118)	06:23	06:50 (104)	07:03	07:43
	21:25	07:06 (118)	20:49	07:08 (104)	19:51	18:49
14	05:48	06:18 (119)	06:24	06:50 (104)	07:05	07:45
	21:24	07:06 (118)	20:47	07:06 (104)	19:49	18:47
15	05:49	06:17 (119)	06:25	06:51 (104)	07:06	07:46
	21:24	07:06 (118)	20:45	07:05 (104)	19:47	18:46
16	05:50	06:18 (119)	06:27	06:53 (104)	07:07	07:48
	21:23	07:07 (118)	20:44	07:03 (104)	19:45	18:44
17	05:51	06:19 (119)	06:28	07:08	07:49	07:35
	21:22	07:07 (118)	20:42	19:43	18:42	16:55
18	05:52	06:20 (119)	06:29	07:10	07:51	07:36
	21:21	07:07 (118)	20:40	19:41	18:40	16:54
19	05:53	06:21 (119)	06:31	07:11	07:52	07:38
	21:21	07:07 (118)	20:39	19:39	18:38	16:53
20	05:54	06:22 (119)	06:32	07:12	07:53	07:39
	21:20	07:07 (118)	20:37	19:37	18:36	16:52
21	05:55	06:23 (119)	06:33	07:14	07:55	07:40
	21:19	07:07 (118)	20:35	19:35	18:35	16:51
22	05:56	06:24 (119)	06:34	07:15	07:56	07:42
	21:18	07:07 (118)	20:33	19:33	18:33	16:50
23	05:57	06:25 (119)	06:36	07:16	07:58	07:43
	21:17	07:07 (118)	20:31	19:31	18:31	16:49
24	05:58	06:38 (118)	06:37	07:18	07:59	07:45
	21:16	07:06 (118)	20:30	19:29	18:29	16:48
25	05:59	06:38 (118)	06:38	07:19	08:01	07:46
	21:15	07:06 (118)	20:28	19:27	18:28	16:47
26	06:00	06:38 (118)	06:40	07:20	08:02	07:47
	21:14	07:06 (118)	20:26	19:25	18:26	16:47
27	06:01	06:39 (118)	06:41	07:22	08:04	07:49
	21:12	07:05 (118)	20:24	19:23	18:24	16:46
28	06:03	06:39 (118)	06:42	07:23	08:05	07:50
	21:11	07:04 (118)	20:22	19:21	18:23	16:45
29	06:04	06:37 (99)	06:44	07:24	08:07	07:51
	21:10	07:03 (118)	20:20	19:19	18:21	16:45
30	06:05	06:36 (99)	06:45	07:26	08:08	07:52
	21:09	07:02 (118)	20:19	19:17	18:19	16:44
31	06:06	06:35 (99)	06:46	07:27	08:09	07:53
	21:08	07:05 (104)	20:17	19:16	18:18	16:43
Potential sun hours	481	442	380	339	283	266
Total, worst case	926	391			413	1272
Sun reduction	0.74	0.71			0.39	0.39
Oper. time red.	0.85	0.85			0.85	0.85
Wind dir. red.	0.64	0.65			0.70	0.70
Total reduction	0.40	0.39			0.23	0.23
Total, real	375	154			96	296

Table layout: For each day in each month the following matrix apply

Day in month	Sun rise (hh:mm)	First time (hh:mm) with flicker	(WTG causing flicker first time)
	Sun set (hh:mm)	Minutes with flicker	Last time (hh:mm) with flicker
			(WTG causing flicker last time)

SHADOW - Calendar

Calculation: Points and Grid Shadow receptor: A274 - Shadow Receptor: 1.0 x 1.0 Azimuth: 0.0° Slope: 90.0° (5164)

Assumptions for shadow calculations

Reference year for calendar

2023

Sunshine probability S/S0 (Sun hours/Possible sun hours) []

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
0.52	0.54	0.59	0.57	0.60	0.64	0.74	0.71	0.63	0.51	0.39	0.39

Operational time

N	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW	Sum
364	231	235	234	299	398	720	587	362	314	482	477	675	931	686	429	7,424

	January	February	March	April	May	June
1	08:16 16:50	07:57 17:31	08:32 (89) 09:01 (89)	07:13 18:12	07:12 19:56	06:17 20:38
2	08:16 16:51	07:56 17:32	08:32 (89) 09:01 (89)	07:11 18:13	07:10 19:58	06:15 20:39
3	08:16 16:52	07:55 17:34	08:32 (89) 09:01 (89)	07:09 18:15	07:08 19:59	06:14 20:40
4	08:16 16:53	07:53 17:35	08:33 (89) 09:01 (89)	07:07 18:16	07:06 20:00	06:12 20:42
5	08:16 16:54	07:52 17:37	08:33 (89) 09:01 (89)	07:05 18:18	07:04 20:02	06:10 20:43
6	08:16 16:55	07:51 17:38	08:33 (89) 09:01 (89)	07:04 18:19	07:02 20:03	06:09 20:44
7	08:16 16:56	07:49 17:40	08:35 (89) 09:01 (89)	07:02 18:21	07:00 20:05	06:07 20:46
8	08:16 16:57	07:48 17:41	08:35 (89) 08:59 (89)	07:00 18:22	06:58 20:06	06:06 20:47
9	08:15 16:59	07:46 17:43	08:36 (89) 08:59 (89)	06:58 18:24	06:57 20:07	06:05 20:48
10	08:15 17:00	07:45 17:45	08:37 (89) 08:58 (89)	06:56 18:25	06:55 20:09	06:03 20:50
11	08:15 17:01	07:43 17:46	08:38 (89) 08:56 (89)	06:54 18:27	06:53 20:10	06:02 20:51
12	08:14 17:02	07:42 17:48	08:41 (89) 08:54 (89)	07:52 18:28	06:51 20:11	06:00 20:52
13	08:14 17:03	07:40 17:49	08:44 (89) 08:50 (89)	07:50 19:30	06:49 20:13	05:59 20:54
14	08:13 17:05	07:39 17:51	07:48 19:31	06:47 20:14	05:58 20:55	05:34 21:26
15	08:13 17:06	07:37 17:52	07:46 19:32	06:45 20:16	05:56 20:56	05:34 21:26
16	08:12 17:07	07:36 17:54	07:44 19:34	06:43 20:17	05:55 20:58	05:34 21:27
17	08:12 17:09	07:34 17:55	07:42 19:35	06:41 20:18	05:54 20:59	05:34 21:27
18	08:11 17:10	07:32 17:57	07:40 19:37	06:39 20:20	05:53 21:00	05:34 21:28
19	08:10 17:11	07:31 17:58	07:38 19:38	06:38 20:21	05:52 21:01	05:34 21:28
20	08:09 17:13	07:29 08:39 (89)	07:36 19:39	06:36 20:23	05:50 21:02	05:34 21:28
21	08:09 17:14	07:27 08:38 (89)	07:34 19:41	06:34 20:24	05:49 21:04	05:34 21:29
22	08:08 17:16	07:25 08:36 (89)	07:32 19:42	06:32 20:25	05:48 21:05	05:35 21:29
23	08:07 17:17	07:24 08:35 (89)	07:30 19:44	06:30 20:27	05:47 21:06	05:35 21:29
24	08:06 17:19	07:22 08:35 (89)	07:28 19:45	06:29 20:28	05:46 21:07	05:35 21:29
25	08:05 17:20	07:20 08:33 (89)	07:26 19:47	06:27 20:29	05:45 21:08	05:35 21:30
26	08:04 17:22	07:18 08:33 (89)	07:24 19:48	06:25 20:31	05:44 21:09	05:36 21:30
27	08:03 17:23	07:17 08:32 (89)	07:22 19:49	06:23 20:32	05:44 21:11	05:36 21:30
28	08:02 17:25	07:15 08:32 (89)	07:20 19:51	06:22 20:34	05:43 21:12	05:37 21:30
29	08:01 17:26	07:14 08:32 (89)	07:18 19:52	06:20 20:35	05:42 21:13	05:37 21:30
30	08:00 17:28	07:13 09:00 (89)	07:16 19:53	06:18 20:36	05:41 21:14	05:37 21:30
31	07:58 17:29	07:12 09:00 (89)	07:14 19:55	06:17 20:37	05:40 21:15	05:37 21:30
Potential sun hours	278	286	367	406	465	475
Total, worst case	264	302	367	406	465	475
Sun reduction	0.52	0.54	0.57	0.57	0.60	0.64
Oper. time red.	0.85	0.85	0.85	0.85	0.85	0.85
Wind dir. red.	0.71	0.71	0.66	0.66	0.65	0.63
Total reduction	0.31	0.33	0.32	0.32	0.33	0.34
Total, real	83	99	70	70	186	341

Table layout: For each day in each month the following matrix apply

Day in month	Sun rise (hh:mm)	First time (hh:mm) with flicker	(WTG causing flicker first time)
	Sun set (hh:mm)	Minutes with flicker	Last time (hh:mm) with flicker
			(WTG causing flicker last time)

Project:

Otter Tail Ashtabula III Wind

Description:

Barnes County, ND

Licensed user:

Epsilon Associates, Inc
3 Clock Tower Place, Suite 250
US-MAYNARD MA 01754
978 897 7100

Richard Lampeter / rlampeter@epsilonassociates.com

Calculated:

6/18/2023 2:05 PM/3.6.366

SHADOW - Calendar

Calculation: Points and Grid Shadow receptor: A274 - Shadow Receptor: 1.0 x 1.0 Azimuth: 0.0° Slope: 90.0° (5164)

Assumptions for shadow calculations

Sunshine probability S/S0 (Sun hours/Possible sun hours) []

Reference year for calendar

2023

Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec
0.52 0.54 0.59 0.57 0.60 0.64 0.74 0.71 0.63 0.51 0.39 0.39

Operational time

N NNE NE ENE E ESE SE SSE S SSW SW WSW W WNW NW NNW Sum
364 231 235 234 299 398 720 587 362 314 482 477 675 931 686 429 7,424

Table with columns for months (July, August, September, October, November, December) and rows for each day of the month, showing sun rise/set times and shadow reduction percentages.

Table layout: For each day in each month the following matrix apply

Day in month Sun rise (hh:mm) Sun set (hh:mm) First time (hh:mm) with flicker Last time (hh:mm) with flicker (WTG causing flicker first time) (WTG causing flicker last time)

SHADOW - Calendar

Calculation: Points and Grid Shadow receptor: A277 - Shadow Receptor: 1.0 x 1.0 Azimuth: 0.0° Slope: 90.0° (5167)

Assumptions for shadow calculations

Reference year for calendar

2023

Sunshine probability S/S0 (Sun hours/Possible sun hours) []

Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec
 0.52 0.54 0.59 0.57 0.60 0.64 0.74 0.71 0.63 0.51 0.39 0.39

Operational time

N NNE NE ENE E ESE SE SSE S SSW SW WSW W WNW NW NNW Sum
 364 231 235 234 299 398 720 587 362 314 482 477 675 931 686 429 7,424

	January	February	March	April	May	June	July	August	September	October	November	December		
1	08:17 16:49	07:57 17:30	07:13 18:12	07:12 19:56	06:16 20:38	05:39 21:16	05:37 21:30	06:07 21:06	06:47 20:15	07:27 19:14	08:11 18:16	07:54 16:43		
2	08:17 16:50	07:56 17:32	07:11 18:13	07:10 19:57	06:15 20:39	05:38 21:17	05:38 21:30	06:08 21:05	06:48 20:13	07:28 19:12	08:12 18:14	07:55 16:42		
3	08:17 16:51	07:55 17:33	07:09 18:15	07:08 19:59	06:13 20:40	05:38 21:18	05:38 21:29	06:09 21:04	06:50 20:11	07:29 19:10	08:14 18:12	07:56 16:42		
4	08:17 16:52	07:53 17:35	07:07 18:16	07:06 20:00	06:11 20:42	05:37 21:19	05:39 21:29	06:11 21:02	06:51 20:09	07:31 19:08	08:15 18:11	07:58 16:41		
5	08:16 16:53	07:52 17:36	07:05 18:17	07:04 20:02	06:10 20:43	05:36 21:19	05:40 21:29	06:12 21:01	06:52 20:07	07:32 19:06	07:17 17:09	07:59 16:41		
6	08:16 16:54	07:51 17:38	07:03 18:19	07:02 20:03	06:08 20:44	05:36 21:20	05:40 21:29	06:13 20:59	06:54 20:05	07:34 19:04	07:18 17:08	08:00 16:41		
7	08:16 16:55	07:49 17:39	07:01 18:20	07:00 20:04	06:07 20:46	05:36 21:21	05:41 21:28	06:14 20:58	06:55 20:03	07:35 19:02	07:20 17:07	08:01 16:40		
8	08:16 16:57	07:48 17:41	06:59 18:22	06:58 20:06	06:05 20:47	05:35 21:22	05:42 21:28	06:16 20:56	06:56 20:01	07:36 19:00	07:21 17:05	08:02 16:40		
9	08:16 16:58	07:46 17:42	06:58 18:23	06:56 20:07	06:04 20:48	05:35 21:23	05:43 21:27	06:17 20:55	06:58 19:59	07:38 18:57	07:23 17:04	08:03 16:40		
10	08:15 16:59	07:45 17:44	06:56 18:25	06:54 20:09	06:02 20:50	05:34 21:23	05:43 21:27	06:18 20:53	06:59 19:57	07:39 18:55	07:24 17:02	08:04 16:40		
11	08:15 17:00	07:43 17:46	06:54 18:26	06:52 20:10	06:01 20:51	05:34 21:24	05:44 21:26	06:19 20:52	07:00 19:55	07:40 18:53	07:26 17:01	08:05 16:40		
12	08:14 17:01	07:42 17:47	07:52 18:28	06:50 20:11	06:00 20:52	05:34 21:25	05:45 21:26	06:21 20:50	07:01 19:53	07:42 18:51	07:27 17:00	08:06 16:40		
13	08:14 17:03	07:40 17:49	07:50 19:29	06:48 20:13	05:58 20:54	05:34 21:25	05:46 21:25	06:22 20:49	07:03 19:51	07:43 18:49	07:29 16:59	08:07 16:40		
14	08:13 17:04	07:39 17:50	07:48 19:31	06:46 20:14	05:57 20:55	05:34 21:26	05:47 21:25	06:23 20:47	07:04 19:49	07:45 18:47	07:30 16:57	08:08 16:40		
15	08:13 17:05	08:41 (97) 08:42 (97)	07:37 17:52	07:46 19:32	06:45 20:16	05:56 20:56	05:33 21:27	05:48 21:24	06:25 20:45	07:05 19:47	07:46 18:45	07:32 16:56	08:09 16:40	
16	08:12 17:07	08:40 (97) 08:43 (97)	07:36 17:53	07:44 19:33	06:43 20:17	05:54 20:58	05:33 21:27	05:49 21:23	06:26 20:44	07:07 19:45	07:48 18:43	07:33 16:55	08:09 16:40	
17	08:12 17:08	08:39 (97) 08:43 (97)	07:34 17:55	07:42 19:35	06:41 20:18	05:53 20:59	05:50 21:22	06:27 20:42	07:08 19:43	07:49 18:41	07:35 16:54	08:10 16:40		
18	08:11 17:09	08:38 (97) 08:43 (97)	07:32 17:56	07:40 19:36	06:39 20:20	05:52 21:00	05:33 21:22	05:51 20:40	06:29 19:41	07:09 18:39	07:50 16:53	08:11 16:41		
19	08:10 17:11	08:38 (97) 08:44 (97)	07:31 17:58	07:38 19:38	06:37 20:21	05:51 21:01	05:33 21:28	06:30 21:21	07:11 19:39	07:52 18:38	07:38 16:52	08:12 16:41		
20	08:09 17:12	08:37 (97) 08:44 (97)	07:29 17:59	07:36 19:39	06:35 20:22	05:50 21:03	05:33 21:29	05:53 21:20	06:31 19:37	07:12 18:36	07:39 16:51	08:13 (97) 08:15 (97)	08:12 16:41	
21	08:09 17:14	08:36 (97) 08:44 (97)	07:27 18:01	07:34 19:41	06:33 20:24	05:49 21:04	05:34 21:29	05:54 21:19	06:33 20:35	07:13 19:35	07:55 18:34	07:40 16:50	08:13 16:42	
22	08:08 17:15	08:35 (97) 08:43 (97)	07:25 18:01	07:32 19:42	06:32 20:25	05:48 21:05	05:34 21:29	05:55 21:18	06:34 20:33	07:15 19:33	07:56 18:32	07:42 16:49	08:14 16:42	
23	08:07 17:16	08:37 (97) 08:42 (97)	07:24 18:02	07:30 19:43	06:30 20:27	05:46 21:06	05:34 21:29	05:56 21:17	06:35 19:31	07:16 18:31	07:58 16:48	07:43 16:48	08:12 (97) 08:19 (97)	08:14 16:43
24	08:06 17:18	08:37 (97) 18:04	07:24 19:45	07:30 20:28	06:30 21:07	05:46 21:07	05:34 21:30	05:57 21:16	06:37 20:30	07:17 19:29	07:59 18:29	07:45 16:47	08:14 (97) 16:43	08:14 16:43
25	08:05 17:19	08:05 18:06	07:26 19:46	06:26 20:29	05:45 21:08	05:35 21:30	05:58 21:15	06:38 20:28	07:19 19:27	08:01 18:27	07:46 16:47	08:15 (97) 16:44	08:15 16:44	
26	08:04 17:21	08:04 18:07	07:24 19:48	06:25 20:31	05:44 21:10	05:35 21:30	06:00 21:14	06:39 20:26	07:20 19:24	08:02 18:25	07:47 16:46	08:17 (97) 16:44	08:15 16:44	
27	08:03 17:22	08:03 18:09	07:22 19:49	06:23 20:32	05:43 21:11	05:35 21:30	06:01 21:13	06:40 20:24	07:21 19:22	08:03 18:24	07:49 16:45	08:18 (97) 16:45	08:16 16:45	
28	08:02 17:24	08:02 17:15	07:20 19:50	06:21 20:34	05:42 21:12	05:36 21:30	06:02 21:11	06:42 20:22	07:23 19:20	08:05 18:22	07:50 16:44	08:20 (97) 16:44	08:16 16:46	
29	08:01 17:25	08:01 17:25	07:18 19:52	06:19 20:35	05:41 21:13	05:36 21:30	06:03 21:10	06:43 20:20	07:24 19:18	08:06 18:20	07:51 16:44	08:21 (97) 16:44	08:16 16:47	
30	08:00 17:27	08:00 17:27	07:16 19:53	06:18 20:36	05:40 21:14	05:37 21:30	06:04 21:09	06:44 20:18	07:25 19:16	08:08 18:19	07:53 16:43	08:22 (97) 16:43	08:16 16:47	
31	07:58 17:28	07:58 17:28	07:14 19:55	05:40 21:15	05:40 21:15	05:40 21:15	06:06 21:08	06:46 20:16	08:09 18:17	08:09 18:17	08:09 18:17	08:16 16:48	08:16 16:48	
Potential sun hours	277	286	367	406	466	475	481	443	380	339	282	266		
Total, worst case	47											47		
Sun reduction	0.52											0.39		
Oper. time red.	0.85											0.85		
Wind dir. red.	0.71											0.71		
Total reduction	0.31											0.23		
Total, real	15											11		

Table layout: For each day in each month the following matrix apply

Day in month	Sun rise (hh:mm)	First time (hh:mm) with flicker	(WTG causing flicker first time)
	Sun set (hh:mm)	Minutes with flicker	Last time (hh:mm) with flicker
			(WTG causing flicker last time)

SHADOW - Calendar

Calculation: Points and Grid Shadow receptor: A279 - Shadow Receptor: 1.0 x 1.0 Azimuth: 0.0° Slope: 90.0° (5169)

Assumptions for shadow calculations

Sunshine probability S/S0 (Sun hours/Possible sun hours) []

Reference year for calendar

2023

Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec
 0.52 0.54 0.59 0.57 0.60 0.64 0.74 0.71 0.63 0.51 0.39 0.39

Operational time

N NNE NE ENE E ESE SE SSE S SSW SW WSW W WNW NW NNW Sum
 364 231 235 234 299 398 720 587 362 314 482 477 675 931 686 429 7,424

	January	February	March	April	May	June
1	08:16 16:49	07:57 17:30	07:13 18:11	07:12 19:56	19:26 (115) 19:32 (115)	06:16 20:38
2	08:16 16:50	07:56 17:31	07:11 18:13	07:10 19:57	06:14 20:39	05:38 21:17
3	08:16 16:51	07:55 17:33	07:09 18:14	07:08 19:59	06:13 20:40	05:37 21:18
4	08:16 16:52	07:53 17:34	07:07 18:16	07:06 20:00	06:11 20:42	05:37 21:18
5	08:16 16:53	07:52 17:36	07:05 18:17	07:04 20:01	06:10 20:43	05:36 21:19
6	08:16 16:54	07:50 17:38	07:03 18:19	07:02 20:03	06:08 20:44	05:36 21:20
7	08:16 16:55	07:49 17:39	07:01 18:20	07:00 20:04	06:07 20:46	05:35 21:21
8	08:16 16:56	07:48 17:41	06:59 18:22	06:58 20:06	19:42 (81) 19:45 (81)	06:05 20:47
9	08:15 16:58	07:46 17:42	06:57 18:23	06:56 20:07	19:40 (81) 19:46 (81)	06:04 20:48
10	08:15 16:59	07:45 17:44	06:55 18:25	06:54 20:08	19:39 (81) 19:47 (81)	06:02 20:50
11	08:15 17:00	07:43 17:45	06:53 18:26	06:52 20:10	19:39 (81) 19:49 (81)	06:01 20:51
12	08:14 17:01	07:42 17:47	07:51 18:28	06:50 20:11	19:38 (81) 19:50 (81)	05:59 20:52
13	08:14 17:02	07:40 17:48	07:50 19:29	06:48 20:13	19:40 (81) 19:51 (81)	05:58 20:54
14	08:13 17:04	07:39 17:50	07:48 19:30	06:46 20:14	19:40 (81) 19:49 (81)	05:57 20:55
15	08:13 17:05	07:37 17:51	07:46 19:32	06:44 20:15	19:42 (81) 19:54 (113)	05:55 20:56
16	08:12 17:06	07:35 17:53	07:44 19:33	06:42 20:17	19:47 (113) 19:56 (113)	05:54 20:57
17	08:11 17:08	07:34 17:55	07:42 19:35	06:41 20:18	19:46 (113) 19:57 (113)	05:53 20:59
18	08:11 17:09	07:32 17:56	07:40 19:36	06:39 20:20	19:45 (113) 19:58 (113)	05:52 21:00
19	08:10 17:10	07:30 17:58	07:38 19:38	06:37 20:21	19:44 (113) 19:59 (113)	05:51 21:01
20	08:09 17:12	07:29 17:59	07:36 19:39	06:35 20:22	19:44 (113) 20:01 (113)	05:49 21:02
21	08:08 17:13	07:27 18:01	07:34 19:40	06:33 20:24	19:43 (113) 20:01 (113)	05:48 21:04
22	08:08 17:15	07:25 18:01	07:32 19:42	06:31 20:25	19:43 (113) 20:00 (113)	05:47 21:05
23	08:07 17:16	07:23 18:02	07:30 19:43	06:30 20:26	19:43 (113) 19:59 (113)	05:46 21:06
24	08:06 17:18	07:22 18:04	07:28 19:45	06:28 20:28	19:44 (113) 19:59 (113)	05:45 21:07
25	08:05 17:19	07:20 18:05	07:26 19:46	06:26 20:29	19:45 (113) 19:58 (113)	05:44 21:08
26	08:04 17:21	07:18 18:07	07:24 19:47	06:24 20:31	19:46 (113) 19:56 (113)	05:43 21:09
27	08:03 17:22	07:16 18:08	07:22 19:49	06:23 20:32	19:51 (113) 19:52 (113)	05:42 21:11
28	08:02 17:24	07:14 18:10	07:20 19:50	06:21 20:33	19:25 (115) 19:30 (115)	05:42 21:12
29	08:01 17:25	07:18 19:52	07:18 19:24 (115)	06:19 20:35	19:32 (115) 19:32 (115)	05:41 21:13
30	07:59 17:27	07:16 19:53	07:16 19:24 (115)	06:18 20:36	19:24 (115) 19:33 (115)	05:40 21:14
31	07:58 17:28	07:14 19:54	07:14 19:34 (115)	06:17 20:37	19:24 (115) 19:34 (115)	05:39 21:15
Potential sun hours	277	286	367	406	466	475
Total, worst case			35	229		655
Sun reduction			0.59	0.57		0.64
Oper. time red.			0.85	0.85		0.85
Wind dir. red.			0.70	0.71		0.72
Total reduction			0.35	0.34		0.39
Total, real			12	79		256

Table layout: For each day in each month the following matrix apply

Day in month	Sun rise (hh:mm)	Minutes with flicker	First time (hh:mm) with flicker	Last time (hh:mm) with flicker	(WTG causing flicker first time)	(WTG causing flicker last time)
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SHADOW - Calendar

Calculation: Points and Grid Shadow receptor: A279 - Shadow Receptor: 1.0 x 1.0 Azimuth: 0.0° Slope: 90.0° (5169)

Assumptions for shadow calculations

Sunshine probability S/S0 (Sun hours/Possible sun hours) []

Reference year for calendar

2023

Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec
 0.52 0.54 0.59 0.57 0.60 0.64 0.74 0.71 0.63 0.51 0.39 0.39

Operational time

N NNE NE ENE E ESE SE SSE S SSW SW WSW W WNW NW NNW Sum
 364 231 235 234 299 398 720 587 362 314 482 477 675 931 686 429 7,424

	July	August	September	October	November	December			
1	05:37	20:33 (86)	06:07	06:47	19:39 (81)	07:27	08:11	07:54	
	21:30	22 20:55 (86)	21:06	20:14	11 19:50 (81)	19:14	18:15	16:42	
2	05:37	20:33 (86)	06:08	06:48	19:38 (81)	07:28	08:12	07:55	
	21:30	22 20:55 (86)	21:05	20:12	10 19:48 (81)	19:12	18:14	16:42	
3	05:38	20:33 (86)	06:09	06:49	19:37 (81)	07:29	08:14	07:56	
	21:29	22 20:55 (86)	21:04	20:11	9 19:46 (81)	19:10	18:12	16:42	
4	05:39	20:33 (86)	06:10	06:51	19:38 (81)	07:31	08:15	07:57	
	21:29	22 20:55 (86)	21:02	20:09	7 19:45 (81)	19:08	18:11	16:41	
5	05:39	20:33 (86)	06:12	06:52	19:38 (81)	07:32	07:17	07:59	
	21:29	23 20:56 (86)	21:01	20:07	5 19:43 (81)	19:06	17:09	16:41	
6	05:40	20:34 (86)	06:13	06:53	19:39 (81)	07:33	07:18	08:00	
	21:29	22 20:56 (86)	20:59	20:05	1 19:40 (81)	19:04	17:08	16:40	
7	05:41	20:33 (86)	06:14	06:55	07:35	07:20	08:01		
	21:28	23 20:56 (86)	20:58	20:03	19:02	17:06	16:40		
8	05:41	20:33 (86)	06:15	06:56	07:36	07:21	08:02		
	21:28	23 20:56 (86)	20:56	20:01	19:00	17:05	16:40		
9	05:42	20:34 (86)	06:17	06:57	07:38	07:23	08:03		
	21:27	23 20:57 (86)	20:55	19:59	18:56	17:04	16:40		
10	05:43	20:34 (86)	06:18	06:59	07:39	07:24	08:04		
	21:27	23 20:57 (86)	20:53	19:57	18:54	17:02	16:40		
11	05:44	20:33 (86)	06:19	07:00	07:40	07:26	08:05		
	21:26	23 20:56 (86)	20:52	19:55	18:52	17:01	16:40		
12	05:45	20:34 (86)	06:21	07:01	07:42	07:27	08:06		
	21:26	23 20:57 (86)	20:50	19:53	18:51	17:00	16:40		
13	05:46	20:34 (86)	06:22	07:03	19:17 (115)	07:43	07:29	08:07	
	21:25	23 20:57 (86)	20:48	19:51	7 19:24 (115)	18:49	16:58	16:40	
14	05:47	20:35 (86)	06:23	07:04	19:15 (115)	07:45	07:30	08:08	
	21:24	22 20:57 (86)	20:47	19:49	9 19:24 (115)	18:47	16:57	16:40	
15	05:48	20:35 (86)	06:24	07:05	19:14 (115)	07:46	07:32	08:08	
	21:24	22 20:57 (86)	20:45	19:47	9 19:23 (115)	18:45	16:56	16:40	
16	05:49	20:35 (86)	06:26	07:07	19:14 (115)	07:47	07:33	08:09	
	21:23	22 20:57 (86)	20:44	19:45	7 19:21 (115)	18:43	16:55	16:40	
17	05:50	20:36 (86)	06:27	07:08	19:13 (115)	07:49	07:35	08:10	
	21:22	20 20:56 (86)	20:42	19:43	5 19:18 (115)	18:41	16:54	16:40	
18	05:51	20:36 (86)	06:28	19:53 (113)	07:09	19:14 (115)	07:50	07:36	08:11
	21:21	19 20:55 (86)	20:40	20:01 (113)	19:41	3 19:17 (115)	18:39	16:53	16:40
19	05:52	20:37 (86)	06:30	19:52 (113)	07:11	07:52	07:37	08:11	
	21:21	18 20:55 (86)	20:38	20:04 (113)	19:39	18:37	16:52	16:41	
20	05:53	20:38 (86)	06:31	19:50 (113)	07:12	07:53	07:39	08:12	
	21:20	16 20:54 (86)	20:37	20:04 (113)	19:36	18:36	16:51	16:41	
21	05:54	20:38 (86)	06:32	19:49 (113)	07:13	07:55	07:40	08:13	
	21:19	15 20:53 (86)	20:35	20:05 (113)	19:34	18:34	16:50	16:42	
22	05:55	20:39 (86)	06:34	19:48 (113)	07:15	07:56	07:42	08:13	
	21:18	13 20:52 (86)	20:33	20:05 (113)	19:32	18:32	16:49	16:42	
23	05:56	20:40 (86)	06:35	19:48 (113)	07:16	07:57	07:43	08:14	
	21:17	11 20:51 (86)	20:31	20:06 (113)	19:30	18:30	16:48	16:42	
24	05:57	20:42 (86)	06:36	19:47 (113)	07:17	07:59	07:44	08:14	
	21:16	8 20:50 (86)	20:29	20:05 (113)	19:28	18:29	16:47	16:43	
25	05:58	20:44 (86)	06:38	19:47 (113)	07:19	08:00	07:46	08:15	
	21:15	5 20:49 (86)	20:28	20:03 (113)	19:26	18:27	16:46	16:44	
26	05:59	06:39	06:39	19:47 (113)	07:20	08:02	07:47	08:15	
	21:14	06:40	20:26	20:01 (113)	19:24	18:25	16:46	16:44	
27	06:01	20:24	12 20:00 (113)	19:48 (113)	07:21	08:03	07:49	08:15	
	21:12	06:42	20:22	20:00 (113)	19:22	18:23	16:45	16:45	
28	06:02	20:22	9 19:58 (113)	19:49 (113)	07:23	08:05	07:50	08:16	
	21:11	06:43	20:20	19:50 (113)	07:24	18:22	16:44	16:46	
29	06:03	20:20	6 19:56 (113)	19:50 (113)	07:24	08:06	07:51	08:16	
	21:10	06:44	9 19:54 (113)	19:18	07:25	18:20	16:44	16:46	
30	06:04	20:18	9 19:54 (113)	19:16	07:25	08:08	07:52	08:16	
	21:09	06:46	10 19:50 (81)	19:40 (81)	07:26	18:18	16:43	16:47	
31	06:05	20:16	10 19:50 (81)	19:40 (81)	07:26	18:18	16:43	16:47	
	21:07	06:43	10 19:50 (81)	19:40 (81)	07:26	18:17	16:42	16:48	
Potential sun hours	482	443	380	339	282	266			
Total, worst case	485	179	83						
Sun reduction	0.74	0.63	0.63						
Oper. time red.	0.85	0.85	0.85						
Wind dir. red.	0.72	0.71	0.71						
Total reduction	0.45	0.43	0.38						
Total, real	220	77	31						

Table layout: For each day in each month the following matrix apply

Day in month	Sun rise (hh:mm)	Sun set (hh:mm)	Minutes with flicker	First time (hh:mm) with flicker	Last time (hh:mm) with flicker	(WTG causing flicker first time)	(WTG causing flicker last time)
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SHADOW - Calendar

Calculation: Points and Grid Shadow receptor: A280 - Shadow Receptor: 1.0 x 1.0 Azimuth: 0.0° Slope: 90.0° (5170)

Assumptions for shadow calculations

Reference year for calendar

2023

Sunshine probability S/S0 (Sun hours/Possible sun hours) []

Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec
 0.52 0.54 0.59 0.57 0.60 0.64 0.74 0.71 0.63 0.51 0.39 0.39

Operational time

N NNE NE ENE E ESE SE SSE S SSW SW WSW W WNW NW NNW Sum
 364 231 235 234 299 398 720 587 362 314 482 477 675 931 686 429 7,424

	January	February	March	April	May	June	July	August	September	October	November	December					
1	08:16	07:57	07:13	07:12	06:17	05:40	05:38	06:07	20:26 (102)	06:47	19:40 (92)	07:27	08:11	07:54			
	16:50	17:31	18:12	19:56	20:38	21:15	21:29	21:06	15	20:41 (102)	20:15	11	19:51 (92)	19:15	18:16	16:43	
2	08:16	07:56	07:11	07:10	06:15	05:39	05:39	06:09	20:26 (102)	06:49	19:39 (92)	07:28	08:12	07:55			
	16:51	17:32	18:13	19:58	20:39	21:16	21:29	21:05	14	20:40 (102)	20:13	10	19:49 (92)	19:13	18:14	16:43	
3	08:16	07:55	07:09	07:08	06:14	05:38	05:39	06:10	20:26 (102)	06:50	19:38 (92)	07:30	08:14	07:56			
	16:52	17:34	18:15	19:59	20:40	21:17	21:29	21:03	12	20:38 (102)	20:11	9	19:47 (92)	19:11	18:13	16:42	
4	08:16	07:53	07:07	07:06	06:12	05:38	05:40	06:11	20:26 (102)	06:51	19:37 (92)	07:31	08:15	07:57			
	16:53	17:35	18:16	20:00	20:42	21:18	21:29	21:02	11	20:37 (102)	20:09	8	19:45 (92)	19:09	18:11	16:42	
5	08:16	07:52	07:05	07:04	06:10	05:37	05:40	06:12	20:27 (102)	06:53	19:38 (92)	07:32	07:17	07:58			
	16:54	17:37	18:18	20:02	20:43	21:19	21:29	21:01	8	20:35 (102)	20:07	5	19:43 (92)	19:07	17:10	16:42	
6	08:16	07:51	07:03	07:02	06:09	20:21 (102)	05:37	06:14	20:27 (102)	06:54	19:38 (92)	07:34	07:18	08:00			
	16:55	17:38	18:19	20:03	20:44	1	20:22 (102)	21:20	20:59	7	20:34 (102)	20:05	3	19:41 (92)	19:05	17:09	16:41
7	08:16	07:49	07:02	07:00	06:07	19:43 (92)	06:07	06:15	20:29 (102)	06:55	19:37 (92)	07:35	07:20	08:01			
	16:56	17:40	18:21	20:04	20:46	4	20:23 (102)	21:21	20:58	4	20:33 (102)	20:03	19:03	17:07	16:41		
8	08:16	07:48	07:00	06:58	06:06	19:41 (92)	06:06	06:16	20:30 (102)	06:57	19:36 (92)	07:36	07:21	08:02			
	16:57	17:41	18:22	20:06	20:47	5	19:46 (92)	20:47	20:56	2	20:32 (102)	20:01	19:01	17:06	16:41		
9	08:15	07:46	06:58	06:56	06:04	19:41 (92)	06:04	06:17	20:16 (102)	06:56	19:38 (92)	07:38	07:23	08:03			
	16:58	17:43	18:24	20:07	20:48	6	19:47 (92)	20:48	20:25 (102)	21:22	21:27	20:55	18:57	17:04	16:41		
10	08:15	07:45	06:56	06:54	06:03	19:40 (92)	06:03	06:19	20:16 (102)	06:55	19:37 (92)	07:39	07:24	08:04			
	17:00	17:44	18:25	20:09	20:50	8	19:48 (92)	20:50	20:26 (102)	21:23	21:27	20:53	18:55	17:03	16:41		
11	08:15	07:43	06:54	06:53	06:02	19:40 (92)	06:02	06:20	20:16 (102)	06:55	19:36 (92)	07:41	07:26	08:05			
	17:01	17:46	18:27	20:10	20:51	9	19:49 (92)	20:51	20:28 (102)	21:24	21:26	20:52	18:53	17:02	16:41		
12	08:14	07:42	07:52	06:51	06:00	19:40 (92)	06:00	06:21	20:16 (102)	06:55	19:36 (92)	07:42	07:27	08:06			
	17:02	17:48	18:28	20:11	20:52	11	19:51 (92)	20:52	20:29 (102)	21:24	21:25	20:50	18:51	17:01	16:41		
13	08:14	07:40	07:50	06:49	06:00	19:41 (92)	05:59	06:23	20:15 (102)	06:54	19:35 (92)	07:43	07:29	08:07			
	17:03	17:49	18:29	20:13	20:54	11	19:52 (92)	20:54	20:30 (102)	21:25	21:25	20:48	18:49	16:59	16:41		
14	08:13	07:39	07:48	06:47	06:00	19:42 (92)	05:58	06:24	20:15 (102)	06:54	19:34 (92)	07:45	07:30	08:07			
	17:05	17:51	18:31	20:14	20:55	8	19:50 (92)	20:55	20:31 (102)	21:26	21:24	20:47	18:47	16:58	16:41		
15	08:13	07:37	07:46	06:45	06:00	19:40 (92)	05:56	06:25	20:16 (102)	06:54	19:34 (92)	07:46	07:32	08:08			
	17:06	17:52	18:32	20:16	20:56	17	20:33 (102)	21:26	20:33 (102)	21:26	21:24	20:45	18:45	16:57	16:41		
16	08:12	07:35	07:44	06:43	06:00	19:39 (92)	05:55	06:27	20:16 (102)	06:54	19:33 (92)	07:48	07:33	08:09			
	17:07	17:54	18:34	20:17	20:57	18	20:34 (102)	21:27	20:34 (102)	21:27	21:23	20:44	18:44	16:56	16:41		
17	08:11	07:34	07:42	06:41	06:00	19:38 (92)	05:54	06:28	20:16 (102)	06:54	19:32 (92)	07:49	07:35	08:10			
	17:09	17:55	18:35	20:18	20:59	19	20:35 (102)	21:27	20:35 (102)	21:27	21:22	20:42	18:42	16:55	16:41		
18	08:11	07:32	07:40	06:39	06:00	19:37 (92)	05:53	06:29	20:17 (102)	06:54	19:31 (92)	07:50	07:36	08:11			
	17:10	17:57	18:37	20:20	21:00	18	20:35 (102)	21:28	20:35 (102)	21:28	21:21	20:40	18:40	16:54	16:42		
19	08:10	07:31	07:38	06:38	06:00	19:36 (92)	05:52	06:30	20:16 (102)	06:54	19:30 (92)	07:52	07:37	08:11			
	17:11	17:58	18:38	20:21	21:01	17	20:33 (102)	21:28	20:33 (102)	21:28	21:20	20:38	18:38	16:53	16:42		
20	08:09	07:29	07:36	06:36	06:00	19:35 (92)	05:50	06:32	20:17 (102)	06:54	19:29 (92)	07:53	07:39	08:12			
	17:13	18:00	18:39	20:22	21:02	16	20:33 (102)	21:28	20:33 (102)	21:28	21:19	20:37	18:36	16:52	16:42		
21	08:08	07:27	07:34	06:34	06:00	19:34 (92)	05:49	06:33	20:18 (102)	06:54	19:28 (92)	07:55	07:40	08:13			
	17:14	18:00	18:39	20:24	21:04	14	20:32 (102)	21:29	20:32 (102)	21:29	21:19	20:35	18:34	16:51	16:43		
22	08:08	07:25	07:32	06:32	06:00	19:33 (92)	05:48	06:34	20:19 (102)	06:55	19:27 (92)	07:56	07:42	08:13			
	17:16	18:01	18:40	20:25	21:05	12	20:31 (102)	21:29	20:31 (102)	21:29	21:18	20:33	18:33	16:50	16:43		
23	08:07	07:24	07:30	06:30	06:00	19:32 (92)	05:47	06:36	20:21 (102)	06:55	19:26 (92)	07:58	07:43	08:14			
	17:17	18:03	18:42	20:27	21:06	10	20:31 (102)	21:29	20:31 (102)	21:29	21:17	20:31	18:31	16:49	16:44		
24	08:06	07:22	07:28	06:29	06:00	19:31 (92)	05:46	06:37	20:23 (102)	06:55	19:25 (92)	07:59	07:44	08:14			
	17:19	18:04	18:43	20:28	21:07	6	20:29 (102)	21:29	20:29 (102)	21:29	21:16	20:30	18:29	16:48	16:44		
25	08:05	07:20	07:26	06:27	06:00	19:30 (92)	05:45	06:38	20:22 (102)	06:56	19:24 (92)	07:59	07:46	08:14			
	17:20	18:06	18:45	20:29	21:08	21:29	21:15	20:28	20:44 (102)	20:28	20:17	19:27	18:28	16:47	16:45		
26	08:04	07:18	07:24	06:25	06:00	19:29 (92)	05:36	06:40	20:18 (102)	06:56	19:23 (92)	07:59	07:47	08:15			
	17:22	18:07	18:46	20:31	21:09	21:30	21:13	20:26	20:44 (102)	20:26	20:15	19:25	18:26	16:47	16:45		
27	08:03	07:16	07:22	06:23	06:00	19:28 (92)	05:36	06:41	20:27 (102)	06:57	19:22 (92)	07:59	07:48	08:15			
	17:23	18:09	18:48	20:32	21:10	21:30	21:12	20:24	20:45 (102)	20:24	20:13	19:23	18:24	16:46	16:46		
28	08:02	07:15	07:20	06:22	06:00	19:27 (92)	05:36	06:42	20:26 (102)	06:58	19:21 (92)	07:59	07:50	08:15			
	17:25	18:10	18:49	20:33	21:11	21:30	21:11	20:22	20:45 (102)	20:22	20:11	19:21	18:22	16:45	16:47		
29	08:01	07:18	07:23	06:20	06:00	19:26 (92)	05:37	06:43	20:26 (102)	06:59	19:20 (92)	07:59	07:51	08:16			
	17:26	18:11	18:50	20:35	21:12	21:30	21:10	20:20	20:44 (102)	20:20	20:09	19:19	18:21	16:45	16:47		
30	07:59	07:16	07:21	06:18	06:00	19:25 (92)	05:37	06:45	20:26 (102)	06:59	19:19 (92)	07:59	07:52	08:16			
	17:28	18:13	18:52	20:36	21:14	21:30	21:09	20:18	20:43 (102)	20:18	20:07	19:17	18:19	16:44	16:48		
31	07:58	07:14	07:19	06:16	06:00	19:24 (92)	05:40	06:46	20:25 (102)	06:59	19:18 (92)	07:59	07:52	08:16			
	17:29	18:14	18:53	20:37	21:15	21:30	21:07	20:17	20:42 (102)	20:17	20:06	19:16	18:18	16:45	16:49		
Potential sun hours	278	286	367	406	465	475	481	442	380	46	339	283	266				
Total, worst case				59	233		160	89		46							
Sun reduction				0.57	0.60		0.74	0.71		0.63							
Oper. time red.				0.85	0.85		0.85	0.85		0.85							
Wind dir. red.				0.71	0.72		0.72	0.71		0.71							
Total reduction				0.34	0.37		0.45	0.43		0.38							
Total, real				20	86		73	39		18							

Table layout: For each day in each month the following matrix apply

Day in month	Sun rise (hh:mm)	First time (hh:mm) with flicker	(WTG causing flicker first time)
	Sun set (hh:mm)	Minutes with flicker	Last time (hh:mm) with flicker
			(WTG causing flicker last time)

Project:

Otter Tail Ashtabula III Wind

Description:

Barnes County, ND

Licensed user:

Epsilon Associates, Inc
3 Clock Tower Place, Suite 250
US-MAYNARD MA 01754
978 897 7100
Richard Lampeter / rlampeter@epsilonassociates.com
Calculated:
6/18/2023 2:05 PM/3.6.366

SHADOW - Calendar

Calculation: Points and Grid Shadow receptor: A287 - Shadow Receptor: 1.0 x 1.0 Azimuth: 0.0° Slope: 90.0° (5177)

Assumptions for shadow calculations

Sunshine probability S/S0 (Sun hours/Possible sun hours) []

Reference year for calendar

2023

Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec
0.52 0.54 0.59 0.57 0.60 0.64 0.74 0.71 0.63 0.51 0.39 0.39

Operational time

N NNE NE ENE E ESE SE SSE S SSW SW WSW W WNW NW NNW Sum
364 231 235 234 299 398 720 587 362 314 482 477 675 931 686 429 7,424

Table with columns for months (January to December) and rows for days (1 to 31). Each cell contains start and end times for shadow calculations. Summary rows at the bottom show total sun hours, reduction, and real time.

Table layout: For each day in each month the following matrix apply

Day in month Sun rise (hh:mm) Sun set (hh:mm) Minutes with flicker First time (hh:mm) with flicker Last time (hh:mm) with flicker (WTG causing flicker first time) (WTG causing flicker last time)

Project:

Otter Tail Ashtabula III Wind

Description:

Barnes County, ND

Licensed user:

Epsilon Associates, Inc
3 Clock Tower Place, Suite 250
US-MAYNARD MA 01754
978 897 7100
Richard Lampeter / rlampeter@epsilonassociates.com
Calculated:
6/18/2023 2:05 PM/3.6.366

SHADOW - Calendar

Calculation: Points and Grid Shadow receptor: A288 - Shadow Receptor: 1.0 x 1.0 Azimuth: 0.0° Slope: 90.0° (5178)

Assumptions for shadow calculations

Sunshine probability S/S0 (Sun hours/Possible sun hours) []

Reference year for calendar

2023

Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec
0.52 0.54 0.59 0.57 0.60 0.64 0.74 0.71 0.63 0.51 0.39 0.39

Operational time

N NNE NE ENE E ESE SE SSE S SSW SW WSW W WNW NW NNW Sum
364 231 235 234 299 398 720 587 362 624 482 477 675 931 686 429 7,424

Table with columns for months (January to December) and rows for days (1 to 31). Each cell contains a time range (e.g., 08:17-17:30) and a numerical value. Summary rows at the bottom show 'Potential sun hours', 'Total, worst case', 'Sun reduction', 'Oper. time red.', 'Wind dir. red.', 'Total reduction', and 'Total, real'.

Table layout: For each day in each month the following matrix apply

Matrix with columns: Day in month, Sun rise (hh:mm), Sun set (hh:mm), Minutes with flicker, First time (hh:mm) with flicker, Last time (hh:mm) with flicker, (WTG causing flicker first time), (WTG causing flicker last time)

SHADOW - Calendar

Calculation: Points and Grid Shadow receptor: A76 - Shadow Receptor: 1.0 x 1.0 Azimuth: 0.0° Slope: 90.0° (4966)

Assumptions for shadow calculations

Reference year for calendar

2023

Sunshine probability S/S0 (Sun hours/Possible sun hours) []

Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec
 0.52 0.54 0.59 0.57 0.60 0.64 0.74 0.71 0.63 0.51 0.39 0.39

Operational time

N NNE NE ENE E ESE SE SSE S SSW SW WSW W WNW NW NNW Sum
 364 231 235 234 299 398 720 587 362 314 482 477 675 931 686 429 7,424

	January	February	March	April	May	June	July	August	September	October	November	December
1	08:16 16:50	07:57 17:31	07:13 18:12	07:12 19:56	06:17 20:38	05:40 21:16	05:38 21:30	06:08 21:06	06:48 20:15	07:27 19:15	08:11 18:16	07:54 16:44
2	08:16 16:51	07:56 17:32	07:11 18:14	07:10 19:58	06:15 20:39	05:39 21:17	05:39 21:30	06:09 21:05	06:49 20:13	07:28 19:13	08:12 18:15	07:55 16:43
3	08:16 16:52	07:55 17:34	07:09 18:15	07:08 19:59	06:14 20:40	05:38 21:18	05:39 21:29	06:10 21:04	06:50 20:11	07:30 19:11	08:14 18:13	07:56 16:43
4	08:16 16:53	07:53 17:35	07:07 18:17	07:06 20:00	06:12 20:42	05:38 21:18	05:40 21:29	06:11 21:02	06:52 20:09	07:31 19:09	08:15 18:12	07:57 16:42
5	08:16 16:54	07:52 17:37	07:05 18:18	07:04 20:02	06:11 20:43	05:37 21:19	05:40 21:29	06:13 21:01	06:53 20:07	07:32 19:07	07:17 17:10	07:59 16:42
6	08:16 16:55	07:51 17:38	07:04 18:19	07:02 20:03	06:09 20:44	05:37 21:20	05:41 21:28	06:14 20:59	06:54 20:05	07:34 19:05	07:18 17:09	08:00 16:42
7	08:16 16:56	07:49 17:40	07:02 18:21	07:00 20:05	06:08 20:46	05:36 21:21	05:42 21:28	06:15 20:58	06:55 20:03	07:35 19:03	07:20 17:07	08:01 16:41
8	08:16 16:57	07:48 17:42	07:00 18:22	06:59 20:06	06:06 20:47	05:36 21:22	05:43 21:28	06:16 20:56	06:57 20:01	07:37 19:01	07:21 17:06	08:02 16:41
9	08:15 16:59	07:46 17:43	06:58 18:24	06:57 20:07	06:05 20:48	05:36 21:23	05:43 21:27	06:18 20:55	06:58 19:59	07:38 18:57	07:23 17:05	08:03 16:41
10	08:15 17:00	07:45 17:45	06:56 18:25	06:55 20:09	06:03 20:50	05:35 21:23	05:44 21:27	06:19 20:53	06:59 19:57	07:39 18:55	07:24 17:03	08:04 16:41
11	08:15 17:01	07:43 17:46	06:54 18:27	06:53 20:10	06:02 20:51	05:35 21:24	05:45 21:26	06:20 20:52	07:01 19:55	07:41 18:53	07:26 17:02	08:05 16:41
12	08:14 17:02	07:42 17:48	06:52 18:28	06:51 20:12	06:00 20:52	05:35 21:25	05:46 21:26	06:21 20:50	07:02 19:53	07:42 18:51	07:27 17:01	08:06 16:41
13	08:14 17:03	07:40 17:49	06:50 19:30	06:49 20:13	06:49 20:54	05:35 21:25	05:47 21:25	06:23 20:49	07:03 19:51	07:44 18:49	07:29 16:59	08:07 16:41
14	08:13 17:05	07:39 17:51	07:48 19:31	06:47 20:14	06:47 20:55	05:34 21:26	05:48 21:24	06:24 20:47	07:05 19:49	07:45 18:47	07:30 16:58	08:08 16:41
15	08:13 17:06	07:37 17:52	07:46 19:32	06:45 20:16	06:45 20:56	05:34 21:26	05:49 21:24	06:25 20:45	07:06 19:47	07:46 18:46	07:32 16:57	08:08 16:41
16	08:12 17:07	07:36 17:54	07:44 19:34	06:43 20:17	06:43 20:58	05:34 21:27	05:50 21:23	06:27 20:44	07:07 19:45	07:48 18:44	07:33 16:56	08:09 16:41
17	08:12 17:09	07:34 17:55	07:42 19:35	06:41 20:18	06:41 20:59	05:34 21:27	05:51 21:22	06:28 20:42	07:09 19:43	07:49 18:42	07:35 16:55	08:10 16:41
18	08:11 17:10	07:32 17:57	07:40 19:37	06:40 20:20	6 07:10 (89) 05:53	05:34 21:28	05:52 21:21	06:29 20:40	07:10 19:41	07:51 18:40	07:36 16:54	08:11 16:42
19	08:10 17:12	07:31 17:58	07:38 19:38	06:38 20:21	7 07:11 (89) 05:52	05:34 21:28	05:53 21:21	06:31 20:39	07:11 19:39	07:52 18:38	07:38 16:53	08:11 16:42
20	08:09 17:13	07:29 18:00	07:36 19:40	06:36 20:23	8 07:11 (89) 21:02	05:34 21:28	05:54 21:20	06:32 20:37	7 07:09 (89) 19:37	07:12 18:36	07:39 16:52	08:12 16:42
21	08:09 17:14	07:27 18:00	07:34 19:41	06:34 20:24	9 07:11 (89) 21:04	05:35 21:29	05:55 21:19	06:33 20:35	8 07:06 (89) 19:35	07:14 18:35	07:40 16:51	08:13 16:43
22	08:08 17:16	07:26 18:02	07:32 19:42	06:32 20:25	10 07:10 (89) 21:05	05:35 21:29	05:56 21:18	06:35 20:33	9 07:05 (89) 19:33	07:15 18:33	07:42 16:50	08:13 16:43
23	08:07 17:17	07:24 18:03	07:30 19:44	06:30 20:27	11 07:10 (89) 21:06	05:35 21:29	05:57 21:17	06:36 20:32	10 07:15 (89) 19:31	07:16 18:31	07:58 16:49	08:14 16:44
24	08:06 17:19	07:22 18:05	07:28 19:45	06:29 20:28	12 07:08 (89) 21:07	05:35 21:29	05:58 21:16	06:37 20:30	11 07:15 (89) 19:29	07:18 18:29	07:59 16:48	08:14 16:44
25	08:05 17:20	07:20 18:06	07:26 19:47	06:27 20:30	05:45 21:08	05:35 21:30	05:59 21:15	06:38 20:28	10 07:15 (89) 19:27	08:01 18:28	07:46 16:47	08:15 16:45
26	08:04 17:22	07:18 18:08	07:24 19:48	06:25 20:31	05:44 21:09	05:36 21:30	06:00 21:14	06:40 20:26	9 07:15 (89) 19:25	08:02 18:26	07:47 16:47	08:15 16:45
27	08:03 17:23	07:17 18:09	07:22 19:49	06:24 20:32	05:44 21:11	05:36 21:30	06:02 21:12	06:41 20:24	8 07:06 (89) 19:23	08:04 18:24	07:49 16:46	08:15 16:46
28	08:02 17:25	07:15 18:11	07:20 19:51	06:22 20:34	05:43 21:12	05:37 21:30	06:03 21:11	06:42 20:22	7 07:12 (89) 19:21	08:05 18:23	07:50 16:45	08:16 16:47
29	08:01 17:26	07:14 19:52	07:18 20:35	06:20 20:35	05:42 21:13	05:37 21:30	06:04 21:10	06:44 20:20	6 07:11 (89) 19:19	08:07 18:21	07:51 16:45	08:16 16:48
30	08:00 17:28	07:12 19:54	07:16 20:36	06:19 20:36	05:41 21:14	05:38 21:30	06:05 21:09	06:45 20:19	5 07:11 (89) 19:17	08:08 18:19	07:53 16:44	08:16 16:48
31	07:58 17:29	07:11 19:55	07:14 20:36	07:14 20:36	05:40 21:15	05:40 21:30	06:06 21:08	06:46 20:17	4 07:11 (89) 18:18	08:10 17:05	08:16 16:44	08:16 16:49
Potential sun hours	278	286	367	406	465	475	481	442	380	339	283	266
Total, worst case					71							73
Sun reduction					0.57							0.71
Oper. time red.					0.85							0.85
Wind dir. red.					0.67							0.67
Total reduction					0.32							0.40
Total, real					23							29

Table layout: For each day in each month the following matrix apply

Day in month	Sun rise (hh:mm)	First time (hh:mm) with flicker	(WTG causing flicker first time)
	Sun set (hh:mm)	Minutes with flicker	Last time (hh:mm) with flicker
			(WTG causing flicker last time)

SHADOW - Calendar

Calculation: Points and Grid Shadow receptor: A77 - Shadow Receptor: 1.0 x 1.0 Azimuth: 0.0° Slope: 90.0° (4967)

Assumptions for shadow calculations

Sunshine probability S/S0 (Sun hours/Possible sun hours) []

Reference year for calendar

2023

Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec
 0.52 0.54 0.59 0.57 0.60 0.64 0.74 0.71 0.63 0.51 0.39 0.39

Operational time

N NNE NE ENE E ESE SE SSE S SSW SW WSW W WNW NW NNW Sum
 364 231 235 234 299 398 720 587 362 314 482 477 675 931 686 429 7,424

	January	February	March	April	May	June	July	August	September	October	November	December
1	08:16 16:50	07:57 17:31	07:13 18:12	07:12 19:56	06:17 20:38	05:40 21:16	05:38 21:30	06:08 21:06	06:48 20:15	07:27 19:15	08:11 18:16	07:54 16:44
2	08:16 16:51	07:56 17:32	07:11 18:14	07:10 19:58	06:15 20:39	05:39 21:17	05:39 21:29	06:09 21:05	06:49 20:13	07:28 19:13	08:12 18:15	07:55 16:43
3	08:16 16:52	07:55 17:34	07:09 18:15	07:08 19:59	06:14 20:40	05:38 21:18	05:39 21:29	06:10 21:04	06:50 20:11	07:30 19:11	08:14 18:13	07:56 16:43
4	08:16 16:53	07:53 17:35	07:07 18:16	07:06 20:00	06:12 20:42	05:38 21:18	05:40 21:29	06:11 21:02	06:52 20:09	07:31 19:09	08:15 18:12	07:57 16:42
5	08:16 16:54	07:52 17:37	07:05 18:18	07:04 20:02	06:11 20:43	05:37 21:19	05:40 21:29	06:13 21:01	06:53 20:07	07:32 19:07	07:17 17:10	07:59 16:42
6	08:16 16:55	07:51 17:38	07:04 18:19	07:02 20:03	06:09 20:44	05:37 21:20	05:41 21:28	06:14 20:59	06:54 20:05	07:34 19:05	07:18 17:09	08:00 16:42
7	08:16 16:56	07:49 17:40	07:02 18:21	07:00 20:05	06:08 20:46	05:36 21:21	05:42 21:28	06:15 20:58	06:55 20:03	07:35 19:03	07:20 17:07	08:01 16:41
8	08:16 16:57	07:48 17:42	07:00 18:22	06:59 20:06	06:06 20:47	05:36 21:22	05:43 21:28	06:16 20:56	06:57 20:01	07:37 19:01	07:21 17:06	08:02 16:41
9	08:15 16:59	07:46 17:43	06:58 18:24	06:57 20:07	06:05 20:48	05:36 21:23	05:43 21:27	06:18 20:55	06:58 19:59	07:38 18:57	07:23 17:05	08:03 16:41
10	08:15 17:00	07:45 17:45	06:56 18:25	06:55 20:09	06:03 20:50	05:35 21:23	05:44 21:27	06:19 20:53	06:59 19:57	07:39 18:55	07:24 17:03	08:04 16:41
11	08:15 17:01	07:43 17:46	06:54 18:27	06:53 20:10	06:02 20:51	05:35 21:24	05:45 21:26	06:20 20:52	07:01 19:55	07:41 18:53	07:26 17:02	08:05 16:41
12	08:14 17:02	07:42 17:48	06:52 18:28	06:51 20:12	06:00 20:52	05:35 21:25	05:46 21:26	06:21 20:50	07:02 19:53	07:42 18:51	07:27 17:01	08:06 16:41
13	08:14 17:03	07:40 17:49	06:50 19:30	06:49 20:13	05:59 20:54	05:35 21:25	05:47 21:25	06:23 20:49	07:03 19:51	07:44 18:49	07:29 16:59	08:07 16:41
14	08:13 17:05	07:39 17:51	07:48 19:31	06:47 20:14	05:58 20:55	05:34 21:26	05:48 21:24	06:24 20:47	07:05 19:49	07:45 18:47	07:30 16:58	08:08 16:41
15	08:13 17:06	07:37 17:52	07:46 19:32	06:45 20:16	05:56 20:56	05:34 21:26	05:49 21:24	06:25 20:45	07:06 19:47	07:46 18:46	07:32 16:57	08:08 16:41
16	08:12 17:07	07:36 17:54	07:44 19:34	06:43 20:17	05:55 20:58	05:34 21:27	05:50 21:23	06:27 20:44	07:07 19:45	07:48 18:44	07:33 16:56	08:09 16:41
17	08:12 17:09	07:34 17:55	07:42 19:35	06:41 20:18	05:54 20:59	05:34 21:27	05:51 21:22	06:28 20:42	07:09 19:43	07:49 18:42	07:35 16:55	08:10 16:41
18	08:11 17:10	07:32 17:57	07:40 19:37	06:40 20:20	05:53 21:00	05:34 21:28	05:52 21:21	06:29 20:40	5 07:08 (89) 07:00 (89)	19:43 19:41	18:42 18:40	16:55 16:54
19	08:10 17:11	07:31 17:58	07:38 19:38	06:38 20:21	05:52 07:01 (89) 21:01	05:34 07:04 (89) 21:01	05:53 21:28	06:31 21:21	10 07:10 (89) 06:59 (89)	19:41 19:39	18:40 18:38	16:54 16:53
20	08:09 17:13	07:29 18:00	07:36 19:40	06:36 20:23	05:51 07:05 (89) 21:02	05:34 21:28	05:54 21:20	06:32 20:37	11 07:10 (89) 06:59 (89)	19:39 19:37	18:38 18:36	16:53 16:52
21	08:09 17:14	07:27 18:00	07:34 19:41	06:34 20:24	05:49 07:06 (89) 21:04	05:35 21:29	05:55 21:19	06:33 20:35	12 06:59 (89) 07:11 (89)	19:41 19:35	18:40 18:35	16:54 16:51
22	08:08 17:16	07:26 18:02	07:32 19:42	06:32 20:25	05:48 07:06 (89) 21:05	05:35 21:29	05:56 21:18	06:35 20:33	11 07:11 (89) 07:11 (89)	19:41 19:33	18:40 18:33	16:54 16:50
23	08:07 17:17	07:24 18:03	07:30 19:44	06:30 20:27	05:47 07:06 (89) 21:06	05:35 21:29	05:57 21:17	06:36 20:32	9 07:10 (89) 07:10 (89)	19:41 19:31	18:40 18:31	16:54 16:49
24	08:06 17:19	07:22 18:05	07:28 19:45	06:29 20:28	05:46 07:06 (89) 21:07	05:35 21:29	05:58 21:16	06:37 20:30	7 07:03 (89) 07:10 (89)	19:41 19:29	18:31 18:29	16:49 16:44
25	08:05 17:20	07:20 18:06	07:26 19:47	06:27 20:30	05:45 07:05 (89) 21:08	05:35 21:30	05:59 21:15	06:38 20:28	07:04 (89) 07:08 (89)	19:41 19:27	18:01 18:28	16:46 16:45
26	08:04 17:22	07:18 18:08	07:24 19:48	06:25 20:31	05:44 07:04 (89) 21:09	05:36 21:30	06:00 21:14	06:40 20:26	07:20 19:25	19:27 18:26	18:02 18:26	16:47 16:45
27	08:03 17:23	07:17 18:09	07:22 19:49	06:24 20:32	05:44 07:03 (89) 21:11	05:36 21:30	06:02 21:12	06:41 20:24	07:22 19:23	19:27 18:24	18:04 18:24	16:49 16:46
28	08:02 17:25	07:15 18:11	07:20 19:51	06:22 20:34	05:43 21:12	05:37 21:30	06:03 21:11	06:42 20:22	07:23 19:21	19:27 18:23	18:05 18:23	16:50 16:45
29	08:01 17:26	07:14 19:52	07:18 20:35	06:20 20:35	05:42 21:13	05:37 21:30	06:04 21:10	06:44 20:20	07:24 19:19	19:27 18:21	18:07 18:21	16:51 16:45
30	08:00 17:28	07:16 19:54	07:16 20:36	06:19 20:36	05:41 21:14	05:38 21:30	06:05 21:09	06:45 20:19	07:26 19:17	19:27 18:19	18:08 18:19	16:53 16:44
31	07:58 17:29	07:14 19:55	07:14 20:36	07:14 20:36	05:40 21:15	05:40 21:30	06:06 21:08	06:46 20:17	18:18	18:18	18:18	16:49
Potential sun hours	278	286	367	406	465	475	481	442	380	339	283	266
Total, worst case					81			81				
Sun reduction					0.57			0.71				
Oper. time red.					0.85			0.85				
Wind dir. red.					0.66			0.66				
Total reduction					0.32			0.40				
Total, real					26			32				

Table layout: For each day in each month the following matrix apply

Day in month	Sun rise (hh:mm)	First time (hh:mm) with flicker	(WTG causing flicker first time)
	Sun set (hh:mm)	Minutes with flicker	Last time (hh:mm) with flicker
			(WTG causing flicker last time)

SHADOW - Calendar

Calculation: Points and Grid Shadow receptor: A79 - Shadow Receptor: 1.0 x 1.0 Azimuth: 0.0° Slope: 90.0° (4969)

Assumptions for shadow calculations

Sunshine probability S/S0 (Sun hours/Possible sun hours) []

Reference year for calendar

2023

Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec
0.52 0.54 0.59 0.57 0.60 0.64 0.74 0.71 0.63 0.51 0.39 0.39

Operational time

N NNE NE ENE E ESE SE SSE S SSW SW WSW W WNW NW NNW Sum
364 231 235 234 299 398 720 587 362 314 482 477 675 931 686 429 7,424

Table with 13 columns (January-December) and multiple rows showing sunrise/sunset times, shadow reduction percentages, and operational hours for each day of the year 2023.

Table layout: For each day in each month the following matrix apply

Matrix with 5 columns: Day in month, Sun rise (hh:mm), Sun set (hh:mm), Minutes with flicker, First time (hh:mm) with flicker, Last time (hh:mm) with flicker, (WTG causing flicker first time), (WTG causing flicker last time)

Project:

Otter Tail Ashtabula III Wind

Description:

Barnes County, ND

Licensed user:

Epsilon Associates, Inc
3 Clock Tower Place, Suite 250
US-MAYNARD MA 01754
978 897 7100
Richard Lampeter / rlampeter@epsilonassociates.com
Calculated:
6/18/2023 2:05 PM/3.6.366

SHADOW - Calendar

Calculation: Points and Grid Shadow receptor: A8 - Shadow Receptor: 1.0 x 1.0 Azimuth: 0.0° Slope: 90.0° (4898)

Assumptions for shadow calculations

Sunshine probability S/S0 (Sun hours/Possible sun hours) []

Reference year for calendar

2023

Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec
0.52 0.54 0.59 0.57 0.60 0.64 0.74 0.71 0.63 0.51 0.39 0.39

Operational time

N NNE NE ENE E ESE SE SSE S SSW SW WSW W WNW NW NNW Sum
364 231 235 234 299 398 720 587 362 314 482 477 675 931 686 429 7,424

Table with columns for months (January-December) and rows for time slots (08:16-17:29). Includes summary rows for 'Potential sun hours', 'Total, worst case', 'Sun reduction', 'Oper. time red.', 'Wind dir. red.', 'Total reduction', and 'Total, real'.

Table layout: For each day in each month the following matrix apply

Matrix with columns: Day in month, Sun rise (hh:mm), Sun set (hh:mm), Minutes with flicker, First time (hh:mm) with flicker, Last time (hh:mm) with flicker, (WTG causing flicker first time), (WTG causing flicker last time)

SHADOW - Calendar

Calculation: Points and Grid Shadow receptor: A80 - Shadow Receptor: 1.0 x 1.0 Azimuth: 0.0° Slope: 90.0° (4970)

Assumptions for shadow calculations

Sunshine probability S/S0 (Sun hours/Possible sun hours) []

Reference year for calendar

2023

Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec
 0.52 0.54 0.59 0.57 0.60 0.64 0.74 0.71 0.63 0.51 0.39 0.39

Operational time

N NNE NE ENE E ESE SE SSE S SSW SW WSW W WNW NW NNW Sum
 364 231 235 234 299 398 720 587 362 314 482 477 675 931 686 429 7,424

	January	February	March	April	May	June	July	August	September	October	November	December
1	08:16 16:50	07:57 17:31	07:13 18:12	07:12 19:56	06:17 20:38	06:57 (114) 21:16	05:40 21:30	05:38 21:06	06:08 20:15	07:27 19:15	08:11 18:16	07:54 16:43
2	08:16 16:51	07:56 17:32	07:11 18:14	07:10 19:58	06:15 20:39	06:59 (114) 21:17	05:39 21:30	05:39 21:05	06:09 21:05	07:28 19:13	08:12 18:15	07:55 16:43
3	08:16 16:52	07:55 17:34	07:09 18:15	07:08 19:59	06:14 20:40	07:00 (114) 21:18	05:38 21:29	05:39 21:04	06:10 21:04	07:30 19:11	08:14 18:13	07:56 16:43
4	08:16 16:53	07:53 17:35	07:07 18:16	07:06 20:00	06:12 20:42	07:07 (114) 21:18	05:38 21:29	06:11 21:02	06:11 21:02	07:31 19:09	08:15 18:12	07:57 16:42
5	08:16 16:54	07:52 17:37	07:05 18:18	07:04 20:02	06:11 20:43		05:37 21:19	06:12 21:01	06:12 21:01	07:32 19:07	08:17 17:10	07:59 16:42
6	08:16 16:55	07:51 17:38	07:04 18:19	07:02 20:03	06:09 20:44		05:37 21:20	06:14 20:59	06:14 20:59	07:34 19:05	08:18 17:09	08:00 16:41
7	08:16 16:56	07:49 17:40	07:02 18:21	07:00 20:05	06:07 20:46		05:36 21:21	06:15 20:58	06:15 20:58	07:35 19:03	08:20 17:07	08:01 16:41
8	08:16 16:57	07:48 17:41	07:00 18:22	06:58 20:06	06:06 20:47		05:36 21:22	06:16 20:56	06:16 20:56	07:37 19:01	08:21 17:06	08:02 16:41
9	08:15 16:59	07:46 17:43	06:58 18:24	06:57 20:07	06:05 20:48		05:36 21:23	06:18 20:55	06:18 20:55	07:38 18:57	08:23 17:04	08:03 16:41
10	08:15 17:00	07:45 17:45	06:56 18:25	06:55 20:09	06:03 20:50		05:35 21:23	06:19 20:53	06:19 20:53	07:39 18:55	08:24 17:03	08:04 16:41
11	08:15 17:01	07:43 17:46	06:54 18:27	06:53 20:10	06:02 20:51		05:35 21:24	06:20 20:52	06:20 20:52	07:41 19:55	08:25 17:02	08:05 16:41
12	08:14 17:02	07:42 17:48	07:52 18:28	06:51 20:12	06:00 20:52		05:35 21:25	06:21 20:50	06:21 20:50	07:42 19:53	08:26 17:01	08:06 16:41
13	08:14 17:03	07:40 17:49	07:50 19:30	06:49 20:13	05:59 20:54	07:14 (118)	05:35 21:25	06:23 20:49	06:23 20:49	07:44 19:51	08:27 16:59	08:07 16:41
14	08:13 17:05	07:39 17:51	07:48 19:31	06:47 20:14	05:58 20:55	07:11 (118) 07:20 (118)	05:34 21:26	06:24 20:47	06:24 20:47	07:45 19:49	08:28 16:58	08:08 16:41
15	08:13 17:06	07:37 17:52	07:46 19:32	06:45 20:16	05:56 20:56	07:09 (118) 07:21 (118)	05:34 21:26	06:25 20:45	06:25 20:45	07:46 19:47	08:29 16:57	08:08 16:41
16	08:12 17:07	07:36 17:54	07:44 19:34	06:43 20:17	05:55 20:58	07:09 (118) 07:22 (118)	05:34 21:27	06:27 20:44	06:27 20:44	07:47 19:45	08:30 16:56	08:09 16:41
17	08:12 17:09	07:34 17:55	07:42 19:35	06:41 20:18	05:54 20:59	07:08 (118) 07:22 (118)	05:34 21:27	06:28 20:42	06:28 20:42	07:48 19:43	08:31 16:55	08:10 16:41
18	08:11 17:10	07:32 17:57	07:40 19:37	06:39 20:20	05:53 21:00	07:08 (118) 07:21 (118)	05:34 21:28	06:29 20:40	06:29 20:40	07:49 19:41	08:32 16:54	08:11 16:42
19	08:10 17:11	07:31 17:58	07:38 19:38	06:38 20:21	05:52 21:01	07:08 (118) 07:21 (118)	05:34 21:28	06:31 20:39	06:31 20:39	07:51 19:39	08:33 16:53	08:11 16:42
20	08:09 17:13	07:29 18:00	07:36 19:40	06:36 20:23	05:50 21:02	07:08 (118) 07:19 (118)	05:34 21:28	06:32 20:37	06:32 20:37	07:52 19:37	08:34 16:52	08:12 16:42
21	08:09 17:14	07:27 18:00	07:34 19:41	06:34 20:24	05:49 21:04	07:02 (114) 07:19 (118)	05:34 21:29	06:33 20:35	06:33 20:35	07:53 19:35	08:35 16:51	08:13 16:43
22	08:08 17:16	07:26 18:01	07:32 19:42	06:32 20:25	05:48 21:05	07:00 (114) 07:16 (118)	05:35 21:29	06:34 20:33	06:34 20:33	07:54 19:33	08:36 16:50	08:14 16:43
23	08:07 17:17	07:24 18:03	07:30 19:44	06:30 20:27	05:47 21:06	06:58 (114) 07:12 (114)	05:35 21:29	06:36 20:32	06:36 20:32	07:55 19:31	08:37 16:49	08:14 16:44
24	08:06 17:19	07:22 18:05	07:28 19:45	06:29 20:28	05:46 21:07	06:58 (114) 07:13 (114)	05:35 21:30	06:37 20:30	06:37 20:30	07:56 19:29	08:38 16:48	08:14 16:44
25	08:05 17:20	07:20 18:06	07:26 19:47	06:27 20:29	05:45 21:08	06:57 (114) 07:13 (114)	05:35 21:30	06:38 20:28	06:38 20:28	07:57 19:27	08:39 16:47	08:15 16:45
26	08:04 17:22	07:18 18:08	07:24 19:48	06:25 20:31	05:44 21:09	06:56 (114) 07:13 (114)	05:36 21:30	06:40 20:26	06:40 20:26	07:58 19:25	08:40 16:47	08:15 16:45
27	08:03 17:23	07:17 18:09	07:22 19:49	06:23 20:32	05:44 21:11	06:56 (114) 07:14 (114)	05:36 21:30	06:41 20:24	06:41 20:24	07:59 19:23	08:41 16:46	08:15 16:46
28	08:02 17:25	07:15 18:11	07:20 19:51	06:22 20:34	05:43 21:12	06:56 (114) 07:13 (114)	05:37 21:30	06:42 20:22	06:42 20:22	08:00 19:21	08:42 16:45	08:16 16:47
29	08:01 17:26		07:18 19:52	06:20 20:35	05:42 21:13	06:56 (114) 07:12 (114)	05:37 21:30	06:44 20:20	06:44 20:20	08:01 19:19	08:43 16:45	08:16 16:47
30	08:00 17:28		07:16 19:54	06:18 20:36	05:41 21:14	06:57 (114) 07:12 (114)	05:37 21:30	06:45 20:19	06:45 20:19	08:02 19:17	08:44 16:44	08:16 16:48
31	07:58 17:29		07:14 19:55	06:17 21:15	05:40 21:15		06:06 21:08	06:46 20:17	06:46 20:17	08:03 18:18	08:45 16:44	08:16 16:49
Potential sun hours	278	286	367	406	465	475	481	442	380	339	283	266
Total, worst case				250	30			281				
Sun reduction				0.57	0.60			0.71				
Oper. time red.				0.85	0.85			0.85				
Wind dir. red.				0.67	0.66			0.67				
Total reduction				0.32	0.34			0.40				
Total, real				80	10			113				

Table layout: For each day in each month the following matrix apply

Day in month	Sun rise (hh:mm)	Sun set (hh:mm)	Minutes with flicker	First time (hh:mm) with flicker	Last time (hh:mm) with flicker	(WTG causing flicker first time)	(WTG causing flicker last time)
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SHADOW - Calendar

Calculation: Points and Grid Shadow receptor: A81 - Shadow Receptor: 1.0 × 1.0 Azimuth: 0.0° Slope: 90.0° (4971)

Assumptions for shadow calculations

Sunshine probability S/S0 (Sun hours/Possible sun hours) []

Reference year for calendar

2023

Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec
0.52 0.54 0.59 0.57 0.60 0.64 0.74 0.71 0.63 0.51 0.39 0.39

Operational time

N NNE NE ENE E ESE SE SSE S SSW SW WSW W WNW NW NNW Sum
364 231 235 234 299 398 720 587 362 314 482 477 675 931 686 429 7,424

	January	February	March	April	May	June	July	August	September	October	November	December	
1	08:16 16:50	07:57 17:31	07:13 18:12	07:12 19:56	06:17 20:38	05:40 21:16	05:38 21:30	06:08 21:06	06:48 20:15	07:17 (118) 14 07:31 (118)	07:27 19:15	08:11 18:16	07:54 16:43
2	08:16 16:51	07:56 17:32	07:11 18:14	07:10 19:58	06:15 20:39	05:39 21:17	05:39 21:30	06:09 21:05	06:49 20:13	07:16 (104) 14 07:30 (118)	07:28 19:13	08:12 18:15	07:55 16:43
3	08:16 16:52	07:55 17:34	07:09 18:15	07:08 19:59	06:14 20:40	05:38 21:18	05:39 21:29	06:10 21:04	06:50 20:11	07:15 (104) 13 07:28 (118)	07:30 19:11	08:14 18:13	07:56 16:43
4	08:16 16:53	07:53 17:35	07:07 18:16	07:06 20:00	06:12 20:42	05:38 21:18	05:40 21:29	06:11 21:02	06:51 20:09	07:16 (104) 10 07:26 (118)	07:31 19:09	08:15 18:12	07:57 16:42
5	08:16 16:54	07:52 17:37	07:05 18:18	07:04 20:02	06:11 20:43	05:37 21:19	05:40 21:29	06:12 21:01	06:53 20:07	07:18 (104) 7 07:25 (104)	07:32 19:07	07:17 17:10	07:59 16:42
6	08:16 16:55	07:51 17:38	07:04 18:19	07:02 20:03	06:09 20:44	05:37 21:20	05:41 21:28	06:14 20:59	06:54 20:05	07:19 (104) 4 07:23 (104)	07:34 19:05	07:18 17:09	08:00 16:41
7	08:16 16:56	07:49 17:40	07:02 18:21	07:00 20:05	06:07 20:46	05:36 21:21	05:42 21:28	06:15 20:58	06:55 20:03		07:35 19:03	07:20 17:07	08:01 16:41
8	08:16 16:57	07:48 17:41	07:00 18:22	06:58 20:06	06:06 20:47	05:36 21:22	05:43 21:28	06:16 20:56	06:57 20:01		07:37 19:01	07:21 17:06	08:02 16:41
9	08:15 16:59	07:46 17:43	06:58 18:24	06:57 20:07	06:05 20:48	05:36 21:23	05:43 21:27	06:18 20:55	06:58 19:59		07:38 18:57	07:23 17:04	08:03 16:41
10	08:15 17:00	07:45 17:45	06:56 18:25	06:55 20:09	06:03 20:50	05:35 21:23	05:44 21:27	06:19 20:53	06:59 19:57		07:39 18:55	07:24 17:03	08:04 16:41
11	08:15 17:01	07:43 17:46	06:54 18:27	06:53 20:10	06:02 20:51	05:35 21:24	05:45 21:26	06:20 20:52	07:01 19:55		07:41 18:53	07:26 17:02	08:05 16:41
12	08:14 17:02	07:42 17:48	07:52 18:28	06:51 20:12	06:00 20:52	05:35 21:25	05:46 21:26	06:21 20:50	07:02 19:53		07:42 18:51	07:27 17:01	08:06 16:41
13	08:14 17:03	07:40 17:49	07:50 18:30	06:49 20:13	06:49 20:54	05:35 21:25	05:47 21:25	06:23 20:49	07:03 19:51		07:44 18:49	07:29 16:59	08:07 16:41
14	08:13 17:05	07:39 17:51	07:48 18:31	06:47 20:14	06:47 20:55	05:34 21:26	05:48 21:24	06:24 20:47	07:05 19:49		07:45 18:47	07:30 16:58	08:08 16:41
15	08:13 17:06	07:37 17:52	07:46 18:32	06:45 20:16	06:45 20:56	05:34 21:26	05:49 21:24	06:25 20:45	07:06 19:47		07:46 18:46	07:32 16:57	08:09 16:41
16	08:12 17:07	07:36 17:54	07:44 18:34	06:43 20:17	06:43 20:58	05:34 21:27	05:50 21:23	06:27 20:44	07:07 19:45		07:48 18:44	07:33 16:56	08:09 16:41
17	08:12 17:09	07:34 17:55	07:42 18:35	06:41 20:18	06:41 20:59	05:34 21:27	05:51 21:22	06:28 20:42	07:09 19:43		07:49 18:42	07:35 16:55	08:10 16:41
18	08:11 17:10	07:32 17:57	07:40 18:37	06:39 20:20	06:39 21:00	05:33 21:28	05:52 21:21	06:29 20:40	07:10 19:41		07:51 18:40	07:36 16:54	08:11 16:42
19	08:10 17:11	07:31 17:58	07:38 18:38	06:38 20:21	06:38 21:01	05:34 21:28	05:53 21:21	06:31 20:39	07:11 19:39	07:17 (114) 8 07:25 (114)	07:52 18:38	07:38 16:53	08:11 16:42
20	08:09 17:13	07:29 18:00	07:36 19:40	06:36 20:23	06:36 21:02	05:34 21:28	05:54 21:20	06:32 20:37	07:12 19:37	07:16 (114) 11 07:27 (114)	07:53 18:36	07:39 16:52	08:12 16:42
21	08:09 17:14	07:27 18:00	07:34 19:41	06:34 20:24	06:34 21:04	05:34 21:29	05:55 21:19	06:33 20:35	07:14 19:35	07:14 (114) 14 07:28 (114)	07:55 18:35	07:40 16:51	08:13 16:43
22	08:08 17:16	07:26 18:01	07:32 19:42	06:32 20:25	06:32 21:05	05:35 21:29	05:56 21:18	06:34 20:33	07:15 19:33	07:13 (114) 15 07:28 (114)	07:56 18:33	07:42 16:50	08:13 16:43
23	08:07 17:17	07:24 18:03	07:30 19:44	06:30 20:27	06:30 21:06	05:35 21:29	05:57 21:17	06:36 20:32	07:16 19:31	07:12 (114) 16 07:28 (114)	07:57 18:31	07:43 16:49	08:14 16:44
24	08:06 17:19	07:22 18:05	07:28 19:45	06:29 20:28	06:29 21:07	05:35 21:30	05:58 21:16	06:37 20:30	07:18 19:29	07:12 (114) 17 07:29 (114)	07:59 18:29	07:45 16:48	08:14 16:44
25	08:05 17:20	07:20 18:06	07:26 19:47	06:27 20:30	06:27 21:08	05:35 21:30	05:59 21:15	06:38 20:28	07:19 19:27	07:12 (114) 16 07:28 (114)	08:01 18:28	07:46 16:47	08:15 16:45
26	08:04 17:22	07:18 18:08	07:24 19:48	06:25 20:31	06:25 21:09	05:36 21:30	06:00 21:14	06:40 20:26	07:20 19:25	07:12 (114) 15 07:27 (114)	08:02 18:26	07:47 16:47	08:15 16:45
27	08:03 17:23	07:17 18:09	07:22 19:49	06:23 20:32	06:23 21:11	05:36 21:30	06:02 21:12	06:41 20:24	07:22 19:23	07:12 (114) 14 07:26 (114)	08:04 18:24	07:49 16:46	08:15 16:46
28	08:02 17:25	07:15 18:11	07:20 19:50	06:22 20:34	06:22 21:12	05:37 21:30	06:03 21:11	06:42 20:22	07:23 19:21	07:13 (114) 16 07:29 (118)	08:05 18:23	07:50 16:45	08:16 16:47
29	08:01 17:26		07:18 19:52	06:20 20:35	06:20 21:13	05:37 21:30	06:04 21:10	06:44 20:20	07:24 19:19	07:14 (114) 16 07:30 (118)	08:07 18:21	07:51 16:45	08:16 16:47
30	08:00 17:28		07:16 19:54	06:18 20:36	06:18 21:14	05:37 21:30	06:05 21:09	06:45 20:19	07:26 19:17	07:18 (118) 12 07:30 (118)	08:08 18:19	07:53 16:44	08:16 16:48
31	07:58 17:29		07:14 19:55	06:17 20:37	06:17 21:15	05:40 21:30	06:06 21:08	06:46 20:17	07:27 19:13	07:17 (118) 13 07:30 (118)	08:10 18:18	07:54 16:49	08:16 16:49
Potential sun hours	278	286	367	406	465	475	481	442	380		339	283	266
Total, worst case				247				183		62			
Sun reduction				0.57				0.71		0.63			
Oper. time red.				0.85				0.85		0.85			
Wind dir. red.				0.67				0.67		0.68			
Total reduction				0.33				0.40		0.36			
Total, real				80				74		23			

Table layout: For each day in each month the following matrix apply

Day in month	Sun rise (hh:mm)	Sun set (hh:mm)	Minutes with flicker	First time (hh:mm) with flicker	Last time (hh:mm) with flicker	(WTG causing flicker first time)	(WTG causing flicker last time)
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Project:

Otter Tail Ashtabula III Wind

Description:

Barnes County, ND

Licensed user:

Epsilon Associates, Inc
3 Clock Tower Place, Suite 250
US-MAYNARD MA 01754
978 897 7100
Richard Lampeter / rlampeter@epsilonassociates.com
Calculated:
6/18/2023 2:05 PM/3.6.366

SHADOW - Calendar

Calculation: Points and Grid Shadow receptor: A82 - Shadow Receptor: 1.0 x 1.0 Azimuth: 0.0° Slope: 90.0° (4972)

Assumptions for shadow calculations

Sunshine probability S/S0 (Sun hours/Possible sun hours) []

Reference year for calendar

2023

Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec
0.52 0.54 0.59 0.57 0.60 0.64 0.74 0.71 0.63 0.51 0.39 0.39

Operational time

N NNE NE ENE E ESE SE SSE S SSW SW WSW W WNW NW NNW Sum
364 231 235 234 299 398 720 587 362 314 482 477 675 931 686 429 7,424

Table with 13 columns for months (January-December) and 13 rows for time slots (1-13). Each cell contains start and end times and a count. Summary rows at the bottom show potential sun hours, total reduction, and real reduction for each month.

Table layout: For each day in each month the following matrix apply

Matrix with 2 rows and 4 columns: Day in month, Sun rise (hh:mm), Sun set (hh:mm), Minutes with flicker, First time (hh:mm) with flicker, Last time (hh:mm) with flicker, (WTG causing flicker first time), (WTG causing flicker last time)

Project:

Otter Tail Ashtabula III Wind

Description:

Barnes County, ND

Licensed user:

Epsilon Associates, Inc
3 Clock Tower Place, Suite 250
US-MAYNARD MA 01754
978 897 7100
Richard Lampeter / rlampeter@epsilonassociates.com
Calculated:
6/18/2023 2:05 PM/3.6.366

SHADOW - Calendar

Calculation: Points and Grid Shadow receptor: A83 - Shadow Receptor: 1.0 x 1.0 Azimuth: 0.0° Slope: 90.0° (4973)

Assumptions for shadow calculations

Sunshine probability S/S0 (Sun hours/Possible sun hours) []

Reference year for calendar

2023

Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec
0.52 0.54 0.59 0.57 0.60 0.64 0.74 0.71 0.63 0.51 0.39 0.39

Operational time

N NNE NE ENE E ESE SE SSE S SSW SW WSW W WNW NW NNW Sum
364 231 235 234 299 398 720 587 362 314 482 477 675 931 686 429 7,424

Table with columns for months (January to December) and rows for days (1 to 31). Each cell contains sun rise and set times, and a grid of shadow reduction values. Summary rows at the bottom show total sun hours and reduction percentages.

Table layout: For each day in each month the following matrix apply

Day in month Sun rise (hh:mm) Sun set (hh:mm) Minutes with flicker First time (hh:mm) with flicker Last time (hh:mm) with flicker (WTG causing flicker first time) (WTG causing flicker last time)

Project:

Otter Tail Ashtabula III Wind

Description:

Barnes County, ND

Licensed user:

Epsilon Associates, Inc
3 Clock Tower Place, Suite 250
US-MAYNARD MA 01754
978 897 7100
Richard Lampeter / rlampeter@epsilonassociates.com
Calculated:
6/18/2023 2:05 PM/3.6.366

SHADOW - Calendar

Calculation: Points and Grid Shadow receptor: A84 - Shadow Receptor: 1.0 x 1.0 Azimuth: 0.0° Slope: 90.0° (4974)

Assumptions for shadow calculations

Sunshine probability S/S0 (Sun hours/Possible sun hours) []

Reference year for calendar

2023

Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec
0.52 0.54 0.59 0.57 0.60 0.64 0.74 0.71 0.63 0.51 0.39 0.39

Operational time

N NNE NE ENE E ESE SE SSE S SSW SW WSW W WNW NW NNW Sum
364 231 235 234 299 398 720 587 362 314 482 477 675 931 686 429 7,424

Table with 13 columns for months (January-December) and 13 rows for days (1-13). Each cell contains start and end times for shadow calculations. Includes summary rows for Potential sun hours, Total, worst case, Sun reduction, Oper. time red., Wind dir. red., Total reduction, and Total, real.

Table layout: For each day in each month the following matrix apply

Matrix with 2 rows and 4 columns: Day in month, Sun rise (hh:mm), Sun set (hh:mm), Minutes with flicker, First time (hh:mm) with flicker, Last time (hh:mm) with flicker, (WTG causing flicker first time), (WTG causing flicker last time)

SHADOW - Calendar

Calculation: Points and Grid Shadow receptor: A85 - Shadow Receptor: 1.0 x 1.0 Azimuth: 0.0° Slope: 90.0° (4975)

Assumptions for shadow calculations

Reference year for calendar

2023

Sunshine probability S/S0 (Sun hours/Possible sun hours) []

Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec
0.52 0.54 0.59 0.57 0.60 0.64 0.74 0.71 0.63 0.51 0.39 0.39

Operational time

N NNE NE ENE E ESE SE SSE S SSW SW WSW W WNW NW NNW Sum
364 231 235 234 299 398 720 587 362 314 482 477 675 931 686 429 7,424

	January	February	March	April	May	June	July	August	September	October	November	December		
1	08:16	07:57	07:13	07:12	06:17	05:40	05:38	06:08	06:48	07:20 (118)	07:27	08:11	07:54	
	16:50	17:31	18:12	19:56	20:38	21:16	21:30	21:06	20:15	13	07:33 (118)	19:15	18:16	16:43
2	08:16	07:56	07:11	07:10	06:15	05:39	05:39	06:09	06:49	07:18 (104)	07:28	08:12	07:55	
	16:51	17:32	18:14	19:58	20:39	21:17	21:30	21:05	20:13	14	07:32 (118)	19:13	18:15	16:43
3	08:16	07:55	07:09	07:08	06:14	05:38	05:39	06:10	06:50	07:17 (104)	07:30	08:14	07:56	
	16:52	17:34	18:15	19:59	20:40	21:18	21:29	21:04	20:11	14	07:31 (118)	19:11	18:13	16:43
4	08:16	07:53	07:07	07:06	06:12	05:38	05:40	06:11	06:51	07:17 (104)	07:31	08:15	07:57	
	16:53	17:35	18:16	20:00	20:42	21:18	21:29	21:02	20:09	13	07:30 (118)	19:09	18:12	16:42
5	08:16	07:52	07:05	07:04	06:11	05:37	05:40	06:12	06:53	07:18 (104)	07:32	07:17	07:59	
	16:54	17:37	18:18	20:02	20:43	21:19	21:29	21:01	20:07	11	07:29 (118)	19:07	17:10	16:42
6	08:16	07:51	07:04	07:02	06:09	05:37	05:41	06:14	06:54	07:19 (104)	07:34	07:18	08:00	
	16:55	17:38	18:19	20:03	20:44	21:20	21:28	20:59	20:05	7	07:26 (118)	19:05	17:09	16:41
7	08:16	07:49	07:02	07:00	06:07	05:36	05:42	06:15	06:55	07:20 (104)	07:35	07:20	08:01	
	16:56	17:40	18:21	20:05	5	07:29 (104)	20:46	21:21	20:03	3	07:23 (104)	19:03	17:07	16:41
8	08:16	07:48	07:00	06:58	06:06	05:36	05:43	06:16	06:57	07:37	07:21	08:02		
	16:57	17:41	18:22	20:06	9	07:31 (118)	20:47	21:22	20:01		19:01	17:06	16:41	
9	08:15	07:46	06:58	06:57	06:05	05:36	05:43	06:18	06:58	07:38	07:23	08:03		
	16:59	17:43	18:24	20:07	13	07:33 (118)	20:48	21:23	19:59		18:57	17:04	16:41	
10	08:15	07:45	06:56	06:55	06:03	05:35	05:44	06:19	06:59	07:39	07:24	08:04		
	17:00	17:45	18:25	20:09	13	07:33 (118)	20:50	21:23	19:57		18:55	17:03	16:41	
11	08:15	07:43	06:54	06:53	06:02	05:35	05:45	06:20	07:01	07:41	07:26	08:05		
	17:01	17:46	18:27	20:10	14	07:33 (118)	20:51	21:24	19:55		18:53	17:02	16:41	
12	08:14	07:42	07:52	06:51	06:00	05:35	05:46	06:21	07:02	07:42	07:27	08:06		
	17:02	17:48	18:28	20:12	13	07:33 (118)	20:52	21:25	19:53		18:51	17:01	16:41	
13	08:14	07:40	07:50	06:49	06:49	07:20 (118)	05:59	05:35	05:47	06:23	07:43	07:29	08:07	
	17:03	17:49	19:30	20:13	12	07:32 (118)	20:54	21:25	19:51		18:49	16:59	16:41	
14	08:13	07:39	07:48	06:47	06:47	07:16 (114)	05:58	05:34	05:48	06:24	07:45	07:30	08:08	
	17:05	17:51	19:31	20:14	15	07:31 (118)	20:55	21:26	19:49		18:47	16:58	16:41	
15	08:13	07:37	07:46	06:45	06:45	07:14 (114)	05:56	05:34	05:49	06:25	07:46	07:32	08:09	
	17:06	17:52	19:32	20:16	16	07:30 (118)	20:56	21:26	19:47		18:46	16:57	16:41	
16	08:12	07:36	07:44	06:43	06:43	07:14 (114)	05:55	05:34	05:50	06:27	07:48	07:33	08:09	
	17:07	17:54	19:34	20:17	14	07:28 (118)	20:58	21:27	19:45		18:44	16:56	16:41	
17	08:12	07:34	07:42	06:41	06:41	07:13 (114)	05:54	05:34	05:51	06:28	07:49	07:35	08:10	
	17:09	17:55	19:35	20:18	15	07:28 (114)	20:59	21:27	19:43		18:42	16:55	16:41	
18	08:11	07:32	07:40	06:39	06:39	07:12 (114)	05:53	05:34	05:52	06:29	07:10	07:36	08:11	
	17:10	17:57	19:37	20:20	16	07:28 (114)	21:00	21:28	19:41		18:40	16:54	16:42	
19	08:10	07:31	07:38	06:38	06:38	07:11 (114)	05:52	05:34	05:53	06:31	07:11	07:38	08:11	
	17:11	17:58	19:38	20:21	17	07:28 (114)	21:01	21:28	19:39		18:38	16:53	16:42	
20	08:09	07:29	07:36	06:36	06:36	07:11 (114)	05:50	05:34	05:54	06:32	07:12	07:39	08:12	
	17:13	18:00	19:40	20:23	16	07:27 (114)	21:02	21:28	19:37	5	07:22 (114)	18:36	16:52	16:42
21	08:09	07:27	07:34	06:34	06:34	07:12 (114)	05:49	05:34	05:55	06:33	07:19 (114)	07:14	08:13	
	17:14	18:00	19:41	20:24	15	07:27 (114)	21:04	21:29	19:35	10	07:29 (114)	18:35	16:51	16:43
22	08:08	07:26	07:32	06:32	06:32	07:12 (114)	05:48	05:35	05:56	06:34	07:17 (114)	07:15	08:13	
	17:16	18:01	19:42	20:25	14	07:26 (114)	21:05	21:29	19:33	13	07:30 (114)	18:33	16:50	16:43
23	08:07	07:24	07:30	06:30	06:30	07:13 (114)	05:47	05:35	05:57	06:36	07:16 (114)	07:16	08:14	
	17:17	18:03	19:44	20:27	11	07:24 (114)	21:06	21:29	19:31	14	07:30 (114)	18:31	16:49	16:44
24	08:06	07:22	07:28	06:29	06:29	07:15 (114)	05:46	05:35	05:58	06:37	07:16 (114)	07:18	08:14	
	17:19	18:05	19:45	20:28	7	07:22 (114)	21:07	21:30	19:29	15	07:31 (114)	18:29	16:48	16:44
25	08:05	07:20	07:26	06:27	06:27	05:45	05:35	05:59	06:38	07:15 (114)	07:19	08:01	07:46	08:15
	17:20	18:06	19:47	20:30	21:08	21:30	21:15	20:28	16	07:31 (114)	19:27	18:28	16:47	16:45
26	08:04	07:18	07:24	06:25	06:25	05:44	05:36	06:00	06:40	07:14 (114)	07:20	08:02	07:47	08:15
	17:22	18:08	19:48	20:31	21:09	21:30	21:14	20:26	17	07:31 (114)	19:25	18:26	16:47	16:45
27	08:03	07:17	07:22	06:23	06:23	05:44	05:36	06:02	06:41	07:14 (114)	07:22	08:04	07:49	08:15
	17:23	18:09	19:49	20:32	21:11	21:30	21:12	20:24	16	07:30 (114)	19:23	18:24	16:46	16:46
28	08:02	07:15	07:20	06:22	06:22	05:43	05:37	06:03	06:42	07:15 (114)	07:23	08:05	07:50	08:16
	17:25	18:11	19:51	20:34	21:12	21:30	21:11	20:22	15	07:30 (114)	19:21	18:23	16:45	16:47
29	08:01	07:18	07:23	06:20	06:20	05:42	05:37	06:04	06:44	07:15 (114)	07:24	08:07	07:51	08:16
	17:26	18:12	19:52	20:35	21:13	21:30	21:10	20:20	16	07:31 (118)	19:19	18:21	16:45	16:47
30	08:00	07:16	07:21	06:18	06:18	05:41	05:37	06:05	06:45	07:16 (114)	07:26	08:08	07:53	08:16
	17:28	18:14	19:54	20:36	21:14	21:30	21:09	20:19	16	07:32 (118)	19:17	18:19	16:44	16:48
31	07:58	07:14	07:19	06:14	06:14	05:40	06:06	06:46	07:18 (114)			08:10	08:16	
	17:29	18:15	19:55	20:37	21:15	21:30	21:08	20:17	14	07:32 (118)		18:18	16:49	
Potential sun hours	278	286	367	406	465	475	481	442	380		339	283	266	
Total, worst case				235				167		75				
Sun reduction				0.57				0.71		0.63				
Oper. time red.				0.85				0.85		0.85				
Wind dir. red.				0.68				0.67		0.68				
Total reduction				0.33				0.41		0.36				
Total, real				77				68		27				

Table layout: For each day in each month the following matrix apply

Day in month	Sun rise (hh:mm)	Minutes with flicker	First time (hh:mm) with flicker	(WTG causing flicker first time)
	Sun set (hh:mm)		Last time (hh:mm) with flicker	(WTG causing flicker last time)

Project:

Otter Tail Ashtabula III Wind

Description:

Barnes County, ND

Licensed user:

Epsilon Associates, Inc
3 Clock Tower Place, Suite 250
US-MAYNARD MA 01754
978 897 7100
Richard Lampeter / rlampeter@epsilonassociates.com
Calculated:
6/18/2023 2:05 PM/3.6.366

SHADOW - Calendar

Calculation: Points and Grid Shadow receptor: A86 - Shadow Receptor: 1.0 x 1.0 Azimuth: 0.0° Slope: 90.0° (4976)

Assumptions for shadow calculations

Sunshine probability S/S0 (Sun hours/Possible sun hours) []

Reference year for calendar

2023

Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec
0.52 0.54 0.59 0.57 0.60 0.64 0.74 0.71 0.63 0.51 0.39 0.39

Operational time

N NNE NE ENE E ESE SE SSE S SSW SW WSW W WNW NW NNW Sum
364 231 235 234 299 398 720 587 362 314 482 477 675 931 686 429 7,424

Table with columns for months (January to December) and rows for days (1 to 31). Each cell contains sun rise and set times (hh:mm) and potential sun hours. Summary rows at the bottom show total reduction and real values for various metrics.

Table layout: For each day in each month the following matrix apply

Day in month Sun rise (hh:mm) Sun set (hh:mm) First time (hh:mm) with flicker Last time (hh:mm) with flicker (WTG causing flicker first time) (WTG causing flicker last time)

SHADOW - Calendar

Calculation: Points and Grid Shadow receptor: A87 - Shadow Receptor: 1.0 x 1.0 Azimuth: 0.0° Slope: 90.0° (4977)

Assumptions for shadow calculations

Sunshine probability S/S0 (Sun hours/Possible sun hours) []

Reference year for calendar

2023

Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec
 0.52 0.54 0.59 0.57 0.60 0.64 0.74 0.71 0.63 0.51 0.39 0.39

Operational time

N NNE NE ENE E ESE SE SSE S SSW SW WSW W WNW NW NNW Sum
 364 231 235 234 299 398 720 587 362 314 482 477 675 931 686 429 7,424

	January	February	March	April	May	June
1	08:16 16:50	07:57 17:31	07:13 18:12	07:12 19:56		06:17 20:38
2	08:16 16:51	07:56 17:32	07:11 18:14	07:10 19:58	07:33 (104) 07:43 (118)	06:15 20:39
3	08:16 16:52	07:55 17:34	07:09 18:15	07:08 19:59	07:31 (104) 07:45 (118)	06:14 20:40
4	08:16 16:53	07:53 17:35	07:07 18:16	07:06 20:00	07:30 (104) 07:45 (118)	06:12 20:42
5	08:16 16:54	07:52 17:37	07:05 18:18	07:04 20:02	07:31 (104) 07:47 (118)	06:11 20:43
6	08:16 16:55	07:51 17:38	07:04 18:19	07:02 20:03	07:31 (104) 07:46 (118)	06:09 20:44
7	08:16 16:56	07:49 17:40	07:02 18:21	07:00 20:05	07:31 (104) 07:46 (118)	06:07 20:46
8	08:16 16:57	07:48 17:41	07:00 18:22	06:58 20:06	07:30 (114) 07:45 (118)	06:06 20:47
9	08:15 16:59	07:46 17:43	06:58 18:24	06:57 20:07	07:29 (114) 07:44 (114)	06:05 20:48
10	08:15 17:00	07:45 17:45	06:56 18:25	06:55 20:09	07:28 (114) 07:44 (114)	06:03 20:50
11	08:15 17:01	07:43 17:46	06:54 18:27	06:53 20:10	07:28 (114) 07:44 (114)	06:02 20:51
12	08:14 17:02	07:42 17:48	08:08 (89) 08:16 (89)	07:52 18:28	06:51 20:12	06:00 20:52
13	08:14 17:03	07:40 17:49	08:06 (89) 08:18 (89)	07:50 19:30	06:49 20:13	05:59 20:54
14	08:13 17:05	07:39 17:51	08:06 (89) 08:19 (89)	07:48 19:31	06:47 20:14	05:58 20:55
15	08:13 17:06	07:37 17:52	08:05 (89) 08:19 (89)	07:46 19:32	06:45 20:16	05:56 20:56
16	08:12 17:07	07:36 17:54	08:05 (89) 08:19 (89)	07:44 19:34	06:43 20:17	05:55 20:58
17	08:12 17:09	07:34 17:55	08:05 (89) 08:20 (89)	07:42 19:35	06:41 20:18	05:54 20:59
18	08:11 17:10	07:32 17:57	08:05 (89) 08:19 (89)	07:40 19:37	06:39 20:20	05:53 21:00
19	08:10 17:11	07:31 17:58	08:05 (89) 08:18 (89)	07:38 19:38	06:38 20:21	05:52 21:01
20	08:09 17:13	07:29 18:00	08:06 (89) 08:17 (89)	07:36 19:40	06:36 20:23	05:50 21:02
21	08:09 17:14	07:27 18:00	08:09 (89) 08:16 (89)	07:34 19:41	06:34 20:24	05:49 21:04
22	08:08 17:16	07:26 18:01	07:32 19:42	06:32 20:25	05:48 21:05	05:35 21:29
23	08:07 17:17	07:24 18:03	07:30 19:44	06:30 20:27	05:47 21:06	05:35 21:29
24	08:06 17:19	07:22 18:05	07:28 19:45	06:29 20:28	05:46 21:07	05:35 21:30
25	08:05 17:20	07:20 18:06	07:26 19:47	06:27 20:30	05:45 21:08	05:35 21:30
26	08:04 17:22	07:18 18:08	07:24 19:48	06:25 20:31	05:44 21:09	05:36 21:30
27	08:03 17:23	07:17 18:09	07:22 19:49	06:23 20:32	05:44 21:11	05:36 21:30
28	08:02 17:25	07:15 18:11	07:20 19:51	06:22 20:34	05:43 21:12	05:37 21:30
29	08:01 17:26		07:18 19:52	06:20 20:35	05:42 21:13	05:37 21:30
30	08:00 17:28		07:16 19:54	06:18 20:36	05:41 21:14	05:37 21:30
31	07:58 17:29		07:14 19:55		05:40 21:15	
Potential sun hours	278	286	367	406	465	475
Total, worst case		121		210		
Sun reduction		0.54		0.57		
Oper. time red.		0.85		0.85		
Wind dir. red.		0.72		0.69		
Total reduction		0.33		0.33		
Total, real		40		70		

Table layout: For each day in each month the following matrix apply

Day in month	Sun rise (hh:mm)	Minutes with flicker	First time (hh:mm) with flicker	(WTG causing flicker first time)
	Sun set (hh:mm)		Last time (hh:mm) with flicker	(WTG causing flicker last time)

SHADOW - Calendar

Calculation: Points and Grid Shadow receptor: A87 - Shadow Receptor: 1.0 x 1.0 Azimuth: 0.0° Slope: 90.0° (4977)

Assumptions for shadow calculations

Sunshine probability S/S0 (Sun hours/Possible sun hours) []

Reference year for calendar

2023

Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec
 0.52 0.54 0.59 0.57 0.60 0.64 0.74 0.71 0.63 0.51 0.39 0.39

Operational time

N NNE NE ENE E ESE SE SSE S SSW SW WSW W WNW NW NNW Sum
 364 231 235 234 299 398 720 587 362 314 482 477 675 931 686 429 7,424

	July	August	September	October	November	December
1	05:38 21:30	06:08 21:06	06:48 20:15	07:27 (114) 16 07:43 (114)	07:27 19:15	08:11 18:16
2	05:39 21:30	06:09 21:05	06:49 20:13	07:26 (114) 16 07:42 (114)	07:28 19:13	08:12 18:15
3	05:39 21:29	06:10 21:04	06:50 20:11	07:26 (114) 16 07:42 (114)	07:30 19:11	08:14 18:13
4	05:40 21:29	06:11 21:02	06:51 20:09	07:26 (114) 15 07:41 (114)	07:31 19:09	08:15 18:12
5	05:40 21:29	06:12 21:01	06:53 20:07	07:27 (114) 14 07:41 (118)	07:32 19:07	08:17 17:10
6	05:41 21:28	06:14 20:59	06:54 20:05	07:27 (114) 14 07:41 (118)	07:34 19:05	08:18 17:09
7	05:42 21:28	06:15 20:58	06:55 20:03	07:26 (104) 15 07:41 (118)	07:35 19:03	08:20 17:07
8	05:43 21:28	06:16 20:56	06:57 20:01	07:25 (104) 16 07:41 (118)	07:37 19:01	08:21 17:06
9	05:43 21:27	06:18 20:55	06:58 19:59	07:25 (104) 16 07:41 (118)	07:38 18:57	08:23 17:04
10	05:44 21:27	06:19 20:53	06:59 19:57	07:25 (104) 14 07:39 (118)	07:39 18:55	08:24 17:03
11	05:45 21:26	06:20 20:52	07:01 19:55	07:25 (104) 12 07:37 (118)	07:41 18:53	08:26 17:02
12	05:46 21:26	06:21 20:50	07:02 19:53	07:27 (104) 5 07:33 (118)	07:42 18:51	08:27 17:01
13	05:47 21:25	06:23 20:49	07:03 19:51	07:03 18:49	07:44 18:49	08:29 16:59
14	05:48 21:24	06:24 20:47	07:05 19:49	07:05 18:47	07:45 18:46	08:30 16:58
15	05:49 21:24	06:25 20:45	07:06 19:47	07:06 18:46	07:46 18:44	08:31 16:57
16	05:50 21:23	06:27 20:44	07:07 19:45	07:07 18:44	07:48 18:44	08:33 16:56
17	05:51 21:22	06:28 20:42	07:09 19:43	07:09 18:42	07:49 18:42	08:35 16:55
18	05:52 21:21	06:29 20:40	07:10 19:41	07:10 18:40	07:51 18:40	08:36 16:54
19	05:53 21:21	06:31 20:39	07:11 19:39	07:11 18:38	07:52 18:38	08:38 16:53
20	05:54 21:20	06:32 20:37	07:12 19:37	07:12 18:36	07:53 18:36	08:39 16:52
21	05:55 21:19	06:33 20:35	07:14 19:35	07:14 18:35	07:55 18:35	08:40 16:51
22	05:56 21:18	06:34 20:33	07:15 19:33	07:15 18:33	07:56 18:33	08:41 16:50
23	05:57 21:17	06:36 20:32	07:16 19:31	07:16 18:31	07:58 18:31	08:42 16:49
24	05:58 21:16	06:37 20:30	07:18 19:29	07:18 18:29	07:59 18:29	08:43 16:48
25	05:59 21:15	06:38 20:28	07:19 19:27	07:19 18:28	08:01 18:28	08:44 16:47
26	06:00 21:14	06:40 20:26	07:20 19:25	07:20 18:26	08:02 18:26	08:45 16:47
27	06:02 21:12	06:41 20:24	07:22 19:23	07:22 18:24	08:04 18:24	08:46 16:46
28	06:03 21:11	06:42 20:22	07:34 (114) 4 07:38 (114)	07:23 19:21	08:05 18:23	08:47 (89) 14 08:49 (89)
29	06:04 21:10	06:44 20:20	07:31 (114) 9 07:40 (114)	07:24 19:19	08:07 18:21	08:48 (89) 14 08:49 (89)
30	06:05 21:09	06:45 20:19	07:29 (114) 12 07:41 (114)	07:26 19:17	08:08 18:19	08:36 (89) 11 08:47 (89)
31	06:06 21:08	06:46 20:17	07:27 (114) 15 07:42 (114)	07:27 18:18	08:10 18:18	08:37 (89) 10 08:47 (89)
Potential sun hours	481	442	380	339	283	266
Total, worst case		40	169	121	4	
Sun reduction		0.71	0.63	0.51	0.39	
Oper. time red.		0.85	0.85	0.85	0.85	
Wind dir. red.		0.69	0.69	0.72	0.72	
Total reduction		0.42	0.37	0.31	0.24	
Total, real		17	63	38	1	

Table layout: For each day in each month the following matrix apply

Day in month	Sun rise (hh:mm)	Sun set (hh:mm)	Minutes with flicker	First time (hh:mm) with flicker	Last time (hh:mm) with flicker	(WTG causing flicker first time)	(WTG causing flicker last time)
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SHADOW - Calendar

Calculation: Points and Grid Shadow receptor: A88 - Shadow Receptor: 1.0 x 1.0 Azimuth: 0.0° Slope: 90.0° (4978)

Assumptions for shadow calculations

Sunshine probability S/S0 (Sun hours/Possible sun hours) []

Reference year for calendar

2023

Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec
 0.52 0.54 0.59 0.57 0.60 0.64 0.74 0.71 0.63 0.51 0.39 0.39

Operational time

N NNE NE ENE E ESE SE SSE S SSW SW WSW W WNW NW NNW Sum
 364 231 235 234 299 398 720 587 362 314 482 477 675 931 686 429 7,424

	January	February	March	April	May	June
1	08:16 16:50	07:57 17:31	07:13 18:12	07:12 19:56	06:17 20:38	05:40 21:16
2	08:16 16:51	07:56 17:32	07:11 18:14	07:10 19:58	06:15 20:39	05:39 21:17
3	08:16 16:52	07:55 17:34	07:09 18:15	07:08 19:59	06:14 20:40	05:38 21:18
4	08:16 16:53	07:53 17:35	07:07 18:16	07:06 20:00	07:29 (104) 07:38 (118)	06:12 20:42
5	08:16 16:54	07:52 17:37	07:05 18:18	07:04 20:02	07:28 (104) 07:41 (118)	06:11 20:43
6	08:16 16:55	07:51 17:38	07:04 18:19	07:02 20:03	07:27 (104) 07:42 (118)	06:09 20:44
7	08:16 16:56	07:49 17:40	07:02 18:21	07:00 20:05	07:26 (104) 07:42 (118)	06:07 20:46
8	08:16 16:57	07:48 17:41	07:00 18:22	06:58 20:06	07:26 (104) 07:42 (118)	06:06 20:47
9	08:15 16:59	07:46 17:43	06:58 18:24	06:57 20:07	07:26 (104) 07:42 (118)	06:05 20:48
10	08:15 17:00	07:45 17:45	08:10 (89) 08:19 (89)	06:56 18:25	06:55 20:09	06:03 20:50
11	08:15 17:01	07:43 17:46	08:08 (89) 08:20 (89)	06:54 18:27	06:53 20:10	06:02 20:51
12	08:14 17:02	07:42 17:48	08:08 (89) 08:21 (89)	07:52 18:28	06:51 20:12	06:00 20:52
13	08:14 17:03	07:40 17:49	08:07 (89) 08:22 (89)	07:50 19:30	06:49 20:13	05:59 20:54
14	08:13 17:05	07:39 17:51	08:07 (89) 08:23 (89)	07:48 19:31	06:47 20:14	05:58 20:55
15	08:13 17:06	07:37 17:52	08:06 (89) 08:23 (89)	07:46 19:32	06:45 20:16	05:56 20:56
16	08:12 17:07	07:36 17:54	08:06 (89) 08:22 (89)	07:44 19:34	06:43 20:17	05:55 20:58
17	08:12 17:09	07:34 17:55	08:07 (89) 08:22 (89)	07:42 19:35	06:41 20:18	05:54 20:59
18	08:11 17:10	07:32 17:57	08:08 (89) 08:21 (89)	07:40 19:37	06:39 20:20	05:53 21:00
19	08:10 17:11	07:31 17:58	08:08 (89) 08:20 (89)	07:38 19:38	06:38 20:21	05:52 21:01
20	08:09 17:13	07:29 18:00	08:10 (89) 08:18 (89)	07:36 19:40	06:36 20:23	05:50 21:02
21	08:09 17:14	07:27 18:00	07:34 19:41	06:34 20:24	05:49 21:04	05:34 21:29
22	08:08 17:16	07:26 18:01	07:32 19:42	06:32 20:25	05:48 21:05	05:35 21:29
23	08:07 17:17	07:24 18:03	07:30 19:44	06:30 20:27	05:47 21:06	05:35 21:29
24	08:06 17:19	07:22 18:05	07:28 19:45	06:29 20:28	05:46 21:07	05:35 21:30
25	08:05 17:20	07:20 18:06	07:26 19:47	06:27 20:30	05:45 21:08	05:35 21:30
26	08:04 17:22	07:18 18:08	07:24 19:48	06:25 20:31	05:44 21:09	05:36 21:30
27	08:03 17:23	07:17 18:09	07:22 19:49	06:23 20:32	05:44 21:11	05:36 21:30
28	08:02 17:25	07:15 18:11	07:20 19:51	06:22 20:34	05:43 21:12	05:37 21:30
29	08:01 17:26		07:18 19:52	06:20 20:35	05:42 21:13	05:37 21:30
30	08:00 17:28		07:16 19:54	06:18 20:36	05:41 21:14	05:37 21:30
31	07:58 17:29		07:14 19:55		05:40 21:15	
Potential sun hours	278	286	367	406	465	475
Total, worst case		146		253		
Sun reduction		0.54		0.57		
Oper. time red.		0.85		0.85		
Wind dir. red.		0.72		0.69		
Total reduction		0.33		0.33		
Total, real		48		84		

Table layout: For each day in each month the following matrix apply

Day in month	Sun rise (hh:mm)	Minutes with flicker	First time (hh:mm) with flicker	(WTG causing flicker first time)
	Sun set (hh:mm)		Last time (hh:mm) with flicker	(WTG causing flicker last time)

SHADOW - Calendar

Calculation: Points and Grid Shadow receptor: A88 - Shadow Receptor: 1.0 x 1.0 Azimuth: 0.0° Slope: 90.0° (4978)

Assumptions for shadow calculations

Sunshine probability S/S0 (Sun hours/Possible sun hours) []

Reference year for calendar

2023

Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec
 0.52 0.54 0.59 0.57 0.60 0.64 0.74 0.71 0.63 0.51 0.39 0.39

Operational time

N NNE NE ENE E ESE SE SSE S SSW SW WSW W WNW NW NNW Sum
 364 231 235 234 299 398 720 587 362 314 482 477 675 931 686 429 7,424

	July	August	September	October	November	December
1	05:38 21:30	06:08 21:06	06:48 20:15	07:22 (114) 16 07:38 (114)	07:27 19:15	08:11 18:16
2	05:39 21:30	06:09 21:05	06:49 20:13	07:22 (114) 16 07:38 (118)	07:28 19:13	08:12 18:15
3	05:39 21:29	06:10 21:04	06:50 20:11	07:22 (114) 16 07:38 (118)	07:30 19:11	08:14 18:13
4	05:40 21:29	06:11 21:02	06:51 20:09	07:23 (114) 15 07:38 (118)	07:31 19:09	08:15 18:12
5	05:40 21:29	06:12 21:01	06:53 20:07	07:23 (104) 16 07:39 (118)	07:32 19:07	07:17 17:10
6	05:41 21:28	06:14 20:59	06:54 20:05	07:22 (104) 16 07:38 (118)	07:34 19:05	07:18 17:09
7	05:42 21:28	06:15 20:58	06:55 20:03	07:22 (104) 15 07:37 (118)	07:35 19:03	07:20 17:07
8	05:43 21:28	06:16 20:56	06:57 20:01	07:21 (104) 15 07:36 (118)	07:37 19:01	07:21 17:06
9	05:43 21:27	06:18 20:55	06:58 19:59	07:23 (104) 12 07:35 (118)	07:38 18:57	07:23 17:04
10	05:44 21:27	06:19 20:53	06:59 19:57	07:24 (104) 7 07:31 (118)	07:39 18:55	07:24 17:03
11	05:45 21:26	06:20 20:52	07:01 19:55	07:41 18:53	07:41 17:02	08:05 16:41
12	05:46 21:26	06:21 20:50	07:02 19:53	07:42 18:51	07:42 17:01	08:06 16:41
13	05:47 21:25	06:23 20:49	07:03 19:51	07:44 18:49	07:44 16:59	08:07 16:41
14	05:48 21:24	06:24 20:47	07:05 19:49	07:45 18:47	07:45 16:58	08:08 16:41
15	05:49 21:24	06:25 20:45	07:06 19:47	07:46 18:46	07:46 16:57	08:09 16:41
16	05:50 21:23	06:27 20:44	07:07 19:45	07:48 18:44	07:48 16:56	08:09 16:41
17	05:51 21:22	06:28 20:42	07:08 19:43	07:49 18:42	07:49 16:55	08:10 16:41
18	05:52 21:21	06:29 20:40	07:10 19:41	07:51 18:40	07:51 16:54	08:11 16:42
19	05:53 21:21	06:31 20:39	07:11 19:39	07:52 18:38	07:52 16:53	08:11 16:42
20	05:54 21:20	06:32 20:37	07:12 19:37	07:53 18:36	07:53 16:52	08:12 16:42
21	05:55 21:19	06:33 20:35	07:14 19:35	07:55 18:35	07:55 16:51	08:13 16:43
22	05:56 21:18	06:34 20:33	07:15 19:33	07:56 18:33	07:56 16:50	08:13 16:43
23	05:57 21:17	06:36 20:32	07:16 19:31	07:58 18:31	08:41 (89) 6 08:47 (89)	07:43 16:49
24	05:58 21:16	06:37 20:30	07:18 19:29	07:59 18:29	08:39 (89) 11 08:50 (89)	07:45 16:48
25	05:59 21:15	06:38 20:28	07:20 19:27	08:01 18:28	08:37 (89) 14 08:51 (89)	07:46 16:47
26	06:00 21:14	06:40 20:26	07:22 19:25	08:02 18:26	08:37 (89) 15 08:52 (89)	07:47 16:47
27	06:02 21:12	06:41 20:24	07:23 19:23	08:04 18:24	08:36 (89) 16 08:52 (89)	07:49 16:46
28	06:03 21:11	06:42 20:22	07:23 19:21	08:05 18:23	08:36 (89) 16 08:52 (89)	07:50 16:45
29	06:04 21:10	06:44 20:20	07:22 19:19	08:07 18:21	08:36 (89) 16 08:52 (89)	07:51 16:45
30	06:05 21:09	06:45 20:19	07:21 19:17	08:08 18:19	08:36 (89) 15 08:51 (89)	07:53 16:44
31	06:06 21:08	06:46 20:17	07:21 07:38 (114)	08:10 18:18	08:37 (89) 14 08:51 (89)	08:16 16:49
Potential sun hours	481	442	380	339	283	266
Total, worst case		114	144	123	28	
Sun reduction		0.71	0.63	0.51	0.39	
Oper. time red.		0.85	0.85	0.85	0.85	
Wind dir. red.		0.68	0.69	0.72	0.72	
Total reduction		0.41	0.37	0.31	0.24	
Total, real		47	53	39	7	

Table layout: For each day in each month the following matrix apply

Day in month	Sun rise (hh:mm)	Sun set (hh:mm)	Minutes with flicker	First time (hh:mm) with flicker	Last time (hh:mm) with flicker	(WTG causing flicker first time)	(WTG causing flicker last time)
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SHADOW - Calendar

Calculation: Points and Grid Shadow receptor: A89 - Shadow Receptor: 1.0 × 1.0 Azimuth: 0.0° Slope: 90.0° (4979)
 Assumptions for shadow calculations

Reference year for calendar

2023

Sunshine probability S/S0 (Sun hours/Possible sun hours) []

Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec
 0.52 0.54 0.59 0.57 0.60 0.64 0.74 0.71 0.63 0.51 0.39 0.39

Operational time

N NNE NE ENE E ESE SE SSE S SSW SW WSW W WNW NW NNW Sum
 364 231 235 234 299 398 720 587 362 314 482 477 675 931 686 429 7,424

	January	February	March	April	May	June
1	08:16 16:50	07:57 17:31	07:13 18:12	07:12 19:56	9 07:36 (104) 07:45 (118)	06:17 20:38
2	08:16 16:51	07:56 17:32	07:11 18:14	07:10 19:58	14 07:33 (104) 07:47 (118)	06:15 20:39
3	08:16 16:52	07:55 17:34	07:09 18:15	07:08 19:59	15 07:32 (104) 07:47 (118)	06:14 20:40
4	08:16 16:53	07:53 17:35	07:07 18:16	07:06 20:00	16 07:32 (104) 07:48 (118)	06:12 20:42
5	08:16 16:54	07:52 17:37	07:05 18:18	07:04 20:02	16 07:32 (104) 07:48 (118)	06:11 20:43
6	08:16 16:55	07:51 17:38	07:04 18:19	07:02 20:03	16 07:32 (104) 07:48 (118)	06:09 20:44
7	08:16 16:56	07:49 17:40	07:02 18:21	07:00 20:05	14 07:33 (114) 07:47 (118)	06:07 20:46
8	08:16 16:57	07:48 17:41	07:00 18:22	06:58 20:06	15 07:31 (114) 07:46 (114)	06:06 20:47
9	08:15 16:59	07:46 17:43	06:58 18:24	06:57 20:07	17 07:30 (114) 07:47 (114)	06:05 20:48
10	08:15 17:00	07:45 17:45	08:12 (89) 08:18 (89)	06:56 18:25	16 07:30 (114) 07:46 (114)	06:03 20:50
11	08:15 17:01	07:43 17:46	08:09 (89) 08:19 (89)	06:54 18:27	16 07:30 (114) 07:46 (114)	06:02 20:51
12	08:14 17:02	07:42 17:48	08:09 (89) 08:21 (89)	07:52 18:28	15 07:30 (114) 07:45 (114)	06:00 20:52
13	08:14 17:03	07:40 17:49	08:08 (89) 08:22 (89)	07:50 19:30	14 07:30 (114) 07:44 (114)	05:59 20:54
14	08:13 17:05	07:39 17:51	08:08 (89) 08:23 (89)	07:48 19:31	11 07:31 (114) 07:42 (114)	05:58 20:55
15	08:13 17:06	07:37 17:52	08:07 (89) 08:22 (89)	07:46 19:32	8 07:32 (114) 07:40 (114)	05:56 20:56
16	08:12 17:07	07:36 17:54	08:07 (89) 08:22 (89)	07:44 19:34	05:55 20:17	05:54 20:58
17	08:12 17:09	07:34 17:55	08:08 (89) 08:22 (89)	07:42 19:35	05:54 20:18	05:34 20:59
18	08:11 17:10	07:32 17:57	08:09 (89) 08:21 (89)	07:40 19:37	05:53 20:20	05:34 20:59
19	08:10 17:11	07:31 17:58	08:10 (89) 08:19 (89)	07:38 19:38	05:52 20:21	05:34 21:00
20	08:09 17:13	07:29 18:00	08:12 (89) 08:17 (89)	07:36 19:40	05:50 21:02	05:34 21:28
21	08:09 17:14	07:27 18:00	07:34 19:41	06:34 20:24	05:49 21:04	05:34 21:29
22	08:08 17:16	07:26 18:01	07:32 19:42	06:32 20:25	05:48 21:05	05:35 21:29
23	08:07 17:17	07:24 18:03	07:30 19:44	06:30 20:27	05:47 21:06	05:35 21:29
24	08:06 17:19	07:22 18:05	07:28 19:45	06:29 20:28	05:46 21:07	05:35 21:30
25	08:05 17:20	07:20 18:06	07:26 19:47	06:27 20:30	05:45 21:08	05:35 21:30
26	08:04 17:22	07:18 18:08	07:24 19:48	06:25 20:31	05:44 21:09	05:36 21:30
27	08:03 17:23	07:17 18:09	07:22 19:49	06:23 20:32	05:44 21:11	05:36 21:30
28	08:02 17:25	07:15 18:11	07:20 19:51	06:22 20:34	05:43 21:12	05:37 21:30
29	08:01 17:26		07:18 19:52	06:20 20:35	05:42 21:13	05:37 21:30
30	08:00 17:28		07:16 19:54	06:18 20:36	05:41 21:14	05:37 21:30
31	07:58 17:29		07:14 19:55		05:40 21:15	
Potential sun hours	278	286	367	406	465	475
Total, worst case		127		212		
Sun reduction		0.54		0.57		
Oper. time red.		0.85		0.85		
Wind dir. red.		0.72		0.69		
Total reduction		0.33		0.34		
Total, real		42		71		

Table layout: For each day in each month the following matrix apply

Day in month	Sun rise (hh:mm)	Minutes with flicker	First time (hh:mm) with flicker	Last time (hh:mm) with flicker	(WTG causing flicker first time)	(WTG causing flicker last time)
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SHADOW - Calendar

Calculation: Points and Grid Shadow receptor: A89 - Shadow Receptor: 1.0 × 1.0 Azimuth: 0.0° Slope: 90.0° (4979)

Assumptions for shadow calculations

Sunshine probability S/S0 (Sun hours/Possible sun hours) []

Reference year for calendar

2023

Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec
 0.52 0.54 0.59 0.57 0.60 0.64 0.74 0.71 0.63 0.51 0.39 0.39

Operational time

N NNE NE ENE E ESE SE SSE S SSW SW WSW W WNW NW NNW Sum
 364 231 235 234 299 398 720 587 362 314 482 477 675 931 686 429 7,424

	July	August	September	October	November	December
1	05:38 21:30	06:08 21:06	06:48 20:15	07:30 (114) 14 07:44 (114)	07:27 19:15	08:11 18:16
2	05:39 21:30	06:09 21:05	06:49 20:13	15 07:44 (114)	07:28 19:13	08:12 18:15
3	05:39 21:29	06:10 21:04	06:50 20:11	16 07:44 (114)	07:30 19:11	08:14 18:13
4	05:40 21:29	06:11 21:02	06:51 20:09	17 07:44 (114)	07:31 19:09	08:15 18:12
5	05:40 21:29	06:12 21:01	06:53 20:07	16 07:44 (114)	07:32 19:07	07:17 17:10
6	05:41 21:28	06:14 20:59	06:54 20:05	14 07:42 (118)	07:34 19:05	07:18 17:09
7	05:42 21:28	06:15 20:58	06:55 20:03	15 07:43 (118)	07:35 19:03	07:20 17:07
8	05:43 21:28	06:16 20:56	06:57 20:01	15 07:42 (118)	07:37 19:01	07:21 17:06
9	05:43 21:27	06:18 20:55	06:58 19:59	16 07:43 (118)	07:38 18:57	07:23 17:04
10	05:44 21:27	06:19 20:53	06:59 19:57	16 07:42 (118)	07:39 18:55	07:24 17:03
11	05:45 21:26	06:20 20:52	07:01 19:55	14 07:40 (118)	07:41 18:53	07:26 17:02
12	05:46 21:26	06:21 20:50	07:02 19:53	12 07:38 (118)	07:42 18:51	07:27 17:01
13	05:47 21:25	06:23 20:49	07:03 19:51		07:44 18:49	07:29 16:59
14	05:48 21:24	06:24 20:47	07:05 19:49		07:45 18:47	07:30 16:58
15	05:49 21:24	06:25 20:45	07:06 19:47		07:46 18:46	07:32 16:57
16	05:50 21:23	06:27 20:44	07:07 19:45		07:48 18:44	07:33 16:56
17	05:51 21:22	06:28 20:42	07:09 19:43		07:49 18:42	07:35 16:55
18	05:52 21:21	06:29 20:40	07:10 19:41		07:51 18:40	07:36 16:54
19	05:53 21:21	06:31 20:39	07:11 19:39		07:52 18:38	07:38 16:53
20	05:54 21:20	06:32 20:37	07:12 19:37		07:53 18:36	07:39 16:52
21	05:55 21:19	06:33 20:35	07:14 19:35		07:55 18:35	07:40 16:51
22	05:56 21:18	06:34 20:33	07:15 19:33		07:56 18:33	07:42 16:50
23	05:57 21:17	06:36 20:32	07:16 19:31		07:58 18:31	07:43 16:49
24	05:58 21:16	06:37 20:30	07:18 19:29		07:59 18:29	07:45 16:48
25	05:59 21:15	06:38 20:28	07:19 19:27		08:01 18:28	07:46 16:47
26	06:00 21:14	06:40 20:26	07:20 19:25		08:02 18:26	07:47 16:47
27	06:02 21:12	06:41 20:24	07:22 19:23		08:04 18:24	07:49 16:46
28	06:03 21:11	06:42 20:22	07:23 19:21		08:05 18:23	07:50 16:45
29	06:04 21:10	06:44 20:20	07:24 19:19		08:07 18:21	07:51 16:45
30	06:05 21:09	06:45 20:19	07:26 19:17		08:08 18:19	07:53 16:44
31	06:06 21:08	06:46 20:17	07:30 (114) 13 07:43 (114)		08:10 18:18	08:38 (89) 13 08:51 (89)
Potential sun hours	481	442	380	339	283	266
Total, worst case		26	180	106	18	
Sun reduction		0.71	0.63	0.51	0.39	
Oper. time red.		0.85	0.85	0.85	0.85	
Wind dir. red.		0.69	0.69	0.72	0.72	
Total reduction		0.42	0.37	0.31	0.24	
Total, real		11	67	33	4	

Table layout: For each day in each month the following matrix apply

Day in month	Sun rise (hh:mm)	Sun set (hh:mm)	Minutes with flicker	First time (hh:mm) with flicker	Last time (hh:mm) with flicker	(WTG causing flicker first time)	(WTG causing flicker last time)
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Project:

Otter Tail Ashtabula III Wind

Description:

Barnes County, ND

Licensed user:

Epsilon Associates, Inc
3 Clock Tower Place, Suite 250
US-MAYNARD MA 01754
978 897 7100
Richard Lampeter / rlampeter@epsilonassociates.com
Calculated:
6/18/2023 2:05 PM/3.6.366

SHADOW - Calendar

Calculation: Points and Grid Shadow receptor: A90 - Shadow Receptor: 1.0 x 1.0 Azimuth: 0.0° Slope: 90.0° (4980)

Assumptions for shadow calculations

Sunshine probability S/S0 (Sun hours/Possible sun hours) []

Reference year for calendar

2023

Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec
0.52 0.54 0.59 0.57 0.60 0.64 0.74 0.71 0.63 0.51 0.39 0.39

Operational time

N NNE NE ENE E ESE SE SSE S SSW SW WSW W WNW NW NNW Sum
364 231 235 234 299 398 720 587 362 314 482 477 675 931 686 429 7,424

Table with columns for months (January to June) and rows for days (1-31) showing sun rise/set times and potential sun hours.

Table layout: For each day in each month the following matrix apply

Day in month Sun rise (hh:mm) Sun set (hh:mm) Minutes with flicker First time (hh:mm) with flicker Last time (hh:mm) with flicker (WTG causing flicker first time) (WTG causing flicker last time)

SHADOW - Calendar

Calculation: Points and Grid Shadow receptor: A90 - Shadow Receptor: 1.0 x 1.0 Azimuth: 0.0° Slope: 90.0° (4980)

Assumptions for shadow calculations

Sunshine probability S/S0 (Sun hours/Possible sun hours) []

Reference year for calendar

2023

Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec
 0.52 0.54 0.59 0.57 0.60 0.64 0.74 0.71 0.63 0.51 0.39 0.39

Operational time

N NNE NE ENE E ESE SE SSE S SSW SW WSW W WNW NW NNW Sum
 364 231 235 234 299 398 720 587 362 314 482 477 675 931 686 429 7,424

	July	August	September	October	November	December
1	05:38	06:08	06:48	07:37 (114)	07:27	08:11
	21:30	21:06	20:15	8 07:45 (114)	19:15	18:16
2	05:39	06:09	06:49	07:34 (114)	07:28	08:12
	21:30	21:05	20:13	12 07:46 (114)	19:13	18:15
3	05:39	06:10	06:50	07:33 (114)	07:30	08:14
	21:29	21:04	20:11	14 07:47 (114)	19:11	18:13
4	05:40	06:11	06:51	07:32 (114)	07:31	08:15
	21:29	21:02	20:09	15 07:47 (114)	19:09	18:12
5	05:40	06:12	06:53	07:32 (114)	07:32	07:17
	21:29	21:01	20:07	16 07:48 (114)	19:07	17:10
6	05:41	06:14	06:54	07:31 (114)	07:34	07:18
	21:28	20:59	20:05	16 07:47 (114)	19:05	17:09
7	05:42	06:15	06:55	07:31 (114)	07:35	07:20
	21:28	20:58	20:03	15 07:46 (114)	19:03	17:07
8	05:43	06:16	06:57	07:30 (114)	07:37	07:21
	21:28	20:56	20:01	15 07:45 (114)	19:01	17:06
9	05:43	06:18	06:58	07:30 (104)	07:38	07:23
	21:27	20:55	19:59	16 07:46 (118)	18:57	17:04
10	05:44	06:19	06:59	07:29 (104)	07:39	07:24
	21:27	20:53	19:57	16 07:45 (118)	18:55	17:03
11	05:45	06:20	07:01	07:28 (104)	07:41	07:26
	21:26	20:52	19:55	17 07:45 (118)	18:53	17:02
12	05:46	06:21	07:02	07:28 (104)	07:42	07:27
	21:26	20:50	19:53	15 07:43 (118)	18:51	17:01
13	05:47	06:23	07:03	07:29 (104)	07:44	07:29
	21:25	20:49	19:51	14 07:43 (118)	18:49	16:59
14	05:48	06:24	07:05	07:30 (104)	07:45	07:30
	21:24	20:47	19:49	10 07:40 (118)	18:47	16:58
15	05:49	06:25	07:06	07:46	07:46	07:32
	21:24	20:45	19:47	18:46	16:57	16:57
16	05:50	06:27	07:07	07:48	07:48	07:33
	21:23	20:44	19:45	18:44	16:56	16:56
17	05:51	06:28	07:09	07:49	07:49	07:35
	21:22	20:42	19:43	18:42	16:55	16:55
18	05:52	06:29	07:10	07:51	07:51	07:36
	21:21	20:40	19:41	18:40	16:54	16:54
19	05:53	06:31	07:11	07:52	07:52	07:38
	21:21	20:39	19:39	18:38	16:53	16:53
20	05:54	06:32	07:12	07:53	07:53	07:39
	21:20	20:37	19:37	18:36	16:52	16:52
21	05:55	06:33	07:14	07:55	07:55	07:40
	21:19	20:35	19:35	18:35	16:51	16:51
22	05:56	06:34	07:15	07:56	07:56	07:42
	21:18	20:33	19:33	18:33	16:50	16:50
23	05:57	06:36	07:16	07:58	07:58	07:43
	21:17	20:32	19:31	18:31	16:49	16:49
24	05:58	06:37	07:18	07:59	07:59	07:45
	21:16	20:30	19:29	18:29	16:48	16:48
25	05:59	06:38	07:19	08:01	08:01	07:46
	21:15	20:28	19:27	18:28	6 08:50 (89)	16:47
26	06:00	06:40	07:20	08:02	08:02	08:42 (89)
	21:14	20:26	19:25	18:26	11 08:53 (89)	16:47
27	06:02	06:41	07:22	08:04	08:04	08:40 (89)
	21:12	20:24	19:23	18:24	13 08:53 (89)	16:46
28	06:03	06:42	07:23	08:05	08:05	08:40 (89)
	21:11	20:22	19:21	18:23	14 08:54 (89)	16:45
29	06:04	06:44	07:24	08:07	08:07	08:40 (89)
	21:10	20:20	19:19	18:21	15 08:55 (89)	16:45
30	06:05	06:45	07:26	08:08	08:39 (89)	07:53
	21:09	20:19	19:17	18:19	15 08:54 (89)	16:44
31	06:06	06:46		08:10	08:40 (89)	
	21:08	20:17		18:18	14 08:54 (89)	16:49
Potential sun hours	481	442	380	339	283	266
Total, worst case			199	88		39
Sun reduction			0.63	0.51		0.39
Oper. time red.			0.85	0.85		0.85
Wind dir. red.			0.70	0.72		0.72
Total reduction			0.37	0.31		0.24
Total, real			74	28		9

Table layout: For each day in each month the following matrix apply

Day in month	Sun rise (hh:mm)	Minutes with flicker	First time (hh:mm) with flicker	Last time (hh:mm) with flicker	(WTG causing flicker first time)	(WTG causing flicker last time)
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Project:

Otter Tail Ashtabula III Wind

Description:

Barnes County, ND

Licensed user:

Epsilon Associates, Inc
3 Clock Tower Place, Suite 250
US-MAYNARD MA 01754
978 897 7100
Richard Lampeter / rlampeter@epsilonassociates.com
Calculated:
6/18/2023 2:05 PM/3.6.366

SHADOW - Calendar

Calculation: Points and Grid Shadow receptor: A91 - Shadow Receptor: 1.0 x 1.0 Azimuth: 0.0° Slope: 90.0° (4981)

Assumptions for shadow calculations

Sunshine probability S/S0 (Sun hours/Possible sun hours) []

Reference year for calendar

2023

Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec
0.52 0.54 0.59 0.57 0.60 0.64 0.74 0.71 0.63 0.51 0.39 0.39

Operational time

N NNE NE ENE E ESE SE SSE S SSW SW WSW W WNW NW NNW Sum
364 231 235 234 299 398 720 587 362 314 482 477 675 931 686 429 7,424

Table with columns for months (January to June) and rows for days (1 to 31) showing sun rise and set times. Includes summary rows for Potential sun hours, Total, worst case, Sun reduction, Oper. time red., Wind dir. red., Total reduction, and Total, real.

Table layout: For each day in each month the following matrix apply

Day in month Sun rise (hh:mm) Sun set (hh:mm) Minutes with flicker First time (hh:mm) with flicker Last time (hh:mm) with flicker (WTG causing flicker first time) (WTG causing flicker last time)

SHADOW - Calendar

Calculation: Points and Grid Shadow receptor: A91 - Shadow Receptor: 1.0 x 1.0 Azimuth: 0.0° Slope: 90.0° (4981)

Assumptions for shadow calculations

Sunshine probability S/S0 (Sun hours/Possible sun hours) []

Reference year for calendar

2023

Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec
 0.52 0.54 0.59 0.57 0.60 0.64 0.74 0.71 0.63 0.51 0.39 0.39

Operational time

N NNE NE ENE E ESE SE SSE S SSW SW WSW W WNW NW NNW Sum
 364 231 235 234 299 398 720 587 362 314 482 477 675 931 686 429 7,424

	July	August	September	October	November	December
1	05:38	06:08	06:48	07:27	08:11	07:54
	21:30	21:06	20:15	19:15	18:16	15 08:57 (89)
2	05:39	06:09	06:49	07:39 (114)	08:12	08:43 (89)
	21:30	21:05	20:13	19:13	18:15	14 08:57 (89)
3	05:39	06:10	06:50	07:36 (114)	08:14	08:44 (89)
	21:29	21:04	20:11	19:11	18:13	13 08:57 (89)
4	05:40	06:11	06:51	07:34 (114)	08:15	08:44 (89)
	21:29	21:02	20:09	19:09	18:12	11 08:55 (89)
5	05:40	06:12	06:53	07:34 (114)	07:17	07:46 (89)
	21:29	21:01	20:07	19:07	17:10	8 07:54 (89)
6	05:41	06:14	06:54	07:33 (114)	07:18	08:00
	21:28	20:59	20:05	19:05	17:09	16:41
7	05:42	06:15	06:55	07:32 (114)	07:20	08:01
	21:28	20:58	20:03	19:03	17:07	16:41
8	05:43	06:16	06:57	07:32 (114)	07:21	08:02
	21:28	20:56	20:01	19:01	17:06	16:41
9	05:43	06:18	06:58	07:32 (104)	07:23	08:03
	21:27	20:55	19:59	18:57	17:04	16:41
10	05:44	06:19	06:59	07:31 (104)	07:24	08:04
	21:27	20:53	19:57	18:55	17:03	16:41
11	05:45	06:20	07:01	07:29 (104)	07:26	08:05
	21:26	20:52	19:55	18:53	17:02	16:41
12	05:46	06:21	07:02	07:29 (104)	07:27	08:06
	21:26	20:50	19:53	18:51	17:01	16:41
13	05:47	06:23	07:03	07:30 (104)	07:29	08:07
	21:25	20:49	19:51	18:49	16:59	16:41
14	05:48	06:24	07:05	07:30 (104)	07:30	08:08
	21:24	20:47	19:49	18:47	16:58	16:41
15	05:49	06:25	07:06	07:32 (104)	07:32	08:09
	21:24	20:45	19:47	18:46	16:57	16:41
16	05:50	06:27	07:07	07:48	07:33	08:09
	21:23	20:44	19:45	18:44	16:56	16:41
17	05:51	06:28	07:09	07:49	07:35	08:10
	21:22	20:42	19:43	18:42	16:55	16:41
18	05:52	06:29	07:10	07:51	07:36	08:11
	21:21	20:40	19:41	18:40	16:54	16:42
19	05:53	06:31	07:11	07:52	07:38	08:11
	21:21	20:39	19:39	18:38	16:53	16:42
20	05:54	06:32	07:12	07:53	07:39	08:12
	21:20	20:37	19:37	18:36	16:52	16:42
21	05:55	06:33	07:14	07:55	07:40	08:13
	21:19	20:35	19:35	18:35	16:51	16:43
22	05:56	06:34	07:15	07:56	07:42	08:13
	21:18	20:33	19:33	18:33	16:50	16:43
23	05:57	06:36	07:16	07:58	07:43	08:14
	21:17	20:32	19:31	18:31	16:49	16:44
24	05:58	06:37	07:18	07:59	07:45	08:14
	21:16	20:30	19:29	18:29	16:48	16:44
25	05:59	06:38	07:19	08:01	07:46	08:15
	21:15	20:28	19:27	18:28	16:47	16:45
26	06:00	06:40	07:20	08:02	08:49 (89)	07:47
	21:14	20:26	19:25	18:26	2 08:51 (89)	16:47
27	06:02	06:41	07:22	08:04	08:45 (89)	07:49
	21:12	20:24	19:23	18:24	9 08:54 (89)	16:46
28	06:03	06:42	07:23	08:05	08:44 (89)	07:50
	21:11	20:22	19:21	18:23	12 08:56 (89)	16:45
29	06:04	06:44	07:24	08:07	08:43 (89)	07:51
	21:10	20:20	19:19	18:21	14 08:57 (89)	16:45
30	06:05	06:45	07:26	08:08	08:42 (89)	07:53
	21:09	20:19	19:17	18:19	15 08:57 (89)	16:44
31	06:06	06:46		08:10	08:42 (89)	08:16
	21:08	20:17		18:18	15 08:57 (89)	16:49
Potential sun hours	481	442	380	339	283	266
Total, worst case			204	67	61	
Sun reduction			0.63	0.51	0.39	
Oper. time red.			0.85	0.85	0.85	
Wind dir. red.			0.70	0.72	0.72	
Total reduction			0.37	0.31	0.24	
Total, real			76	21	15	

Table layout: For each day in each month the following matrix apply

Day in month	Sun rise (hh:mm)	First time (hh:mm) with flicker	(WTG causing flicker first time)
	Sun set (hh:mm)	Minutes with flicker	Last time (hh:mm) with flicker
			(WTG causing flicker last time)

SHADOW - Calendar

Calculation: Points and Grid Shadow receptor: A92 - Shadow Receptor: 1.0 x 1.0 Azimuth: 0.0° Slope: 90.0° (4982)

Assumptions for shadow calculations

Reference year for calendar

2023

Sunshine probability S/S0 (Sun hours/Possible sun hours) []

Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec
 0.52 0.54 0.59 0.57 0.60 0.64 0.74 0.71 0.63 0.51 0.39 0.39

Operational time

N NNE NE ENE E ESE SE SSE S SSW SW WSW W WNW NW NNW Sum
 364 231 235 234 299 398 720 587 362 314 482 477 675 931 686 429 7,424

	January	February	March	April	May	June
1	08:16 16:50	07:57 17:31	07:13 18:12	07:12 19:56	07:37 (104) 18 07:55 (118)	06:17 20:38
2	08:16 16:51	07:56 17:32	07:11 18:14	07:10 19:58	07:37 (104) 17 07:54 (118)	06:15 20:39
3	08:16 16:52	07:55 17:33	07:09 18:15	07:08 19:59	07:37 (104) 17 07:54 (118)	06:14 20:40
4	08:16 16:53	07:53 17:35	07:07 18:16	07:06 20:00	07:38 (104) 16 07:54 (114)	06:12 20:42
5	08:16 16:54	07:52 17:37	07:05 18:18	07:04 20:02	07:39 (114) 16 07:55 (114)	06:11 20:43
6	08:16 16:55	07:51 17:38	08:18 (89) 08:25 (89)	07:04 18:19	07:39 (114) 16 07:55 (114)	06:09 20:44
7	08:16 16:56	07:49 17:40	08:17 (89) 08:27 (89)	07:02 18:21	07:38 (114) 17 07:55 (114)	06:07 20:46
8	08:16 16:57	07:48 17:41	08:15 (89) 08:28 (89)	07:00 18:22	07:38 (114) 16 07:54 (114)	06:06 20:47
9	08:15 16:59	07:46 17:43	08:15 (89) 08:29 (89)	06:58 18:24	07:39 (114) 14 07:53 (114)	06:05 20:48
10	08:15 17:00	07:45 17:45	08:15 (89) 08:29 (89)	06:56 18:25	07:39 (114) 12 07:51 (114)	06:03 20:50
11	08:15 17:01	07:43 17:46	08:14 (89) 08:29 (89)	06:54 18:27	07:41 (114) 8 07:49 (114)	06:02 20:51
12	08:14 17:02	07:42 17:48	08:15 (89) 08:30 (89)	07:52 18:28	06:51 20:12	06:00 20:52
13	08:14 17:03	07:40 17:49	08:15 (89) 08:29 (89)	07:50 19:30	06:49 20:13	05:59 20:54
14	08:13 17:05	07:39 17:51	08:16 (89) 08:29 (89)	07:48 19:31	06:47 20:14	05:58 20:55
15	08:13 17:06	07:37 17:52	08:17 (89) 08:27 (89)	07:46 19:32	06:45 20:16	05:56 20:56
16	08:12 17:07	07:36 17:54	08:19 (89) 08:25 (89)	07:44 19:34	06:43 20:17	05:55 20:58
17	08:12 17:09	07:34 17:55	07:42 19:35	06:41 20:18	05:54 20:59	05:54 21:27
18	08:11 17:10	07:32 17:57	07:40 19:37	06:39 20:20	05:53 21:00	05:53 21:28
19	08:10 17:11	07:31 17:58	07:38 19:38	06:38 20:21	05:52 21:01	05:52 21:28
20	08:09 17:13	07:29 18:00	07:36 19:40	06:36 20:23	05:50 21:02	05:50 21:28
21	08:09 17:14	07:27 18:00	07:34 19:41	06:34 20:24	05:49 21:04	05:54 21:29
22	08:08 17:16	07:26 18:01	07:32 19:42	06:32 20:25	05:48 21:05	05:55 21:29
23	08:07 17:17	07:24 18:03	07:30 19:44	06:30 20:27	05:47 21:06	05:55 21:29
24	08:06 17:19	07:22 18:05	07:28 19:45	06:29 20:28	05:46 21:07	05:55 21:30
25	08:05 17:20	07:20 18:06	07:26 19:47	06:27 20:30	05:45 21:08	05:55 21:30
26	08:04 17:22	07:18 18:08	07:24 19:48	06:25 20:31	05:44 21:09	05:56 21:30
27	08:03 17:23	07:17 18:09	07:22 19:49	06:23 20:32	05:44 21:11	05:56 21:30
28	08:02 17:25	07:15 18:11	07:20 19:51	06:22 20:34	05:43 21:12	05:57 21:30
29	08:01 17:26		07:18 19:52	07:47 (118) 5 07:52 (118)	06:20 20:35	05:42 21:13
30	08:00 17:28		07:16 19:54	07:40 (104) 14 07:54 (118)	06:18 20:36	05:41 21:30
31	07:58 17:29		07:14 19:55	07:38 (104) 16 07:54 (118)	06:16 21:15	05:40 21:30
Potential sun hours	278	286	367	406	465	475
Total, worst case		131	35	167		
Sun reduction		0.54	0.59	0.57		
Oper. time red.		0.85	0.85	0.85		
Wind dir. red.		0.72	0.70	0.70		
Total reduction		0.33	0.35	0.34		
Total, real		43	12	56		

Table layout: For each day in each month the following matrix apply

Day in month	Sun rise (hh:mm)	Sun set (hh:mm)	Minutes with flicker	First time (hh:mm) with flicker	Last time (hh:mm) with flicker	(WTG causing flicker first time)	(WTG causing flicker last time)
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SHADOW - Calendar

Calculation: Points and Grid Shadow receptor: A92 - Shadow Receptor: 1.0 x 1.0 Azimuth: 0.0° Slope: 90.0° (4982)

Assumptions for shadow calculations

Reference year for calendar

2023

Sunshine probability S/S0 (Sun hours/Possible sun hours) []

Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec
 0.52 0.54 0.59 0.57 0.60 0.64 0.74 0.71 0.63 0.51 0.39 0.39

Operational time

N NNE NE ENE E ESE SE SSE S SSW SW WSW W WNW NW NNW Sum
 364 231 235 234 299 398 720 587 362 314 482 477 675 931 686 429 7,424

	July	August	September	October	November	December
1	05:38 21:30	06:08 21:06	06:48 20:15	07:27 19:15	08:11 18:16	07:54 16:43
2	05:39 21:30	06:09 21:05	06:49 20:13	07:28 19:13	08:12 18:15	07:55 16:43
3	05:39 21:29	06:10 21:04	06:50 20:11	07:29 19:11	08:13 18:14	07:56 16:43
4	05:40 21:29	06:11 21:02	06:51 20:09	07:30 19:09	08:15 18:12	07:57 16:42
5	05:40 21:29	06:12 21:01	06:53 20:07	07:32 19:07	08:16 18:11	07:58 16:42
6	05:41 21:28	06:14 20:59	06:54 20:05	07:34 19:05	08:17 18:10	08:00 16:41
7	05:42 21:28	06:15 20:58	06:55 20:03	07:35 19:03	08:18 18:09	08:01 16:41
8	05:43 21:28	06:16 20:56	06:57 20:01	07:37 19:01	08:19 18:08	08:02 16:41
9	05:43 21:27	06:18 20:55	06:58 19:59	07:38 18:57	08:20 18:07	08:03 16:41
10	05:44 21:27	06:19 20:53	06:59 19:57	07:39 18:55	08:21 18:06	08:04 16:41
11	05:45 21:26	06:20 20:52	07:01 19:55	07:41 18:53	08:22 18:05	08:05 16:41
12	05:46 21:26	06:21 20:50	07:02 19:53	07:42 18:51	08:23 18:04	08:06 16:41
13	05:47 21:25	06:23 20:49	07:03 19:51	07:44 18:49	08:24 18:03	08:07 16:41
14	05:48 21:24	06:24 20:47	07:05 19:49	07:45 18:47	08:25 18:02	08:08 16:41
15	05:49 21:24	06:25 20:45	07:06 19:47	07:46 18:46	08:26 18:01	08:09 16:41
16	05:50 21:23	06:27 20:44	07:07 19:45	07:48 18:44	08:27 18:00	08:09 16:41
17	05:51 21:22	06:28 20:42	07:09 19:43	07:49 18:42	08:28 17:59	08:10 16:41
18	05:52 21:21	06:29 20:40	07:10 19:41	07:51 18:40	08:29 17:58	08:11 16:41
19	05:53 21:21	06:31 20:39	07:11 19:39	07:52 18:38	08:30 17:57	08:11 16:41
20	05:54 21:20	06:32 20:37	07:12 19:37	07:53 18:36	08:31 17:56	08:12 16:42
21	05:55 21:19	06:33 20:35	07:14 19:35	07:55 18:35	08:32 17:55	08:13 16:43
22	05:56 21:18	06:34 20:33	07:15 19:33	07:56 18:33	08:33 17:54	08:13 16:43
23	05:57 21:17	06:36 20:32	07:16 19:31	07:58 18:31	08:34 17:53	08:14 16:44
24	05:58 21:16	06:37 20:30	07:18 19:29	07:59 18:29	08:35 17:52	08:14 16:44
25	05:59 21:15	06:38 20:28	07:19 19:27	08:01 18:28	08:36 17:51	08:15 16:45
26	06:00 21:14	06:40 20:26	07:20 19:25	08:02 18:26	08:37 17:50	08:15 16:45
27	06:02 21:12	06:41 20:24	07:22 19:23	08:04 18:24	08:38 17:49	08:15 16:46
28	06:03 21:11	06:42 20:22	07:23 19:21	08:05 18:23	08:39 17:48	08:16 16:47
29	06:04 21:10	06:44 20:20	07:24 19:19	08:07 18:21	08:40 17:47	08:16 16:47
30	06:05 21:09	06:45 20:19	07:26 19:17	08:08 18:19	08:41 17:46	08:16 16:48
31	06:06 21:08	06:46 20:17	07:27 19:15	08:10 18:18	08:42 17:45	08:16 16:49
Potential sun hours	481	442	380	339	283	266
Total, worst case			206	53	81	
Sun reduction			0.63	0.51	0.39	
Oper. time red.			0.85	0.85	0.85	
Wind dir. red.			0.70	0.72	0.72	
Total reduction			0.37	0.31	0.24	
Total, real			77	17	19	

Table layout: For each day in each month the following matrix apply

Day in month	Sun rise (hh:mm)	Sun set (hh:mm)	Minutes with flicker	First time (hh:mm) with flicker	Last time (hh:mm) with flicker	(WTG causing flicker first time)	(WTG causing flicker last time)
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SHADOW - Calendar

Calculation: Points and Grid Shadow receptor: A93 - Shadow Receptor: 1.0 x 1.0 Azimuth: 0.0° Slope: 90.0° (4983)

Assumptions for shadow calculations

Reference year for calendar

2023

Sunshine probability S/S0 (Sun hours/Possible sun hours) []

Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec
 0.52 0.54 0.59 0.57 0.60 0.64 0.74 0.71 0.63 0.51 0.39 0.39

Operational time

N NNE NE ENE E ESE SE SSE S SSW SW WSW W WNW NW NNW Sum
 364 231 235 234 299 398 720 587 362 314 482 477 675 931 686 429 7,424

	January	February	March	April	May	June
1	08:16 16:50	07:57 17:31	07:13 18:12	07:12 19:56	07:38 (104) 18 07:56 (118)	06:17 20:38
2	08:16 16:51	07:56 17:32	07:11 18:14	07:10 19:58	07:38 (104) 18 07:56 (118)	06:15 20:39
3	08:16 16:52	07:55 17:34	07:09 18:15	07:08 19:59	07:38 (104) 18 07:56 (114)	06:14 20:40
4	08:16 16:53	07:53 17:35	08:22 (89) 08:26 (89)	07:07 18:16	07:39 (104) 20:00	06:12 20:42
5	08:16 16:54	07:52 17:37	08:20 (89) 08:29 (89)	07:05 18:18	07:40 (114) 20:02	06:11 20:43
6	08:16 16:55	07:51 17:38	08:18 (89) 08:30 (89)	07:04 18:19	07:40 (114) 20:03	06:09 20:44
7	08:16 16:56	07:49 17:40	08:18 (89) 08:31 (89)	07:02 18:21	07:40 (114) 20:05	06:07 20:46
8	08:16 16:57	07:48 17:41	08:17 (89) 08:31 (89)	07:00 18:22	07:40 (114) 20:06	06:06 20:47
9	08:15 16:59	07:46 17:43	08:17 (89) 08:32 (89)	06:58 18:24	07:40 (114) 20:07	06:05 20:48
10	08:15 17:00	07:45 17:45	08:17 (89) 08:32 (89)	06:56 18:25	07:41 (114) 20:09	06:03 20:50
11	08:15 17:01	07:43 17:46	08:17 (89) 08:31 (89)	06:54 18:27	07:43 (114) 20:10	06:02 20:51
12	08:14 17:02	07:42 17:48	08:18 (89) 08:32 (89)	07:52 18:28	06:51 20:12	06:00 20:52
13	08:14 17:03	07:40 17:49	08:18 (89) 08:30 (89)	07:50 19:30	06:49 20:13	05:59 20:54
14	08:13 17:05	07:39 17:51	08:20 (89) 08:30 (89)	07:48 19:31	06:47 20:14	05:58 20:55
15	08:13 17:06	07:37 17:52	08:22 (89) 08:27 (89)	07:46 19:32	06:45 20:16	05:56 20:56
16	08:12 17:07	07:36 17:54	07:44 19:34	06:43 20:17	05:55 20:58	05:54 21:27
17	08:12 17:09	07:34 17:55	07:42 19:35	06:41 20:18	05:54 20:59	05:54 21:27
18	08:11 17:10	07:32 17:57	07:40 19:37	06:39 20:20	05:53 21:00	05:53 21:28
19	08:10 17:11	07:31 17:58	07:38 19:38	06:38 20:21	05:52 21:01	05:52 21:28
20	08:09 17:13	07:29 18:00	07:36 19:40	06:36 20:23	05:50 21:02	05:50 21:28
21	08:09 17:14	07:27 18:00	07:34 19:41	06:34 20:24	05:49 21:04	05:54 21:29
22	08:08 17:16	07:26 18:01	07:32 19:42	06:32 20:25	05:48 21:05	05:53 21:29
23	08:07 17:17	07:24 18:03	07:30 19:44	06:30 20:27	05:47 21:06	05:53 21:29
24	08:06 17:19	07:22 18:05	07:28 19:45	06:29 20:28	05:46 21:07	05:35 21:30
25	08:05 17:20	07:20 18:06	07:26 19:47	06:27 20:30	05:45 21:08	05:35 21:30
26	08:04 17:22	07:18 18:08	07:24 19:48	06:25 20:31	05:44 21:09	05:36 21:30
27	08:03 17:23	07:17 18:09	07:22 19:49	06:23 20:32	05:44 21:11	05:36 21:30
28	08:02 17:25	07:15 18:11	07:20 19:51	06:22 20:34	05:43 21:12	05:37 21:30
29	08:01 17:26		07:18 19:52	07:43 (104) 11 07:54 (118)	06:20 20:35	05:42 21:13
30	08:00 17:28		07:16 19:54	07:40 (104) 15 07:55 (118)	06:18 20:36	05:41 21:14
31	07:58 17:29		07:14 19:55	07:39 (104) 17 07:56 (118)	06:16 21:15	05:40 21:15
Potential sun hours	278	286	367	406	465	475
Total, worst case		137	43	167		
Sun reduction		0.54	0.59	0.57		
Oper. time red.		0.85	0.85	0.85		
Wind dir. red.		0.72	0.70	0.70		
Total reduction		0.33	0.35	0.34		
Total, real		45	15	57		

Table layout: For each day in each month the following matrix apply

Day in month	Sun rise (hh:mm)	Sun set (hh:mm)	Minutes with flicker	First time (hh:mm) with flicker	Last time (hh:mm) with flicker	(WTG causing flicker first time)	(WTG causing flicker last time)
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SHADOW - Calendar

Calculation: Points and Grid Shadow receptor: A93 - Shadow Receptor: 1.0 × 1.0 Azimuth: 0.0° Slope: 90.0° (4983)
 Assumptions for shadow calculations

Reference year for calendar 2023

Sunshine probability S/S0 (Sun hours/Possible sun hours) []
 Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec
 0.52 0.54 0.59 0.57 0.60 0.64 0.74 0.71 0.63 0.51 0.39 0.39

Operational time

N NNE NE ENE E ESE SE SSE S SSW SW WSW W WNW NW NNW Sum
 364 231 235 234 299 398 720 587 362 314 482 477 675 931 686 429 7,424

	July	August	September	October	November	December
1	05:38 21:30	06:08 21:06	06:48 20:15	07:27 19:15	08:11 18:16	07:54 16:43
2	05:39 21:30	06:09 21:05	06:49 20:13	07:28 19:13	08:12 18:15	07:55 16:43
3	05:39 21:29	06:10 21:04	06:50 20:11	07:30 19:11	08:14 18:13	07:56 16:43
4	05:40 21:29	06:11 21:02	06:51 20:09	07:31 19:09	08:15 18:12	07:57 16:42
5	05:40 21:29	06:12 21:01	06:53 20:07	07:32 19:07	08:16 18:11	07:58 16:42
6	05:41 21:28	06:14 20:59	06:54 20:05	07:34 19:05	08:18 18:10	08:00 16:41
7	05:42 21:28	06:15 20:58	06:55 20:03	07:35 19:03	08:20 18:09	08:01 16:41
8	05:43 21:28	06:16 20:56	06:57 20:01	07:37 19:01	08:22 18:08	08:03 16:41
9	05:43 21:27	06:18 20:55	06:58 19:59	07:38 18:57	08:23 18:07	08:04 16:41
10	05:44 21:27	06:19 20:53	06:59 19:57	07:39 18:55	08:24 18:06	08:05 16:41
11	05:45 21:26	06:20 20:52	07:01 19:55	07:41 18:53	08:26 18:05	08:06 16:41
12	05:46 21:26	06:21 20:50	07:02 19:53	07:42 18:51	08:27 18:04	08:07 16:41
13	05:47 21:25	06:23 20:49	07:03 19:51	07:44 18:49	08:29 18:03	08:08 16:41
14	05:48 21:24	06:24 20:47	07:05 19:49	07:45 18:47	08:30 18:02	08:09 16:41
15	05:49 21:24	06:25 20:45	07:06 19:47	07:46 18:46	08:31 18:01	08:10 16:41
16	05:50 21:23	06:27 20:44	07:07 19:45	07:48 18:44	08:33 18:00	08:11 16:41
17	05:51 21:22	06:28 20:42	07:09 19:43	07:49 18:42	08:35 17:59	08:12 16:41
18	05:52 21:21	06:29 20:40	07:10 19:41	07:51 18:40	08:36 17:58	08:13 16:41
19	05:53 21:21	06:31 20:39	07:11 19:39	07:52 18:38	08:38 17:57	08:14 16:41
20	05:54 21:20	06:32 20:37	07:12 19:37	07:53 18:36	08:39 17:56	08:15 16:41
21	05:55 21:19	06:33 20:35	07:14 19:35	07:55 18:35	08:40 17:55	08:16 16:41
22	05:56 21:18	06:34 20:33	07:15 19:33	07:56 18:33	08:41 17:54	08:17 16:41
23	05:57 21:17	06:36 20:32	07:16 19:31	07:58 18:31	08:42 17:53	08:18 16:41
24	05:58 21:16	06:37 20:30	07:18 19:29	07:59 18:29	08:43 17:52	08:19 16:41
25	05:59 21:15	06:38 20:28	07:19 19:27	08:01 18:28	08:44 17:51	08:20 16:41
26	06:00 21:14	06:40 20:26	07:20 19:25	08:02 18:26	08:45 17:50	08:21 16:41
27	06:02 21:12	06:41 20:24	07:22 19:23	08:04 18:24	08:46 17:49	08:22 16:41
28	06:03 21:11	06:42 20:22	07:23 19:21	08:05 18:23	08:47 17:48	08:23 16:41
29	06:04 21:10	06:44 20:20	07:24 19:19	08:07 18:21	08:48 17:47	08:24 16:41
30	06:05 21:09	06:45 20:19	07:26 19:17	08:08 18:19	08:49 17:46	08:25 16:41
31	06:06 21:08	06:46 20:17	07:27 19:15	08:10 18:18	08:50 17:45	08:26 16:41
Potential sun hours	481	442	380	339	283	266
Total, worst case			208	35	105	
Sun reduction			0.63	0.51	0.39	
Oper. time red.			0.85	0.85	0.85	
Wind dir. red.			0.70	0.72	0.72	
Total reduction			0.37	0.31	0.24	
Total, real			78	11	25	

Table layout: For each day in each month the following matrix apply

Day in month	Sun rise (hh:mm)	Minutes with flicker	First time (hh:mm) with flicker	Last time (hh:mm) with flicker	(WTG causing flicker first time)	(WTG causing flicker last time)
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Project:

Otter Tail Ashtabula III Wind

Description:

Barnes County, ND

Licensed user:

Epsilon Associates, Inc
3 Clock Tower Place, Suite 250
US-MAYNARD MA 01754
978 897 7100
Richard Lampeter / rlampeter@epsilonassociates.com
Calculated:
6/18/2023 2:05 PM/3.6.366

SHADOW - Calendar

Calculation: Points and Grid Shadow receptor: A94 - Shadow Receptor: 1.0 x 1.0 Azimuth: 0.0° Slope: 90.0° (4984)

Assumptions for shadow calculations

Sunshine probability S/S0 (Sun hours/Possible sun hours) []

Reference year for calendar

2023

Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec
0.52 0.54 0.59 0.57 0.60 0.64 0.74 0.71 0.63 0.51 0.39 0.39

Operational time

N NNE NE ENE E ESE SE SSE S SSW SW WSW W WNW NW NNW Sum
364 231 235 234 299 398 720 587 362 314 482 477 675 931 686 429 7,424

Table with columns for months (January to June) and rows for days (1 to 31) showing sun rise and set times. Includes summary rows for Potential sun hours, Total, worst case, Sun reduction, Oper. time red., Wind dir. red., Total reduction, and Total, real.

Table layout: For each day in each month the following matrix apply

Day in month Sun rise (hh:mm) Sun set (hh:mm) Minutes with flicker First time (hh:mm) with flicker Last time (hh:mm) with flicker (WTG causing flicker first time) (WTG causing flicker last time)

SHADOW - Calendar

Calculation: Points and Grid Shadow receptor: A94 - Shadow Receptor: 1.0 x 1.0 Azimuth: 0.0° Slope: 90.0° (4984)

Assumptions for shadow calculations

Sunshine probability S/S0 (Sun hours/Possible sun hours) []

Reference year for calendar

2023

Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec
 0.52 0.54 0.59 0.57 0.60 0.64 0.74 0.71 0.63 0.51 0.39 0.39

Operational time

N NNE NE ENE E ESE SE SSE S SSW SW WSW W WNW NW NNW Sum
 364 231 235 234 299 398 720 587 362 314 482 477 675 931 686 429 7,424

	July	August	September	October	November	December
1	05:38	06:08	06:48	07:27	08:11	07:54
	21:30	21:06	20:15	19:15	18:16	13 09:02 (89) 16:43
2	05:39	06:09	06:49	07:28	08:12	08:49 (89) 07:55
	21:30	21:05	20:13	19:13	18:15	14 09:03 (89) 16:43
3	05:39	06:10	06:50	07:30	08:14	08:49 (89) 07:56
	21:29	21:04	20:11	19:11	18:13	15 09:04 (89) 16:43
4	05:40	06:11	06:51	07:31	08:15	08:48 (89) 07:57
	21:29	21:02	20:09	19:09	18:12	16 09:04 (89) 16:42
5	05:40	06:12	06:53	07:32	07:17	07:49 (89) 07:59
	21:29	21:01	20:07	19:07	17:10	15 08:04 (89) 16:42
6	05:41	06:14	06:54	07:34	07:18	07:49 (89) 08:00
	21:28	20:59	20:05	19:05	17:09	14 08:03 (89) 16:41
7	05:42	06:15	06:55	07:35	07:20	07:50 (89) 08:01
	21:28	20:58	20:03	19:03	17:07	13 08:03 (89) 16:41
8	05:43	06:16	06:57	07:37	07:21	07:51 (89) 08:02
	21:28	20:56	20:01	19:01	17:06	11 08:02 (89) 16:41
9	05:43	06:18	06:58	07:38	07:23	07:52 (89) 08:03
	21:27	20:55	19:59	18:57	17:04	8 08:00 (89) 16:41
10	05:44	06:19	06:59	07:39	07:24	08:04
	21:27	20:53	19:57	18:55	17:03	16:41
11	05:45	06:20	07:01	07:41	07:26	08:05
	21:26	20:52	19:55	18:53	17:02	16:41
12	05:46	06:21	07:02	07:42	07:27	08:06
	21:26	20:50	19:53	18:51	17:01	16:41
13	05:47	06:23	07:03	07:44	07:29	08:07
	21:25	20:49	19:51	18:49	16:59	16:41
14	05:48	06:24	07:05	07:45	07:30	08:08
	21:24	20:47	19:49	18:47	16:58	16:41
15	05:49	06:25	07:06	07:46	07:32	08:09
	21:24	20:45	19:47	18:46	16:57	16:41
16	05:50	06:27	07:07	07:48	07:33	08:09
	21:23	20:44	19:45	18:44	16:56	16:41
17	05:51	06:28	07:08	07:49	07:35	08:10
	21:22	20:42	19:43	18:42	16:55	16:41
18	05:52	06:29	07:10	07:51	07:36	08:11
	21:21	20:40	19:41	18:40	16:54	16:42
19	05:53	06:31	07:11	07:52	07:38	08:11
	21:21	20:39	19:39	18:38	16:53	16:42
20	05:54	06:32	07:12	07:53	07:39	08:12
	21:20	20:37	19:37	18:36	16:52	16:42
21	05:55	06:33	07:14	07:55	07:40	08:13
	21:19	20:35	19:35	18:35	16:51	16:43
22	05:56	06:34	07:15	07:56	07:42	08:13
	21:18	20:33	19:33	18:33	16:50	16:43
23	05:57	06:36	07:16	07:58	07:43	08:14
	21:17	20:32	19:31	18:31	16:49	16:44
24	05:58	06:37	07:18	07:59	07:45	08:14
	21:16	20:30	19:29	18:29	16:48	16:44
25	05:59	06:38	07:19	08:01	07:46	08:15
	21:15	20:28	19:27	18:28	16:47	16:45
26	06:00	06:40	07:20	08:02	07:47	08:15
	21:14	20:26	19:25	18:26	16:47	16:45
27	06:02	06:41	07:22	08:04	07:49	08:15
	21:12	20:24	19:23	18:24	16:46	16:46
28	06:03	06:42	07:23	08:05	07:50	08:16
	21:11	20:22	19:21	18:23	16:45	16:47
29	06:04	06:44	07:24	08:07	07:51	08:16
	21:10	20:20	19:19	18:21	16:45	16:47
30	06:05	06:45	07:26	08:08	08:52 (89) 07:53	08:16
	21:09	20:19	19:17	18:19	8 09:00 (89) 16:44	16:48
31	06:06	06:46		08:10	08:51 (89)	08:16
	21:08	20:17		18:18	11 09:02 (89)	16:49
Potential sun hours	481	442	380	339	283	266
Total, worst case			216	19	119	
Sun reduction			0.63	0.51	0.39	
Oper. time red.			0.85	0.85	0.85	
Wind dir. red.			0.70	0.72	0.72	
Total reduction			0.37	0.31	0.24	
Total, real			81	6	28	

Table layout: For each day in each month the following matrix apply

Day in month	Sun rise (hh:mm)	Sun set (hh:mm)	Minutes with flicker	First time (hh:mm) with flicker	Last time (hh:mm) with flicker	(WTG causing flicker first time)	(WTG causing flicker last time)
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Project:

Otter Tail Ashtabula III Wind

Description:

Barnes County, ND

Licensed user:

Epsilon Associates, Inc
3 Clock Tower Place, Suite 250
US-MAYNARD MA 01754
978 897 7100
Richard Lampeter / rlampeter@epsilonassociates.com
Calculated:
6/18/2023 2:05 PM/3.6.366

SHADOW - Calendar

Calculation: Points and Grid Shadow receptor: A95 - Shadow Receptor: 1.0 x 1.0 Azimuth: 0.0° Slope: 90.0° (4985)

Assumptions for shadow calculations

Sunshine probability S/S0 (Sun hours/Possible sun hours) []

Reference year for calendar

2023

Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec
0.52 0.54 0.59 0.57 0.60 0.64 0.74 0.71 0.63 0.51 0.39 0.39

Operational time

N NNE NE ENE E ESE SE SSE S SSW SW WSW W WNW NW NNW Sum
364 231 235 234 299 398 720 587 362 314 482 477 675 931 686 429 7,424

Table with columns for months (January to June) and rows for days (1 to 31) showing sun rise and set times. Includes summary rows for Potential sun hours, Total, worst case, Sun reduction, Oper. time red., Wind dir. red., Total reduction, and Total, real.

Table layout: For each day in each month the following matrix apply

Day in month Sun rise (hh:mm) Sun set (hh:mm) Minutes with flicker First time (hh:mm) with flicker Last time (hh:mm) with flicker (WTG causing flicker first time) (WTG causing flicker last time)

SHADOW - Calendar

Calculation: Points and Grid Shadow receptor: A95 - Shadow Receptor: 1.0 x 1.0 Azimuth: 0.0° Slope: 90.0° (4985)

Assumptions for shadow calculations

Sunshine probability S/S0 (Sun hours/Possible sun hours) []

Reference year for calendar

2023

Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec
 0.52 0.54 0.59 0.57 0.60 0.64 0.74 0.71 0.63 0.51 0.39 0.39

Operational time

N NNE NE ENE E ESE SE SSE S SSW SW WSW W WNW NW NNW Sum
 364 231 235 234 299 398 720 587 362 314 482 477 675 931 686 429 7,424

	July	August	September	October	November	December
1	05:38	06:08	06:48	07:27	08:11	08:52 (89)
	21:30	21:06	20:15	19:15	18:16	11 09:03 (89)
2	05:39	06:09	06:49	07:28	08:12	08:51 (89)
	21:30	21:05	20:13	19:13	18:15	14 09:05 (89)
3	05:39	06:10	06:50	07:30	08:14	08:51 (89)
	21:29	21:04	20:11	19:11	18:13	14 09:05 (89)
4	05:40	06:11	06:51	07:31	08:15	08:50 (89)
	21:29	21:02	20:09	8 07:51 (114)	19:09	18:12
5	05:40	06:12	06:53	07:32	07:17	15 09:05 (89)
	21:29	21:01	20:07	12 07:53 (114)	19:07	18:12
6	05:41	06:14	06:54	07:34	07:18	16 08:06 (89)
	21:28	20:59	20:05	15 07:54 (114)	19:05	18:12
7	05:42	06:15	06:55	07:35	07:20	15 08:05 (89)
	21:28	20:58	20:03	16 07:54 (114)	19:03	18:12
8	05:43	06:16	06:57	07:37	07:21	15 09:05 (89)
	21:28	20:56	20:01	17 07:54 (114)	19:01	18:12
9	05:43	06:18	06:58	07:38	07:23	13 08:05 (89)
	21:27	20:55	19:59	17 07:54 (114)	18:57	17:06
10	05:44	06:19	06:59	07:39	07:24	11 08:03 (89)
	21:27	20:53	19:57	18 07:54 (114)	18:55	17:04
11	05:45	06:20	07:01	07:41	07:26	9 08:03 (89)
	21:26	20:52	19:55	19 07:53 (114)	18:53	17:02
12	05:46	06:21	07:02	07:42	07:27	2 07:59 (89)
	21:26	20:50	19:53	19 07:51 (114)	18:51	17:02
13	05:47	06:23	07:03	07:44	07:29	17:01
	21:25	20:49	19:51	19 07:51 (118)	18:49	16:59
14	05:48	06:24	07:05	07:45	07:30	16:58
	21:24	20:47	19:49	18 07:50 (118)	18:47	16:57
15	05:49	06:25	07:06	07:46	07:32	16:57
	21:24	20:45	19:47	17 07:49 (118)	18:46	16:56
16	05:50	06:27	07:07	07:48	07:33	16:56
	21:23	20:44	19:45	15 07:48 (118)	18:44	16:55
17	05:51	06:28	07:08	07:49	07:35	16:54
	21:22	20:42	19:43	7 07:46 (118)	18:42	16:54
18	05:52	06:29	07:10	07:51	07:36	16:53
	21:21	20:40	19:41	18:40	16:54	16:53
19	05:53	06:31	07:11	07:52	07:38	16:52
	21:21	20:39	19:39	18:38	16:53	16:52
20	05:54	06:32	07:12	07:53	07:39	16:51
	21:20	20:37	19:37	18:36	16:52	16:51
21	05:55	06:33	07:14	07:55	07:40	16:50
	21:19	20:35	19:35	18:35	16:51	16:50
22	05:56	06:34	07:15	07:56	07:42	16:49
	21:18	20:33	19:33	18:33	16:50	16:49
23	05:57	06:36	07:16	07:58	07:43	16:48
	21:17	20:32	19:31	18:31	16:49	16:48
24	05:58	06:37	07:18	07:59	07:45	16:47
	21:16	20:30	19:29	18:29	16:48	16:47
25	05:59	06:38	07:19	08:01	07:46	16:46
	21:15	20:28	19:27	18:28	16:47	16:46
26	06:00	06:40	07:20	08:02	07:47	16:45
	21:14	20:26	19:25	18:26	16:47	16:45
27	06:02	06:41	07:22	08:04	07:49	16:44
	21:12	20:24	19:23	18:24	16:46	16:44
28	06:03	06:42	07:23	08:05	07:50	16:43
	21:11	20:22	19:21	18:23	16:45	16:43
29	06:04	06:44	07:24	08:07	07:51	16:42
	21:10	20:20	19:19	18:21	16:45	16:42
30	06:05	06:45	07:26	08:08	08:57 (89)	16:41
	21:09	20:19	19:17	18:19	1 08:58 (89)	16:40
31	06:06	06:46		08:10	08:54 (89)	16:39
	21:08	20:17		18:18	8 09:02 (89)	16:38
Potential sun hours	481	442	380	339	283	266
Total, worst case			217	9	134	
Sun reduction			0.63	0.51	0.39	
Oper. time red.			0.85	0.85	0.85	
Wind dir. red.			0.70	0.72	0.72	
Total reduction			0.38	0.31	0.24	
Total, real			81	3	32	

Table layout: For each day in each month the following matrix apply

Day in month	Sun rise (hh:mm)	Minutes with flicker	First time (hh:mm) with flicker	(WTG causing flicker first time)
	Sun set (hh:mm)		Last time (hh:mm) with flicker	(WTG causing flicker last time)

Project: Otter Tail Ashtabula III Wind

Description: Barnes County, ND

Licensed user:
 Epsilon Associates, Inc
 3 Clock Tower Place, Suite 250
 US-MAYNARD MA 01754
 978 897 7100
 Richard Lampeter / rlampeter@epsilonassociates.com
 Calculated:
 6/18/2023 2:05 PM/3.6.366

SHADOW - Calendar

Calculation: Points and Grid Shadow receptor: A96 - Shadow Receptor: 1.0 x 1.0 Azimuth: 0.0° Slope: 90.0° (4986)

Assumptions for shadow calculations

Sunshine probability S/S0 (Sun hours/Possible sun hours) []

Reference year for calendar

2023

Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec
 0.52 0.54 0.59 0.57 0.60 0.64 0.74 0.71 0.63 0.51 0.39 0.39

Operational time

N NNE NE ENE E ESE SE SSE S SSW SW WSW W WNW NW NNW Sum
 364 231 235 234 299 398 720 587 362 314 482 477 675 931 686 429 7,424

	January	February	March	April	May	June
1	08:16 16:50	07:57 17:31 10	08:26 (89) 18:12	07:12 19:56 21	07:42 (104) 20:38	05:40 21:16
2	08:16 16:51	07:56 17:32 13	08:25 (89) 18:14	07:10 19:58 20	07:43 (104) 20:39	05:39 21:17
3	08:16 16:52	07:55 17:34 14	08:24 (89) 18:15	07:08 19:59 19	07:44 (104) 20:40	05:38 21:18
4	08:16 16:53	07:53 17:35 15	08:24 (89) 18:16	07:06 20:00 17	07:45 (114) 20:42	05:38 21:18
5	08:16 16:54	07:52 17:37 16	08:24 (89) 18:18	07:04 20:02 17	07:45 (114) 20:43	05:37 21:19
6	08:16 16:55	07:51 17:38 15	08:24 (89) 18:19	07:02 20:03 16	07:46 (114) 20:44	05:37 21:20
7	08:16 16:56	07:49 17:40 15	08:25 (89) 18:21	07:00 20:05 13	07:47 (114) 20:46	05:36 21:21
8	08:16 16:57	07:48 17:41 14	08:25 (89) 18:22	06:58 20:06 10	07:48 (114) 20:47	05:36 21:22
9	08:15 16:59	07:46 17:43 13	08:26 (89) 18:24	06:57 20:07 3	07:51 (114) 20:48	05:36 21:23
10	08:15 17:00	07:45 17:45 10	08:27 (89) 18:25	06:55 20:09	07:54 (114) 20:50	05:35 21:23
11	08:15 17:01	07:43 17:46 7	08:28 (89) 18:27	06:53 20:10	06:02 20:51	05:35 21:24
12	08:14 17:02	07:42 17:48	07:52 18:28	06:51 20:12	06:00 20:52	05:35 21:25
13	08:14 17:03	07:40 17:49	07:50 19:30	06:49 20:13	05:59 20:54	05:35 21:25
14	08:13 17:05	07:39 17:51	07:48 19:31	06:47 20:14	05:58 20:55	05:34 21:26
15	08:13 17:06	07:37 17:52	07:46 19:32	06:45 20:16	05:56 20:56	05:34 21:26
16	08:12 17:07	07:36 17:54	07:44 19:34	06:43 20:17	05:55 20:58	05:34 21:27
17	08:12 17:09	07:34 17:55	07:42 19:35	06:41 20:18	05:54 20:59	05:34 21:27
18	08:11 17:10	07:32 17:57	07:40 19:37	06:39 20:20	05:53 21:00	05:34 21:28
19	08:10 17:11	07:31 17:58	07:38 19:38	06:38 20:21	05:52 21:01	05:34 21:28
20	08:09 17:13	07:29 18:00	07:36 19:40	06:36 20:23	05:50 21:02	05:34 21:28
21	08:09 17:14	07:27 18:00	07:34 19:41	06:34 20:24	05:49 21:04	05:34 21:29
22	08:08 17:16	07:26 18:01	07:32 19:42	06:32 20:25	05:48 21:05	05:35 21:29
23	08:07 17:17	07:24 18:03	07:30 19:44	06:30 20:27	05:47 21:06	05:35 21:29
24	08:06 17:19	07:22 18:05	07:28 19:45	06:29 20:28	05:46 21:07	05:35 21:30
25	08:05 17:20	07:20 18:06	07:26 19:47	06:27 20:30	05:45 21:08	05:35 21:30
26	08:04 17:22	07:18 18:08	07:24 19:48	06:25 20:31	05:44 21:09	05:36 21:30
27	08:03 17:23	07:17 18:09	07:22 19:49	06:23 20:32	05:44 21:11	05:36 21:30
28	08:02 17:25	07:15 18:11	07:20 19:51	11 08:00 (118) 06:22	07:45 (104) 20:34	05:37 21:30
29	08:01 17:26		07:18 19:52	16 08:01 (118) 06:20	07:43 (104) 20:35	05:37 21:30
30	08:00 17:28		07:16 19:54	18 08:01 (118) 20:36	07:42 (104) 06:18	05:37 21:30
31	07:58 17:29	08:27 (89) 08:34 (89)	07:14 19:55	19 08:01 (118) 20	07:42 (104) 08:02 (114)	05:40 21:15
Potential sun hours	278	286	367	406	465	475
Total, worst case	7	142	84	136		
Sun reduction	0.52	0.54	0.59	0.57		
Oper. time red.	0.85	0.85	0.85	0.85		
Wind dir. red.	0.72	0.72	0.70	0.70		
Total reduction	0.32	0.33	0.35	0.34		
Total, real	2	47	30	46		

Table layout: For each day in each month the following matrix apply

Day in month	Sun rise (hh:mm)	First time (hh:mm) with flicker	(WTG causing flicker first time)
	Sun set (hh:mm)	Minutes with flicker	Last time (hh:mm) with flicker
			(WTG causing flicker last time)

Project: Otter Tail Ashtabula III Wind
 Description: Barnes County, ND

Licensed user:
 Epsilon Associates, Inc
 3 Clock Tower Place, Suite 250
 US-MAYNARD MA 01754
 978 897 7100
 Richard Lampeter / rlampeter@epsilonassociates.com
 Calculated:
 6/18/2023 2:05 PM/3.6.366

SHADOW - Calendar

Calculation: Points and Grid Shadow receptor: A96 - Shadow Receptor: 1.0 x 1.0 Azimuth: 0.0° Slope: 90.0° (4986)
 Assumptions for shadow calculations

Reference year for calendar

2023

Sunshine probability S/S0 (Sun hours/Possible sun hours) []

Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec
 0.52 0.54 0.59 0.57 0.60 0.64 0.74 0.71 0.63 0.51 0.39 0.39

Operational time

N NNE NE ENE E ESE SE SSE S SSW SW WSW W WNW NW NNW Sum
 364 231 235 234 299 398 720 587 362 314 482 477 675 931 686 429 7,424

	July	August	September	October	November	December
1	05:38 21:30	06:08 21:06	06:48 20:15	07:27 19:15	08:11 18:16	08:59 (89) 16:43
2	05:39 21:30	06:09 21:05	06:49 20:13	07:28 19:13	08:12 18:15	08:57 (89) 16:43
3	05:39 21:29	06:10 21:04	06:50 20:11	07:30 19:11	08:14 18:13	08:56 (89) 16:43
4	05:40 21:29	06:11 21:02	06:51 20:09	07:31 19:09	08:15 18:12	08:54 (89) 16:42
5	05:40 21:29	06:12 21:01	06:53 20:07	07:32 19:07	07:17 17:10	07:54 (89) 16:42
6	05:41 21:28	06:14 20:59	06:54 20:05	07:34 19:05	07:18 17:09	07:53 (89) 16:41
7	05:42 21:28	06:15 20:58	06:55 20:03	07:35 19:03	07:20 17:07	07:54 (89) 16:41
8	05:43 21:28	06:16 20:56	06:57 20:01	07:37 19:01	07:21 17:06	07:54 (89) 16:41
9	05:43 21:27	06:18 20:55	06:58 19:59	07:38 19:00	07:23 17:04	07:54 (89) 16:41
10	05:44 21:27	06:19 20:53	06:59 19:57	07:39 18:55	07:24 17:03	07:55 (89) 16:41
11	05:45 21:26	06:20 20:52	07:01 19:55	07:41 18:53	07:26 17:02	07:56 (89) 16:41
12	05:46 21:26	06:21 20:50	07:02 19:53	07:42 18:51	07:27 17:01	07:57 (89) 16:41
13	05:47 21:25	06:23 20:49	07:03 19:51	07:44 18:49	07:29 16:59	08:00 (89) 16:41
14	05:48 21:24	06:24 20:47	07:05 19:49	07:45 18:47	07:30 16:58	08:08 16:41
15	05:49 21:24	06:25 20:45	07:06 19:47	07:46 18:46	07:32 16:57	08:09 16:41
16	05:50 21:23	06:27 20:44	07:07 19:45	07:48 18:44	07:33 16:56	08:09 16:41
17	05:51 21:22	06:28 20:42	07:08 19:43	07:49 18:42	07:35 16:55	08:10 16:41
18	05:52 21:21	06:29 20:40	07:10 19:41	07:51 18:40	07:36 16:54	08:11 16:42
19	05:53 21:21	06:31 20:39	07:11 19:39	07:52 18:38	07:38 16:53	08:11 16:42
20	05:54 21:20	06:32 20:37	07:12 19:37	07:53 18:36	07:39 16:52	08:12 16:42
21	05:55 21:19	06:33 20:35	07:14 19:35	07:55 18:35	07:40 16:51	08:13 16:43
22	05:56 21:18	06:34 20:33	07:15 19:33	07:56 18:33	07:42 16:50	08:13 16:43
23	05:57 21:17	06:36 20:32	07:16 19:31	07:58 18:31	07:43 16:49	08:14 16:44
24	05:58 21:16	06:37 20:30	07:18 19:29	07:59 18:29	07:45 16:48	08:14 16:44
25	05:59 21:15	06:38 20:28	07:19 19:27	08:01 18:28	07:46 16:47	08:15 16:45
26	06:00 21:14	06:40 20:26	07:20 19:25	08:02 18:26	07:47 16:47	08:15 16:45
27	06:02 21:12	06:41 20:24	07:22 19:23	08:04 18:24	07:49 16:46	08:15 16:46
28	06:03 21:11	06:42 20:22	07:23 19:21	08:05 18:23	07:50 16:45	08:16 16:47
29	06:04 21:10	06:44 20:20	07:24 19:19	08:07 18:21	07:51 16:45	08:16 16:47
30	06:05 21:09	06:45 20:19	07:26 19:17	08:08 18:19	07:53 16:44	08:16 16:48
31	06:06 21:08	06:46 20:17		08:10 18:18		08:16 16:49
Potential sun hours	481	442	380	339	283	266
Total, worst case			223		156	
Sun reduction			0.63		0.39	
Oper. time red.			0.85		0.85	
Wind dir. red.			0.70		0.72	
Total reduction			0.38		0.24	
Total, real			84		37	

Table layout: For each day in each month the following matrix apply

Day in month	Sun rise (hh:mm)	Minutes with flicker	First time (hh:mm) with flicker	(WTG causing flicker first time)
	Sun set (hh:mm)		Last time (hh:mm) with flicker	(WTG causing flicker last time)

Project:

Otter Tail Ashtabula III Wind

Description:

Barnes County, ND

Licensed user:

Epsilon Associates, Inc
3 Clock Tower Place, Suite 250
US-MAYNARD MA 01754
978 897 7100
Richard Lampeter / rlampeter@epsilonassociates.com
Calculated:
6/18/2023 2:05 PM/3.6.366

SHADOW - Calendar

Calculation: Points and Grid Shadow receptor: A97 - Shadow Receptor: 1.0 x 1.0 Azimuth: 0.0° Slope: 90.0° (4987)

Assumptions for shadow calculations

Sunshine probability S/S0 (Sun hours/Possible sun hours) []

Reference year for calendar

2023

Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec
0.52 0.54 0.59 0.57 0.60 0.64 0.74 0.71 0.63 0.51 0.39 0.39

Operational time

N NNE NE ENE E ESE SE SSE S SSW SW WSW W WNW NW NNW Sum
364 231 235 234 299 398 720 587 362 314 482 477 675 931 686 429 7,424

Table with columns for months (January to June) and rows for days (1-31) showing sun rise/set times and shadow reduction factors.

Table layout: For each day in each month the following matrix apply

Day in month Sun rise (hh:mm) Sun set (hh:mm) Minutes with flicker First time (hh:mm) with flicker Last time (hh:mm) with flicker (WTG causing flicker first time) (WTG causing flicker last time)

SHADOW - Calendar

Calculation: Points and Grid Shadow receptor: A97 - Shadow Receptor: 1.0 x 1.0 Azimuth: 0.0° Slope: 90.0° (4987)

Assumptions for shadow calculations

Sunshine probability S/S0 (Sun hours/Possible sun hours) []

Reference year for calendar

2023

Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec
 0.52 0.54 0.59 0.57 0.60 0.64 0.74 0.71 0.63 0.51 0.39 0.39

Operational time

N NNE NE ENE E ESE SE SSE S SSW SW WSW W WNW NW NNW Sum
 364 231 235 234 299 398 720 587 362 314 482 477 675 931 686 429 7,424

	July	August	September	October	November	December
1	05:38 21:30	06:08 21:06	06:48 20:15	07:34 (114) 19:15	08:11 18:16	08:49 (89) 16:43
2	05:39 21:30	06:09 21:05	06:49 20:13	07:33 (114) 19:13	08:12 18:15	08:49 (89) 16:43
3	05:39 21:29	06:10 21:04	06:50 20:11	07:32 (114) 19:11	08:14 18:13	08:49 (89) 16:43
4	05:40 21:29	06:11 21:02	06:51 20:09	07:31 (114) 19:09	08:15 18:12	08:49 (89) 16:42
5	05:40 21:29	06:12 21:01	06:53 20:07	07:31 (114) 19:07	07:17 17:10	07:49 (89) 16:42
6	05:41 21:28	06:14 20:59	06:54 20:05	07:31 (114) 19:05	07:18 17:09	07:49 (89) 16:41
7	05:42 21:28	06:15 20:58	06:55 20:03	07:31 (114) 19:03	07:20 17:07	07:50 (89) 16:41
8	05:43 21:28	06:16 20:56	06:57 20:01	07:30 (104) 19:01	07:21 17:06	07:51 (89) 16:41
9	05:43 21:27	06:18 20:55	06:58 19:59	07:29 (104) 18:57	07:23 17:04	07:52 (89) 16:41
10	05:44 21:27	06:19 20:53	06:59 19:57	07:28 (104) 18:55	07:24 17:03	07:54 (89) 16:41
11	05:45 21:26	06:20 20:52	07:01 19:55	07:28 (104) 18:53	07:26 17:02	08:01 (89) 16:41
12	05:46 21:26	06:21 20:50	07:02 19:53	07:27 (104) 18:51	07:27 17:01	08:06 16:41
13	05:47 21:25	06:23 20:49	07:03 19:51	07:29 (104) 18:49	07:29 16:59	08:07 16:41
14	05:48 21:24	06:24 20:47	07:05 19:49	07:30 (104) 18:47	07:30 16:58	08:08 16:41
15	05:49 21:24	06:25 20:45	07:06 19:47	07:46 (118) 18:46	07:32 16:57	08:09 16:41
16	05:50 21:23	06:27 20:44	07:07 19:45	07:48 18:44	07:33 16:56	08:09 16:41
17	05:51 21:22	06:28 20:42	07:08 19:43	07:49 18:42	07:35 16:55	08:10 16:41
18	05:52 21:21	06:29 20:40	07:10 19:41	07:51 18:40	07:36 16:54	08:11 16:42
19	05:53 21:21	06:31 20:39	07:11 19:39	07:52 18:38	07:38 16:53	08:11 16:42
20	05:54 21:20	06:32 20:37	07:12 19:37	07:53 18:36	07:39 16:52	08:12 16:42
21	05:55 21:19	06:33 20:35	07:14 19:35	07:55 18:35	07:40 16:51	08:13 16:43
22	05:56 21:18	06:34 20:33	07:15 19:33	07:56 18:33	07:42 16:50	08:13 16:43
23	05:57 21:17	06:36 20:32	07:16 19:31	07:58 18:31	07:43 16:49	08:14 16:44
24	05:58 21:16	06:37 20:30	07:18 19:29	07:59 18:29	07:45 16:48	08:14 16:44
25	05:59 21:15	06:38 20:28	07:19 19:27	08:01 18:28	07:46 16:47	08:15 16:45
26	06:00 21:14	06:40 20:26	07:20 19:25	08:02 18:26	07:47 16:47	08:15 16:45
27	06:02 21:12	06:41 20:24	07:22 19:23	08:04 18:24	07:49 16:46	08:15 16:46
28	06:03 21:11	06:42 20:22	07:23 19:21	08:05 18:23	07:50 16:45	08:16 16:47
29	06:04 21:10	06:44 20:20	07:24 19:19	08:07 18:21	07:51 16:45	08:16 16:47
30	06:05 21:09	06:45 20:19	07:26 19:17	08:08 18:19	08:56 (89) 09:01 (89)	07:53 16:44
31	06:06 21:08	06:46 20:17	07:35 (114) 07:48 (114)	08:10 18:18	08:58 (89) 09:03 (89)	16:45 16:49
Potential sun hours	481	442	380	339	283	266
Total, worst case		22	230	23	138	
Sun reduction		0.71	0.63	0.51	0.39	
Oper. time red.		0.85	0.85	0.85	0.85	
Wind dir. red.		0.69	0.70	0.72	0.72	
Total reduction		0.42	0.37	0.31	0.24	
Total, real		9	86	7	33	

Table layout: For each day in each month the following matrix apply

Day in month	Sun rise (hh:mm)	Sun set (hh:mm)	Minutes with flicker	First time (hh:mm) with flicker	Last time (hh:mm) with flicker	(WTG causing flicker first time)	(WTG causing flicker last time)
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Project:

Otter Tail Ashtabula III Wind

Description:

Barnes County, ND

Licensed user:

Epsilon Associates, Inc
3 Clock Tower Place, Suite 250
US-MAYNARD MA 01754
978 897 7100
Richard Lampeter / rlampeter@epsilonassociates.com
Calculated:
6/18/2023 2:05 PM/3.6.366

SHADOW - Calendar

Calculation: Points and Grid Shadow receptor: A98 - Shadow Receptor: 1.0 x 1.0 Azimuth: 0.0° Slope: 90.0° (4988)

Assumptions for shadow calculations

Sunshine probability S/S0 (Sun hours/Possible sun hours) []

Reference year for calendar

2023

Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec
0.52 0.54 0.59 0.57 0.60 0.64 0.74 0.71 0.63 0.51 0.39 0.39

Operational time

N NNE NE ENE E ESE SE SSE S SSW SW WSW W WNW NW NNW Sum
364 231 235 234 299 398 720 587 362 314 482 477 675 931 686 429 7,424

Table with columns for months (January to June) and rows for each day of the month, showing sun rise and set times, and a summary section for potential sun hours and various reductions.

Table layout: For each day in each month the following matrix apply

Day in month Sun rise (hh:mm) Sun set (hh:mm) Minutes with flicker First time (hh:mm) with flicker Last time (hh:mm) with flicker (WTG causing flicker first time) (WTG causing flicker last time)

SHADOW - Calendar

Calculation: Points and Grid Shadow receptor: A98 - Shadow Receptor: 1.0 x 1.0 Azimuth: 0.0° Slope: 90.0° (4988)

Assumptions for shadow calculations

Sunshine probability S/S0 (Sun hours/Possible sun hours) []

Reference year for calendar

2023

Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec
 0.52 0.54 0.59 0.57 0.60 0.64 0.74 0.71 0.63 0.51 0.39 0.39

Operational time

N NNE NE ENE E ESE SE SSE S SSW SW WSW W WNW NW NNW Sum
 364 231 235 234 299 398 720 587 362 314 482 477 675 931 686 429 7,424

	July	August	September	October	November	December
1	05:38	06:08	06:48	07:27	08:11	07:54
	21:30	21:06	20:15	19:15	18:16	16:43
2	05:39	06:09	06:49	07:28	08:12	07:55
	21:30	21:05	20:13	19:13	18:15	16:43
3	05:39	06:10	06:50	07:30	08:14	07:56
	21:29	21:04	20:11	19:11	18:13	16:43
4	05:40	06:11	06:51	07:31	08:15	07:57
	21:29	21:02	20:09	19:09	18:12	16:42
5	05:40	06:12	06:53	07:32	07:17	07:59
	21:29	21:01	20:07	19:07	17:10	16:42
6	05:41	06:14	06:54	07:34	07:18	08:00
	21:28	20:59	20:05	19:05	17:09	16:41
7	05:42	06:15	06:55	07:35	07:20	08:01
	21:28	20:58	20:03	19:03	17:07	16:41
8	05:43	06:16	06:57	07:37	07:21	08:02
	21:28	20:56	20:01	19:01	17:06	16:41
9	05:43	06:18	06:58	07:38	07:23	08:03
	21:27	20:55	19:59	18:57	17:04	16:41
10	05:44	06:19	06:59	07:39	07:24	08:04
	21:27	20:53	19:57	18:55	17:03	16:41
11	05:45	06:20	07:01	07:45	07:26	08:05
	21:26	20:52	19:55	18:53	17:02	16:41
12	05:46	06:21	07:02	07:43	07:27	08:06
	21:26	20:50	19:53	18:51	17:01	16:41
13	05:47	06:23	07:03	07:44	07:29	08:07
	21:25	20:49	19:51	18:49	16:59	16:41
14	05:48	06:24	07:05	07:43	07:30	08:08
	21:24	20:47	19:49	18:47	16:58	16:41
15	05:49	06:25	07:06	07:43	07:32	08:09
	21:24	20:45	19:47	18:46	16:57	16:41
16	05:50	06:27	07:07	07:42	07:33	08:09
	21:23	20:44	19:45	18:44	16:56	16:41
17	05:51	06:28	07:08	07:42	07:35	08:10
	21:22	20:42	19:43	18:42	16:55	16:41
18	05:52	06:29	07:10	07:41	07:36	08:11
	21:21	20:40	19:41	18:40	16:54	16:42
19	05:53	06:31	07:11	07:41	07:38	08:11
	21:21	20:39	19:39	18:38	16:53	16:42
20	05:54	06:32	07:12	07:43	07:39	08:12
	21:20	20:37	19:37	18:36	16:52	16:42
21	05:55	06:33	07:14	07:45	07:40	08:13
	21:19	20:35	19:35	18:35	16:51	16:43
22	05:56	06:34	07:15	07:56	07:42	08:13
	21:18	20:33	19:33	18:33	16:50	16:43
23	05:57	06:36	07:16	07:58	07:43	08:14
	21:17	20:32	19:31	18:31	16:49	16:44
24	05:58	06:37	07:18	07:59	07:45	08:14
	21:16	20:30	19:29	18:29	16:48	16:44
25	05:59	06:38	07:19	08:01	07:46	08:15
	21:15	20:28	19:27	18:28	16:47	16:45
26	06:00	06:40	07:20	08:02	07:47	08:15
	21:14	20:26	19:25	18:26	16:47	16:45
27	06:02	06:41	07:22	08:04	07:49	08:15
	21:12	20:24	19:23	18:24	16:46	16:46
28	06:03	06:42	07:23	08:05	07:50	08:16
	21:11	20:22	19:21	18:23	16:45	16:47
29	06:04	06:44	07:24	08:07	07:51	08:16
	21:10	20:20	19:19	18:21	16:45	16:47
30	06:05	06:45	07:26	08:08	07:53	08:16
	21:09	20:19	19:17	18:19	16:44	16:48
31	06:06	06:46		08:10		08:16
	21:08	20:17		18:18		16:49
Potential sun hours	481	442	380	339	283	266
Total, worst case			182		156	
Sun reduction			0.63		0.39	
Oper. time red.			0.85		0.85	
Wind dir. red.			0.71		0.72	
Total reduction			0.38		0.24	
Total, real			69		37	

Table layout: For each day in each month the following matrix apply

Day in month	Sun rise (hh:mm)	Sun set (hh:mm)	Minutes with flicker	First time (hh:mm) with flicker	Last time (hh:mm) with flicker	(WTG causing flicker first time)	(WTG causing flicker last time)
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SHADOW - Calendar

Calculation: Points and Grid Shadow receptor: A99 - Shadow Receptor: 1.0 x 1.0 Azimuth: 0.0° Slope: 90.0° (4989)

Assumptions for shadow calculations

Sunshine probability S/S0 (Sun hours/Possible sun hours) []

Reference year for calendar

2023

Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec
 0.52 0.54 0.59 0.57 0.60 0.64 0.74 0.71 0.63 0.51 0.39 0.39

Operational time

N NNE NE ENE E ESE SE SSE S SSW SW WSW W WNW NW NNW Sum
 364 231 235 234 299 398 720 587 362 314 482 477 675 931 686 429 7,424

	January	February	March	April	May	June
1	08:16 16:50	07:57 17:31	08:29 (89) 18:12	07:12 19:56	07:46 (104) 08:08 (114)	06:17 20:38
2	08:16 16:51	07:56 17:32	08:30 (89) 18:14	07:10 19:58	07:49 (114) 08:07 (114)	06:15 20:39
3	08:16 16:52	07:55 17:34	08:30 (89) 18:15	07:08 19:59	07:49 (114) 08:06 (114)	06:14 20:40
4	08:16 16:53	07:53 17:35	08:31 (89) 18:16	07:06 20:00	07:50 (114) 08:05 (114)	06:12 20:42
5	08:16 16:54	07:52 17:37	08:32 (89) 18:18	07:04 20:02	07:51 (114) 08:03 (114)	06:10 20:43
6	08:16 16:55	07:51 17:38	08:33 (89) 18:19	07:02 20:03	07:54 (114) 08:02 (114)	06:09 20:44
7	08:16 16:56	07:49 17:40	08:36 (89) 18:21	07:00 20:05	07:00 20:05	06:07 20:46
8	08:16 16:57	07:48 17:41	07:00 18:22	06:58 20:06	06:06 20:06	05:36 21:22
9	08:15 16:59	07:46 17:43	06:58 18:24	06:57 20:07	06:05 20:07	05:36 21:23
10	08:15 17:00	07:45 17:45	06:56 18:25	06:55 20:09	06:03 20:50	05:35 21:23
11	08:15 17:01	07:43 17:46	06:54 18:27	06:53 20:10	06:02 20:51	05:35 21:24
12	08:14 17:02	07:42 17:48	07:52 18:28	06:51 20:12	06:00 20:52	05:35 21:25
13	08:14 17:03	07:40 17:49	07:50 19:30	06:49 20:13	05:59 20:54	05:35 21:25
14	08:13 17:05	07:39 17:51	07:48 19:31	06:47 20:14	05:58 20:55	05:34 21:26
15	08:13 17:06	07:37 17:52	07:46 19:32	06:45 20:16	05:56 20:56	05:34 21:26
16	08:12 17:07	07:36 17:54	07:44 19:34	06:43 20:17	05:55 20:58	05:34 21:27
17	08:12 17:09	07:34 17:55	07:42 19:35	06:41 20:18	05:54 20:59	05:34 21:27
18	08:11 17:10	07:32 17:57	07:40 19:37	06:39 20:20	05:53 21:00	05:34 21:28
19	08:10 17:11	07:31 17:58	07:38 19:38	06:38 20:21	05:52 21:01	05:34 21:28
20	08:09 17:13	07:29 18:00	07:36 19:40	06:36 20:23	05:50 21:02	05:34 21:28
21	08:09 17:14	07:27 18:00	07:34 19:41	06:34 20:24	05:49 21:04	05:34 21:29
22	08:08 17:16	07:26 18:01	07:32 19:42	06:32 20:25	05:48 21:05	05:35 21:29
23	08:07 17:17	07:24 18:03	07:30 19:44	06:30 20:27	05:47 21:06	05:35 21:29
24	08:06 17:19	07:22 18:05	07:28 19:45	06:29 20:28	05:46 21:07	05:35 21:30
25	08:05 17:20	07:20 18:06	07:26 19:47	06:27 20:30	05:45 21:08	05:35 21:30
26	08:04 17:22	08:33 (89) 08:31 (89)	07:24 19:48	06:25 20:31	05:44 21:09	05:36 21:30
27	08:03 17:23	08:40 (89) 08:30 (89)	07:22 19:49	06:23 20:32	05:44 21:11	05:36 21:30
28	08:02 17:25	08:42 (89) 08:30 (89)	07:17 19:51	06:22 20:34	05:43 21:12	05:37 21:30
29	08:01 17:26	08:43 (89) 08:29 (89)	07:15 19:52	06:20 20:35	05:42 21:13	05:37 21:30
30	08:00 17:28	08:44 (89) 08:29 (89)	07:14 19:54	06:18 20:36	05:41 21:14	05:37 21:30
31	07:58 17:29	08:45 (89) 08:29 (89)	07:14 19:55	06:18 20:36	05:40 21:15	05:37 21:30
Potential sun hours	278	286	367	406	465	475
Total, worst case	87	85	140		92	
Sun reduction	0.52	0.54	0.59		0.57	
Oper. time red.	0.85	0.85	0.85		0.85	
Wind dir. red.	0.71	0.71	0.71		0.71	
Total reduction	0.31	0.33	0.35		0.34	
Total, real	27	28	49		31	

Table layout: For each day in each month the following matrix apply

Day in month	Sun rise (hh:mm)	Sun set (hh:mm)	Minutes with flicker	First time (hh:mm) with flicker	Last time (hh:mm) with flicker	(WTG causing flicker first time)	(WTG causing flicker last time)
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SHADOW - Calendar

Calculation: Points and Grid Shadow receptor: A99 - Shadow Receptor: 1.0 x 1.0 Azimuth: 0.0° Slope: 90.0° (4989)
 Assumptions for shadow calculations

Reference year for calendar

2023

Sunshine probability S/S0 (Sun hours/Possible sun hours) []

Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec
 0.52 0.54 0.59 0.57 0.60 0.64 0.74 0.71 0.63 0.51 0.39 0.39

Operational time

N NNE NE ENE E ESE SE SSE S SSW SW WSW W WNW NW NNW Sum
 364 231 235 234 299 398 720 587 362 314 482 477 675 931 686 429 7,424

	July	August	September	October	November	December
1	05:38	06:08	06:48	07:27	08:11	07:54
	21:30	21:06	20:15	19:15	18:16	16:43
2	05:39	06:09	06:49	07:28	08:12	07:55
	21:30	21:05	20:13	19:13	18:15	16:43
3	05:39	06:10	06:50	07:30	08:14	07:56
	21:29	21:04	20:11	19:11	18:13	16:43
4	05:40	06:11	06:51	07:31	08:15	07:57
	21:29	21:02	20:09	19:09	18:12	16:42
5	05:40	06:12	06:53	07:32	07:17	07:59
	21:29	21:01	20:07	19:07	17:10	16:42
6	05:41	06:14	06:54	07:34	07:18	08:00 (89)
	21:28	20:59	20:05	19:05	17:09	7 08:11 (89) 16:41
7	05:42	06:15	06:55	07:51 (114)	07:35	07:20 08:02 (89) 08:01
	21:28	20:58	20:03	3 07:54 (114)	19:03	17:07 11 08:13 (89) 16:41
8	05:43	06:16	06:57	07:47 (114)	07:37	07:21 08:02 (89) 08:02
	21:28	20:56	20:01	10 07:57 (114)	19:01	17:06 13 08:15 (89) 16:41
9	05:43	06:18	06:58	07:46 (114)	07:38	07:23 08:01 (89) 08:03
	21:27	20:55	19:59	13 07:59 (114)	18:57	17:04 14 08:15 (89) 16:41
10	05:44	06:19	06:59	07:44 (114)	07:39	07:24 08:01 (89) 08:04
	21:27	20:53	19:57	16 08:00 (114)	18:55	17:03 15 08:16 (89) 16:41
11	05:45	06:20	07:01	07:43 (114)	07:41	07:26 08:00 (89) 08:05
	21:26	20:52	19:55	17 08:00 (114)	18:53	17:02 16 08:16 (89) 16:41
12	05:46	06:21	07:02	07:41 (114)	07:42	07:27 08:00 (89) 08:06
	21:26	20:50	19:53	18 07:59 (114)	18:51	17:01 16 08:16 (89) 16:41
13	05:47	06:23	07:03	07:38 (104)	07:44	07:29 08:01 (89) 08:07
	21:25	20:49	19:51	22 08:00 (114)	18:49	16:59 16 08:17 (89) 16:41
14	05:48	06:24	07:05	07:36 (104)	07:45	07:30 08:01 (89) 08:08
	21:24	20:47	19:49	23 07:59 (114)	18:47	16:58 15 08:16 (89) 16:41
15	05:49	06:25	07:06	07:35 (104)	07:46	07:32 08:02 (89) 08:09
	21:24	20:45	19:47	23 07:58 (114)	18:46	16:57 14 08:16 (89) 16:41
16	05:50	06:27	07:07	07:35 (104)	07:48	07:33 08:02 (89) 08:09
	21:23	20:44	19:45	23 07:58 (114)	18:44	16:56 13 08:15 (89) 16:41
17	05:51	06:28	07:08	07:35 (104)	07:49	07:35 08:04 (89) 08:10
	21:22	20:42	19:43	21 07:56 (114)	18:42	16:55 11 08:15 (89) 16:41
18	05:52	06:29	07:10	07:35 (104)	07:51	07:36 08:06 (89) 08:11
	21:21	20:40	19:41	19 07:54 (118)	18:40	16:54 8 08:14 (89) 16:42
19	05:53	06:31	07:11	07:36 (104)	07:52	07:38 08:08 (89) 08:11
	21:21	20:39	19:39	16 07:52 (118)	18:38	16:53 3 08:11 (89) 16:42
20	05:54	06:32	07:12	07:42 (118)	07:53	07:39 08:12
	21:20	20:37	19:37	9 07:51 (118)	18:36	16:52 16:42
21	05:55	06:33	07:14	07:45 (118)	07:55	07:40 08:13
	21:19	20:35	19:35	2 07:47 (118)	18:35	16:51 16:43
22	05:56	06:34	07:15		07:56	07:42 08:13
	21:18	20:33	19:33		18:33	16:50 16:43
23	05:57	06:36	07:16		07:58	07:43 08:14
	21:17	20:32	19:31		18:31	16:49 16:44
24	05:58	06:37	07:18		07:59	07:45 08:14
	21:16	20:30	19:29		18:29	16:48 16:44
25	05:59	06:38	07:19		08:01	07:46 08:15
	21:15	20:28	19:27		18:28	16:47 16:45
26	06:00	06:40	07:20		08:02	07:47 08:15
	21:14	20:26	19:25		18:26	16:47 16:45
27	06:02	06:41	07:22		08:04	07:49 08:15
	21:12	20:24	19:23		18:24	16:46 16:46
28	06:03	06:42	07:23		08:05	07:50 08:16
	21:11	20:22	19:21		18:23	16:45 16:47
29	06:04	06:44	07:24		08:07	07:51 08:16
	21:10	20:20	19:19		18:21	16:45 16:47
30	06:05	06:45	07:26		08:08	07:53 08:16
	21:09	20:19	19:17		18:19	16:44 16:48
31	06:06	06:46			08:10	07:54 08:16
	21:08	20:17			18:18	16:43 16:49
Potential sun hours	481	442	380	339	283	266
Total, worst case			235		172	
Sun reduction			0.63		0.39	
Oper. time red.			0.85		0.85	
Wind dir. red.			0.71		0.71	
Total reduction			0.38		0.24	
Total, real			89		41	

Table layout: For each day in each month the following matrix apply

Day in month	Sun rise (hh:mm)	Sun set (hh:mm)	Minutes with flicker	First time (hh:mm) with flicker	Last time (hh:mm) with flicker	(WTG causing flicker first time)	(WTG causing flicker last time)
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Appendix C – FAA Filings

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**Otter Tail Power Company Ashtabula III Upgrade Project
Federal Aviation Administration (FAA) Filings**

Turbine Number	Structure Name	Latitude	Longitude	ASN	Prior ASN	OE Status
267	AIII-19	47.207175	97.863533	2023-WTE-988-OE	2010-WTE-6476-OE	Work in Progress
258	AIII-alt 2	47.201939	97.927747	2023-WTE-989-OE	2010-WTE-6487-OE	Work in Progress
248	AIII-alt 4	47.225364	97.914650	2023-WTE-990-OE	2010-WTE-6488-OE	Work in Progress
249	AIII-alt 5	47.228619	97.912308	2023-WTE-991-OE	2010-WTE-6490-OE	Work in Progress
253	AIII-6	47.225011	97.899606	2023-WTE-992-OE	2010-WTE-6448-OE	Work in Progress
245	AIII-1	47.214817	97.920772	2023-WTE-993-OE	2010-WTE-6449-OE	Work in Progress
259	AIII-10	47.200792	97.915264	2023-WTE-994-OE	2010-WTE-6450-OE	Work in Progress
262	AIII-13	47.202683	97.899958	2023-WTE-995-OE	2010-WTE-6451-OE	Work in Progress
266	AIII-17	47.201750	97.878092	2023-WTE-996-OE	2010-WTE-6452-OE	Work in Progress
268	AIII-20	47.207344	97.859919	2023-WTE-997-OE	2010-WTE-6454-OE	Work in Progress
257	AIII-alt 1	47.199672	97.930044	2023-WTE-998-OE	2010-WTE-6460-OE	Work in Progress
250	AIII-alt 6	47.231392	97.909881	2023-WTE-999-OE	2010-WTE-6462-OE	Work in Progress
256	AIII-9	47.229742	97.886114	2023-WTE-1000-OE	2010-WTE-6464-OE	Work in Progress
261	AIII-12	47.200797	97.905242	2023-WTE-1001-OE	2010-WTE-6465-OE	Work in Progress
260	AIII-11	47.200464	97.910492	2023-WTE-1002-OE	2010-WTE-6466-OE	Work in Progress
255	AIII-8	47.227058	97.889519	2023-WTE-1003-OE	2010-WTE-6467-OE	Work in Progress
254	AIII-7	47.225169	97.893486	2023-WTE-1004-OE	2010-WTE-6468-OE	Work in Progress
252	AIII-5	47.223169	97.902081	2023-WTE-1005-OE	2010-WTE-6469-OE	Work in Progress
251	AIII-4	47.221417	97.904689	2023-WTE-1006-OE	2010-WTE-6470-OE	Work in Progress
247	AIII-3	47.217014	97.914578	2023-WTE-1007-OE	2010-WTE-6471-OE	Work in Progress
246	AIII-2	47.215197	97.916858	2023-WTE-1008-OE	2010-WTE-6472-OE	Work in Progress
263	AIII-14	47.203489	97.895142	2023-WTE-1009-OE	2010-WTE-6473-OE	Work in Progress
264	AIII-15	47.204467	97.891792	2023-WTE-1010-OE	2010-WTE-6474-OE	Work in Progress
265	AIII-16	47.199883	97.882317	2023-WTE-1011-OE	2010-WTE-6475-OE	Work in Progress
270	AIII-22	47.076564	97.995281	2023-WTE-1012-OE	2010-WTE-6477-OE	Work in Progress
271	AIII-23	47.078881	97.991453	2023-WTE-1013-OE	2010-WTE-6478-OE	Work in Progress
272	AIII-24	47.086414	97.995728	2023-WTE-1014-OE	2010-WTE-6479-OE	Work in Progress
274	AIII-26	47.092600	97.991669	2023-WTE-1015-OE	2010-WTE-6480-OE	Work in Progress
275	AIII-27	47.092942	97.987744	2023-WTE-1016-OE	2010-WTE-6481-OE	Work in Progress
277	AIII-29	47.095594	97.980703	2023-WTE-1017-OE	2010-WTE-6482-OE	Work in Progress
278	AIII-30	47.098039	97.978458	2023-WTE-1018-OE	2010-WTE-6483-OE	Work in Progress
279	AIII-31	47.098808	97.974014	2023-WTE-1019-OE	2010-WTE-6484-OE	Work in Progress
281	AIII-33	47.107372	97.964153	2023-WTE-1020-OE	2010-WTE-6485-OE	Work in Progress
283	AIII-35	47.118772	97.960136	2023-WTE-1021-OE	2010-WTE-6486-OE	Work in Progress
269	AIII-21	47.074447	98.000164	2023-WTE-1022-OE	2010-WTE-6455-OE	Work in Progress
273	AIII-25	47.092800	97.995939	2023-WTE-1023-OE	2010-WTE-6456-OE	Work in Progress
276	AIII-28	47.094244	97.984553	2023-WTE-1024-OE	2010-WTE-6457-OE	Work in Progress
280	AIII-32	47.103858	97.967703	2023-WTE-1025-OE	2010-WTE-6458-OE	Work in Progress
282	AIII-34	47.117214	97.962839	2023-WTE-1026-OE	2010-WTE-6459-OE	Work in Progress

Appendix D – Microwave Beam Path Study

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Wind Power GeoPlanner™

Microwave Study

Ashtabula & Ashtabula III



Prepared on Behalf of
Atwell, LLC

March 22, 2023



COMSEARCH
A CommScope Company

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1. Introduction

Microwave bands that may be affected by the installation of wind turbine facilities operate over a wide frequency range (900 MHz – 23 GHz). Comsearch has developed and maintains comprehensive technical databases containing information on licensed microwave networks throughout the United States. These systems are the telecommunication backbone of the country, providing long-distance and local telephone service, backhaul for cellular and personal communication service, data interconnects for mainframe computers and the Internet, network controls for utilities and railroads, and various video services. This report focuses on the potential impact of wind turbines on licensed, proposed and applied non-federal government microwave systems.

2. Project Overview

Project Information

Name: Ashtabula & Ashtabula III

Number of Turbines: 71

County: Barnes

Blade Diameter: 97 meters

State: North Dakota

Hub Height: 80 meters

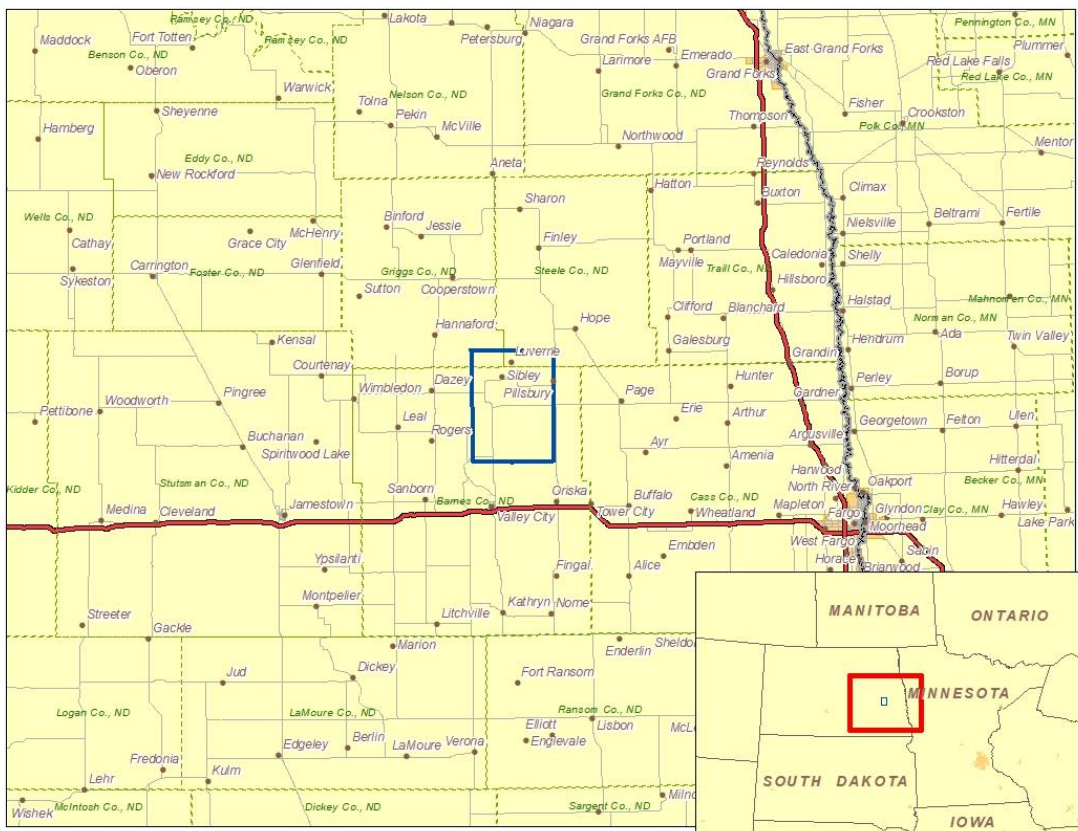


Figure 1: Area of Interest

3. Two-Dimensional Fresnel Zone Analysis

Methodology

Our obstruction analysis was performed using Comsearch’s proprietary microwave database, which contains all non-government licensed, proposed and applied paths from 0.9 - 23 GHz¹. First, we determined all microwave paths that intersect the area of interest² and listed them in Table 1. This path and the area of interest that encompasses the planned turbine locations are shown in Figure 2.

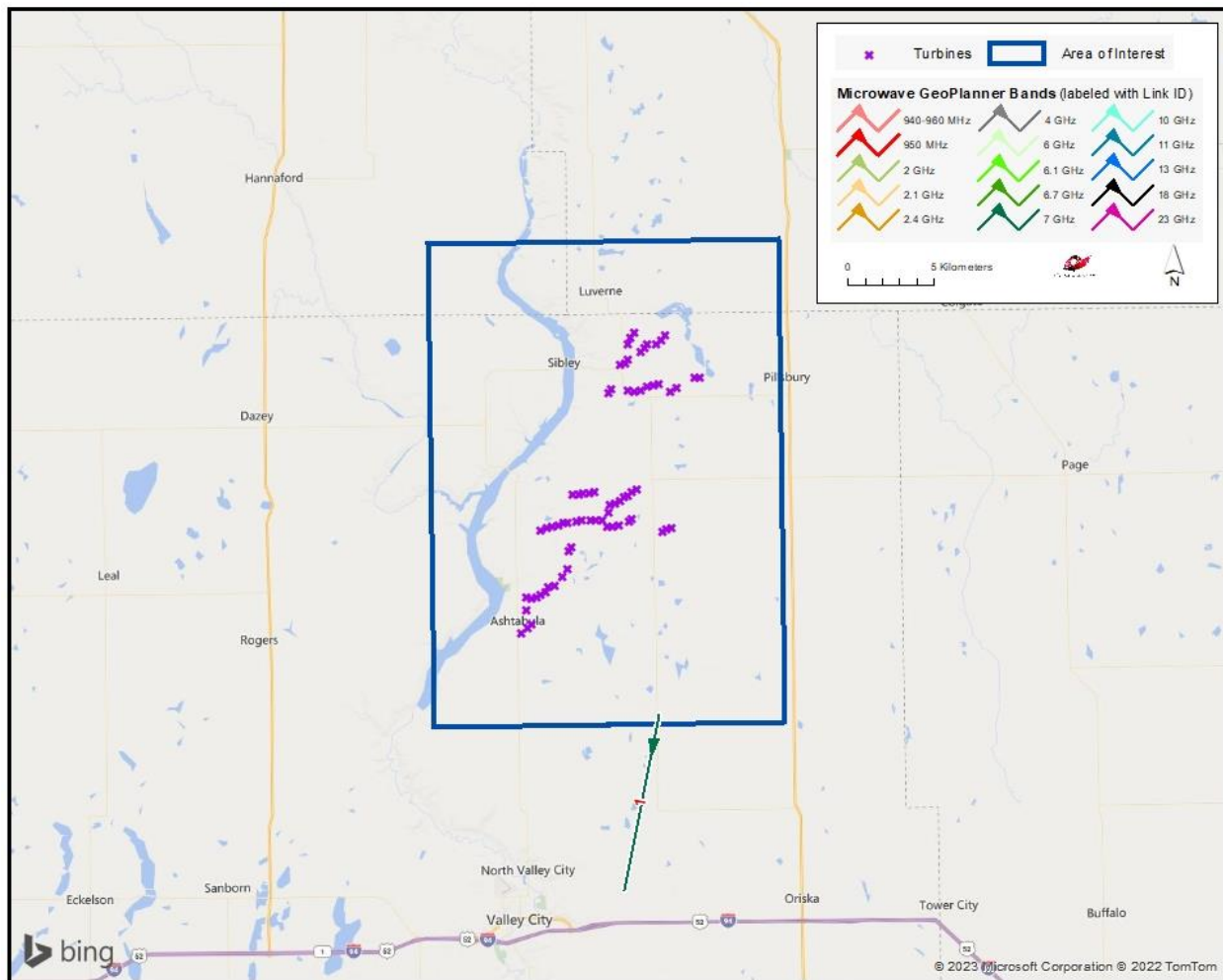


Figure 2: Microwave Paths that Intersect the Area of Interest

¹ Please note that this analysis does not include unlicensed microwave paths or federal government paths that are not registered with the FCC.

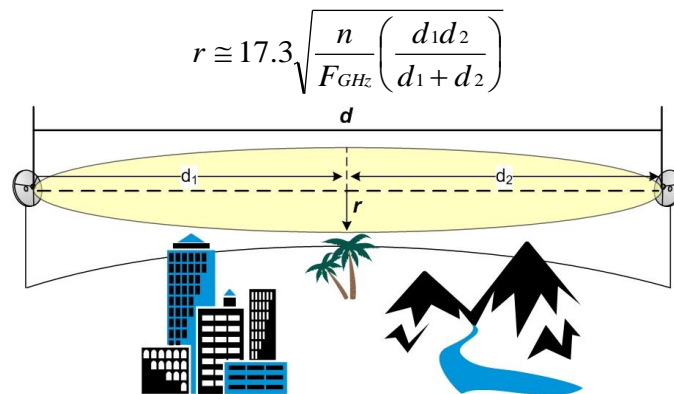
² We use FCC-licensed coordinates to determine which paths intersect the area of interest. It is possible that as-built coordinates may differ slightly from those on the FCC license.

ID	Status	Callsign 1	Callsign 2	Band	Path Length (km)	Licensee
1	Licensed	KAZ80	RXONLY	7 GHz	10.42	South Dakota Television, Inc

Table 1: Summary of Microwave Paths that Intersect the Area of Interest

(See enclosed mw_geopl.xlsx for more information and GP_dict_matrix_description.xls for detailed field descriptions)

Next, we calculated a Fresnel Zone for the path based on the following formula:



Where,

- r = Fresnel Zone radius at a specific point in the microwave path, meters
- n = Fresnel Zone number, 1
- F_{GHz} = Frequency of microwave system, GHz
- d₁ = Distance from antenna 1 to a specific point in the microwave path, kilometers
- d₂ = Distance from antenna 2 to a specific point in the microwave path, kilometers

In general, this is the area where the planned wind turbines should be avoided, if possible. Likewise, Comsearch recommends that an area directly in front of each microwave antenna should be avoided. This corresponds to the Consultation Zone which measures 1 kilometer along the main beam of the antenna and 24 ft (7.3 meters) wide. A depiction of the Fresnel Zones and Consultation Zones for the microwave path listed can be found in Figure 3, and is also included in the enclosed shapefiles^{3,4}.

³ The ESRI® shapefiles enclosed are in NAD 83 UTM Zone 14 projected coordinate system.

⁴ Comsearch makes no warranty as to the accuracy of the data included in this report beyond the date of the report. The data provided in this report is governed by Comsearch's data license notification and agreement located at http://www.comsearch.com/files/data_license.pdf.

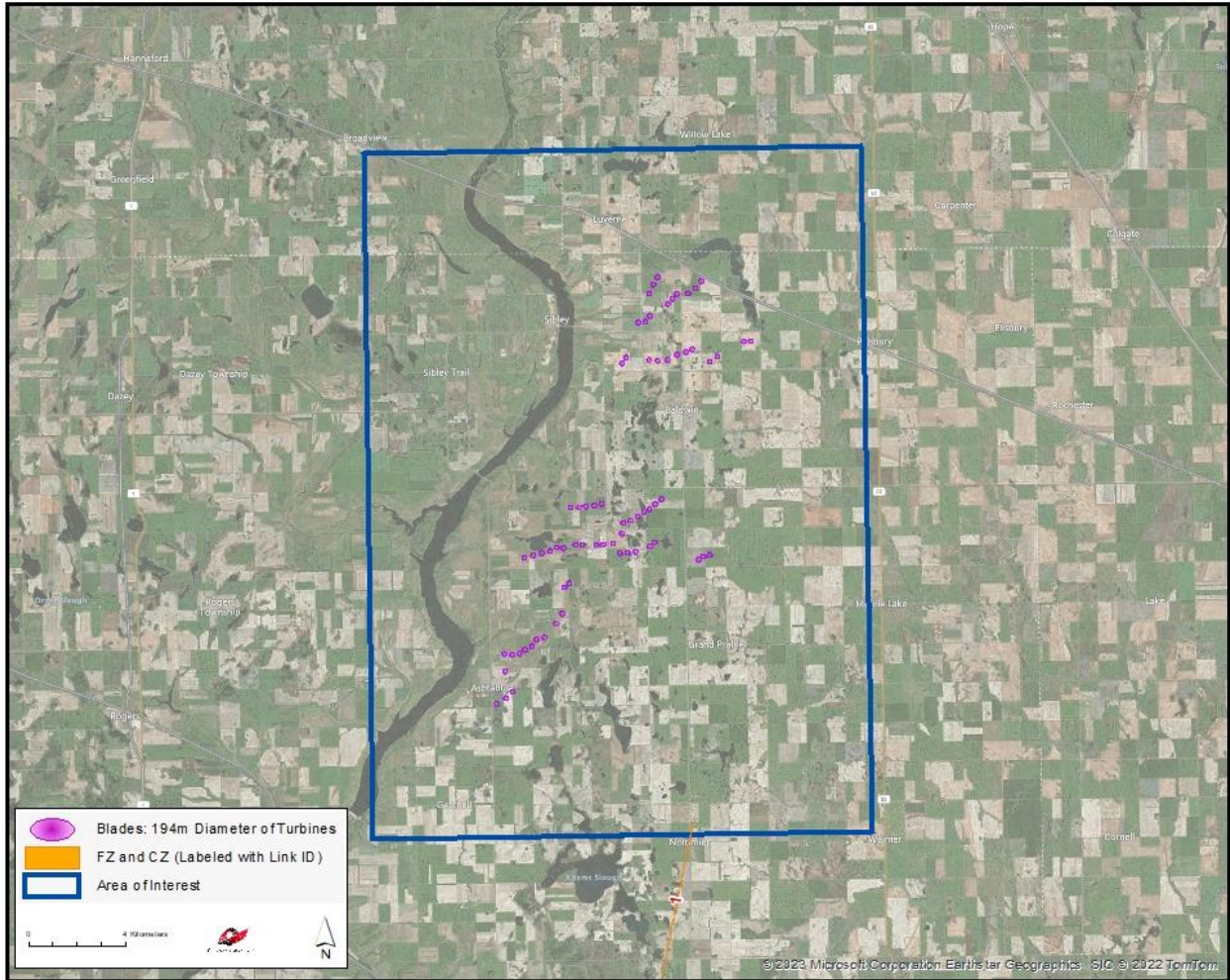


Figure 3: Microwave Paths with Fresnel Zones

4. Conclusion

Total Microwave Paths	Paths with Affected Fresnel Zones	Total Turbines	Turbines intersecting the Fresnel Zones
1	0	71	0

Table 2: Fresnel Zone Analysis Result

Our study identified one microwave path intersecting the Ashtabula & Ashtabula III area of interest. The Fresnel and Consultation Zones for this microwave path were calculated and mapped in order to assess the potential impact from the turbines. A total of seventy-one turbines were considered in the analysis, each with a blade diameter of 97 meters and a hub height of 80 meters. Of those turbines, none were found to have potential obstruction with the microwave systems in the area.

5. Contact

For questions or information regarding the Microwave Study, please contact:

Contact person: David Meyer
 Title: Senior Manager
 Company: Comsearch
 Address: 21515 Ridgetop Circle, Suite 300, Sterling, VA 20166
 Telephone: 703-726-5656
 Fax: 703-726-5595
 Email: David.Meyer@CommScope.com
 Web site: www.comsearch.com

Appendix: Turbine Locations

Case ID	FAA ASN	Latitude	Longitude
3035149	38-020866	47.117191	-97.962791
3035175	38-020889	47.201893	-97.927689
3035164	38-020843	47.207191	-97.863693
3035146	38-020898	47.092793	-97.995888
3035161	38-020847	47.203491	-97.895088
3035142	38-020916	47.20269	-97.899994
3035139	38-020985	47.224991	-97.89959
3035171	38-020835	47.097992	-97.978493
3035152	38-020861	47.229691	-97.886093
3071426	missing	47.098801	-97.974007
3035173	38-020983	47.107391	-97.964188
3035158	38-020852	47.221394	-97.904694
3035168	38-020838	47.09259	-97.991692
3035155	38-020858	47.227093	-97.889488
3035151	38-020862	47.231392	-97.909889
3035174	38-020900	47.118793	-97.960091
3035169	38-020837	47.092892	-97.987694
3035153	38-020860	47.20079	-97.90519
3035177	38-020914	47.228592	-97.912292
3035148	38-020867	47.103893	-97.96769
3035157	38-020853	47.22319	-97.902092
3035144	38-020979	47.207291	-97.859894
3035154	38-020859	47.200493	-97.910492
3035176	38-020893	47.225391	-97.914589
3035170	38-020836	47.095592	-97.98069
3035159	38-020851	47.216991	-97.914589
3035167	38-020839	47.086391	-97.995689
3035143	38-020915	47.201691	-97.87809
3035162	38-020845	47.204491	-97.891792
3035160	38-020850	47.215092	-97.916893
3035156	38-020856	47.225193	-97.893494
3035165	38-020842	47.076591	-97.995293
3035150	38-020863	47.199692	-97.929993
3035163	38-020844	47.19989	-97.882294
3035147	38-020868	47.094193	-97.984589

Case ID	FAA ASN	Latitude	Longitude
3035166	38-020840	47.078892	-97.991493
3035145	38-020903	47.07439	-98.000191
3035140	38-020960	47.21479	-97.920792
3035141	38-020905	47.20079	-97.915291
3104371	38-020302	47.132893	-97.95269
3104415	38-020294	47.149292	-97.909393
3104421	38-020298	47.140793	-97.930489
3104381	38-020313	47.14669	-97.954292
3104373	38-020308	47.129093	-97.979591
3104382	38-020306	47.130692	-97.970291
3104447	38-020311	47.147392	-97.945992
3104424	38-020291	47.129993	-97.924088
3104405	38-020301	47.132793	-97.941391
3104430	38-020406	47.132793	-97.944992
3104449	38-020290	47.131992	-97.916191
3104416	38-020407	47.145592	-97.916191
3104457	38-020304	47.13179	-97.96299
3104444	38-020309	47.128292	-97.984291
3104458	38-020307	47.12989	-97.974792
3104413	38-020312	47.146992	-97.950691
3104450	38-020299	47.136791	-97.93129
3104374	38-020310	47.147892	-97.942093
3104461	38-020297	47.14159	-97.926491
3104414	38-020295	47.144691	-97.919189
3104433	38-020314	47.14669	-97.958893
3104391	38-020408	47.147392	-97.913094
3104401	38-020292	47.129791	-97.928291
3104440	38-020412	47.133392	-97.913589
3104411	38-020300	47.133091	-97.936188
3104446	38-020293	47.129494	-97.932487
3104394	38-020296	47.14299	-97.922691
3104404	38-020305	47.131992	-97.966591
3104407	38-020303	47.132793	-97.95649
3104383	38-020212	47.127892	-97.887093
3104435	38-020213	47.12849	-97.883591
3104436	38-020211	47.126694	-97.889793

**Appendix E – Class I Literature Review – Cultural Resource Report
and Unanticipated Discoveries Plan**

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CLASS I LITERATURE REVIEW

ASHTABULA III WIND UPGRADE PROJECT BARNES COUNTY, NORTH DAKOTA

Prepared for

Otter Tail Power Company
215 S. Cascade Street
Fergus Falls, Minnesota 56537

Atwell Project No. 23000081

Submitted by Atwell, LLC

June 21, 2023

EXECUTIVE SUMMARY

In February of 2023, Atwell, LLC (Atwell) was contracted by Otter Tail Power Company (Otter Tail) to conduct a Class I literature review for the proposed Ashtabula III Wind Upgrade Project (Project) located in Barnes County, North Dakota (Figure 1). The Project includes replacing current wind turbine technology with longer blades and new hub and gearbox with turbine generators being refurbished at 39 wind turbine locations. The existing Ashtabula III Wind turbines are GE 1.5 megawatt [MW] turbines with a 77-meter rotor diameter and a total height of 388.8 feet, and these will be replaced with new wind turbine technology (GE 1.6 MW turbines with rotor diameter of up to 97-meters and a total height of up to 128.5 meters). The existing 39 turbine locations remain the same and Otter Tail plans to use the existing turbine structural steel towers, turbine foundations, collection/communication systems, permanent access roads, and other associated facilities whose locations will not change.

During installation of the equipment upgrades, existing access roads and the gravel ring around the turbines may be temporarily widened to accommodate delivery and staging of components and equipment. A temporary laydown yard will be utilized during the Project. The laydown yard and most of the areas where temporary access roads and construction easements will occur were previously used during initial project construction. In all cases, the planned temporary construction areas meet exclusion and avoidance area criteria.

Currently, no federal trigger has been identified for this Project; therefore, Section 106 regulations do not apply. Should Section 106 be triggered, methods for archaeological and aboveground architectural investigations should be determined through consultation with the lead federal agency and the State Historical Society of North Dakota (SHSND).

The SHSND files were reviewed and rendered the following information:

- Five previously identified archaeological sites are in the Study Area.
- No previously documented architectural resources are in the Study Area.
- No architectural or archaeological resources listed on the National Register of Historic Places are within the Study Area, but a single listed structure, the Alderman School, is located within one mile.
- No cemeteries are located within the Study Area.

Based on a review of the data presented above in conjunction with the fact that the Disturbance Area has largely been previously surveyed (99.75%) and disturbed by the original construction of the wind farm, Atwell makes the following recommendations:

PUBLIC DOCUMENT - NONPUBLIC DATA HAS BEEN EXCISED

- The Project proceed as planned without additional archaeological resource work prior to construction.
- Atwell recommends a 30m buffer area be placed around resources 32BA195, 32BA196, 32BA197, 32BA198, and 32BA199 for the duration of construction to prevent disturbances as originally recommended by Beaver Creek Inc. in the 2010 report (Grimsrud Burns 2010).
- An Unanticipated Discovery Plan should be developed to establish procedures and relevant contact information in the event that human remains or archaeological deposits are discovered during the construction, operational, and decommission phases of the Project. See full Unanticipated Discovery Plan in Appendix A.
 - If buried archaeological resources are encountered, all activity should cease in the immediate area and within a 100-foot buffer area, and the artifacts should be left in place. Otter Tail’s archaeologist should be contacted immediately, and unanticipated discovery procedures should be initiated.
 - If human remains are encountered, construction should stop in the immediate area of discovery and within a 100-foot buffer area, and law enforcement should be notified immediately. Law enforcement officials should determine whether the discovery is a crime scene and whether the remains are prehistoric or historic Native American remains. The SHSND should be contacted immediately if the human remains are determined to be prehistoric or historic in nature and/or Native American remains.

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1 INTRODUCTION

1.1 BACKGROUND

Atwell, LLC (Atwell) was contracted by Otter Tail Power Company (Otter Tail) to conduct a Class I literature review for the proposed Ashtabula III Wind Upgrade Project (Project) located in Barnes County, North Dakota (Figure 1). The Project is located on approximately 94 acres of mixed-use agricultural land in the following locations: Township 142 North, Range 57 West, Section 18; Township 142 North, Range 58 West; Sections 13, 23-27, 34-35; and Township 143 North, Range 57 West; Sections 3-4, 8-10, 13-17, 20 and 22. These areas are located in Baldwin, Ashtabula, and Grand Prairie Townships. The Project's Study Area comprises approximately 313 acres and encompasses a 300-foot buffer around the center point of each existing turbine and a 50-foot buffer (100-foot corridor) off the approximately 8.9 miles of existing access roads. The 94-acre Disturbance Area is the area where construction is expected to occur and includes a 150-foot buffer around the center point of each existing turbine and the footprint of the approximately 8.9 miles of existing access roads.

The Project involves replacing current wind turbine technology with longer blades and new hub and gearbox with turbine generators being refurbished at 39 wind turbine locations. The existing Ashtabula III Wind turbines are GE 1.6 megawatt [MW] turbines with a 77-meter rotor diameter and a total height of 118.5 meters, and these will be replaced with new wind turbine technology (GE 1.6 MW turbines with rotor diameter of up to 97-meters and a total height of up to 128.5 meters). The existing 39 turbine locations remain the same and Otter Tail plans to use the existing turbine structural steel towers, turbine foundations, collection/communication systems, permanent access roads, and other associated facilities whose locations will not change.

During installation of the equipment upgrades, existing access roads and the gravel ring around the turbines may be temporarily widened to accommodate delivery and staging of components and equipment. A temporary laydown yard will be utilized during the Project. The laydown yard and most of the areas where temporary access roads and construction easements will occur were previously used during initial project construction. In all cases, the planned temporary construction areas meet exclusion and avoidance area criteria.

1.2 APPLICABLE REGULATIONS

North Dakota does not have laws that mandate cultural resources surveys for private projects lacking characteristics that would trigger Section 106 of the National Historic Preservation Act of 1966, as amended (54 U.S.C. 306108), and its implementing regulations (36 CFR 800). The

exception to this is human remains. Human remains are protected under the North Dakota Century Code 23-06-27 (Protection of Human Burial Sites, Human Remains, and Burial Goods).

Currently, no federal trigger has been identified for this project; therefore, Section 106 regulations do not apply. Should Section 106 be triggered, methods for archaeological pedestrian survey and aboveground architectural survey should be determined through consultation with the lead federal agency and the State Historical Society of North Dakota (SHSND).

An Unanticipated Discovery Plan is being developed to establish procedures and relevant contact information in the event that human remains or archaeological deposits are discovered during the construction, operational, and decommission phases of the Project.

2 METHODS

In February of 2023, staff from Atwell conducted background research at the SHSND for information on previously identified archaeological sites and architectural properties within one mile (1.6 km) of the Study Area and on surveys previously conducted within the Study Area.

3 ENVIRONMENT

The Study Area is located in Barnes County, North Dakota in a primarily rural agricultural area that is sparsely populated and supports a mix of grasslands, prairie potholes, cultivated cropland, hayfields, and pasturelands. Agricultural production (cultivated crops, hay, and pasture) is the primary land use within the Study Area. The Study Area is split into two large clusters, the larger of which is located north of County Highway 4 and south of 11th St. SE, south and east of Luverne, ND. The second cluster is located primarily west of 120th Ave. SE, between 120th Ave SE and County Highway 21. One turbine in the southern cluster is located east of 120th Ave SE. Small farmsteads are located within the Study Area as well as small tracts of forested areas, wetlands, and natural stream corridors; however, these natural features are of limited size. Small, isolated woodlots, generally associated with wind breaks for farmsteads, are also scattered within the Study Area. Public roads are generally situated in a grid-like arrangement.

The Study Area is predominately located within the End Moraine Complex ecoregion of the Northern Glaciated Plains (Bryce et al. 1996). According to the United States Geological Service (USGS) ecoregion mapping data, this ecoregion is characterized by the following:

The End Moraine Complex is a concentration of glacial features in east central North Dakota. Blue Mountain and Devils Lake Mountain are composed of blocks of surficial material scraped off and thrust up by the continental glacier at the south end of the

Devils Lake basin. In the western part of the ecoregion, patches of stagnation moraine similar to the Missouri Coteau (42A) have high wetland densities. On the moraines south of Devils Lake basin, favorable precipitation, aspect, and slightly higher elevations result in wooded lake margins and morainal ridges (Bryce et al. 1996).

The surficial geology in the region is relatively flat with little visual relief. The surface soil texture is primarily well drained loam (USDA 2017). The Study Area is generally flat, but it also extends into several of the area’s small hills and ridges. Elevations within the Study Area range between 1,360 and 1,530 feet above mean sea level.

Natural Resource Conservation Service Soil Survey data for Barnes County identified 24 different types of soils within the Study Area. These soils vary greatly in texture, natural drainage, slope, and other characteristics. The Study Area is dominated by a variety of loam texture soils (Table 1):

Table 1. Soils throughout Study Area

Soil Type	Hydric	Percent of Study Area
G143C: Barnes-Buse-Langhei loams, 6 to 9 percent slopes	Yes	27.35%
G144B: Barnes-Buse loams, 3 to 6 percent slopes	No	20.59%
G143B: Barnes-Svea loams, 3 to 6 percent slopes	No	14.64%
G143F: Buse-Barnes loams, 15 to 35 percent slopes	No	11.24%
G143D: Barnes-Buse-Langhei loams, 9 to 15 percent slopes	No	7.58%
G430A: Bearden silty clay loam, 0 to 2 percent slopes	Yes	4.59%
G506A: Overly-Bearden silty clay loams, 0 to 2 percent slopes	No	2.06%
G143A: Barnes-Svea loams, 0 to 3 percent slopes	No	1.85%
G680C: Barnes-Sioux complex, 3 to 9 percent slopes	No	1.55%
G275A: Renshaw loam, 0 to 2 percent slopes	No	1.43%
G146B: Barnes-Buse-Parnell complex, 0 to 6 percent slopes	No	1.41%
G147C: Buse-Barnes-Darnen loams, 3 to 9 percent slopes	Yes	1.07%
G680B: Barnes-Sioux complex, 1 to 6 percent slopes	No	0.86%
G148F: Buse-Barnes-La Prairie, occasionally flooded loams, 6 to 35 percent slopes	No	0.80%
G490B: Gardena-Zell loams, 2 to 6 percent slopes	No	0.68%
G454A: Glyndon loam, 0 to 2 percent slopes	No	0.58%
G732B: Swenoda-Barnes complex, 3 to 6 percent slopes	No	0.49%
G732C: Lanona-Buse complex, 6 to 9 percent slopes	No	0.32%

Soil Type	Hydric	Percent of Study Area
G100A: Hamerly-Tonka complex, 0 to 3 percent slopes	No	0.22%
G523A: Lowe-Fluvaquents, channeled complex, 0 to 2 percent slopes, frequently flooded	No	0.19%
G447A: Colvin-Borup complex, saline, 0 to 1 percent slopes	No	0.15%
G147F: Buse-Barnes-Darnen loams, 9 to 35 percent slopes	No	0.13%
G3A: Parnell silty clay loam, 0 to 1 percent slopes	No	0.12%
G276B: Renshaw-Sioux complex, 2 to 6 percent slopes	No	0.10%

4 LITERATURE SEARCH

4.1 PREVIOUS CULTURAL RESOURCES STUDIES

Research indicated that two archaeological surveys have been conducted within the current Study Area (Table 2).

Table 2. Previously Conducted Cultural Resources Surveys

Survey Number	Authors	Year	Title
011665	Christina Grimsrud Burns	2010	Ashtabula III Wind Farm Project: A Class III Cultural Resource Inventory, Barnes County, North Dakota.
015989	Brittany Brooks	2015	BEK Communication Buried Fiber Optic Line – Valley City North: A Class II Reconnaissance and Class III Intensive Cultural Resource Inventory in Barnes County, North Dakota.

In 2010, a Class II Cultural Resources Inventory was conducted by Beaver Creek Archaeology Inc., on the behalf of NextEra Energy Resources, LLC to document cultural resources within the footprint of a proposed Ashtabula III Wind Farm Project in Barnes County, North Dakota (Figure 2 Map Set; (Grimsrud Burns 2010). The investigation identified five archaeological sites, 32BA195, 32BA196, 32BA197, 32BA198, and 32BA199. All five of these resources are located within the current Study Area.

In 2015, a Class II and Class III cultural resources inventory was conducted by Beaver Creek Archaeology Inc., on the behalf of BEK Communications to document cultural resources for a planned, buried fiber optics line in Barnes County, North Dakota (Figure 2 Map Set; (Brooks 2015). This survey identified one isolate find (32BAx293) and three archaeological sites (32BA279, 32BA280, and 32BA281), none of which fall within the current Study Area.

4.2 PREVIOUSLY RECORDED ARCHAEOLOGICAL SITES

Five archaeological sites, 32BA195, 32BA196, 32BA197, 32BA198, and 32BA199, have been previously recorded within the current Study Area (Figure 2 Map Set; Table 3). Site 32BA195 is a historic burial, and sites 32BA196-199 are sites composed of prehistoric stone features. Previous surveys at these locations did not reveal any additional archaeological deposits (Grimsrud Burns 2010).

Table 3. Previously Documented Archaeological Resources within the Study Area

Site Number	Description	Status
32BA195	Historic Burial	Not Eligible
32BA196	Stone Circle	Unevaluated
32BA197	Stone Cairn	Unevaluated
32BA198	Stone Cairn	Unevaluated
32BA199	Stone Cairn	Unevaluated

An additional six archaeological sites, and eleven archaeological site leads have been previously identified within one mile of the Study Area (Figure 3 Map Set; Table 4).

Table 4. Previously Documented Archaeological Resources within One Mile

Site Number	Description	Status
32BAx314	Isolated Historic Artifact	Recommended Not Eligible
32BAx326	Isolated Historic Artifact	Recommended Not Eligible
32BAx235	Prehistoric Mound Site	Unevaluated
32BAx328	Isolated Historic Artifact	Recommended Not Eligible
32BAx315	Isolated Historic Artifact	Recommended Not Eligible
32BAx340	Isolated Lithic	Recommended Not Eligible
32BAx312	Isolated Historic Artifact	Recommended Not Eligible
32BAx320	Isolated Historic Artifact Scatter	Recommended Not Eligible
32BAx325	Isolated Lithic	Recommended Not Eligible
32BAx262	Prehistoric Artifact Scatter	Unevaluated
32BAx165	Camp Libby	Unevaluated
32BAx338	Stone Cairns	Unevaluated
32BA414	Prehistoric Habitation Site	Unevaluated
32BA280	Historic Archaeological Site	Recommended Not Eligible

PUBLIC DOCUMENT - NONPUBLIC DATA HAS BEEN EXCISED

Site Number	Description	Status
32BA161	Prehistoric Lithic Scatter	Unevaluated
32BA5	Prehistoric Habitation Site	Unevaluated [REDACTED]
32BA172	Stone Circle and Stone Cairn Features	Unevaluated
32BA1189	Historic Artifact Scatter	Recommended Not Eligible

4.3 PREVIOUSLY RECORDED ARCHITECTURAL HISTORY PROPERTIES

No historical architectural properties have been recorded within the Study Area. A total of five historic architectural resources (32BA159, 32BAx168, 32ST171, 32BAx184, and 32BAx185) were identified within one mile of the Study Area. Site 32BA159, the Alderman School, is a NRHP listed site. The Alderman School is an excellently preserved one-roomed North Dakota school house. The school operated from 1925 to 1959 and has since been managed by the Ashtabula Township Hall and is presently maintained by the Historic Alderman School Association (Quinnell 2013).

Table 5. Previously Documented Architectural Resources within One Mile

Site Number	Description	Status
32BAx185	Wilma Post Office	Unevaluated
32BAx184	Algeo Post Office	Unevaluated
32ST171	Canadian Pacific Soo Line	Unevaluated
32BAx168	Alderman Post Office	Unevaluated
32BA159	Alderman School	Listed on the NRHP

5 CONCLUSIONS AND RECOMMENDATIONS

5.1 CONCLUSIONS

As a result of the literature review, Atwell has reached the following conclusions:

- Five previously identified archaeological sites are in the Study Area.
- No previously documented architectural resources are in the Study Area.
- No architectural or archaeological resources listed on the National Register of Historic Places are in the Study Area.

- No cemeteries are located within the Study Area.

Currently, no federal trigger has been identified for this project; therefore, Section 106 regulations do not apply. Should Section 106 be triggered, methods for archaeological pedestrian survey and aboveground architectural survey should be determined through consultation with the lead federal agency and the SHSND.

5.2 RECOMMENDATIONS

Based on a review of the data presented above in conjunction with the fact that the Disturbance Area has largely been previously surveyed (99.75%) and disturbed by the original construction of the wind farm, Atwell makes the following recommendations:

- The Project proceed as planned without additional archaeological resource work prior to construction.
- Atwell recommends a 30 meter buffer area placed around resources 32BA195, 32BA196, 32BA197, 32BA198, and 32BA199 for the duration of construction to prevent disturbances as originally recommended by Beaver Creek Inc. in the 2010 report (Grimsrud Burns 2010).
- An Unanticipated Discovery Plan should be developed to establish procedures and relevant contact information in the event that human remains or archaeological deposits are discovered during the construction, operational, and decommission phases of the Project. See full Unanticipated Discovery Plan in Appendix A.
 - If buried archaeological resources are encountered, all activity should cease in the immediate area and within a 100-foot buffer area and the artifacts should be left in place. Otter Tail’s archaeologist should be contacted immediately, and unanticipated discovery procedures should be initiated.
 - If human remains are encountered, construction should stop in the immediate area of discovery and within a 100-foot buffer area, and law enforcement should be notified immediately. Law enforcement officials should determine whether the discovery is a crime scene and whether the remains are prehistoric or historic Native American remains. The SHSND should be contacted immediately if the human remains are determined to be prehistoric or historic in nature and/or Native American remains.

6 REFERENCES

Brooks B. 2015. BEK Communication Buried Fiber Optic Line - Valley City North: A Class II Reconnaissance and Class III Intensive Cultural Resources Inventory in Barnes County, North Dakota. Bismarck, North Dakota: Beaver Creek Archaeology, Inc. Report No.: 015989.

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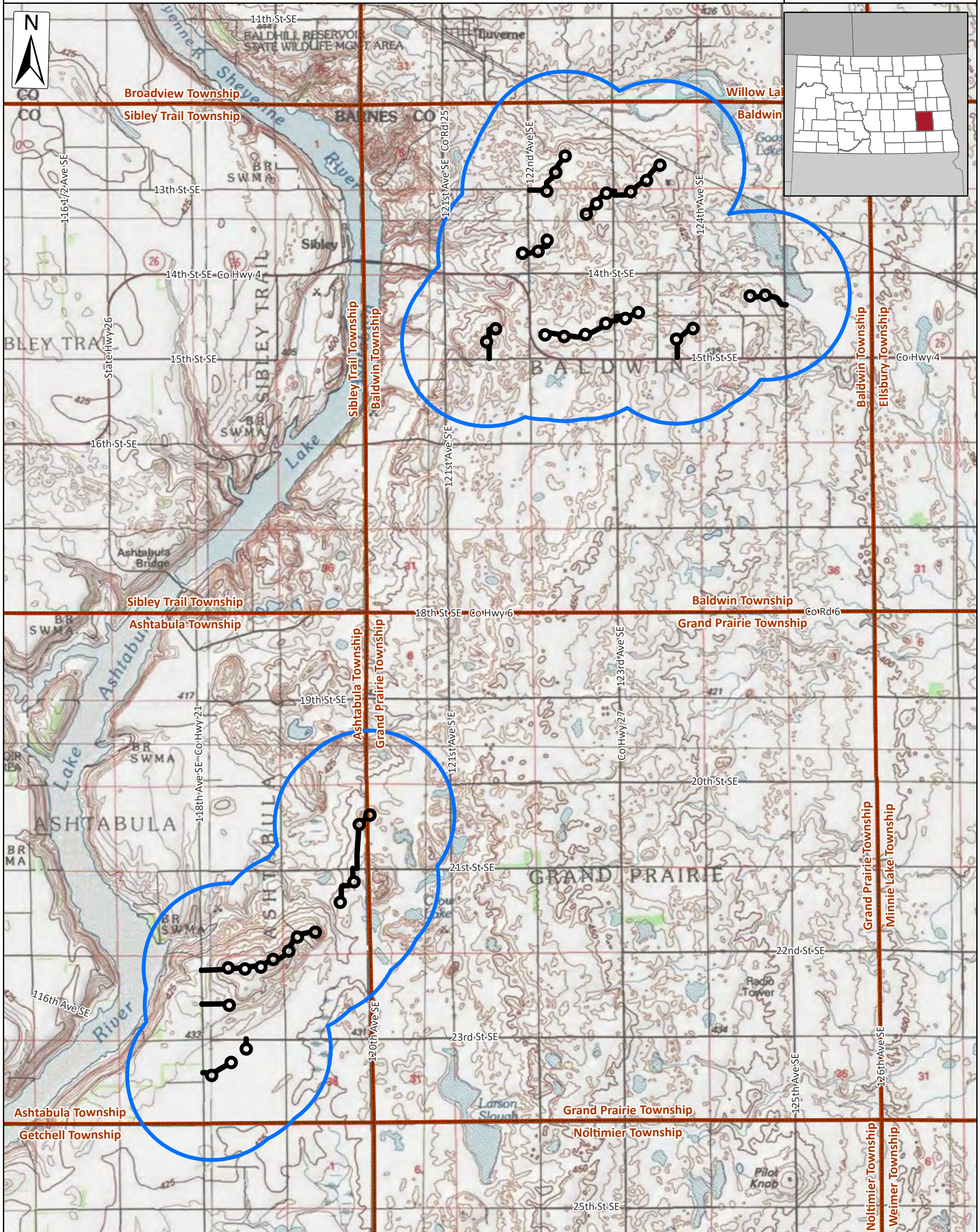
FIGURES




Ashtabula III Re-Power Wind Farm

Issue Date:
3/7/2023

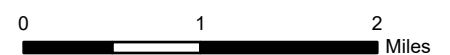
Figure 1 – Site Location

Barnes County, North Dakota



-  Study Area
-  1 mile Buffer
-  Township

SOURCE: USGS Topo Map

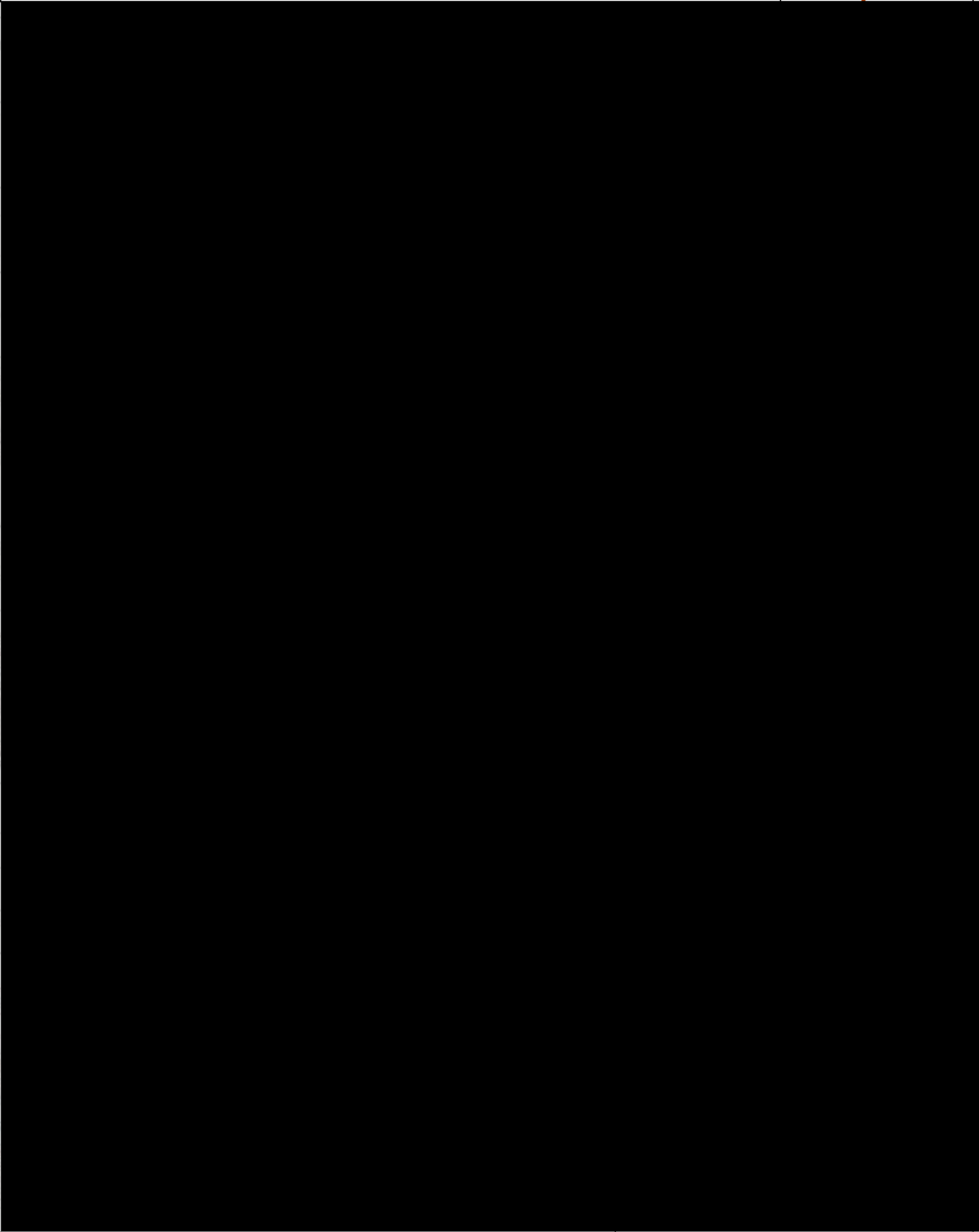













Ashtabula III Re-Power Wind Farm

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Figure 2 – Known Cultural Resources Index

Barnes County, North Dakota



- | | | |
|---|--|---|
|  Archeological Site (Point) |  Existing Turbine Locations |  1 mile Buffer |
|  Archeological Site (Poly) |  Existing Access Roads |  Mapbook Page |
|  Architectural Site (Poly) |  Disturbance Area (~94 acres) |  Township |
|  Archaeological Survey |  Study Area | |

SOURCE: USGS Topo Map



0 1.25 2.5 Miles

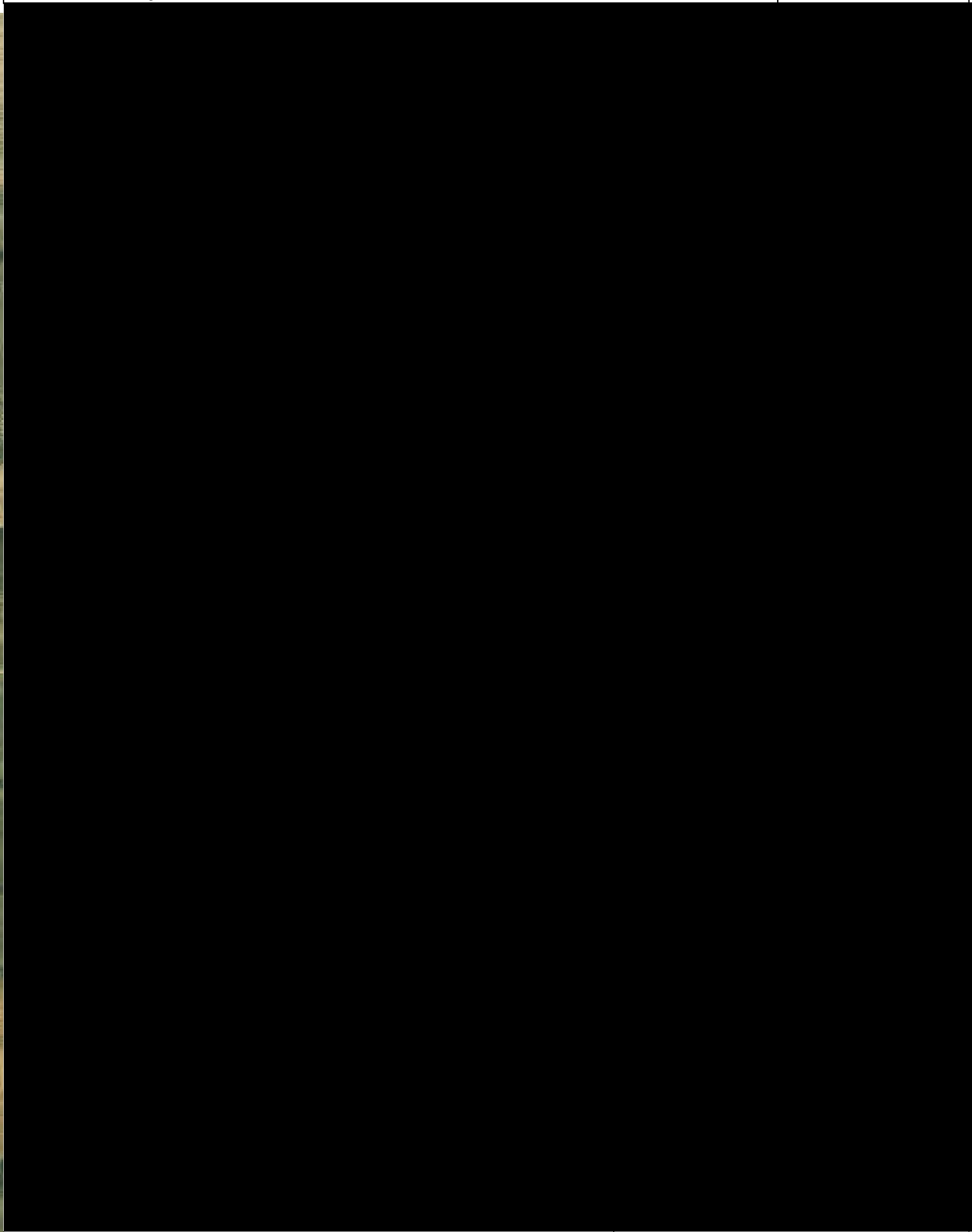
Ashtabula III Wind Upgrade Project



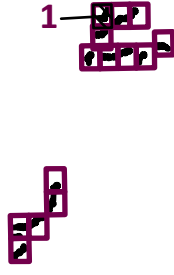








Figure 2 – Known Cultural Resources

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|  National Register of Historic Places |  Existing Turbine Locations |  |
|  Archeological Site (Point) |  Existing Access Roads | |
|  Architectural Site (Poly) |  Disturbance Area (~94 acres) | |
|  Archeological Site (Poly) |  Study Area | |
|  Archaeological Survey |  Township | |

SOURCE: Esri World Imagery (2021)



0 500 US Feet



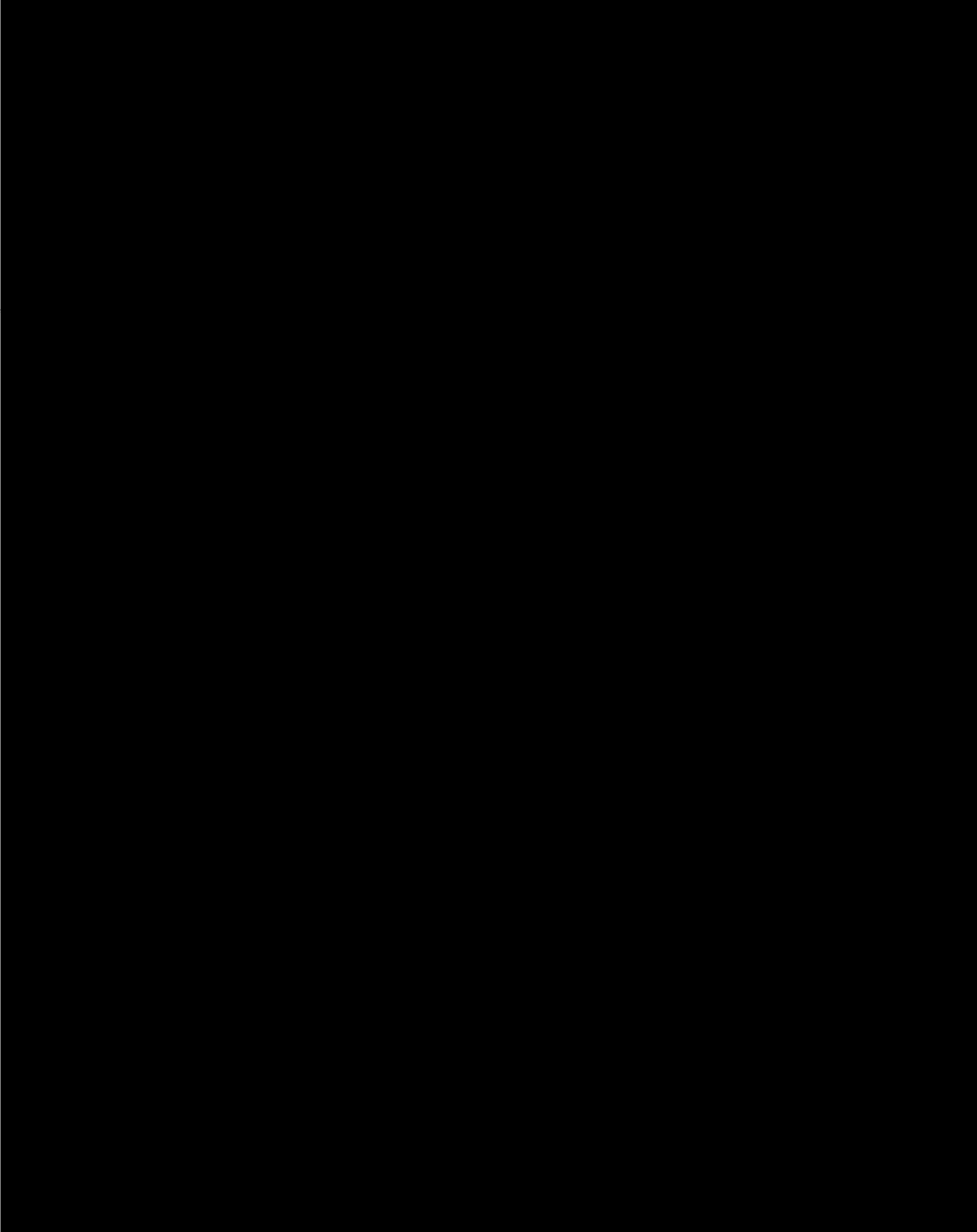
Ashtabula III Wind Upgrade Project







Figure 2 – Known Cultural Resources

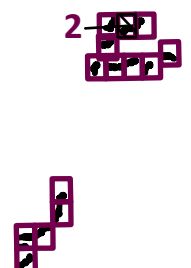
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|  Archaeological Survey |  Township |



SOURCE: Esri World Imagery (2021)

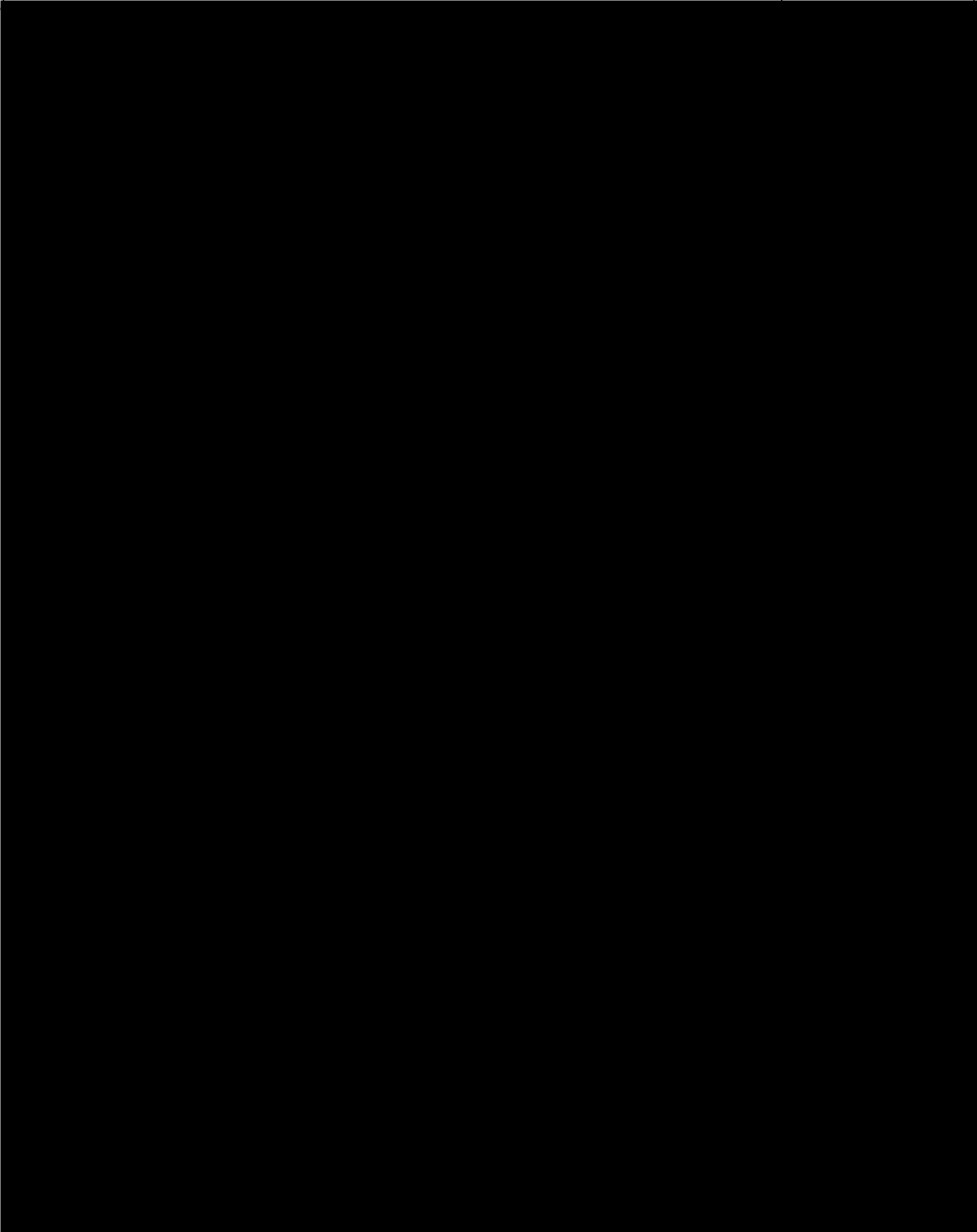
Ashtabula III Wind Upgrade Project











Figure 2 – Known Cultural Resources




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|  National Register of Historic Places |  Existing Turbine Locations |
|  Archeological Site (Point) |  Existing Access Roads |
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|  Archaeological Survey |  Township |
- SOURCE: Esri World Imagery (2021)



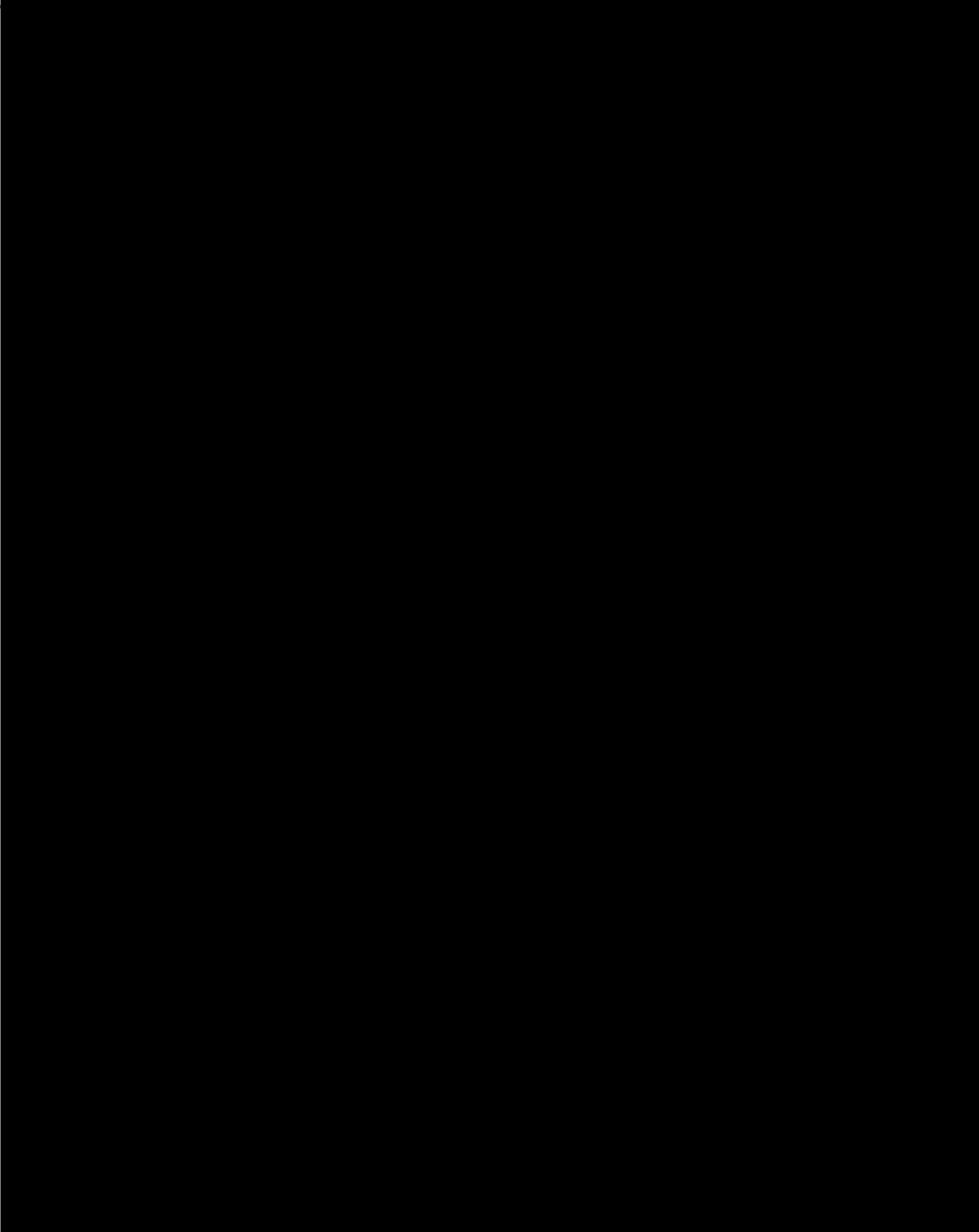
Ashtabula III Wind Upgrade Project











Figure 2 – Known Cultural Resources

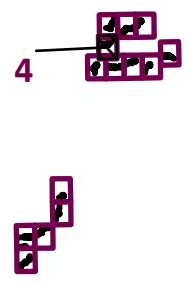
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|  Architectural Site (Poly) |  Disturbance Area (~94 acres) |
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|  Archaeological Survey |  Township |



SOURCE: Esri World Imagery (2021)

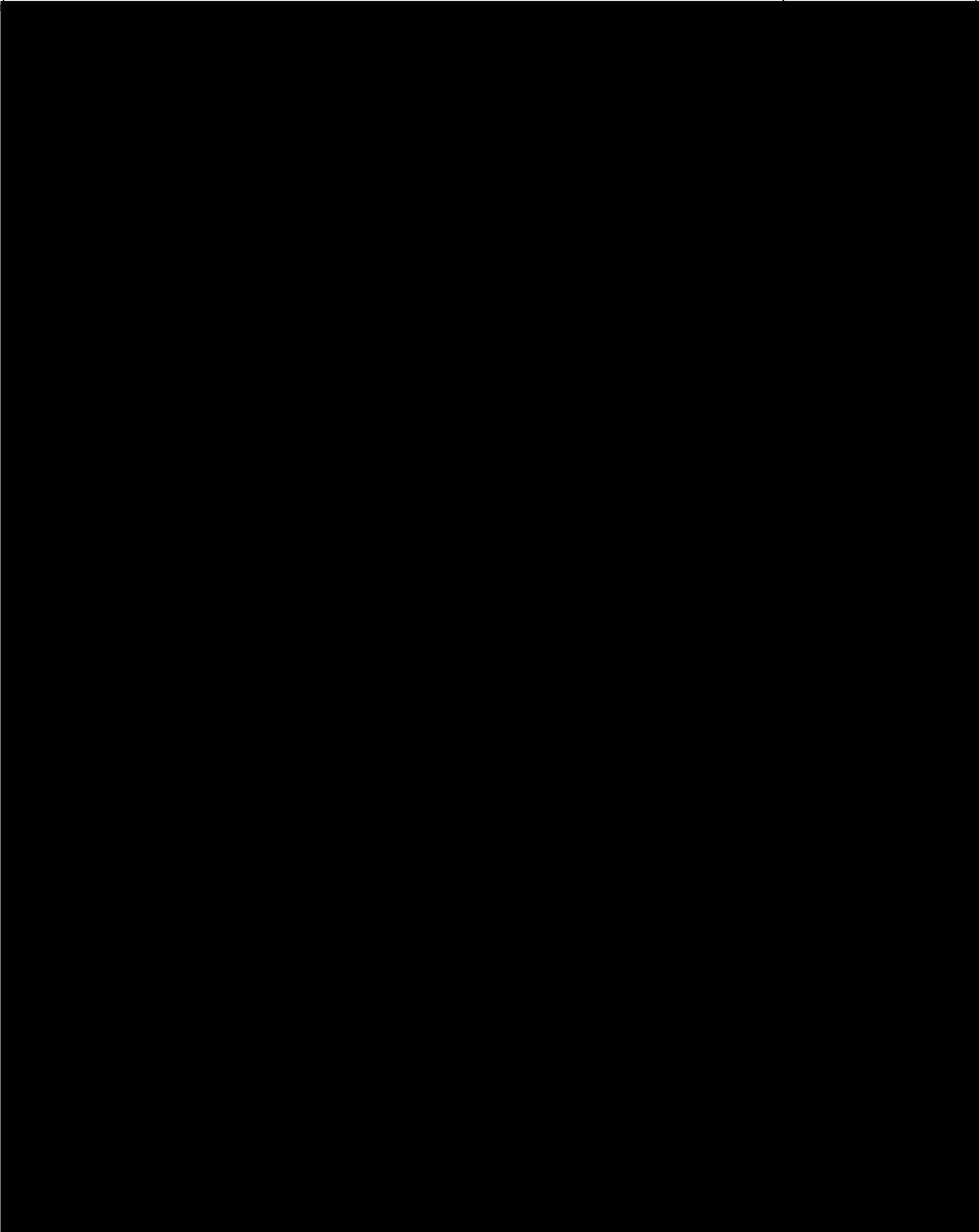
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Figure 2 – Known Cultural Resources

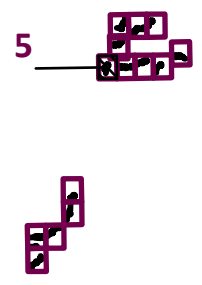
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|  Archaeological Survey |  Township |



SOURCE: Esri World Imagery (2021)

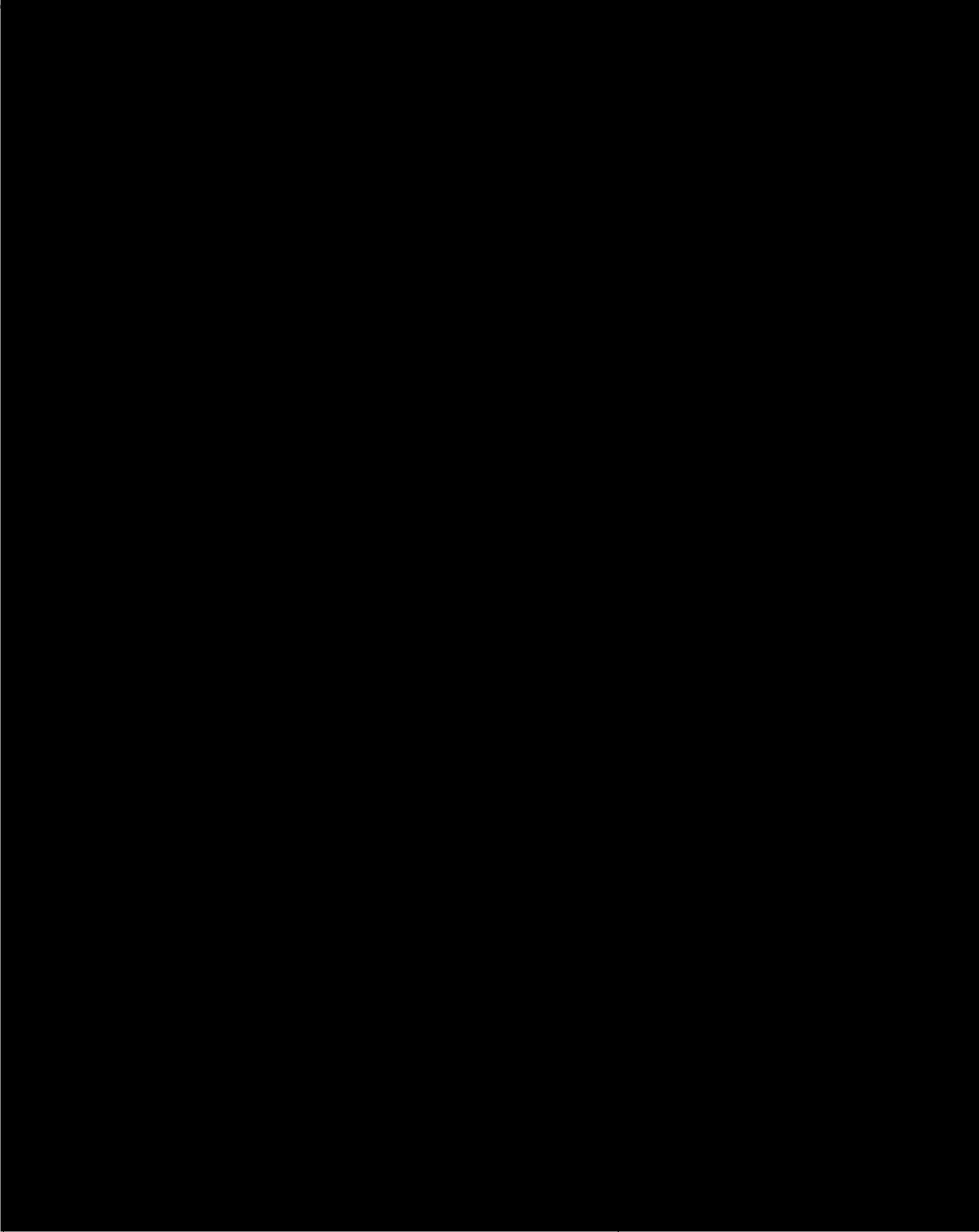
Ashtabula III Wind Upgrade Project











Figure 2 – Known Cultural Resources

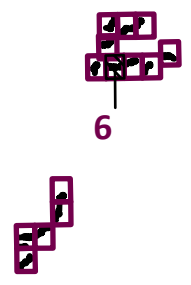
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|  Archaeological Survey |  Township |



SOURCE: Esri World Imagery (2021)

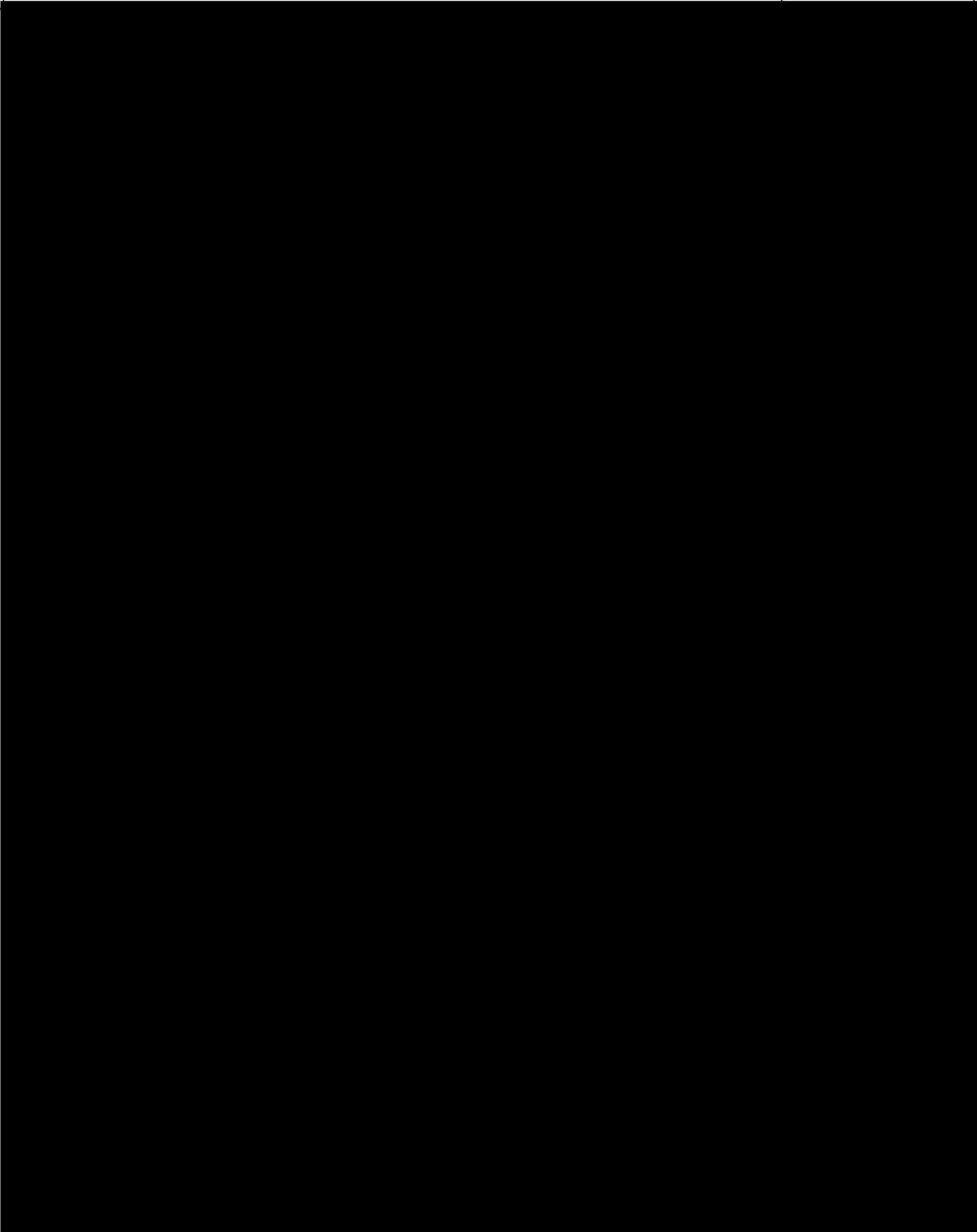
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Figure 2 – Known Cultural Resources

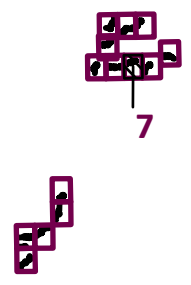
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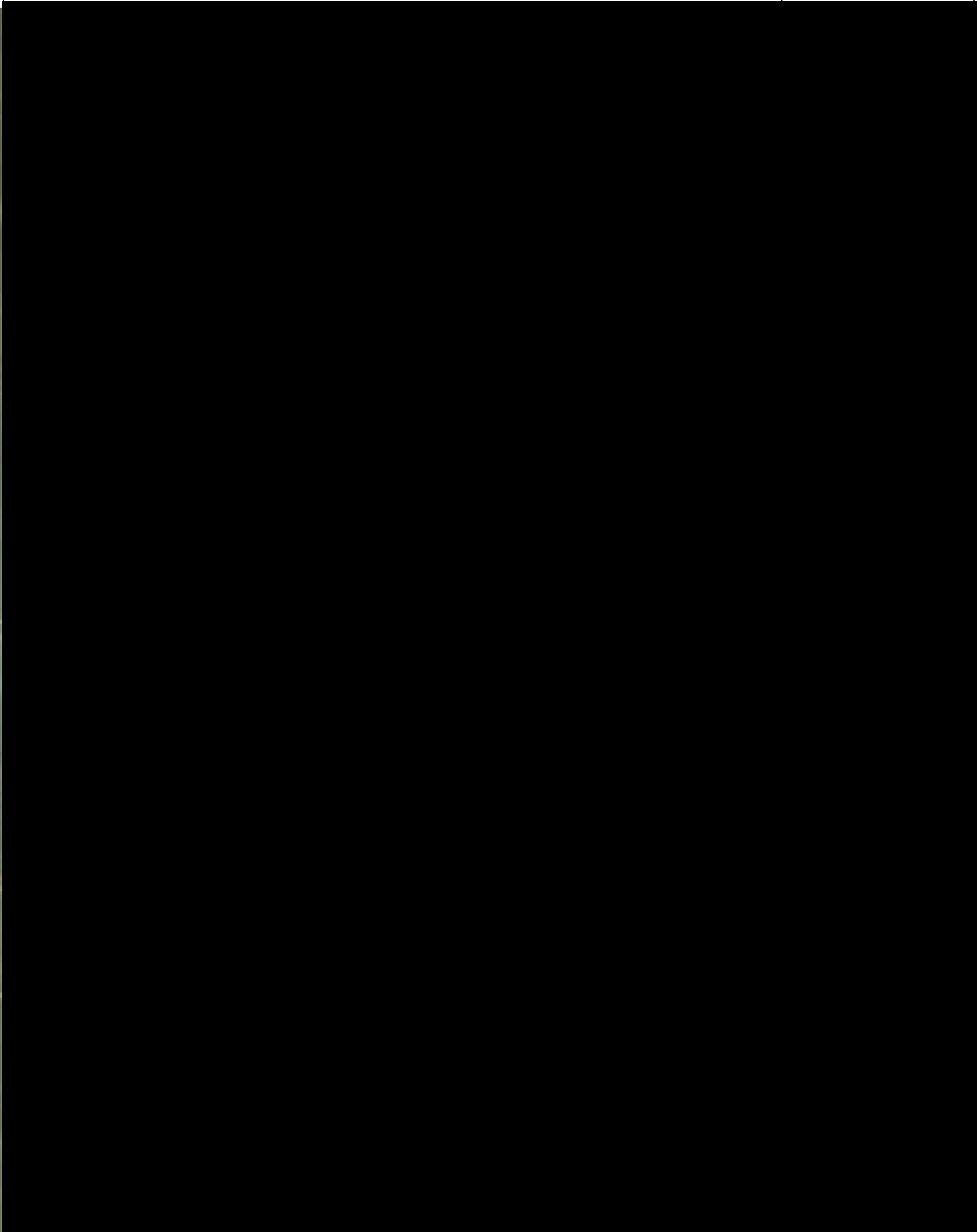
Ashtabula III Wind Upgrade Project











Figure 2 – Known Cultural Resources

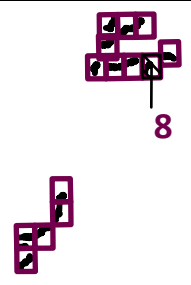
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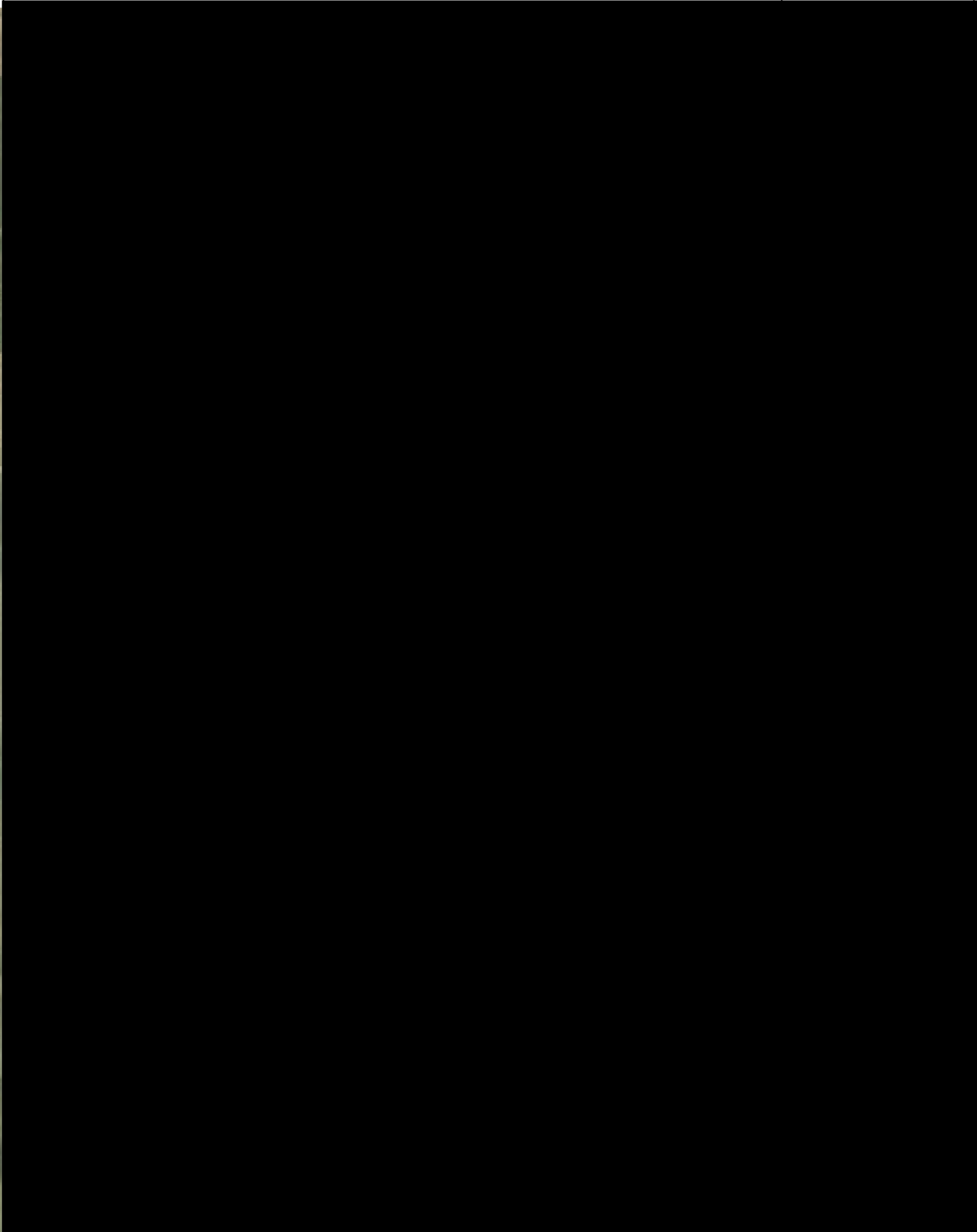
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Figure 2 – Known Cultural Resources

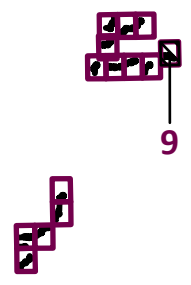
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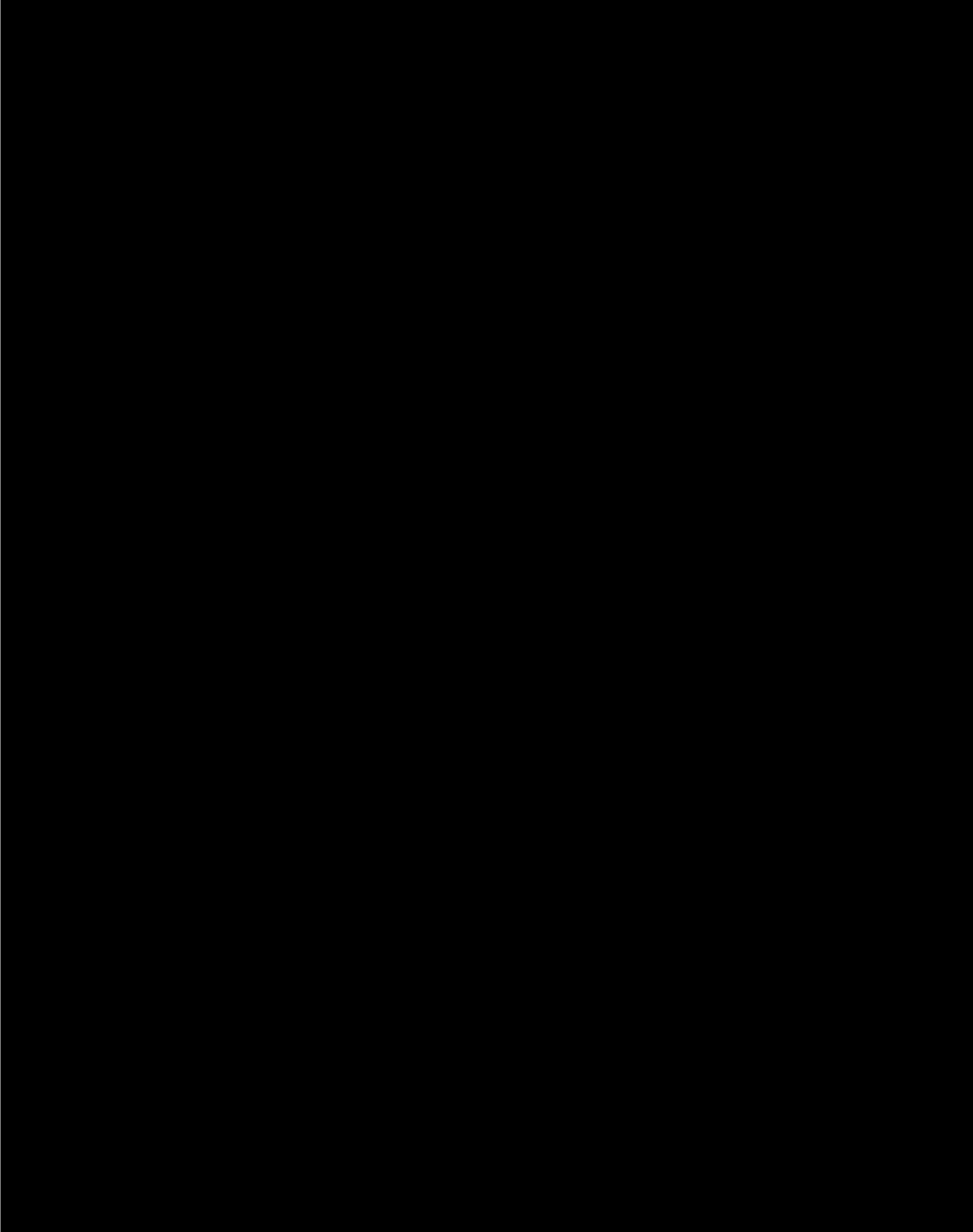
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Figure 2 – Known Cultural Resources

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 National Register of Historic Places	 Existing Turbine Locations
 Archeological Site (Point)	 Existing Access Roads
 Architectural Site (Poly)	 Disturbance Area (~94 acres)
 Archeological Site (Poly)	 Study Area
 Archaeological Survey	 Township

SOURCE: Esri World Imagery (2021)

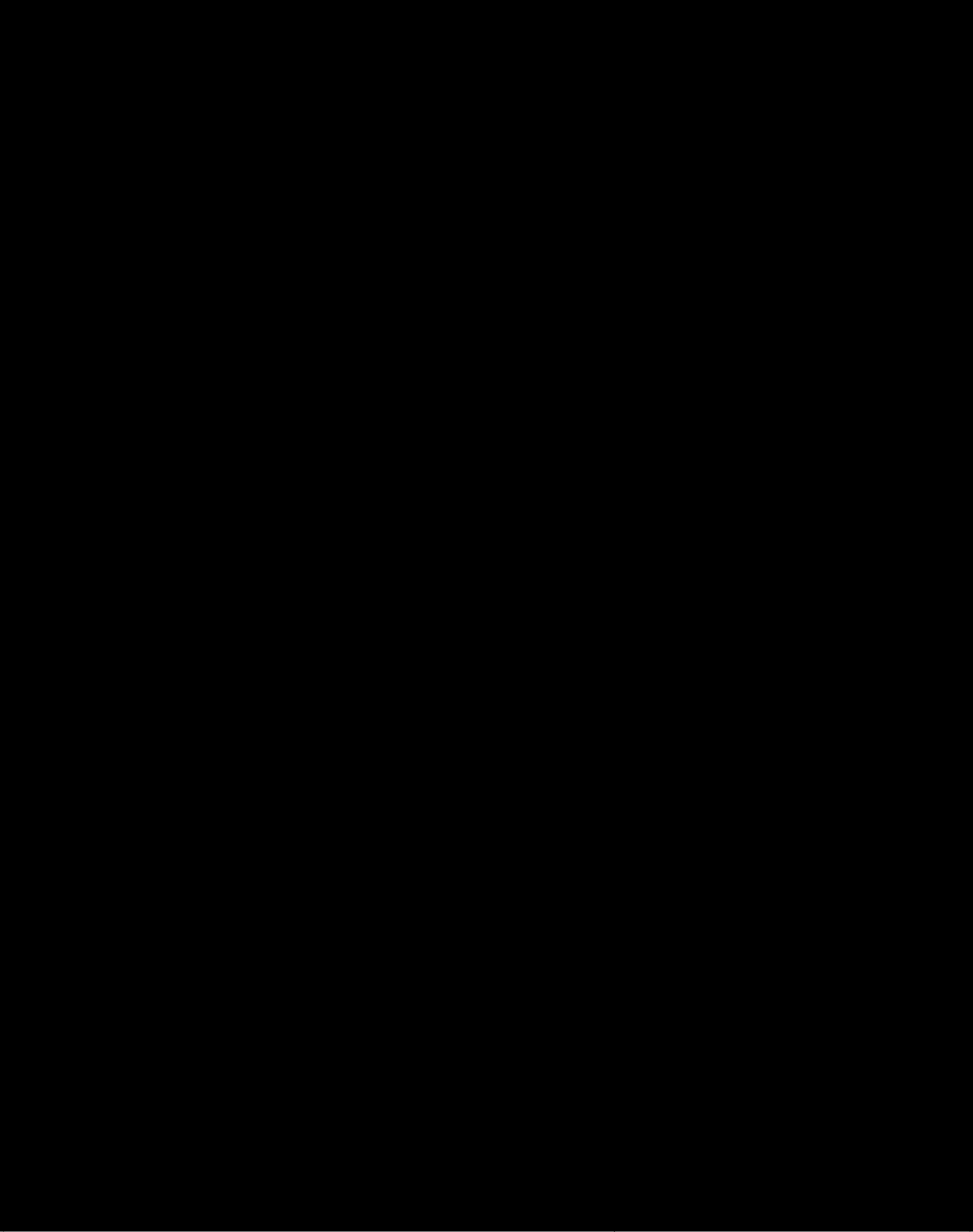
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Figure 2 – Known Cultural Resources

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 National Register of Historic Places	 Existing Turbine Locations
 Archeological Site (Point)	 Existing Access Roads
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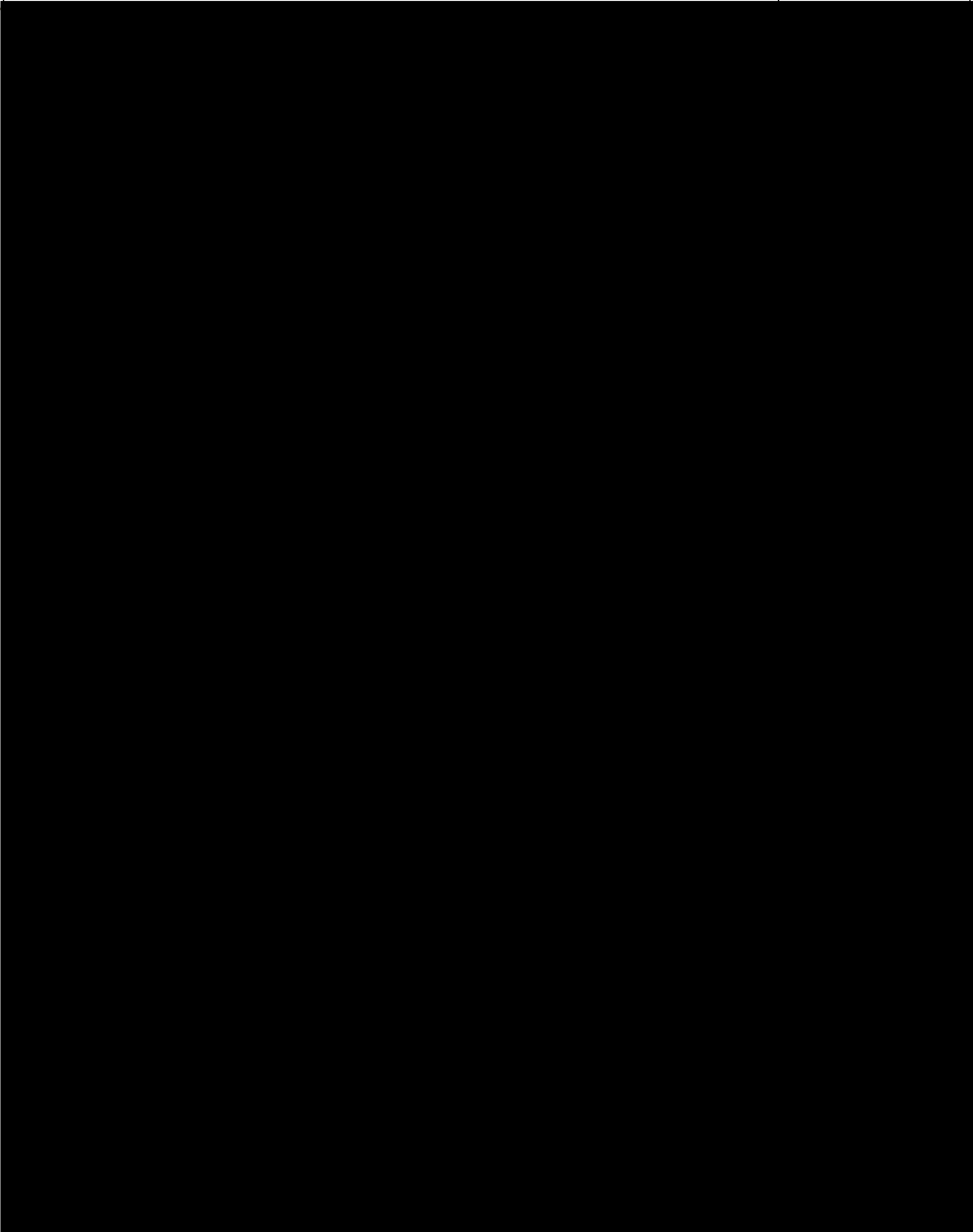
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Figure 2 – Known Cultural Resources

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 National Register of Historic Places	 Existing Turbine Locations
 Archeological Site (Point)	 Existing Access Roads
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SOURCE: Esri World Imagery (2021)



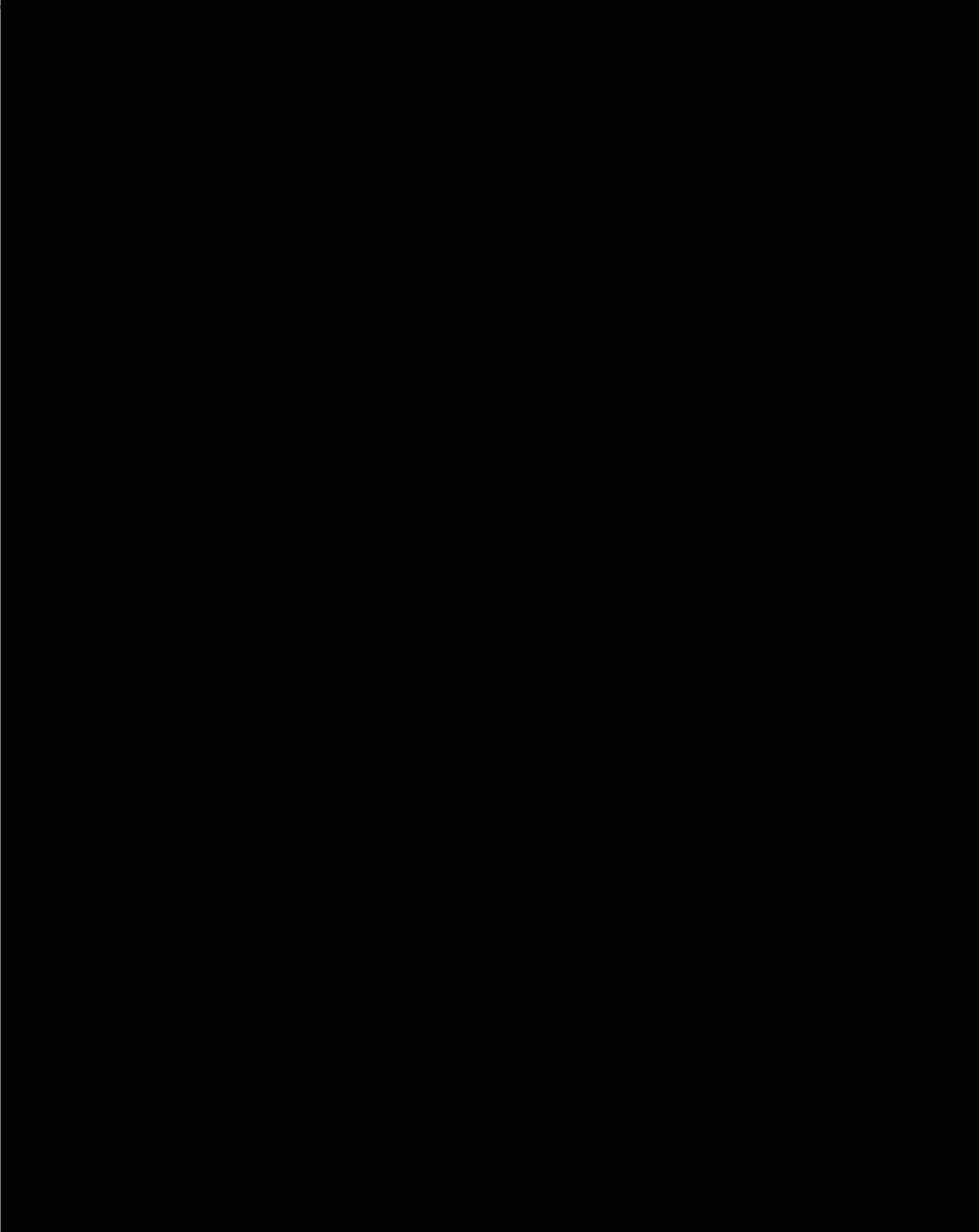
Ashtabula III Wind Upgrade Project

Figure 2 – Known Cultural Resources

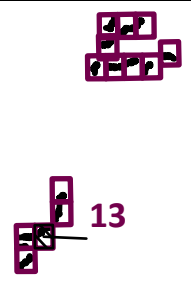
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- ▲ Archeological Site (Point)
- Architectural Site (Poly)
- Archeological Site (Poly)
- Archaeological Survey
- ✈ Existing Turbine Locations
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- Disturbance Area (~94 acres)
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- Township



SOURCE: Esri World Imagery (2021)

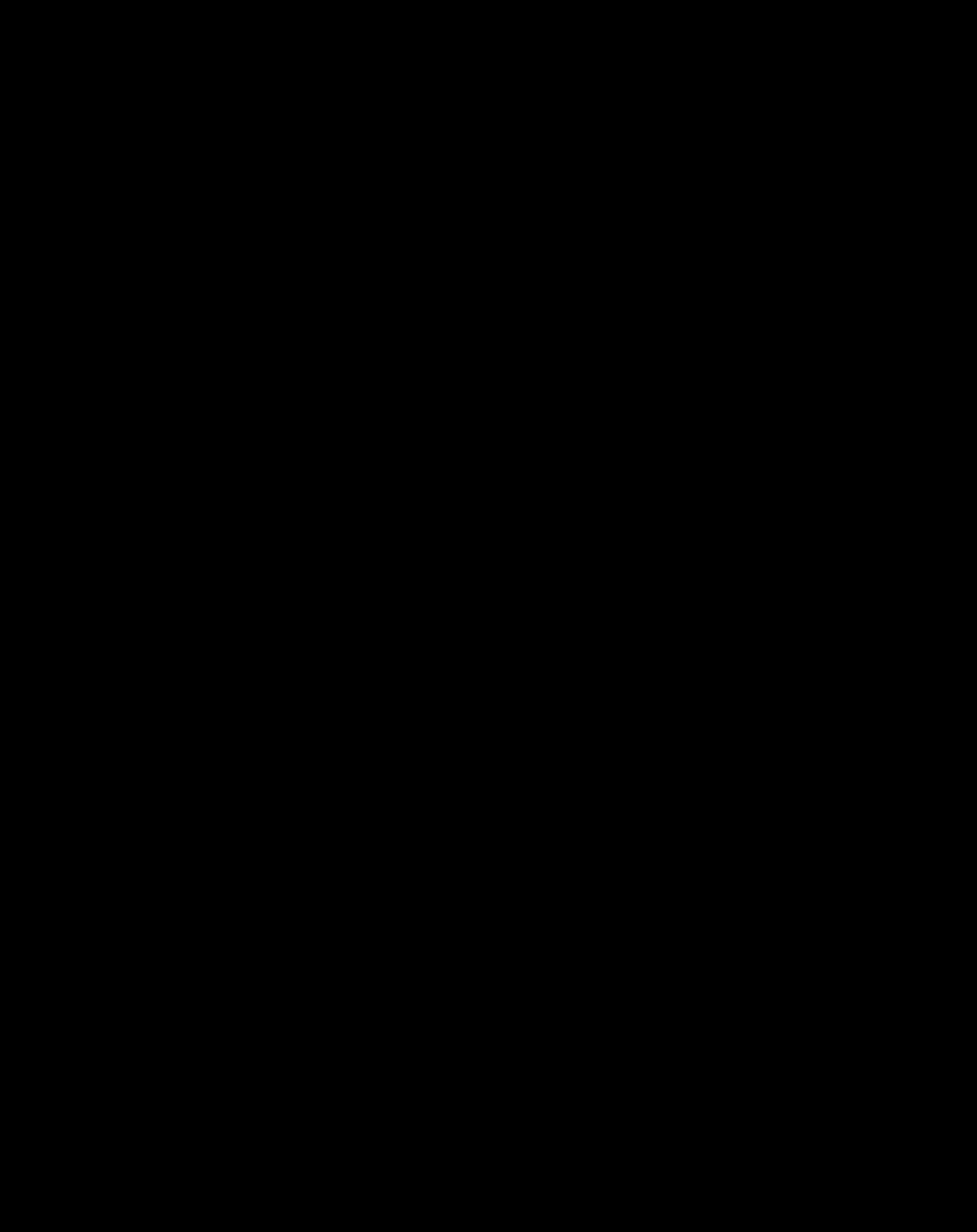
Ashtabula III Wind Upgrade Project











Figure 2 – Known Cultural Resources

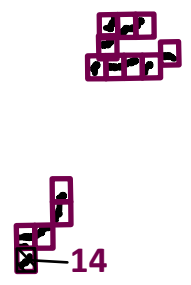
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SOURCE: Esri World Imagery (2021)

APPENDIX



UNANTICIPATED DISCOVERIES PLAN

ASHTABULA III WIND UPGRADE PROJECT BARNES COUNTY, NORTH DAKOTA

Prepared for

Otter Tail Power Company
215 S. Cascade Street
Fergus Falls, Minnesota 56537

Atwell Project No. 23000081

Submitted by Atwell, LLC

June 21, 2023

Contents

1 INTRODUCTION..... 1

2 SUMMARY OF ARCHAEOLOGICAL INVESTIGATIONS..... 2

3 REGULATORY BACKGROUND AND AUTHORITY 3

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5 KEY PERSONNEL AND OFFICIALS 8

Appendices

Appendix A: Examples of Archaeological Resources

1 Introduction

This Unanticipated Discoveries Plan (UDP) has been developed to lay out specific protocols and procedures to be taken should unanticipated archaeological resources be discovered during construction, operation, or decommission of the proposed Ashtabula III Wind Upgrade Project (Project) located in Barnes County, North Dakota. *Unanticipated Discoveries* are previously unknown or unrecorded archaeological resources, including human remains, discovered during Project activities. A series of steps to minimize physical impacts to archaeological resources is outlined in this UDP.

The protocols and procedures in the UDP outline actions to be taken if unanticipated discoveries are encountered during construction, operations, and decommission. The UDP is applicable to ground disturbing work associated with the Project during the construction, operations, and decommissioning phases. The UDP may be revised on occasion in accordance with regulatory changes, approved practices, or expansion into previous non-Project areas.

The UDP includes procedures in accordance with the State Historical Society of North Dakota (SHSND) for compliance with state requirements. In addition, general requirements for meeting the National Historic Preservation Act (NHPA) are included in the UDP.

The objectives of these procedures are to identify and promote the avoidance and/or the preservation and recording of any archaeological material discovered. A key component of the UDP is the notification of archaeological authorities to resolve any issues that may arise from unanticipated discoveries.

2 Summary of Archaeological Investigations

An archaeological literature review, completed in March of 2023, indicated that two previous archaeological surveys had been conducted within the Project Area, one of which covered nearly the entire Project Area. The literature review also indicated that a total of five archaeological sites, 32BA195, 32BA196, 32BA197, 32BA198, and 32BA199, have been previously recorded within the current Project Area.

Based on the literature review in conjunction with the fact that the Project Area has largely been previously surveyed and disturbed by the original construction of the wind farm, Atwell makes the following recommendations:

- The Project proceed as planned without additional cultural resource work prior to construction.
- Provided that 32BA195, 32BA196, 32BA197, 32BA198, and 32BA199 are still extant, Atwell recommends a 30m buffer area placed around the resources for the duration of construction to prevent disturbances as originally recommended by Beaver Creek Inc. in the 2010 report.
- An UDP should be developed to establish procedures and relevant contact information in the event that human remains or archaeological deposits are discovered during the construction, operational, and decommission phases of the Project.
 - If buried archaeological resources are encountered, all activity should cease in the immediate area and within a 100-foot buffer area and the artifacts should be left in place. The Client's archaeologist should be contacted immediately, and unanticipated discovery procedures should be initiated.
 - If human remains are encountered, construction should stop in the immediate area of discovery and within a 100-foot buffer area, and law enforcement should be notified immediately. Law enforcement officials should determine whether the discovery is a crime scene and whether the remains are prehistoric or historic Native American remains. The SHSND should be contacted immediately if the human remains are determined to be prehistoric or historic in nature and/or Native American remains.

The report was submitted to the SHSND on June 16, 2023.

3 Regulatory Background and Authority

The UDP is designed to meet North Dakota and federal regulations governing the discovery of archeological materials and human remains. The applicable state and federal regulations are:

- North Dakota Century Code 55-10-11 – Recognition of Federal Historical Preservation Law;
- North Dakota Century Code 23-06-27 – Protection of human burial sites, human remains, and burial goods;
- Section 106 of the National Historic Preservation Act, (NHPA), as Amended; and

Currently, no federal trigger has been identified for this Project; therefore, Section 106 regulation do not apply. However, this UDP has been designed to comply with Section 106 should a federal trigger be identified in the future.

North Dakota has stringent state laws protecting human burials. A human burial can be marked or unmarked. An “unmarked burial” includes any location where human remains have been or may be found inadvertently and where there is no surficial evidence of a burial site (i.e., cemetery fence lines, tombstones, grave markers, etc.). This includes all prehistoric or historic Native American burials as well as all early historic-period Euro-American, African-American, and other isolated burials and abandoned cemeteries that are no longer being used for internments or being maintained in good condition. Human burials are protected under North Dakota Century Code 23-06-27. This law outlines the penalties for disturbing these resources as well and outlines the reporting protocol in the event an unmarked grave, burial, or historic cemetery is discovered.

4 Unanticipated Discovery Procedures

The general process for managing unanticipated discoveries is outlined in the following section, followed by information specific to archaeological sites and human remains or unmarked burials.

A responsible person who will be involved with all aspects of Project-related ground disturbing work during the construction, operations, and decommissioning phases should be identified. The designated responsible person (cultural liaison) should be present onsite during most Project activities and have some level of training, awareness, and sensitivity to the cultural resources that may be encountered within the Project site. This person will act as the Project liaison with the owner, Project archeologist, and cultural resources authorities in the event of unanticipated discoveries. S/he also will serve as the initial contact in the event of unanticipated discoveries during Project activities and be listed in the contacts section of this UDP.

During the Project kick-off meeting, all contractors will be made aware of the UDP and will be provided contact information for the cultural liaison, who will contact the Project archeologist to evaluate the need for further action. Whenever new personnel are brought onsite, they also will be informed of the UDP and the contact information. A copy of the UDP, including contact information, shall be posted in an accessible location onsite for reference as needed.

4.1 Archaeological Material

For purposes of the UDP, “archaeological material” could be from prehistoric or historic periods and includes, though not exclusively, the following types of materials (see Appendix A for additional examples):

- An area of charcoal or charcoal-stained soils associated with historic-period or prehistoric-period remains, such as bones, pottery sherds, shell, stone tools or chips;
- An arrowhead, pottery sherds, shell, stone tool, or stone chips;
- A historic-period bottle, old glass fragments, square nails, bricks and mortar, decorated white ware ceramics, etc.;
- A cluster of shell, sherds, and/or bones or large field stones or burned rocks in association with stone tools or chips;
- Dredging, pumping, industrial, and/or agricultural equipment older than 50 years;
- Buried structures, brick foundation piers or concrete slabs from remnant outbuildings or residences;
- A cluster of darkened soils in association with bones; and
- Undisturbed mounds of soil in areas that were once wetlands or shorelines.

The following general procedure is to be executed if archaeological material is discovered.

1. The site supervisor/foreman is informed of the discovery. The site supervisor/foreman will then contact the cultural liaison.
2. All construction activity within 100 feet of the discovery area/feature/site will cease immediately.
3. All remains or materials are to be left in place unless in jeopardy because of Project activities.
4. The area will be secured to prevent any damage or loss of removable objects. If feasible, a fence or other barrier will be erected to demarcate and protect the discovery area.
5. The cultural liaison will contact the Project archeologist, who will record the discovery location and delineate the extent of the discovery relative to planned Project activities. The Project archeologist will assess, record, and photograph the find.
6. Within 48 hours of the discovery, the Project archeologist will notify the SHSND and provide a brief written summary of the discovery that will include a recommendation on the NRHP eligibility of the resources, the effect of Project activity on historic properties, if present, and a proposed treatment to resolve adverse effects, if applicable.
7. The SHSND will review the recommendation made by the Project archaeologist and determine the appropriate course of action.
8. If cultural resources or remains have the potential to be culturally significant to a living Native American Tribe, the SHSND will notify the appropriate Tribes.
9. If human remains or unmarked burial sites are discovered, procedures in the next section should be followed.

4.2 Human Remains and Unmarked Burials

It is recommended that the Project follow the unanticipated discoveries protocol outlined in this section if any human remains or unmarked burial sites are discovered during Project activities.

Human remains may include any human body parts. Burial artifacts and burial sites are not easily recognized, but generally would include intact prehistoric pots, clusters of artifacts, or modern grave features (e.g., headstones, coffin parts, etc.). If in doubt whether the bones or other materials are human, it is best to stop work in the immediate area of the discovery and seek advice from the Project archaeologist.

Procedures for unanticipated discoveries involving human remains or unmarked burials are outlined below. In the event that human remains, an unmarked burial, or an abandoned cemetery is encountered by Project staff, the following procedures are applicable.

1. On discovery of the remains, construction activities (including excavation or any other below ground work) within 100 feet of the discovery will cease.
2. The site supervisor/foreman will be informed of the discovery. The site supervisor/foreman will then notify the cultural liaison.
3. Temporary site protection measures (e.g., high visibility warning tape and stakes, avoidance signs in language[s] understandable to the Project team, etc.) will be installed around the discovery area to prevent unintentional incursion and potential damage to the remains.
4. The cultural liaison will contact local law enforcement (e.g., police department, county sheriff) within 24 hours. Local law enforcement will notify the appropriate medical examiner's office.
5. The cultural liaison will contact the Project archaeologist, who will be or will engage a qualified professional archaeologist who is permitted in North Dakota and who has a background in osteology, forensic anthropology, physical anthropology, or equivalent.
6. The Project archaeologist will notify the SHSND within 48 hours of the discovery and provide the SHSND with a brief summary of the findings and recommendations.
7. The local law enforcement officials must be given site access to assess the nature and age of the remains. If the medical examiner's office determines that the human remains are older than 50 years of age and there is no need for a legal inquiry or criminal investigation, the SHSND will have jurisdiction over the remains.
8. If the SHSND believes the remains may have ethnic affinity with a living Native American Tribe, the SHSND will notify the appropriate Tribal representative(s) of the discovery.
9. Consultation will be initiated between the Project personnel (consisting of OTP or their agent, the Project archaeologist or qualified professional archaeologist, and the cultural liaison) and the SHSND to determine the final disposition of the human remains. The below will be considered during consultation if the remains are determined to be Native American.
 - a. The National Park Services' Native American Graves Protection and Repatriation Act (NAGPRA) (U.S. Code 25, §3001, et seq.) database and Tribal websites.
 - b. Information available at the Great Plains Regional Office of the Bureau of Indian Affairs.
 - c. The potential interest of additional state-recognized Tribes.

10. No work that will cause a direct effect to the discovery area will proceed until all human remains and associated artifacts have been recovered, and, where applicable, the appropriate regulatory agencies have given clearance for the Project work to proceed.

5 Key Personnel and Officials

In the event of an unanticipated discovery, the key personnel and agency officials listed below should be contacted consistent with the steps outlined above.

Cultural Liaison

Bryce Haugen
Energy Supply
215 S. Cascade St.
Fergus Falls, MN 56537
(701) 739-8385
bhaugen@otpc.com

Project Archaeologist

Matthew Chouest
2 Towne Square
Southfield, MI 48076
(517) 231-2053
mchouest@atwell-group.com

State Historical Society of North Dakota (SHSND)

Andrew J. Robinson
State Archaeologist
State Historical Society of North Dakota
Archaeology and Historic Preservation
612 East Boulevard Avenue
Bismarck, ND 58505-0830
Phone: (701) 328-3575
Email: andrewrobinson@nd.gov

Barnes County Sheriff's Office

57510th St. SW Suite 4
Valley City, ND 58072
Phone: (701) 845-8530

Barnes County Coroner's Office

520 Chautauqua Boulevard
Valley City, ND 58072
Phone: (701) 845-6000

APPENDIX A - EXAMPLES OF ARCHAEOLOGICAL RESOURCES

Surface or subsurface structures, shelters, facilities, or features, including, but not limited to

- domestic structures
- storage structures
- cooking structures
- ceremonial structures
- artificial mounds
- earthworks
- fortifications
- canals
- reservoirs
- gardens or fields
- bedrock mortars
- grinding surfaces
- rock alignments
- cairns
- trails
- borrow pits
- cooking pits
- refuse pits
- burial pits or graves
- hearths
- kilns
- post molds
- wall trenches

PUBLIC DOCUMENT - NONPUBLIC DATA HAS BEEN EXCISED

- middens
- Surface or subsurface artifact concentrations or scatters
- Whole or fragmentary tools, implements, containers, weapons or weapon projectiles, clothing, and ornaments, including, but not limited to:
 - pottery
 - other ceramics
 - cordage
 - basketry
 - other weaving
 - bottles
 - other glassware
 - bone
 - ivory
 - shell
 - metal
 - wood
 - hide
 - feathers
 - pigments
 - flaked stone
 - ground stone
 - pecked stone
- By-products, waste products, or debris resulting from manufacture or use of human-made or natural materials
- Organic waste, including, but not limited to: vegetal and animal remains, coprolites
- Human remains, including, but not limited to: bone, teeth, mummified flesh, burials, cremations

PUBLIC DOCUMENT - NONPUBLIC DATA HAS BEEN EXCISED

- Rock carvings, rock paintings, intaglios, and other works of artistic or symbolic representation
- Rock shelters and caves or portions thereof containing any of the above material remains
- All portions of shipwrecks, including, but not limited to: armaments, apparel, tackle, cargo
- Any portion or piece of any of the foregoing

Appendix F – IPaC Resource List

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IPaC resource list

This report is an automatically generated list of species and other resources such as critical habitat (collectively referred to as *trust resources*) under the U.S. Fish and Wildlife Service's (USFWS) jurisdiction that are known or expected to be on or near the project area referenced below. The list may also include trust resources that occur outside of the project area, but that could potentially be directly or indirectly affected by activities in the project area. However, determining the likelihood and extent of effects a project may have on trust resources typically requires gathering additional site-specific (e.g., vegetation/species surveys) and project-specific (e.g., magnitude and timing of proposed activities) information.

Below is a summary of the project information you provided and contact information for the USFWS office(s) with jurisdiction in the defined project area. Please read the introduction to each section that follows (Endangered Species, Migratory Birds, USFWS Facilities, and NWI Wetlands) for additional information applicable to the trust resources addressed in that section.

Location

Barnes County, North Dakota



Local office

North Dakota Ecological Services Field Office

☎ (701) 250-4481

📠 (701) 355-8513

3425 Miriam Avenue

Bismarck, ND 58501-7926

NOT FOR CONSULTATION

Endangered species

This resource list is for informational purposes only and does not constitute an analysis of project level impacts.

The primary information used to generate this list is the known or expected range of each species. Additional areas of influence (AOI) for species are also considered. An AOI includes areas outside of the species range if the species could be indirectly affected by activities in that area (e.g., placing a dam upstream of a fish population even if that fish does not occur at the dam site, may indirectly impact the species by reducing or eliminating water flow downstream). Because species can move, and site conditions can change, the species on this list are not guaranteed to be found on or near the project area. To fully determine any potential effects to species, additional site-specific and project-specific information is often required.

Section 7 of the Endangered Species Act **requires** Federal agencies to "request of the Secretary information whether any species which is listed or proposed to be listed may be present in the area of such proposed action" for any project that is conducted, permitted, funded, or licensed by any Federal agency. A letter from the local office and a species list which fulfills this requirement can **only** be obtained by requesting an official species list from either the Regulatory Review section in IPaC (see directions below) or from the local field office directly.

For project evaluations that require USFWS concurrence/review, please return to the IPaC website and request an official species list by doing the following:

1. Draw the project location and click CONTINUE.
2. Click DEFINE PROJECT.
3. Log in (if directed to do so).
4. Provide a name and description for your project.
5. Click REQUEST SPECIES LIST.

Listed species¹ and their critical habitats are managed by the [Ecological Services Program](#) of the U.S. Fish and Wildlife Service (USFWS) and the fisheries division of the National Oceanic and Atmospheric Administration (NOAA Fisheries²).

Species and critical habitats under the sole responsibility of NOAA Fisheries are **not** shown on this list. Please contact [NOAA Fisheries](#) for [species under their jurisdiction](#).

-
1. Species listed under the [Endangered Species Act](#) are threatened or endangered; IPaC also shows species that are candidates, or proposed, for listing. See the [listing status page](#) for more information. IPaC only shows species that are regulated by USFWS (see FAQ).

2. [NOAA Fisheries](#), also known as the National Marine Fisheries Service (NMFS), is an office of the National Oceanic and Atmospheric Administration within the Department of Commerce.

The following species are potentially affected by activities in this location:

Mammals

NAME	STATUS
Northern Long-eared Bat <i>Myotis septentrionalis</i> Wherever found No critical habitat has been designated for this species. https://ecos.fws.gov/ecp/species/9045	Endangered

Insects

NAME	STATUS
Dakota Skipper <i>Hesperia dactotae</i> Wherever found There is final critical habitat for this species. Your location does not overlap the critical habitat. https://ecos.fws.gov/ecp/species/1028	Threatened
Monarch Butterfly <i>Danaus plexippus</i> Wherever found No critical habitat has been designated for this species. https://ecos.fws.gov/ecp/species/9743	Candidate

Critical habitats

Potential effects to critical habitat(s) in this location must be analyzed along with the endangered species themselves.

There are no critical habitats at this location.

Migratory birds

Certain birds are protected under the Migratory Bird Treaty Act¹ and the Bald and Golden Eagle Protection Act².

Any person or organization who plans or conducts activities that may result in impacts to migratory birds, eagles, and their habitats should follow appropriate regulations and consider implementing appropriate conservation measures, as described [below](#).

1. The [Migratory Birds Treaty Act](#) of 1918.
2. The [Bald and Golden Eagle Protection Act](#) of 1940.

Additional information can be found using the following links:

- Birds of Conservation Concern <https://www.fws.gov/program/migratory-birds/species>
- Measures for avoiding and minimizing impacts to birds <https://www.fws.gov/library/collections/avoiding-and-minimizing-incident-take-migratory-birds>
- Nationwide conservation measures for birds <https://www.fws.gov/sites/default/files/documents/nationwide-standard-conservation-measures.pdf>

The birds listed below are birds of particular concern either because they occur on the [USFWS Birds of Conservation Concern \(BCC\)](#) list or warrant special attention in your project location. To learn more about the levels of concern for birds on your list and how this list is generated, see the FAQ [below](#). This is not a list of every bird you may find in this location, nor a guarantee that every bird on this list will be found in your project area. To see exact locations of where birders and the general public have sighted birds in and around your project area, visit the [E-bird data mapping tool](#) (Tip: enter your location, desired date range and a species on your list). For projects that occur off the Atlantic Coast, additional maps and models detailing the relative occurrence and abundance of bird species on your list are available. Links to additional information about Atlantic Coast birds, and other important information about your migratory bird list, including how to properly interpret and use your migratory bird report, can be found [below](#).

For guidance on when to schedule activities or implement avoidance and minimization measures to reduce impacts to migratory birds on your list, click on the PROBABILITY OF PRESENCE SUMMARY at the top of your list to see when these birds are most likely to be present and breeding in your project area.

NAME	BREEDING SEASON
<p>American Golden-plover <i>Pluvialis dominica</i></p> <p>This is a Bird of Conservation Concern (BCC) throughout its range in the continental USA and Alaska.</p>	Breeds elsewhere
<p>Bald Eagle <i>Haliaeetus leucocephalus</i></p> <p>This is not a Bird of Conservation Concern (BCC) in this area, but warrants attention because of the Eagle Act or for potential susceptibilities in offshore areas from certain types of development or activities.</p>	Breeds Dec 1 to Aug 31

Black Tern <i>Chlidonias niger</i> This is a Bird of Conservation Concern (BCC) throughout its range in the continental USA and Alaska. https://ecos.fws.gov/ecp/species/3093	Breeds May 15 to Aug 20
Black-billed Cuckoo <i>Coccyzus erythrophthalmus</i> This is a Bird of Conservation Concern (BCC) throughout its range in the continental USA and Alaska. https://ecos.fws.gov/ecp/species/9399	Breeds May 15 to Oct 10
Bobolink <i>Dolichonyx oryzivorus</i> This is a Bird of Conservation Concern (BCC) throughout its range in the continental USA and Alaska.	Breeds May 20 to Jul 31
California Gull <i>Larus californicus</i> This is a Bird of Conservation Concern (BCC) throughout its range in the continental USA and Alaska.	Breeds Mar 1 to Jul 31
Chestnut-collared Longspur <i>Calcarius ornatus</i> This is a Bird of Conservation Concern (BCC) throughout its range in the continental USA and Alaska.	Breeds May 1 to Aug 10
Chimney Swift <i>Chaetura pelagica</i> This is a Bird of Conservation Concern (BCC) throughout its range in the continental USA and Alaska.	Breeds Mar 15 to Aug 25
Clark's Grebe <i>Aechmophorus clarkii</i> This is a Bird of Conservation Concern (BCC) throughout its range in the continental USA and Alaska.	Breeds Jun 1 to Aug 31
Franklin's Gull <i>Leucophaeus pipixcan</i> This is a Bird of Conservation Concern (BCC) throughout its range in the continental USA and Alaska.	Breeds May 1 to Jul 31
Golden Eagle <i>Aquila chrysaetos</i> This is not a Bird of Conservation Concern (BCC) in this area, but warrants attention because of the Eagle Act or for potential susceptibilities in offshore areas from certain types of development or activities. https://ecos.fws.gov/ecp/species/1680	Breeds Jan 1 to Aug 31

Golden-winged Warbler <i>Vermivora chrysoptera</i> This is a Bird of Conservation Concern (BCC) throughout its range in the continental USA and Alaska. https://ecos.fws.gov/ecp/species/8745	Breeds May 1 to Jul 20
Hudsonian Godwit <i>Limosa haemastica</i> This is a Bird of Conservation Concern (BCC) throughout its range in the continental USA and Alaska.	Breeds elsewhere
Lesser Yellowlegs <i>Tringa flavipes</i> This is a Bird of Conservation Concern (BCC) throughout its range in the continental USA and Alaska. https://ecos.fws.gov/ecp/species/9679	Breeds elsewhere
Long-eared Owl <i>asio otus</i> This is a Bird of Conservation Concern (BCC) throughout its range in the continental USA and Alaska. https://ecos.fws.gov/ecp/species/3631	Breeds Mar 1 to Jul 15
Marbled Godwit <i>Limosa fedoa</i> This is a Bird of Conservation Concern (BCC) throughout its range in the continental USA and Alaska. https://ecos.fws.gov/ecp/species/9481	Breeds May 1 to Jul 31
Red-headed Woodpecker <i>Melanerpes erythrocephalus</i> This is a Bird of Conservation Concern (BCC) throughout its range in the continental USA and Alaska.	Breeds May 10 to Sep 10
Ruddy Turnstone <i>Arenaria interpres morinella</i> This is a Bird of Conservation Concern (BCC) only in particular Bird Conservation Regions (BCRs) in the continental USA	Breeds elsewhere
Short-billed Dowitcher <i>Limnodromus griseus</i> This is a Bird of Conservation Concern (BCC) throughout its range in the continental USA and Alaska. https://ecos.fws.gov/ecp/species/9480	Breeds elsewhere
Western Grebe <i>aechmophorus occidentalis</i> This is a Bird of Conservation Concern (BCC) throughout its range in the continental USA and Alaska. https://ecos.fws.gov/ecp/species/6743	Breeds Jun 1 to Aug 31

Willet *Tringa semipalmata*

Breeds Apr 20 to Aug 5

This is a Bird of Conservation Concern (BCC) throughout its range in the continental USA and Alaska.

Probability of Presence Summary

The graphs below provide our best understanding of when birds of concern are most likely to be present in your project area. This information can be used to tailor and schedule your project activities to avoid or minimize impacts to birds. Please make sure you read and understand the FAQ "Proper Interpretation and Use of Your Migratory Bird Report" before using or attempting to interpret this report.

Probability of Presence (■)

Each green bar represents the bird's relative probability of presence in the 10km grid cell(s) your project overlaps during a particular week of the year. (A year is represented as 12 4-week months.) A taller bar indicates a higher probability of species presence. The survey effort (see below) can be used to establish a level of confidence in the presence score. One can have higher confidence in the presence score if the corresponding survey effort is also high.

How is the probability of presence score calculated? The calculation is done in three steps:

1. The probability of presence for each week is calculated as the number of survey events in the week where the species was detected divided by the total number of survey events for that week. For example, if in week 12 there were 20 survey events and the Spotted Towhee was found in 5 of them, the probability of presence of the Spotted Towhee in week 12 is 0.25.
2. To properly present the pattern of presence across the year, the relative probability of presence is calculated. This is the probability of presence divided by the maximum probability of presence across all weeks. For example, imagine the probability of presence in week 20 for the Spotted Towhee is 0.05, and that the probability of presence at week 12 (0.25) is the maximum of any week of the year. The relative probability of presence on week 12 is $0.25/0.25 = 1$; at week 20 it is $0.05/0.25 = 0.2$.
3. The relative probability of presence calculated in the previous step undergoes a statistical conversion so that all possible values fall between 0 and 10, inclusive. This is the probability of presence score.

To see a bar's probability of presence score, simply hover your mouse cursor over the bar.

Breeding Season (■)

Yellow bars denote a very liberal estimate of the time-frame inside which the bird breeds across its entire range. If there are no yellow bars shown for a bird, it does not breed in your project area.

Survey Effort (I)

Vertical black lines superimposed on probability of presence bars indicate the number of surveys performed for that species in the 10km grid cell(s) your project area overlaps. The number of surveys is expressed as a range, for example, 33 to 64 surveys.

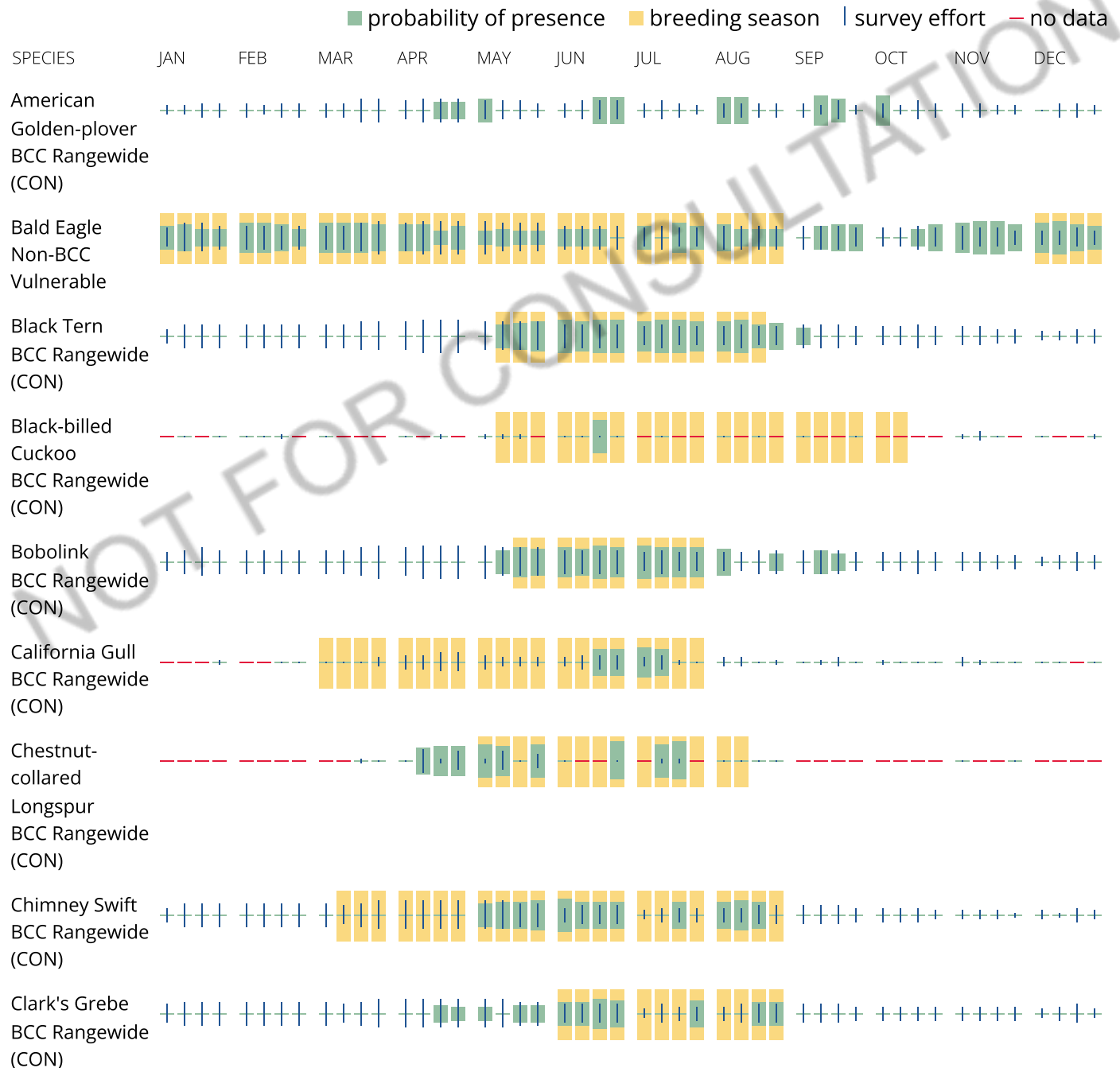
To see a bar's survey effort range, simply hover your mouse cursor over the bar.

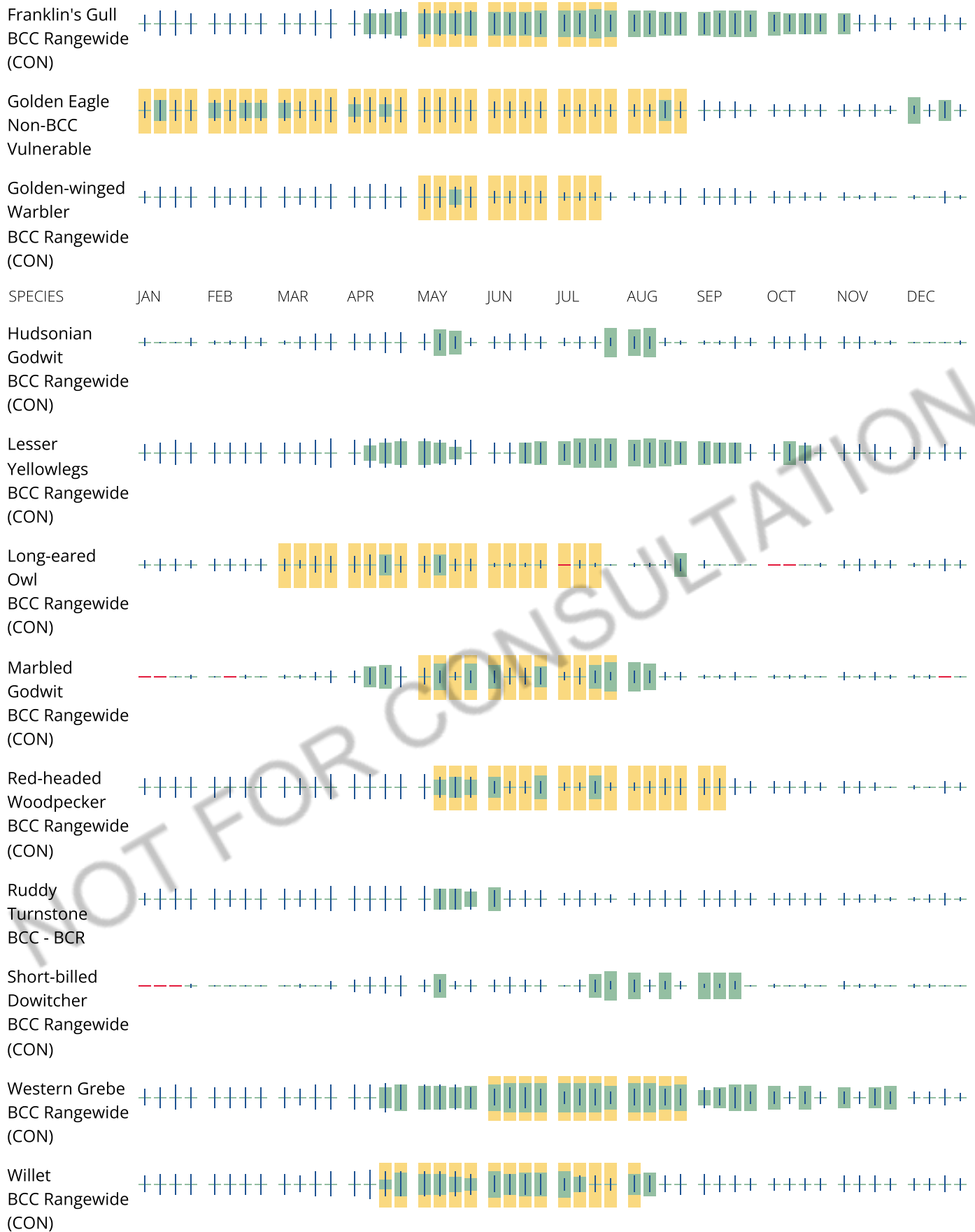
No Data (-)

A week is marked as having no data if there were no survey events for that week.

Survey Timeframe

Surveys from only the last 10 years are used in order to ensure delivery of currently relevant information. The exception to this is areas off the Atlantic coast, where bird returns are based on all years of available data, since data in these areas is currently much more sparse.





Tell me more about conservation measures I can implement to avoid or minimize impacts to migratory birds.

[Nationwide Conservation Measures](#) describes measures that can help avoid and minimize impacts to all birds at any location year round. Implementation of these measures is particularly important when birds are most likely to occur in the project area. When birds may be breeding in the area, identifying the locations of any active nests and avoiding their destruction is a very helpful impact minimization measure. To see when birds are most likely to occur and be breeding in your project area, view the Probability of Presence Summary. [Additional measures](#) or [permits](#) may be advisable depending on the type of activity you are conducting and the type of infrastructure or bird species present on your project site.

What does IPaC use to generate the list of migratory birds that potentially occur in my specified location?

The Migratory Bird Resource List is comprised of USFWS [Birds of Conservation Concern \(BCC\)](#) and other species that may warrant special attention in your project location.

The migratory bird list generated for your project is derived from data provided by the [Avian Knowledge Network \(AKN\)](#). The AKN data is based on a growing collection of [survey, banding, and citizen science datasets](#) and is queried and filtered to return a list of those birds reported as occurring in the 10km grid cell(s) which your project intersects, and that have been identified as warranting special attention because they are a BCC species in that area, an eagle ([Eagle Act](#) requirements may apply), or a species that has a particular vulnerability to offshore activities or development.

Again, the Migratory Bird Resource list includes only a subset of birds that may occur in your project area. It is not representative of all birds that may occur in your project area. To get a list of all birds potentially present in your project area, please visit the [Rapid Avian Information Locator \(RAIL\) Tool](#).

What does IPaC use to generate the probability of presence graphs for the migratory birds potentially occurring in my specified location?

The probability of presence graphs associated with your migratory bird list are based on data provided by the [Avian Knowledge Network \(AKN\)](#). This data is derived from a growing collection of [survey, banding, and citizen science datasets](#).

Probability of presence data is continuously being updated as new and better information becomes available. To learn more about how the probability of presence graphs are produced and how to interpret them, go to the Probability of Presence Summary and then click on the "Tell me about these graphs" link.

How do I know if a bird is breeding, wintering or migrating in my area?

To see what part of a particular bird's range your project area falls within (i.e. breeding, wintering, migrating or year-round), you may query your location using the [RAIL Tool](#) and look at the range maps provided for birds in your area at the bottom of the profiles provided for each bird in your results. If a bird on your migratory bird species list has a breeding season associated with it, if that bird does occur in your project area, there may be nests present at some point within the timeframe specified. If "Breeds elsewhere" is indicated, then the bird likely does not breed in your project area.

What are the levels of concern for migratory birds?

Migratory birds delivered through IPaC fall into the following distinct categories of concern:

1. "BCC Rangewide" birds are [Birds of Conservation Concern](#) (BCC) that are of concern throughout their range anywhere within the USA (including Hawaii, the Pacific Islands, Puerto Rico, and the Virgin Islands);

2. "BCC - BCR" birds are BCCs that are of concern only in particular Bird Conservation Regions (BCRs) in the continental USA; and
3. "Non-BCC - Vulnerable" birds are not BCC species in your project area, but appear on your list either because of the [Eagle Act](#) requirements (for eagles) or (for non-eagles) potential susceptibilities in offshore areas from certain types of development or activities (e.g. offshore energy development or longline fishing).

Although it is important to try to avoid and minimize impacts to all birds, efforts should be made, in particular, to avoid and minimize impacts to the birds on this list, especially eagles and BCC species of rangewide concern. For more information on conservation measures you can implement to help avoid and minimize migratory bird impacts and requirements for eagles, please see the FAQs for these topics.

Details about birds that are potentially affected by offshore projects

For additional details about the relative occurrence and abundance of both individual bird species and groups of bird species within your project area off the Atlantic Coast, please visit the [Northeast Ocean Data Portal](#). The Portal also offers data and information about other taxa besides birds that may be helpful to you in your project review. Alternately, you may download the bird model results files underlying the portal maps through the [NOAA NCCOS Integrative Statistical Modeling and Predictive Mapping of Marine Bird Distributions and Abundance on the Atlantic Outer Continental Shelf](#) project webpage.

Bird tracking data can also provide additional details about occurrence and habitat use throughout the year, including migration. Models relying on survey data may not include this information. For additional information on marine bird tracking data, see the [Diving Bird Study](#) and the [nanotag studies](#) or contact [Caleb Spiegel](#) or [Pam Loring](#).

What if I have eagles on my list?

If your project has the potential to disturb or kill eagles, you may need to [obtain a permit](#) to avoid violating the Eagle Act should such impacts occur.

Proper Interpretation and Use of Your Migratory Bird Report

The migratory bird list generated is not a list of all birds in your project area, only a subset of birds of priority concern. To learn more about how your list is generated, and see options for identifying what other birds may be in your project area, please see the FAQ "What does IPaC use to generate the migratory birds potentially occurring in my specified location". Please be aware this report provides the "probability of presence" of birds within the 10 km grid cell(s) that overlap your project; not your exact project footprint. On the graphs provided, please also look carefully at the survey effort (indicated by the black vertical bar) and for the existence of the "no data" indicator (a red horizontal bar). A high survey effort is the key component. If the survey effort is high, then the probability of presence score can be viewed as more dependable. In contrast, a low survey effort bar or no data bar means a lack of data and, therefore, a lack of certainty about presence of the species. This list is not perfect; it is simply a starting point for identifying what birds of concern have the potential to be in your project area, when they might be there, and if they might be breeding (which means nests might be present). The list helps you know what to look for to confirm presence, and helps guide you in knowing when to implement conservation measures to avoid or minimize potential impacts from your project activities, should presence be confirmed. To learn more about conservation measures, visit the FAQ "Tell me about conservation measures I can implement to avoid or minimize impacts to migratory birds" at the bottom of your migratory bird trust resources page.

Facilities

National Wildlife Refuge lands

Any activity proposed on lands managed by the [National Wildlife Refuge](#) system must undergo a 'Compatibility Determination' conducted by the Refuge. Please contact the individual Refuges to discuss any questions or concerns.

This location overlaps the following National Wildlife Refuge lands:

LAND	ACRES
BARNES COUNTY WATERFOWL PRODUCTION AREA	13,945.83 acres
HOBART LAKE NATIONAL WILDLIFE REFUGE	2,007.05 acres
STONEY SLOUGH NATIONAL WILDLIFE REFUGE	887.02 acres
TOMAHAWK NATIONAL WILDLIFE REFUGE	438.38 acres

Fish hatcheries

This location overlaps the following [National Fish Hatcheries](#). Please contact them for further guidance.

HATCHERY	ACRES
VALLEY CITY NATIONAL FISH HATCHERY	116.28 acres

Wetlands in the National Wetlands Inventory (NWI)

Impacts to [NWI wetlands](#) and other aquatic habitats may be subject to regulation under Section 404 of the Clean Water Act, or other State/Federal statutes.

For more information please contact the Regulatory Program of the local [U.S. Army Corps of Engineers District](#).

This location did not intersect any wetlands mapped by NWI.

NOTE: This initial screening does **not** replace an on-site delineation to determine whether wetlands occur. Additional information on the NWI data is provided below.

Data limitations

The Service's objective of mapping wetlands and deepwater habitats is to produce reconnaissance level information on the location, type and size of these resources. The maps are prepared from the analysis of high altitude imagery. Wetlands are identified based on vegetation, visible hydrology and geography. A margin of error is inherent in the use of imagery; thus, detailed on-the-ground inspection of any particular site may result in revision of the wetland boundaries or classification established through image analysis.

The accuracy of image interpretation depends on the quality of the imagery, the experience of the image analysts, the amount and quality of the collateral data and the amount of ground truth verification work conducted. Metadata should be consulted to determine the date of the source imagery used and any mapping problems.

Wetlands or other mapped features may have changed since the date of the imagery or field work. There may be occasional differences in polygon boundaries or classifications between the information depicted on the map and the actual conditions on site.

Data exclusions

Certain wetland habitats are excluded from the National mapping program because of the limitations of aerial imagery as the primary data source used to detect wetlands. These habitats include seagrasses or submerged aquatic vegetation that are found in the intertidal and subtidal zones of estuaries and nearshore coastal waters. Some deepwater reef communities (coral or tubercid worm reefs) have also been excluded from the inventory. These habitats, because of their depth, go undetected by aerial imagery.

Data precautions

Federal, state, and local regulatory agencies with jurisdiction over wetlands may define and describe wetlands in a different manner than that used in this inventory. There is no attempt, in either the design or products of this inventory, to define the limits of proprietary jurisdiction of any Federal, state, or local government or to establish the geographical scope of the regulatory programs of government agencies. Persons intending to engage in activities involving modifications within or adjacent to wetland areas should seek the advice of appropriate Federal, state, or local agencies concerning specified agency regulatory programs and proprietary jurisdictions that may affect such activities.

Appendix G – Setback Waiver

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Prepared by and when recorded
Return to:

Otter Tail Power Company
215 South Cascade Street
Fergus Falls, MN 56537

Land Contracts Assignment and Assumption Agreement

This Land Contracts Assignment and Assumption Agreement (this "**Agreement**"), dated January 3, 2023 (the "**Effective Date**"), is entered into by and between Ashtabula Wind III, LLC, a Delaware limited liability company ("**Assignor**") and Otter Tail Power Company, a Minnesota corporation ("**Assignee**"). Assignor and Assignee shall hereinafter be referred to individually as a "**Party**" and collectively as the "**Parties**".

WHEREAS, Assignor entered into those certain wind farm easements, collection easements and other agreements with certain real property owners and interest holders as further described on Exhibit A attached hereto (collectively, the "**Land Contracts**"); and

WHEREAS, Assignor desires to assign to Assignee all of Assignor's right, title and interest in the Land Contracts, and Assignee desires to assume the Land Contracts.

NOW THEREFORE, in consideration of the mutual covenants and agreements contained in this Agreement, Purchase and Sale Agreement and other good and valuable consideration, the receipt and sufficiency of which are hereby acknowledged, the Parties agree as follows:

1. Assignment. As of the Effective Date, Assignor hereby sells, assigns, transfers, conveys and delivers to Assignee all of Assignor's right, title and interest in, to and under the Land Contracts.
2. Assumption. As of the Effective Date, Assignee shall hold all of Assignor's right, title and interest in, to and under the Land Contracts, and hereby assumes the obligations for the performance of all covenants, agreements and obligations of Assignor with respect to the Land Contracts.
3. Indemnity. Assignor agrees to defend, indemnify and hold harmless Assignee and its successors and assigns from and against any loss, damage, claim or liability (including, but not limited to, reasonable attorneys' fees and other costs) related to or arising out of Assignor's ownership or use of the Land Contracts prior to the Effective Date. Assignee agrees to defend, indemnify and hold harmless Assignor and its successors and assigns from and against any loss, damage, claim or liability (including, but not limited to, reasonable attorneys' fees and other costs) related to or arising out of Assignee's ownership or use of the Land Contracts on or after the Effective Date.

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Return To: STEWART TITLE GUARANTY COMPANY
1700 WEST 82ND STREET SUITE 100 ATTN DEREK
MINNEAPOLIS MN 55431

4. Further Assurances. The Parties hereto agree to (a) furnish upon request to each other such information, (b) execute and deliver to each other such other documents, and (c) do such other acts and things, all as the other party may reasonably request for the purpose of effectuating the intent of this Agreement and any documents executed pursuant hereto or in connection herewith or of complying with any applicable laws.

5. Governing Law. This Agreement shall be governed by and construed in accordance with the laws of the State of North Dakota without regard to its principles of conflict of laws.

6. Successors and Assigns. This Agreement shall be binding upon and inure to the benefit of and be enforceable by the successors and assigns of the Parties hereto.

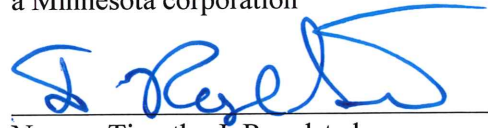
7. Counterpart. This Agreement may be executed in counterparts, each of which shall be deemed an original and all of which shall be one and the same instrument.

[THE REMAINDER OF THIS PAGE IS BLANK. SIGNATURE PAGE FOLLOWS.]

IN WITNESS WHEREOF, Assignee and Assignor have caused this Assignment and Assumption Agreement to be duly executed and delivered as of the Effective Date.

ASSIGNEE:

OTTER TAIL POWER COMPANY,
a Minnesota corporation



Name: Timothy J. Rogelstad


Title: President

STATE OF MINNESOTA

COUNTY OF OTTER TAIL

On this 15th day of December, 2022, before me personally appeared Timothy J. Rogelstad, the President of **Otter Tail Power Company, a Minnesota corporation**, known to me to be the person who is described in, and who executed the within and foregoing instrument and severally acknowledged that he or she executed the same.




Notary Public Cynthia C. Geray
My Commission expires: 01-31-2026

ASSIGNOR:

ASHTABULA WIND III, LLC
a Delaware limited liability company



Lane S. Witten, Vice President

STATE OF FLORIDA)
) ss:
COUNTY OF PALM BEACH)

The foregoing instrument was acknowledged before me **by means of** **physical presence** or **online notarization**, this 20th day of December, 2022 by Lane S. Witten, as Vice President of Ashtabula Wind III, LLC, a Delaware limited liability company, on behalf of the company, who is personally known to me or has produced a driver's license as identification.

(notary seal)



NOTARY PUBLIC, STATE OF FLORIDA

My commission expires: _____

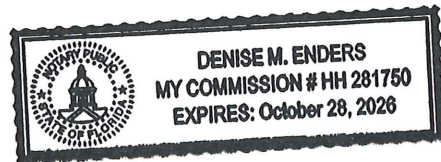


EXHIBIT A

Land Contracts

Tract 1:

Wind Farm Easement Agreement dated February 18, 2008, as evidenced by that certain MEMORANDUM OF EASEMENTS from PHYLLIS LARSON AND CAROL D. LARSON, AS CO-TRUSTEES OF THE DOROTHY ACKLEY FAMILY TRUST, DATED JANUARY 1, 2005 to BOULEVARD ASSOCIATES, LLC, A DELAWARE LIMITED LIABILITY COMPANY. Filed April 8, 2008, recorded as Document Number 262348, and by that certain notice letter exercising its option to acquire the easements thereunder dated September 28, 2010, and as assigned by ASSIGNMENT OF WIND FARM EASEMENT AGREEMENTS between BOULEVARD ASSOCIATES, LLC and ASHTABULA WIND III, LLC. Filed September 13, 2011, recorded as Document Number 271035.

Legal Description: The Southwest Quarter (SW¼), Section Seventeen (17); AND the East Half (E½) of the Southwest Quarter (SW¼) AND the South Half (S½) of the Southeast Quarter (SE¼) of Section 20; AND the North Half (N½) and the Southwest Quarter (SW¼) of Section 29, in Township One Hundred Forty-three North (143N), Range Fifty-seven West (57W) of the 5th P.M., Barnes County, North Dakota, according to the United States Government Survey thereof.

Tract 2:

Wind Farm Easement Agreement dated December 17, 2007, as evidenced by that certain MEMORANDUM OF EASEMENTS from GLADYS M. BJORNSON, A SINGLE PERSON, A ONE-QUARTER INTEREST; ROSALIND I. JACOBSEN, A SINGLE PERSON, A ONE-QUARTER INTEREST; ROBERT A. PICKAR, A SINGLE PERSON, A ONE-QUARTER INTEREST; LINDA J. FUS AND ROBERT FUS, WIFE AND HUSBAND, KATHLEEN L. FAGERLIN AND STEVE FAGERLIN, WIFE AND HUSBAND, JUSTIN C. WEBBER AND ELAINE WEBBER, HUSBAND AND WIFE, SUBJECT TO THE LIFE ESTATE OF WALTER G. WEBBER, A SINGLE PERSON, A ONE-QUARTER INTEREST, to BOULEVARD ASSOCIATES, LLC, A DELAWARE LIMITED LIABILITY COMPANY. Filed February 4, 2008, recorded as Document Number 261616, and by that certain notice letter exercising its option to acquire the easements thereunder dated September 28, 2010, as affected by EASEMENT CONSENT AGREEMENT from BOULEVARD ASSOCIATES, LLC, A DELAWARE LIMITED LIABILITY COMPANY, and ASHTABULA WIND, LLC, A DELAWARE LIMITED LIABILITY COMPANY. Dated May 12, 2009; Filed May 14, 2009, recorded as Document Number 265194, as partially released by PARTIAL RELEASE OF EASEMENT BY BOULEVARD ASSOCIATES, LLC, AND DEBBY PETERS, A SINGLE PERSON; BECKY BURCHILL AND RUSSELL BURCHILL, WIFE AND HUSBAND; KELCEY HILL (F/K/A KELCEY FLATT) AND PETER HILL, WIFE AND HUSBAND; CAREY FLATT AND ROCHELLE FLATT, HUSBAND AND WIFE; AND JODY RAHLF AND RICK RAHLF, WIFE AND HUSBAND, SUBJECT TO THE LIFE ESTATE OF JEANNE R. DIEMERT. Filed November 12, 2010, recorded as Document Number 269082, as amended by AMENDMENT TO PARTIAL RELEASE OF EASEMENT by BOULEVARD ASSOCIATES, LLC, A DELAWARE LIMITED LIABILITY COMPANY dated March 1, 2011, recorded as Document Number 269905, as assigned by ASSIGNMENT OF WIND FARM EASEMENT AGREEMENTS from BOULEVARD ASSOCIATES, LLC to ASHTABULA WIND III, LLC. Filed September 13, 2011, recorded as Document Number 271036.

Legal Description: The Northeast Quarter (NE¼), of Section 21, The East Half (E½) of Section 16, and The Southwest Quarter (SW¼) of Section Sixteen (16), all in Township One Hundred Forty-three North

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Return To: STEWART TITLE GUARANTY COMPANY
1700 WEST 82ND STREET SUITE 100 ATTN DEREK
MINNEAPOLIS MN 55431

The North One-Half of the Northwest Quarter (N $\frac{1}{2}$ NW $\frac{1}{4}$), of the Northeast Quarter (NE $\frac{1}{4}$) of Section 17, in Township 143N, Range 57W, Barnes County, North Dakota.

Tract 24:

Wind Farm Easement Agreement dated August 10, 2007, as evidenced by that certain MEMORANDUM OF EASEMENTS from MARK SWANBERG AND TONI SWANBERG, HUSBAND AND WIFE, to BOULEVARD ASSOCIATES, LLC, A DELAWARE LIMITED LIABILITY COMPANY. Filed November 27, 2007, recorded as Document Number 261010, partially released by PARTIAL RELEASE OF EASEMENT from MARK SWANBERG AND TONI SWANBERG, HUSBAND AND WIFE, to BOULEVARD ASSOCIATES, LLC. Filed November 3, 2010, recorded as Document Number 269006, and by that certain notice letter exercising its option to acquire the easements thereunder dated September 28, 2010, as affected by SETBACK WAIVER by MARK SWANBERG AND TONI SWANBERG, HUSBAND AND WIFE, and ASHTABULA WIND III, LLC. Dated October 26, 2010; Filed November 3, 2010, recorded as Document Number 269005, and as assigned by ASSIGNMENT OF WIND FARM EASEMENT AGREEMENTS between BOULEVARD ASSOCIATES, LLC and ASHTABULA WIND III, LLC. Filed September 13, 2011, recorded as Document Number 271035.

Legal Description:

Parcel 1:

That part of the East Half of the Northeast Quarter (E $\frac{1}{2}$ NE $\frac{1}{4}$), Section Twenty-six (26), Township One Hundred Forty-two (142), Range Fifty-eight (58), Barnes County, North Dakota, that lies within the North 850 feet of the East Half of the Northeast Quarter (E $\frac{1}{2}$ NE $\frac{1}{4}$), Section Twenty-six (26), Township One Hundred Forty-two North (142N), Range Fifty-eight West (58W) of the Fifth Principal Meridian Barnes County, North Dakota. Tract contains 53.98 acres, more or less.

Parcel 2:

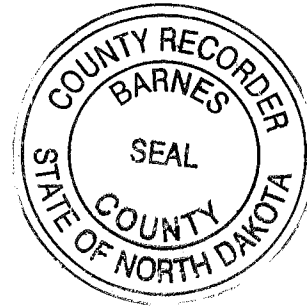
The part of the West Half of the Northwest Quarter (W $\frac{1}{2}$ NW $\frac{1}{4}$), of Section Twenty-five (25), Township One Hundred Forty-two North (142N), Range Fifty-eight West (58W) of the 5th P.M., Barnes County, North Dakota, that lies within the North 330 feet of the West 330 feet of the West Half of the Northwest Quarter (W $\frac{1}{2}$ NW $\frac{1}{4}$) of Section Twenty-five (25), Township One Hundred Forty-two North (142N), Range Fifty-eight West (58W) of the Fifth Principal Meridian, Barnes County, North Dakota.

Tract 26:

Wind Farm Easement Agreement dated May 13, 2008, as evidenced by that certain MEMORANDUM OF EASEMENTS from ALBERT K. WITTENBERG, A SINGLE PERSON AND KURT H. WITTENBERG, A SINGLE PERSON, to BOULEVARD ASSOCIATES, LLC, A DELAWARE LIMITED LIABILITY COMPANY. Filed August 15, 2008, recorded as Document Number 263451, and by that certain notice letter exercising its option to acquire the easements thereunder dated September 28, 2010, and as assigned by ASSIGNMENT OF WIND FARM EASEMENT AGREEMENTS from BOULEVARD ASSOCIATES, LLC, ASSIGNOR, to ASHTABULA WIND III, LLC, ASSIGNEE. Filed September 13, 2011, recorded as Document Number 271035.

Legal Description: The North Half (N $\frac{1}{2}$) of Section Thirty-five (35) and the South Half of the South Half (S $\frac{1}{2}$ S $\frac{1}{2}$) of Section Twenty-six (26), in Township One Hundred Forty-two North (142N), of Range Fifty-eight West (58W) of the Fifth Principal Meridian, Barnes County, North Dakota, excepting therefrom A tract of land commencing at a point in the NW corner of the SW $\frac{1}{4}$ SW $\frac{1}{4}$ of said Section 26, where the North

Grantor	<i>[Signature]</i>
Grantee	<i>[Signature]</i>
Indexed	<i>[Signature]</i>
Checked	<i>[Signature]</i>



AFTER RECORDING RETURN TO

Carlos Megias, Esq.
FPL Energy, LLC
700 Universe Blvd. (LAW/JB)
Juno Beach, FL 33408

Fee: \$ 19.00 269005
 OFFICE OF COUNTY RECORDER County of Barnes, North Dakota
 I hereby certify that the within instrument was filed in this office
 on 11/3/2010 at 10:05 AM and was duly recorded.
 _____ County Recorder
Jody Jeff
 By _____ Deputy

SETBACK WAIVER

This Setback Waiver ("Waiver") is granted this 26th day of October, 2010 by Mark Swanberg and Toni Swanberg, husband and wife, (collectively "Owners") and Ashtabula Wind III, LLC, a Delaware limited liability company, its successors and assigns ("Operator").

Owners own property in Barnes County, North Dakota ("Property"), described as on attached Exhibit "A".

In consideration of a Partial Release of Easement granted to Owners by Operator, Owners hereby consent to Operator placing one (1) Wind Turbine on the adjoining or nearby property, Property at less than four hundred forty (440) feet from Owner's Property. Owners hereby waive any objection to Operator placing one (1) Wind Turbine less than forty (440) feet from Owner's Property that Owners may have under the laws, regulations and ordinances enacted by local, state or federal government applicable to the development of a wind farm in Barnes County, North Dakota by Operator. Owners acknowledge that the consent and waiver given hereby is a covenant running with the Property and applies to succeeding and subsequent owners of the Property described herein. Owners consent to Operator recording this Waiver in the Office of the Barnes County Recorder to provide notice of this Agreement to succeeding and subsequent owners of the Property.

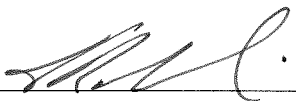
Return To: NextEra Energy Resources, LLC
700 Universe Blvd. LAW/JB
JUNO BEACH FL 33408

(This space reserved for recording information)

IN WITNESS WHEREOF, the Operator has executed this Memorandum of Easements on the date set forth below:

Operator:


Ashtabula Wind III, LLC,
a Delaware Limited Liability Company

By: 
Dean R. Gosselin, Vice President

STATE OF FLORIDA)
) SS.
COUNTY OF PALM BEACH)

The forgoing instrument was acknowledged before me this 06 day of October 2010, by Dean R. Gosselin, as Vice President of Ashtabula Wind III, LLC, a Delaware limited liability company, who is personally known to me who subscribed to the foregoing instrument and acknowledged that he executed the same on behalf of said limited liability company and that he was duly authorized to do so.




Name: _____
Notary Public, State of Florida
My Commission Expires: _____

Return To: NextEra Energy Resources, LLC
700 Universe Blvd. LAW/JB
JUNO BEACH FL 33408

(this space reserved for recording information)

EXHIBIT A

THE WEST HALF OF THE NORTHWEST QUARTER (W1/2NW1/4), LESS ALL THAT PART THAT LIES WITHIN THE NORTH 330 FEET OF THE WEST 330 FEET OF THE WEST HALF OF THE NORTHWEST QUARTER (W1/2NW1/4) OF SECTION 25, TOWNSHIP 142 NORTH, RANGE 58 WEST OF THE FIFTH PRINCIPAL MERIDIAN BARNES COUNTY, NORTH DAKOTA.

THE ABOVE DESCRIBED TRACT CONTAINS 77.52 ACRES, MORE OR LESS.

AND

THE EAST HALF OF THE NORTHEAST QUARTER (E1/2NE1/4), LESS ALL THAT PART THAT LIES WITHIN THE NORTH 850 FEET OF THE EAST HALF OF THE NORTHEAST QUARTER (E1/2NE1/4) OF SECTION 26, TOWNSHIP 142 NORTH, RANGE 58 WEST OF THE FIFTH PRINCIPAL MERIDIAN BARNES COUNTY, NORTH DAKOTA.

THE ABOVE DESCRIBED TRACT CONTAINS 53.98 ACRES, MORE OR LESS.