WENCK File #2759-05
April 2017

Palmer's Creek Wind Farm
Site Permit Application
Chippewa County, Minnesota

Prepared for:

Palmer's Creek Wind Farm, LLC

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Responsive partner.
Exceptional outcomes.

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Acronyms and Terms

ANSI	American Standards Institute
AWST	AWS Truepower, LLC
BMP	best management practice
CCSWSD Plan	Chippewa County Soil and Water Conservation District's Comprehensive District Plan
County	Chippewa County
CR	County Road
CREP	Conservation Reserve Enhancement Program
CUP	Conditional Use Permit
dB(A)	decibel
DWSMA	Drinking Water Supply Management Area
EPA	Environmental Protection Agency
FAA	Federal Aviation Administration
FEMA	Federal Emergency Management Agency
IAV	Interannual Variation
LWECS	Large Wind Energy Conversion System
kV	kilovolt
MCP	measure-correlate-predict
MERRA-2	Modern-Era Retrospective Analysis for Research Applications
MNDH	Minnesota Department of Health
MNDNR	Minnesota Department of Natural Resources
MPCA	Minnesota Pollution Control Agency
MW	megawatt
NAC	Noise Area Classification
NEPA	National Environmental Policy Act
NESC	National Electric Safety Code
O&M	Operations and Maintenance
P&H	Patrick and Henderson
Palmer's Creek	Palmer's Creek Wind Farm, LLC
PEIS	Upper Great Plans Wind Energy Programmatic Environmental Impact Statement
PPA	power purchase agreement
Project	Palmer's Creek Wind Energy Facility
River	Minnesota River
SCADA	Supervisory Control and Data Acquisition
SE	southeast
Section 8	Chippewa County Zoning Ordinance: Section 8 MN River Management District
Section 12	Chippewa County Zoning Ordinance: Section 12 Windpower Management
SODAR	Sonic Detection and Ranging
SPP	Southwest Power Pool
US Hwy	U.S. Highway
USDA	U.S. Department of Agriculture
Water Plan	2013-2023 Chippewa County Water Plan with 2013-2018 Implementation Plan
WAPA	Western Area Power Administration

WHPA	Wellhead Protection Area
WMA	Wildlife Management Area
WTG	wind turbine generator

1.0 Applicant Information

Palmer's Creek Wind Farm, LLC (Palmer's Creek or Applicant) proposes to construct the Palmer's Creek Wind Farm (Project), a Large Wind Energy Conversion System (LWECS), with a 44.6- megawatt (MW) nameplate capacity in Chippewa County, Minnesota (**Figure 1**). The project area consists of 18 wind turbines located on approximately 6,150 acres of privately owned land. The Project will also include associated access roads, a new collector substation, an operations and maintenance (O&M) facility, and associated transmission interconnection facilities. Palmer's Creek further proposes to interconnect the Project to an existing Western Area Power Administration (WAPA) substation, the Granite Falls Substation, which is within the project area boundary.

Palmer's Creek Proposed Action is to execute an interconnection agreement with the Southwest Power Pool (SPP) to connect the Palmer's Creek Project to WAPA's Granite Falls Substation. As part of the Proposed Action, WAPA will install necessary equipment in their existing substation to accept the generated power.

WAPA's purpose and need is to consider and respond to Palmer's Creek interconnection request in accordance with the SPP Tariff and the Federal Power Act as described in Section 1.1.1 of the Upper Great Plans Wind Energy Programmatic Environmental Impact Statement (PEIS) (WAPA 2015). WAPA is currently operating under the SPP Tariff.

The Palmer's Creek Wind Farm will consist of two (2) 2.3-MW and sixteen (16) 2.5-MW wind turbines with an aggregate nameplate capacity of 44.6 MW. The Project will also include:

- Underground electric collector lines,
- New central collector substation (Palmer's Creek Substation),
- Approximately 1000-foot long T-line interconnecting the Granite Falls Substation,
- O&M facility,
- Access roads connecting to each turbine,
- One permanent meteorological tower,
- Supervisory control and data acquisition (SCADA) system, and
- Temporary laydown yard.

Figure 2 shows the proposed layout of the Project facilities. The expected life of the Project is approximately 20 to 40 years (leases for the Project are for the life of the power purchase agreement (PPA), with an option to upgrade turbines and extend leases for an additional 20 years).

Palmer's Creek goals and objectives for the Project are to provide an economically viable, reliable, and cost-effective source of renewable energy to users in Minnesota, the Dakotas and throughout WAPA's service area. To accomplish this purpose, the Project must be technically, environmentally, and economically feasible. To that end, Palmer's Creek needs for the following factors to be present:

- A reliable wind resource capable of producing enough power for the Project to be economically viable,
- Landowners willing to participate in the Project,

- Environmental conditions that allow the Project to comply with applicable environmental regulation at a reasonable cost, and
- An interconnection agreement with WAPA to transmit power to a power purchaser.

The interconnection of the Project to WAPA's transmission system is a federal action under the National Environmental Policy Act of 1969 (NEPA), and therefore requires the completion of Federal environmental review. A Programmatic Environmental Assessment (EA) will be prepared for the Project.

1.1 LETTER OF TRANSMITTAL

Please see cover.

1.2 CONTACT INFORMATION

The applicant and permittee are the same entity, Palmer's Creek Wind Farm, LLC.

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1.3 SIGNATURE

This application has been prepared by Fagen Engineering in Granite Falls, Minnesota LLC, with consultation from Wenck in Maple Plain, Minnesota.

1.4 ROLE OF THE APPLICANT

Palmer's Creek will construct, operate, and own, or partially own the Project.

1.5 OPERATOR OF THE LWECS

The Project will be operated by Palmer's Creek Wind Farm, LLC.

1.6 NAME OF THE PERSON TO BE THE PERMITTEE

Palmer's Creek Wind Farm, LLC will be the named permittee for the site permit.

2.0 State Policy

The contents and treatment of applications for LWECS site permits are governed by Minnesota Rule Chapter 7854 under the Wind Siting Act. The Wind Siting Act also requires an application for a site permit for an LWECS to meet the substantive criteria set forth in Minnesota Statutes Section 216E.03, subd. 7. This application provides information necessary to demonstrate compliance with these criteria and Minnesota Rule Chapter 7854. In addition, this application has been organized following the Minnesota Department of Commerce, Energy Facility Permitting ("EFP") Application Guidance for Site Permitting of Large Wind Energy Conversion Systems in Minnesota (August 2010) ("LWECS Application Guidance").

A Certificate of Need (CON) for the Project is not required from the Minnesota Public Utilities Commission (PUC) because the Project's nameplate capacity is less than 50 MW (Minnesota Statute 216b.2421).

The siting of an LWECS is to be made in an orderly manner compatible with environmental preservation, sustainable development, and the efficient use of resources (Minn. Stat. § 216F.03). Palmer's Creek is designing the Project to comply with the PUC's wind turbine setback and siting guidelines.

Power generated by the Project will be sold by way of a long-term PPA or Merchant Market.

3.0 Project Description and Overview

Palmer's Creek Wind Farm, LLC (Palmer's Creek or Applicant) proposes to construct the, a Large Wind Energy Conversion System (LWECS), with a 44.6 megawatt (MW) nameplate capacity wind energy facility in Chippewa County, Minnesota, approximately 1.5 miles north of the City of Granite Falls (**Figure 1**). The Project includes approximately 18 wind turbines, associated access roads, a new collector substation, an O&M facility, and associated transmission interconnection facilities. Palmer's Creek further proposes to interconnect the Project to the existing Granite Falls Substation within the project area boundary. The anticipated timeline for construction is July 2017 to February 2018 with commercial operation date (COD) of March 2018.

The Project will be consistent with Minnesota's LWECS siting objectives to optimizing wind resources. Palmer's Creek goals and objectives for the Project are to provide an economically viable, reliable, and cost-effective source of renewable energy to users in Minnesota, the Dakotas and throughout WAPA's service area. To accomplish this purpose, the Project must be technically, environmentally, and economically feasible, including careful consideration of site selection, layout and design, equipment, and spacing to optimize the efficient use of the project area and wind resources.

The project area, approximately 6,150 acres of privately owned land, was chosen for several reasons including:

- Flat open terrain,
- Low population,
- Good wind resources,
- Close proximity to existing electrical transmission infrastructure,
- Ability to obtain land, and
- Other factors needed for wind power generation.

The Project will place 18 turbines across the project area, connecting these turbines by access roads and transmission facilities. Project construction is anticipated to include land disturbance for the 18 turbines, approximately 14 miles of collection lines, an approximately 1,000 foot transmission line at 115 kV, approximately 5.5 miles of new or upgraded roads; approximately 5.5. miles of temporary, construction access roads; a new substation using approximately one acre; approximately three acres of laydown area; a 2,800-square foot O&M Facility; and one meteorological tower.

3.1 PROJECT LOCATION

The southern boundary of the project area is located approximately one mile north of the City of Granite Falls in Chippewa County, Minnesota in Granite Falls Township, east of the Minnesota River (**Figure 1**).

Table 3-1: Project Location

County	Township Name	Township	Range	Sections
Chippewa	Granite Falls	116 North	39 West	3-10, 15-22, 27, 28, 29
Chippewa	Granite Falls	116 North	40 West	1, 12, 13

3.2 SIZE OF THE PROJECT AREA

The project area boundary is approximately 6,150 acres. Project construction is anticipated to include temporary land disturbance of approximately 172 acres for Project construction. Permanent land disturbance will be approximately 12 acres for turbines and associated facilities.

3.3 NAMEPLATE SIZE

The Project will consist of two (2) 2.3-MW and sixteen (16) 2.5-MW wind turbines with an aggregate nameplate capacity of 44.6 MW.

3.4 TURBINE SITES

It is anticipated that 18 turbines will be placed within the project area. **Figure 2** provides a map showing the current proposed turbine locations. Final turbine placement will be dependent upon completion of environmental review, securing land, and permitting approvals.

3.5 METEOROLOGICAL TOWERS

The Applicant has deployed one temporary approximately 200 foot (60 meter) meteorological tower and one SODAR unit within the project area (**Figure 2**). These temporary towers are expected to be removed within one year of Project construction completion. The Applicant anticipates the Project will include wind measurement equipment, which could consist of one permanent approximately 290 foot (90 meter) meteorological tower to house anemometers to measure the wind speed. The permanent tower (**Figure 2**) will not have guy wires and will be lighted in compliance with Federal Aviation Administration (FAA) regulations.

3.6 WIND RIGHTS SECURED

The Project has secured 98 percent of the wind rights in the project area and has also secured additional wind rights outside of the project area. The long-term leases include wind turbine and substation locations, access roads, transmission line alignment, ancillary facilities, and wind rights.

3.7 OTHER FACILITIES

The Applicant does not own or operate any other WTGs within ten miles of the project area. However, the applicant owns and operates a Large Wind Energy Facility (Big Blue Wind Farm) in southern Minnesota consisting of 18 WTGs with a total output of 36 MWs. Big Blue is a similar project in terms of total number of WTGs, total number of access roads and lengths, total collection line lengths, and land disturbance.

4.0 Project Design

The Project was designed to optimize wind resources, while minimizing potential impacts to ecological and cultural resources. Primary Project features include: wind turbines, collection lines, access roads, new substation, O&M facility, temporary and permanent meteorological towers, and SODAR unit. Temporary features include laydown areas and crane walks. **Figure 2** shows the Project features.

4.1 DESCRIPTION OF LAYOUT AND SETBACK

The Project will construct the turbines primarily on agricultural land. The Project's layout follows PUC guidelines (Minnesota Statute 2016F.03, Minnesota Rules Chapter 7854), applicable local government ordinances (Chippewa County Zoning Ordinance Section 12), and the Applicant's goal to optimize wind resources while providing an economically viable, reliable, and cost-effective source of renewable energy.

Setbacks for LWECS are regulated by the PUC and Chippewa County. The County has informed the Applicant that following the PUC process will be sufficient to satisfy County regulations of LWECS (see Sections 7.4 and 10.1 for further detail) (**Appendix G**). Under Minnesota Statute 216F.081, the PUC, "in considering a permit application for LWECS in a county that has adopted more stringent standards, shall consider and apply those more stringent standards, unless the commission finds good cause not to apply the standards." The applicable setbacks for the Project are summarized in **Table 4-1**.

Table 4-1: PUC Setback Requirements

Object	Setback
Wind Access Buffer – Prevailing Wind Directions	5 rotor diameters
Wind Access Buffer – Non-Prevailing Wind Directions	3 rotor diameters
Internal Turbine Spacing: Crosswind	3 rotor diameters
Internal Turbine Spacing: Downwind	5 rotor diameters
Meteorological Towers	250 feet
Residences	1,000 feet (or further to meet noise standards)
Public Roads (from right-of-way)	250 feet(1)
Noise Requirements	Minnesota Noise Standards (Minnesota Rules Chapter 7030) at all residential receivers (homes). Residential noise standard NAC 1, L50 50 dBA during overnight hours.
Protected Waters and Wetlands	Avoidance, crossing subject to agency approval

(1)PUC has adopted as case-by-case approach where necessary and in the public interest which applies to public roads and trails.

Source: Minnesota Statute 216F

The current Project layout may differ from the final construction layout, but the Applicant anticipates the final layout will remain similar to what is presented in this site permit application. The changes that may occur to the current Project layout will be the result of ongoing information gathering and monitoring data, permitting, and micro-siting activities. Any changes in the proposed turbine layout will be evaluated throughout the Site Permit process, and any layout changes that would work following Site Permit issuance will be evaluated to ensure that the revised turbine locations have similar human and environmental impacts when compared with the original proposed and/or permit turbine locations. Any turbine location changes will be identified, evaluated, and discussed with the DOC-Energy, Environmental Review and Analysis (EERA) staff prior to beginning construction.

4.2 DESCRIPTION OF TURBINES AND TOWERS

Basic wind turbine components include a nacelle, hub, blades, tower and foundation. A wind turbine operates three propeller-like blades mounted to a hub, which forms the rotor. Wind causes the rotor to turn. The rotor is connected to a main shaft, which spins a generator to create electricity. The nacelle houses the gear box, generator, brake to stop the rotor during emergencies, and other electrical and mechanical systems. The nacelle is mounted on a tower and foundation allowing for maximum use of wind energy in a given area. The electricity produced from wind turbines is typically transferred to an electrical substation that is connected to an electricity grid for distribution to consumers.

4.2.1 Wind Turbine Design

Palmer's Creek plans to install two (2) 2.3-MW and sixteen (16) 2.5-MW horizontal axis wind turbines for the Project. Each will have an anticipated hub height between 262 and 295 feet (80 and 90 meters) and a rotor diameter of approximately 380 feet (116 meters). The total height of each turbine will be approximately 485 feet (146 meters) when a blade is in vertical position. **Table 4-2** provides a summary of the turbine characteristics.

Table 4-2: Turbine Characteristics

	GE 2.3	GE 2.5
Nameplate Capacity	2.3 MW	2.5 MW
Hub Height	262 feet (80 meters)	295 feet (90 meters)
Rotor Diameter	380 feet (116 meters)	380 feet (116 meters)
Total Height	452 feet (150 meters)	485 feet (146 meters)
Swept Area	113,411 feet (10,568 meters)	113,411 feet (10,568 meters)
Cut-in Wind Speed	6.7 mph (3 m/s)	6.7 mph (3 m/s)
Cut-out Wind Speed	56 mph (25 m/s)	56 mph (25 m/s)
Rated Wind Speed	85 mph (38 m/s)	85 mph (38 m/s)
Rotor Speed	8-15.7 rpm	8-15.7 rpm

4.2.2 Rotor

The rotor consists of three blades mounted to a rotor hub. The hub is attached to the nacelle, which houses the gearbox, generator, brake, cooling system, and other electrical and mechanical systems. The rotor diameter for the proposed wind turbines is approximately 380 foot (116 meters). The rotor speed will be between 8 to 15.7 revolutions per minute (rpm).

4.2.3 Tower

Turbine towers will be cylindrical monopoles, approximately 262 to 295 feet (80 to 90 meters) in height. The towers will be constructed of high strength tubular steel, approximately 15 feet (five meters) in diameter at the base, with internal joint flanges. Towers will be fabricated in three sections per American National Standards Institute (ANSI) specifications and assembled onsite. The tower color will be non-reflective light grey, and all surfaces will be multi-layer coated for protection against corrosion. Base of each tower will have a steel door for access into the tower and ladder inside to access the nacelle.

Turbine nacelles and towers will be cleaned regularly to remove spilled or leaking fluids and the dirt and dust that accumulates over time. A controller cabinet will be located inside each tower base. Marking and lighting of the wind farm will be done in compliance with Federal Aviation Administration (FAA) regulations.

4.2.4 Foundations

The wind turbine foundations will typically be reinforced concrete spread foundations. A spread foundation requires a shallow excavation, generally 10 to 12 feet deep. The actual foundation for each turbine will be specifically designed based on geotechnical analysis of a 50-foot (15 meter) core sample at each turbine location combined with structural loading requirements for the turbine. The pedestal diameter for an approximate 262 feet (80 meter) tower is approximately 18 feet (five meters) anchored by high strength bolts into a concrete foundation of approximately 60 feet in diameter. In some cases, for step-and-touch voltage compliance, an area around a turbine may be covered in four inches of gravel or crushed stone. The excavated area for the turbine foundations will typically be approximately 75 feet by 75 feet (23 meters by 23 meters). During construction, a larger area, approximately 300-foot diameter (92 meters), will be used to lay down the rotors and maneuver cranes during turbine assembly.

4.2.5 Temporary Laydown and Crane Walks

An approximately 3-acre laydown area is located near the proposed substation and O&M building (Figure **2**). The temporary area will serve as locations for job trailers, temporary offices, parking, and storage for items necessary for the Project. The location of the laydown area will be selected during final design; however, a preferred location will be an undeveloped or previously disturbed area that is flat and does not contain streams, wetlands or other environmentally sensitive resources.

In addition to the approximately 3-acre laydown area, temporary crane walk disturbances will also be necessary for the Project. Crane walks are estimated to be 40 feet in width and will be located throughout the Project based on the shortest route to the next turbine in the construction sequence. However, cranes will utilize access roads if feasible. Where feasible, the Applicant will make every effort to avoid streams, wetlands, and other environmentally sensitive resources. If avoidance is not possible, the Applicant will acquire the necessary permits/approvals for Project construction and operation and will minimize impacts to the greatest extent possible.

4.2.6 Operation

Palmer's Creek Wind Farm, LLC will oversee all operations, maintenance, and management of the Project facilities through a service agreement with a qualified operations and maintenance (O&M) service. The Project will have a full time staff of technicians, supervisor, and others as necessary. The staff will be required to perform scheduled maintenance, non-scheduled repairs, daily checks, and resets. On call technicians will be available to perform repairs in a timely manner.

On-site service and maintenance activities include:

- Routine inspections, regular preventive maintenance on all turbines and related facilities, unscheduled maintenance and repair, and routine minor maintenance on the wind turbines, electrical power systems, and communications systems;
- Assessing oil levels and filters, tightening of bolts, repair minor electrical issues, upgrade software as needed, and periodically test the SCADA and other monitoring systems.

WTG and substation maintenance schedules and required outage durations are based on equipment manufacturer's recommendations and the Applicant's operating experience. During WTG commissioning and initial commercial operation, WTGs will be inspected daily to see that they are operating properly. Upon reaching commercial operation, the WTGs will be remotely monitored on a continuous basis. WTG scheduled maintenance includes a three-month scheduled maintenance after the turbines have been commissioned and engaged. Following the three-month scheduled maintenance, WTGs will be maintained bi-annually according to the manufacturer's checklist.

O&M Service Provider will address both scheduled and unscheduled maintenance on the wind project, including repairs, replacement of parts and removal of failed parts. WTG maintenance will be performed as an on-going function during the life of the Project. Transformer and other substation maintenance will be completed on an annual basis and will be scheduled during times with minimal impact to production.

General maintenance includes maintaining Project structures, access roads, drainage systems and other facilities. General maintenance will be ongoing for the life of the project and scheduled as needed.

Other maintenance activities include dealing with environmental concerns such as management of lubricants, solvents, and other hazardous materials, and the implementation of appropriate security methods. Project access roads will also be maintained to facilitate site access including snow removal and grading as necessary.

The Applicant will operate a Site Control and Data Acquisition (SCADA) System located at the base section of each WTG, substation control building, and O&M building.

4.2.7 Turbine Safety Systems

All safety measures are accounted for within the SCADA system located in the base section of each turbine, substation control building, and O&M building. Each of the turbines will be equipped with physical safety devices to protect employees throughout all phases of construction, operation and decommissioning according to OSHA standards. All employees who enter the turbine will be trained and qualified.

4.3 DESCRIPTION OF ELECTRICAL SYSTEM

Each turbine will have a step-up transformer to raise the voltage to the 34.5 kilovolt (kV) collection line system. The electricity generated by each turbine will run through underground collection lines to the proposed Palmer's Creek Substation. The electricity will be converted to 115 kV at the new Palmer's Creek Substation and distributed via new proposed 115 kV transmission line to the existing Granite Falls (WAPA) Substation.

4.3.1 Transformers

A generator step-up transformer will be installed at the base of each wind turbine to increase the output voltage of the wind turbine to the voltage of the power collection system (34.5-kV). The transformers will be mounted on concrete pads and will be placed next to each wind turbine.

4.3.2 Electrical Collection Systems

Each wind turbine within the Project Area will be interconnected by communication and electrical power collection circuit facilities. These facilities will include underground feeder lines (collector lines) that will collect wind-generated power from each wind turbine and deliver it to the Palmer's Creek Substation.

This system will be used to route the power from each turbine to the Palmer's Creek Substation (collector substation) where the electrical voltage will be stepped up from 34.5-kV to 115-kV. The underground collector system will be placed in one trench, approximately 18-24 inches wide, and will connect each of the turbines to the Palmer's Creek Substation. The estimate trench length, is approximately 73,920 feet (approximately 14 miles).

The underground collector circuits will consist of three power cables contained in an insulated jacket and buried at a depth of approximately four feet that will not interfere with farming operations. Access to the underground lines will be located at each turbine site, and where the cables enter the Palmer's Creek Substation. Due to the power carrying limits of underground cabling, there will be two underground collector lines or circuits to collect power from the individual turbines.

The underground electrical collector and communication systems generally will be installed by plowing or trenching the cables. Using this method, the disturbed soils and topsoil are typically replaced over the buried cable within one day, and the drainage patterns and surface topography are restored to pre-existing conditions. In grassland/rangeland areas, disturbed soils will be re-vegetated with a weed-free native plant seed mix.

The fiber optic communication cables for the Project will be installed in the same trenches as the underground electrical collector cables and will connect the communication channels from each turbine to the control room in the Palmer's Creek Substation.

4.3.3 Substation and Switching Station

A new collector substation, Palmer's Creek Substation, will be constructed at the south end of the project area, on private land, where the 34.5-kV electric collection grid and fiber optic communication network will terminate. Palmer's Creek Substation will include a transformer to step up the voltage of the collection grid from 34.5-kV to 115-kV, above-ground bus structures or T-lines to interconnect the substation components, breakers, a control building, relays, switchgear, communications and controls, and other related facilities required for delivery of electric power to the adjacent 115-kV Granite Falls Substation.

The design of Palmer's Creek Substation is not finalized, but Palmer's Creek Wind Farm expects it will be enclosed by a chain link fence with dimensions roughly 110 feet by 170 feet (33.5 meters by 52 meters). The substation components will be placed on concrete and steel foundations. Palmer's Creek Substation will be designed in compliance with Federal, State and local regulations, NESC standards, Independent Systems Operator needs (Southwest Power Pool), transmission owner, and other applicable industry standards.

4.3.4 Interconnection

Palmer's Creek Wind Farm will consist of two (2) 2.3-MW and sixteen (16) 2.5-MW wind turbines with an aggregate nameplate capacity of 44.6 MW. The Project will also include 34.5 kV underground collection lines, a central collector substation (Palmer's Creek Substation) which will convert the electricity from 34.5 kV to 115 kV via the Main Transformer, an approximately 1,000-foot long (304 meter) 115 kV 3-Phase transmission line interconnecting the Project to the Granite Falls (WAPA) Substation. There are several options for the power to be directed out of the Granite Falls (WAPA) Substation as there are seven different transmission lines exiting the facility.

5.0 Description and Location of Associated Facilities

There are several facilities associated with the Project that will be required for operation. These include project substation, collector lines, an approximate 1,000-foot 115 kV 3 phase transmission line, permanent meteorological tower, access roads, SCADA building, and O&M facility.

5.1 TRANSMISSION AND PROJECT SUBSTATION

A new collector substation, Palmer's Creek Substation, will be constructed at the south end of the project area, on private land, where the 34.5-kilovolt (kV) electric collection grid and fiber optic communication network will terminate (**Figure 2**). The design of Palmer's Creek Substation is not finalized, but Palmer's Creek Wind Farm expects it will be roughly 110 feet by 170 feet (33.5 meters by 52 meters). Additional details are provided in Section 4.3 Description of Electrical System.

A 115 kV, 3-phase transmission line approximately 1,000 feet (304 Meters) in length will be used to connect the proposed Palmer's Creek Substation to the 115 kV Granite Falls Substation for the delivery of electric power. The Applicant is currently working to obtain an interconnection agreement with SPP to interconnect the facility at the WAPA-owned Granite Falls Substation to supply 44.6 MW of electricity to the grid.

5.2 COLLECTOR LINES AND FEEDER LINES

The collector lines from each turbine, as previously described in greater detail in Section 4.3 and shown on **Figure 2**, will be comprised of approximately 14 miles of underground, insulated electrical cable. The collection system and communication system will connect to Palmer's Creek Substation.

5.3 ACCESS ROADS

Approximately 5.5 miles of new or upgraded roads will be constructed to facilitate both construction and maintenance of the wind turbines, **Figure 2**. These roads have been designed to minimize length and construction impact. Initially, turbine access roads will be approximately 40 feet in width to accommodate the safe operation of construction equipment. Upon completion of construction, the turbine access roads will be reclaimed and narrowed to an extent allowing for the routine maintenance of the facility, or approximately 16 feet in width. The wind turbines will be accessible from public roads. Access roads will follow fence lines, field lines, and existing field access roads to the extent possible. Siting roads in areas with unstable soil will be avoided wherever possible. Roads will include appropriate drainage controls, including culverts and will be constructed in a manner to allow farm and/or land owner equipment to cross. The access road cross sections will consist of graded soil, with soil stabilization, and surfaced with compacted aggregate base course. Final access road locations will be established with input from landowners. Gates will be installed where access roads cross landowner fences.

5.4 METEOROLOGICAL TOWERS

One permanent meteorological tower will be installed at the Project site to monitor the wind during the operation of the wind farm (**Figure 2**). This tower will be approximately 90 meters in height (295 ft.) tall. The tower will have a grounding system similar to that of the

WTGs with a buried copper ring and grounding rod or rod installed at the top of the tower to provide an umbrella of protection for the upper sensors. The tower will be connected to the wind farms central SCADA system. In addition, some of the previously permitted temporary meteorological test towers may be kept in place for approximately one year after construction.

5.5 SCADA SYSTEM

The Applicant will operate a Site Control and Data Acquisition (SCADA) System located at the base section of each WTG, substation control building, and O&M building. Each WTG in the Project will communicate directly with the SCADA system for the purposes of performance monitoring, energy reporting, and trouble-shooting. Under normal conditions each WTG operates autonomously, making its own control decisions. Alarms and warnings will be sent to the Operations Control Center to be determined if the nature of the alarm needs prompt attention. Site technicians will be alerted if necessary.

The SCADA system provides the O&M team with access to WTG and production data, availability, meteorological, and communications data, as well as alarms and communication error information. Performance data and parameters for each machine can also be viewed in real time, and machine status can be changed.

5.6 O&M FACILITY

An O&M facility will be located near the approach and access road to a proposed turbine location (**Figure 2**). The property will be graded and a 4,000-square foot utility building will be erected for offices, storage and maintenance work. The proposed O&M facility will house the equipment to operate and maintain the wind farm. A gravel parking pad will provide the building with a parking area. The O&M Facility will have a new septic system and well for domestic purposes.

6.0 Wind Rights

The Applicant has secured wind rights through long-term lease agreements from private landowners. The lease agreements may include, but are not limited to, wind turbines and Project facilities, wind and buffer easements, access roads, collection lines, transmission line, and land to mitigate environmental impacts. All Project facilities have been sited on leased land and the current leasehold is sufficient to accommodate the Project, required buffers, and turbine placement flexibility as needed to avoid natural resources, homes, and other sensitive features. Additional wind rights may be secured in the future, but are not necessary to construct the Project.

7.0 Environmental Impacts

The environmental conditions within the project area are described along with other information used to complete the environmental analysis for the Project. This analysis was conducted following PUC procedures on siting LWECS and applicable portions of the Power Plant Siting Act, which was used to determine various exclusion and avoidance criteria considered in the selection of the project area.

Preliminary information used for evaluating environmental conditions and selecting the project area included agency queries to the Minnesota Department of Natural Resources (MDNR), Minnesota State Historic Preservation Office (SHPO), Minnesota Department of Commerce (DOC), and Chippewa County.

The southern boundary of the project area is located approximately one mile north of the City of Granite Falls in Chippewa County, Minnesota in Granite Falls Township, east of the Minnesota River. The project area is at approximately 1040 feet above mean sea level (amsl) above the Minnesota River valley at approximately 925 feet amsl. The project area is comprised primarily of agricultural fields with dispersed rural homesteads.

7.1 SOCIOECONOMICS

Depending on the size and location, the construction and operation of LWECs can result in impacts to demographics and socioeconomics of a community.

7.1.1 Description of Resources

The Project is located in Chippewa County in southwestern Minnesota, north of the City of Granite Falls. The county has a population of approximately 12,440 people. Chippewa County is mostly rural with an average age of 43 years old and an average household size of 2.4 people (USCB 2010a). The City of Granite Falls, the closest community to the Project, has a population of approximately 2,800. The City of Montevideo, approximately 5,400 people, is located north of the project area approximately six miles. Both communities offer amenities, such as restaurants, lodging, and other businesses and public services.

Approximately 51 percent (6,365 people ages 16 and older) of the County is employed (USCB 2010b). Employment types are shown in **Table 7-1**.

Table 7-1: Employment Summary

Field	Estimated Workers	Percentage
Management, business, science, and arts occupations	1,848	29%
Service occupations	1,263	20%
Sales and office occupations	1,247	20%
Natural resources, construction, and maintenance occupations:	915	14%
Production, transportation, and material moving occupations	1,092	17%
TOTAL	6,365	100%

Source: USCB 2010b

The project area is comprised of several rural residences and landowners. Many of these property owners rely on agriculture as their primary source of income. The households also find employment in nearby communities. The 2014 median income for Chippewa County was approximately $51,500 (USCB 2010b).

7.1.2 Impacts

The Project is anticipated to be beneficial to the local economy. The Project will create approximately 100 temporary jobs during construction and approximately five permanent jobs. The salary range for these jobs will be between $30,000 and $70,000. These jobs could bring additional people into the County and positively contribute to the local economy. Expenditures made by the construction workers could benefit local businesses. Construction and operation of the Project has the potential to increase the local tax base.

Additionally, landowners will be compensated for potential loss of land use from WTG installation through voluntary land leases and wind easements. The land surrounding each WTG could remain in the existing use and continue to be farmed or grazed. No substantial impacts to permanent housing in the project area and surrounding areas are anticipated.

In general, impacts to demographics are expected to beneficial.

7.1.3 Mitigative Measures

The Project will not have a substantial impact on demographics. Socioeconomic impacts are anticipated to be primarily positive, and therefore, mitigation measures are not proposed.

7.2 LAND-BASED ECONOMIES

Land-based economies depend on use of land and natural resources to generate revenue.

7.2.1 Description of Resources

Land-based economies in the project area consist primarily of agricultural farming, specifically cultivated crops and livestock. According to US Census Bureau, agriculture, forestry, fishing and hunting, and mining account for approximately nine percent (9%) of the jobs within Chippewa County (USCB 2010b).

7.2.2 Impacts

Most WTGs will be sited in locations which are currently agricultural land used for cultivated crops or grazing. Each WTG will have an estimated footprint of approximately 0.65 acres or approximately 12 acres total for 18 WTGs. Farming will be allowed up to the edge of the access roads and turbine pads. Given the project area is approximately 6,150 acres and the continued ability to farm around the WTGs, impacts to land based economies are not anticipated.

7.2.3 Mitigative Measures

Compensation for loss of productive land will be negotiated with individual landowners through lease agreements and wind rights easements. These agreements between the landowner and the Applicant are anticipated to offset any potential lost income by the landowner from the Project.

There are also several Best Management Practices (BMPs) and conservation measures, derived from the Upper Great Plains Wind Energy Final Programmatic EIS, the Applicant has committed to implement for the Palmer’s Creek Wind Farm Project. The primary Land-Based

Economic BMPs include removing all above and near-ground structures, including turbines and ancillary structures, during decommissioning. The complete, detailed list of BMPs can be found in Appendix A.

7.3 RECREATION AND TOURISM

Recreation and tourism near the project area primarily include public land, Minnesota River, tourist attractions, and cultural centers. These resources were evaluated for potential impacts from the Project.

7.3.1 Description of Resources

Recreation and tourism near the project area consists of natural features and businesses. Three tourism-related businesses include the Prairie's Edge Casino and Resort, Fagen Fighters WWII Museum, and Yellow Medicine County Museum and Historical Society. All three businesses are located south of Granite Falls. The Upper Sioux Agency State Park is also located south of Granite Falls.

Wildlife Management Areas (WMA) are public lands, managed by the Minnesota Department of Natural Resources (MNDNR) for hunting, wildlife viewing, and general outdoor activities. Recreational areas within the project area are shown on **Figure 3**. The Spartan WMA is located on the southwestern border of the Project. WTG-5 will be located approximately one-quarter mile northeast of this WMA, and WTG-9 will be located approximately one-half mile east-southeast from the Spartan WMA. The Sween WMA is outside of the northern border of the project area in Sections 5 and 6 of T116N, R39W. The Sween WMA is approximately one-half mile northeast of WTG-2 and approximately one-half mile northwest of WTG-4. Both WMAs are known for deer, small game, forest upland birds, pheasants, and waterfowl (MNDNR 2016a, 2016b). The Spartan WMA is also known for turkey (2016a).

The Minnesota River is located along the west boundary of the project area. The Minnesota River is designated, the MNDNR, as a State Water Trail from Ortonville, Minnesota past Granite Falls to its confluence with the Mississippi River at Fort Snelling. The segment of river flowing past the project area is also designated as a State Wild and Scenic River by the MNDNR and classified as a recreational river (**Figure 3**).

In this area, the Minnesota River flows in a 100- to 150-foot-wide channel through a wide floodplain. Granite outcrops are prevalent south of Montevideo into Granite Falls. Maple, cottonwood, and elm trees along with a variety of other vegetation line the riverbank. The river is also known for abundant wildlife and fishing opportunities. It is also used as a migratory flyway for many species of birds and waterfowl.

The State Wild and Scenic River designation requires special regulations that are implemented through the Chippewa County zoning ordinance.

7.3.2 Impacts

WTGs 2, 3, and 4 are located closest to the Sween WMA near the northern boundary of the project area. These WTGs will be visible from the Sween WMA. WTGs 1, 5, and 9 are located closest to the Spartan WMA. These WTGs will be visible from the Spartan WMA. In both cases, the nearest WTGs from the WMA boundary meet the required Wind Access Buffer setbacks of 3 RD (760-985 ft) on east-west axis and 5 RD (1,280-1640 ft) on north-south axis.

The Project may result in the mortality of individual species of birds due to contact with WTGs during operation. This is not anticipated to be detrimental to the species populations in the area. The Project will be constructed outside of the WMA on agricultural land that is currently cultivated or grazed, and therefore, the Project will not degrade wildlife habitat in the WMAs or along the river corridor.

The visibility of the WTGs may affect an individual visitor's experience at the WMAs and within the Minnesota River corridor, but will not cause direct impacts to these areas or wildlife within these areas. In general, the Project is not anticipated to cause detrimental effects to recreation resources, such as bird watching, wildlife viewing, fishing and hunting.

7.3.3 Mitigative Measures

The Applicant has committed to implement several BMPs and conservation measures, derived from the Upper Great Plains Wind Energy Final Programmatic EIS, for the Palmer's Creek Wind Farm Project. The primary recreation and tourism BMPs include:

- Implementation of safety measures for recreational visitors to adjacent properties
- All facilities shall be kept clean and materials properly stored
- Use colors on structures and facilities to blend in with viewsheds
- Protect trees when possible
- Minimize disturbances to the extent possible, including minimizing the number of new roads
- Siting considerations
    - Avoid areas of unique or important recreation, wildlife, or visual resources
    - When feasible, site on already altered landscapes
    - Maximize setbacks to the extent possible
- Decommissioning
    - Remove all above ground and near-ground structures, including turbines and ancillary structures

The complete, detailed list of BMPs can be found in Appendix A.

7.4 LAND USE

Land use within the project area is primarily agricultural. The Applicant reviewed local plans and ordinances relevant to the Project, as well as conservation easements that may existing within the project area.

7.4.1 Description of Resources

7.4.1.1 Local Zoning and Comprehensive Plans

Plans and ordinances for the project area, located in Granite Falls Township and Sparta Township in Chippewa County, were reviewed. These included the 2013-2023 Chippewa County Water Plan, Hawk Creek Watershed District Reports, and Chippewa County Zoning Ordinance. The townships do not have comprehensive plans or zoning ordinances. Planning and zoning for these townships is conducted by Chippewa County.

Setbacks for LWECS are regulated by both the PUC and Chippewa County. Ordinance Section 12 outlines regulations for LWECs, which are WECs with the capacity to generate over 5 MW of electricity (Ordinance Section 12.1). Under Section 12 definitions, the Project will be categorized as a Commercial Wind Energy Conversion System, as it will be capable of generating over 125 KW of energy (Ordinance Section 12.2.2). The County has informed the Applicant that following the PUC process will be sufficient to satisfy County regulations of LWECS (**Appendix G**). However, other local permits for building, utilities, access roads, and moving oversized loads may be required as discussed in Section 10.1.

The authority for counties to regulate land development was established in Minnesota Statute Chapter 394.21. The project area, which includes lands zoned Agricultural District (Ordinance Section 3), Urban Expansion District (Ordinance Section 4), and Minnesota River Management District (Ordinance Section 8) are summarized below as relevant to the Project.

Most of the project area is zoned as Agricultural Preservation District. The southwest quarter of the northeast quarter in Section 28 is zoned Urban Expansion. This site is the location of the Granite Falls electrical substation. The proposed Palmer's Creek Substation will be located across the road, adjacent to the existing substation. This area is within the Minnesota River Management District, which is designated as part of the Wild and Scenic Rivers system. That portion of the Minnesota River from the Lac qui Parle Dam to the Redwood County State-Aid Highway 11 bridge near Franklin is designated a component of the Minnesota Wild and Scenic Rivers system. Regulations in the Wild and Scenic River boundary are implemented by Chippewa County and surrounding affected counties and cities through land use controls, such as zoning. The boundaries of the river district may not exceed 320 acres per river mile on both sides of the river. Land within the river district have minimum standards for land use, development, and administration. This portion of the project area is classified as Recreational. Per Section 8 of the Chippewa County Ordinance, private roads and minor public streets are a permitted use, while power transmission lines are considered a conditional use. The Applicant is working with the County for approvals for locating and constructing the substation and O&M building.

The Project will require setbacks to meet PUC regulations. Setback requirements that will apply to the Project were previously discussed in Section 4.1 and summarized in **Table 4-1**.

7.4.1.2 Conservation Easements

Three conservation easements, through the Conservation Reserve Enhancement Program (CREP), are located within the project area. CREP is administered by the US Department of Agriculture (USDA) Farm Service Agency and is an offshoot of the Conservation Reserve Program. CREP pays landowners an annual rental rate to transfer environmentally sensitive lands from production into conservation practices (USDA 2016). CREP parcels are summarized below in **Table 7-2** and are shown on **Figure 3**.

Table 7-2: Conservation Easement Summary

Easement Type/Public Access	Easement Number	Parcel Acres	Closest WTG	Date Established / Duration
CREP / Closed	903164[1]	41.9	WTG 1, WTG 2	October 10, 2002 / Permanent
CREP / Closed	903105[2]	33.1	WTG 6	January 2, 2003 / Permanent
CREP / Closed	903013[3]	21.4	WTG 11	January 5, 2001 / Permanent

[1] http://www.conservationeasement.us/projects/284642
[2] http://www.conservationeasement.us/projects/284721
[3] http://www.conservationeasement.us/projects/284827

There are other easements located within the vicinity of the project area primarily along the Minnesota River Valley. These include Reinvest in Minnesota (RIM) Reserve and Permanent Wetland Preserve (PWP) land conservation easements, as shown on **Figure 3**. The closest RIM easement is near the existing substation.

7.4.2 Impacts

None of the wind turbine generator (WTG) will be within the Minnesota River Management Zoning. The proposed substation and O&M building will be located within the Minnesota River Management District, and will require local zoning approvals for construction. The Applicant is currently working with the County for the necessary approvals for construction.

The location of the CREP easements were evaluated based on location relative to the current WTG siting, access road, and gathering line locations. None of the WTG will directly impact CREP conservation easements. The gathering line between WTG 1 and WTG 2 is close to a CREP easement, but avoids direct impacts. A gathering line and access road near WTG 6 is also close to a CREP easement, but also avoids direct impacts.

RIM and PWP land conservation easements will not be directly impacted by the Project.

7.4.3 Mitigative Measures

Appropriate approvals and permits will be acquired prior to construction and operation of the project. These include any local zoning approvals and permits, such as building permits, and utility or roadway permits.

The Applicant has committed to implement several BMPs and conservation measures, derived from the Upper Great Plains Wind Energy Final Programmatic EIS, for the Palmer's Creek Wind Farm Project. The primary land use BMPs include:

- Implementation of safety measures for recreational visitors to adjacent
- Properties and for the Project area
- Implementation of a traffic management plan to avoid adverse traffic impacts
- Develop a reclamation/restoration plan
  - Include plans to restore all temporary disturbance areas
- Access roads
  - Minimize access road impacts
  - Use existing roads to the extent possible
  - Properly maintain to avoid erosion and other impacts

    - Recontour and revegetate access roads when they are no longer needed
- Implementation of a transportation management plan to minimize impacts
- Siting considerations
    - Consult with Federal (including Department of Defense), State, and county agencies; tribes; property owners, and other stakeholders to identify potentially significant issues
    - Avoid areas of unique or important recreation, wildlife, or visual resources
    - Consolidate infrastructure whenever possible
    - Minimize visual impacts to the extent possible
- Construction activities
    - Coordinate with landowners to minimize impacts
    - Properly remove debris
    - Correct any drainage problems created during construction
- Decommissioning
    - Remove all above ground and near-ground structures, including turbines and ancillary structures

The complete, detailed list of BMPs can be found in Appendix A.

7.5 NOISE

Noise is defined as any unwanted sound and is regulated by the MPCA under Minnesota Administrative Rules 7030. Noise areas are classified as a 1, 2, or 3 based upon their land use activities (Minnesota Rules 7030.0050) and acceptable noise levels are defined for each Noise Area Classification (NAC) based on day or night times. Residential areas are classified as NAC 1 and farmland is classified as NAC 3 Minnesota Rules 7030.0050. The standards list the sound levels not to be exceeded for 10 and 50 percent of the time in a one-hour survey (L10 and L50) for each noise area classification, as shown in **Table 7-3**.

Table 7-3: Applicable Minnesota Noise Standards

Noise Area Classification		Noise, Standard, dB(A)			
		Daytime (7 am to 10 pm)		Nighttime (10 pm to 7 am)	
		L50	L10	L50	L10
1	Residential	60	65	50	55
2	Commercial	65	70	65	70
3	Industrial	75	80	75	80

The standards are given in terms of the percent of time during a measurement period (typically one hour) during which a particular decibel dB(A) level may not be exceeded. A daytime L50 of 60 dB(A), for example, means that during the daytime, noise levels may not exceed 60 dB(A) more than 50 percent of the time (i.e., 30 minutes of an hour).

Sound is created by wind turbine generators dependent upon operating and weather conditions. This sound may be deemed as noise. A Noise Study was completed for the Project (WSB 2017) which identified potential sources of noise from wind turbines: mechanical noise, aerodynamic noise, modulation of aerodynamic noise, and wind farm noise.

7.5.1 Description of Resources

The project area contains 47 residences, a farm museum, and an electrical substation. Most of the area is farmlands or rural lands. Field assessment monitoring and noise modeling were conducted for the Project as part of the Noise Study. For monitoring locations within the proposed project area, the current L50 sound levels range from 45.1 dBA to 60.4 dBA for both daytime and nighttime. The existing sound levels met or exceeded State daytime noise standards at monitoring location 3, and met or occasionally exceeded nighttime noise standards at monitoring locations 1 and 2.

7.5.2 Impacts

The proposed wind turbines are projected to generate an apparent sound level of approximately 107 dB output per the manufacturer's specifications adjacent to the turbine hub. All conditions were modeled slightly above the worst case scenario at 109 dB. For a single turbine at an 80-meter hub-height, the worst-case resultant noise produced drops below 50 dBA at distances greater than approximately 160 meters (500 feet). Turbine WTG 08 was found to be the closest to any of the proposed receptors, and is 1,076 feet away from Receptor R36 (WSB 2017).

Two turbine layout scenarios were modeled in the Noise Study to determine the sound-related impact of the proposed wind farm. The highest predicted change in sound level above 45 dBA is 2.8 dBA. Changes in sound levels less than 3 dBA are barely perceptible to the human ear. Noise Study analysis indicates that construction of the Project will not have an impact of 60 dBA or greater on any modeled receptor, nor will the cumulative impact on any receptor exceed 60 dBA when assuming a 35 dBA, 40 dBA, 45 dBA, 50 dBA, or 55 dBA background sound level. During the daytime, and only with a background sound level already approaching or exceeding the 60 dBA threshold would the cumulative sound level (background and wind turbine sound) exceed 60 dBA. The same is true for the nighttime threshold; only with a background sound level already approaching or exceeding the 50 dBA threshold would the cumulative sound level exceed 50 dBA (WSB 2107).

The proposed substation will be located next to the existing substation and will not result in significant increases in noise.

7.5.3 Mitigative Measures

Palmer's Creek will implement Best Management Practices (BMPs) to avoid and minimize impacts. These practices include siting turbines at least 1,000 feet from residences and compliance with state noise standards at all residences. Additional mitigation measures will be addressed during the permitting process, including conducting post-construction noise monitoring, which will be compared to the pre-construciton noise modeling results to verify noise compliance at receptors in the project area.

Specifically, the Applicant has committed to implement several BMPs and conservation measures, derived from the Upper Great Plains Wind Energy Final Programmatic EIS, for the Palmer's Creek Wind Farm Project. The primary BMPs related to noise include:

- Vehicles shall operate within posted speeds
- Construction activities
  - Notify near-by residents prior to blasting or pile driving
  - Coordinate noisy activities to occur at the same time as feasible
  - Limit noisy activities to times when nearby sensitive receptors are least likely to be disturbed

- Locate stationary equipment as far as practical from nearby sensitive receptors
- To the extent possible, select equipment with the lowest noise levels and no prominent discrete tones
- To the extent possible, use topography and distance to nearby sensitive receptors when positioning potential sources of noise
- Establish a process for documenting, investigating, evaluating, and resolving Project-related noise complaints
- Maintain all Project related equipment in good working order

The complete, detailed list of BMPs can be found in Appendix A.

7.6 VISUAL IMPACTS

Visual impacts from the installation of WTGs can occur to public resources, such as recreation areas and the Minnesota River, as well as private land and residences. WTGs add an element to the landscape and visual horizon that may not have been previously there.

7.6.1 Description of Resources

The project area is rural with primarily flat agricultural fields and a few rolling hills and valley drainages. **Figure 4** shows the topography of the project area with the locations of the proposed WTGs. There are several rural residences located throughout the project area. There are also several electrical transmission lines of various sizes that cross the project area in many locations (**Figure 5**).

The Minnesota River (River) runs along the western boundary of the project area. Dike's Road, a township road, runs along the western edge of the Minnesota River and U.S. Highway (US Hwy) 212 runs along the ridge of the west river bluff. The east boundary of the project area is County Road 5 (CR 5). US Hwy 212 is part of the Minnesota River Valley National Scenic Byway. Designated alternate routes to the National Scenic Byway within the project area boundary include Palmer Creek Road from CR 5 to 5th Avenue SW to CR 15. Designation of the National Scenic Byway is intended "to strengthen Minnesota River Valley communities through both economic means (i.e., more visitors and tourism) and through a closer connection to the river and the Valley's exceptional history (i.e., through investments in recreational facilities, resource protection and interpretive programs)." (MRVSBA, 2001)

7.6.2 Impacts

A viewshed analysis was completed for the Project that evaluated the inter-visibility relationship between the WTGs and three observer points, the city center of Granite Falls, and two observation points on the Upper Sioux Reservation (BCA 2016). The viewshed analysis used an elevation raster based model and the original Thomas Matrix (Sullivan et al 2012) to determine potential visual impacts. The viewshed analysis is summarized below and provided in Appendix C. The following uses the results of the viewshed analysis and observations of the existing conditions in and around the project area.

7.6.2.1 Visual Impacts on Public Resources

The viewshed analysis indicated that several WTGs will be visible from the city center of Granite Falls and from the observation points on the Upper Sioux Reservation.

Three of the WTGs (WTG 5, 9, and 12) will be located near the eastern river bluff and could be visible to those on the River depending on their vantage point and tree canopy. The WTGs will also be visible along Dike's Road and US Hwy 212 on the west side of the River. The Project will be visible along CR 15, which run along the north edge of the project area.

While traveling Palmer Creek Road in the river floodplain, travelers will not have a good view of the WTGs due to the location of the WTGs above on the bluff and existing tree cover along the bluff slope.

The Project will be visible to those using the Minnesota River Valley National Scenic Byway. Those using the Byway alternate routes will be directly adjacent to the proposed substation. Minnesota River Valley National Scenic Byway technical staff were contacted regarding potential impacts from the project. The project would be located in an area that currently has significant existing HVTL and transmission lines running near and across the Minnesota River Valley. The project would contribute additional infrastructure on the bluff area, which would be visible at points on the Byway. If the viewshed of the Byway has significant impacts to its scenic nature, the Byway may lose national designation. Its designation status would be evaluated by Minnesota River Valley National Scenic Byway Commission, an interagency committee, that reviews compliance with Byway rules on a case-by-case basis.

The WTGs will be lit to meet the minimum FAA regulations, which require red flashing, strobe, or pulsed obstruction lights at night. No daytime lighting is required (FAA, 2016).

7.6.2.2 Visual Impacts on Private Lands and Homes

WTGs will be visible from most residences and interrupt horizon views within the project area and in some areas outside of the project area boundary. WTGs will range from 262 to 295 feet high and have rotor diameters of 380 feet. **Table 7-4**: Nearest Residences to Wind Turbine Generators summarizes the distance from each WTG to the nearest residence. All residences are a minimum of 1,000 feet from each WTG, as depicted on **Figure 6**.

Table 7-4: Nearest Residences to Wind Turbine Generators

WTG	Nearest Residence	Distance (ft.)	Direction From Residence
1	31	1,600	East
2	25	1,700	Northeast
3	32	1,400	South-southeast
4	24	1,400	North
5	37	1,000	South-southeast
6	37	2,700	Southwest
7	32	2,000	North
8	36	1,000	Southeast
9	37	2,800	Northwest
10	39	4,000	Southeast
11	39	1,600	South-southeast
12	39	1,600	North-northeast
13	42	1,400	West
14	6	1,800	East-northeast
15	9	2,100	East
16	9	1,400	South
17	12	2,500	Northeast

WTG	Nearest Residence	Distance (ft.)	Direction From Residence
18	22	2,000	North-northeast
2	Swenson Farm Museum	3,100	Southwest
14	Substation Office/Shop	4,400	Northeast

The proposed substation will be located next to the existing substation and is not anticipated to result in a significant visual impact.

7.6.2.3 Shadow Flicker

Shadow flicker from wind turbines occur when rotating wind turbine blades move between the sun and the observer. Shadow flicker is generally experienced in areas near wind turbines where the distance between the observer and wind turbine blade is short enough that sunlight has not been significantly diffused by the atmosphere. When the blades rotate, this shadow creates a pulsating effect, known as shadow flicker. If the blade's shadow is passing over the window of a building, it will have the effect of increasing and decreasing the light intensity in the room at a low frequency in the range of 0.5 to 1.2 Hz, hence the term "flicker." This flickering effect can also be experienced outdoors, but the effect is typically less intense and becomes even less intense when farther from the wind turbine causing the flicker. The moving shadow of a wind turbine blade on the ground is similar to the effect one experiences when driving on a road when there are shadows cast across the road by an adjacent row of trees.

The flickering effect is most noticeable within approximately 1,000 m of the turbine, and becomes more and more diffused as distance increases. There are no uniform standards defining what distance from the turbine is regarded as an acceptable limit beyond which the shadow flicker is considered insignificant. The same applies to the number of hours of flicker that is deemed to be acceptable. Thirty is the standard allowed maximum hours of shadow per year in other places such as Germany.

Shadow flicker is typically greatest in winter months when the angle of the sun is lower and casts longer shadows. The effect is also more pronounced around sunrise and sunset when the sun is near the horizon and shadows are longer. Several factors influence the amount of shadow flicker on the shadow receptors (simulated windows). One consideration is the environment around the shadow receptor. Obstacles such as terrain, trees or buildings between the wind turbine and the receptor can significantly reduce or eliminate shadow flicker effects. Deciduous trees may block some degree of shadow flickering depending on the tree density, species present and time of year. They can lead to a reduction of shadow flicker during the summer when the trees are bearing leaves. However, during the winter months, these trees are without their leaves and their impact on shadow flicker is not as significant. Coniferous trees may provide shading year round.

Another consideration is the time of day when shadow flicker occurs. For example, a factory or office building would not be significantly affected if all the shadow flicker impact occurred before or after business hours. In contrast, it may be more acceptable for private homes to experience shadow flickering during working hours when family members may be at work or school.

The climate also needs be considered when assessing shadow flicker. In areas with high incidence of overcast weather there would be less shadow flicker. Also, if the wind is not blowing, the turbines would not be operational and therefore not creating shadow flickering.

A study (EAPC, 2016) was conducted for the Project using WindPRO, a sophisticated modeling software program, to calculate detailed shadow flicker maps across the entire project area and at specific locations using shadow receptors (Appendix D). A distance of 1,600 m was used for each iteration of shadow flicker modeling. The shadow maps indicate where shadows would be cast by the Project and for how long. The evaluation accounted for theoretical worst case, meaning turbine operational hours, wind direction, and local sunshine probabilities were not accounted for. The evaluation did not give credit for potential shading from any type of tree or other obstacles that would reduce the number of shadow flickering hours at the structures. The study also evaluated realistic scenarios that factored turbine operational hours, rotor orientation, and sunshine probabilities into the model.

The conservative results of the study indicate that of the 49 receptors modeled, 10 modeled zero shadow flicker across all scenarios, 17 modeled 30 or more hours per year theoretical worst case with 80 m HH (hub height), 16 modeled 30 hours or per year theoretical worst case with 80 m + 90 m HH, 18 modeled 30 hours or per year theoretical worst case with 80 m + 94 m HH and one receptor modeled over 30 hours per year under realistic conditions for 80 m, 80 m and 90 m HH, and 80 + 94 m HH. This analysis is based on several other assumptions including:

- A human would always be present at the receptor to observe the effect.
- A human would be situated in an area where the flickering occurs.
- The receptors are omni-directional rather than modeling specific aspects of building facades or window openings.
  - Receptor windows are 2m in width x 1.5 m in height x 1 m above ground level; 90 degree vertical.

The overall effect of using these assumptions indicates that the actual number of hours of shadow flicker that would be observed will likely be less than those predicted by this study.

7.6.3 Mitigative Measures

The Applicant has committed to implement several BMPs and conservation measures, derived from the Upper Great Plains Wind Energy Final Programmatic EIS, for the Palmer's Creek Wind Farm Project. BMPs related to visual impacts include:

- Implementation of a traffic management plan to avoid adverse traffic impacts
- Implement dust abatement measures to minimize the impacts of vehicular and pedestrian traffic, construction, and wind on exposed surface soils
- Develop a reclamation/restoration plan prior to construction
  - Include plans to immediately restore all temporary disturbance areas
  - Use native vegetation during reclamation as practical
- Low-profile structures shall be chosen whenever possible for ancillary buildings and other structures
- Wind turbines should exhibit visual uniformity in the shape, color, and size of rotor blades, nacelles, and towers.
- Siting considerations

- Consult with Federal (including Department of Defense), State, and county agencies; tribes; property owners, and other stakeholders to identify potentially significant issues
- Avoid skylining to the extent feasible
- Follow natural contours to the extent feasible
- Project elements should not be sited next to prominent landscape features, where possible
- Site and design wind energy facilities to eliminate glint and glare effects
- Structures and roads should be designed and located to minimize and balance cuts and fills.
- Avoid areas of unique or important recreation, wildlife, or visual resources
- Maximize setbacks as feasible
- Take advantage of existing clearings and disturbed areas as feasible
- To the extent practical, site facilities, structures, and roads in stable fertile soils
- Wind turbines should be sited properly to eliminate shadow flicker effects on nearby residences or other highly sensitive viewing locations, or reduce them to the lowest achievable level
- In forested areas and shrublands, openings in vegetation for facilities, structures, roads, etc., should mimic the size, shape, and characteristics of naturally occurring openings to the extent possible
- Locations for transmission line and ROW road crossings of other roads, streams, and other linear features within a corridor should be chosen to avoid Key Observation Points (KOP) viewsheds and other visually sensitive areas and to minimize disturbance to vegetation and landforms
- ROWs should cross linear features (e.g., trails, roads, and rivers) at right angles whenever possible to minimize the viewing area and duration
- Natural or previously excavated bedrock landforms shall be sculpted and shaped when excavation of these landforms is required

▲ Construction activities

- Visual impact mitigation objectives and activities shall be discussed with equipment operators before construction activities begin
- Consolidate infrastructure whenever possible
- Minimize disturbed areas to the extent feasible
- Excess cut/fill materials shall be hauled in or out to minimize ground disturbance and impacts from fill piles
- Excess fill material shall not be disposed of downslope in order to avoid creating color contrast with existing vegetation/soils
- For road construction, excess fill shall be used to fill uphill-side swales to reduce slope interruption that would appear unnatural and to reduce fill piles
- Soil borrow areas, cut-and-fill slopes, berms, waterbars, and other disturbed areas shall be contoured to approximate naturally occurring slopes. Contouring to rough texture would trap seed and discourage off-road travel, thereby reducing associated visual impacts.
- Topsoil from cut/fill activities shall be segregated and spread on freshly disturbed areas to reduce color contrast and aid rapid revegetation. Topsoil piles shall not be left in sensitive viewing areas.

▲ Avoid or minimize the use of guy wires and where needed, mark with line marking devices

▲ Use colors on structures and facilities, including culvert ends, to blend in with viewsheds

▲ Minimize use of commercial messages and symbols on turbines and ancillary facilities

- Bury communication and other local utility cables when feasible
- Randomly scarified and roughen cut slopes to reduce texture contrasts
- Existing rocks, vegetation, and drainage patterns shall be preserved to the maximum extent possible
- Facilities and off-site surrounding areas shall be kept clean of debris and on-site materials should be properly stored
- Signage shall be minimized; reverse sides of signs and mounts shall be painted or coated to reduce color contrasts with the existing landscape.
- Maintenance activities
  - All equipment shall be properly maintained. Inoperative turbines shall be repaired, replaced, or removed quickly. Nacelle covers and rotor nose cones shall always be in place and undamaged
  - Maintenance activities shall include dust abatement (in arid environments) and noxious weed control
  - Road maintenance activities shall avoid blading of existing forbs and grasses in ditches and adjacent to roads; however, any invasive or noxious weeds shall be controlled as needed
- Minimize the amount of lighting installed on project turbines; all outdoor lighting on project buildings shall be downshielded
- Nacelles and towers shall be cleaned regularly (yearly, at minimum) to remove spilled or leaking fluids and the dirt and dust that accumulates, especially in seeping lubricants
- Decommissioning
  - Remove all above ground and near-ground structures, including turbines and ancillary structures
  - Contour all disturbed areas to approximate naturally occurring slopes
  - Rocks, brush, and forest debris should be restored, whenever possible, to approximate preexisting visual conditions.

7.7 PUBLIC SERVICES AND INFRASTRUCTURE

Public services and infrastructure are located throughout the project area and include roads, communication systems, airports, and other services provided by the community.

7.7.1 Description of Resources

7.7.1.1 Roads

The project area is bounded by both Chippewa County and Sparta and Granite Falls Township roads. To the north, CR 15/100th Street Southeast (SE) creates the northern boundary, to the east by CR 5/30th Avenue SE, and diagonally to the southwest by Palmer Creek Road. CR 15 and CR 5 are both County State Aid Highways (CSAHs). The township roads include Palmer Creek Road, 5th Ave. SE, 15th Ave SE, 115th St. SE, and 10th Ave. SE, 125th St. SE. As shown on **Figure 5**, many of the access roads will lead from the smaller township roads. All paved county roads have an axle restriction of 10 tons, and all gravel county and township roads have an axle restriction of 5 tons (Chippewa County Highway Dept., 2016a). Per the County website, no county highway projects are planned within the Granite Falls Township between 2016 through 2021 (Chippewa County Highway Dept., 2016b).

Annual Average Daily Traffic (AADT) data from Minnesota Department of Transportation (MnDOT) is provided in **Table 7-5**. The highest AADT based on recorded data near the project area is 1,000 vehicles per day on CR 5 between CR 15 and Granite Falls. Traffic counts in Granite Falls are significantly higher than those recorded north and east of the project area.

Table 7-5: AADT On Project Area Roads

Road Segment Description	AADT	AADT Year
CR 15 (100th St SW) between CR 7 and CR 6	275	2012
CR 15 (100th St SE) between CR 6 and CR 5 (30th Ave SE)	410	2012
CR 5 (30th Ave SE) between CR 15 and Granite Falls	1000	2013

Source: MnDOT 2014 Publication Traffic Volumes – Chippewa County

7.7.1.2 Communication Systems

There are no cellular communication or other Federal Communications Commission (FCC) registered towers located within the project area. However, there are several towers registered in the surrounding area. Cable, internet, and telephone providers in the area include MVTV Wireless, Century Link, and Mediacom Cable. The Applicant will be required to locate existing utilities prior to construction, including telephone lines, and will avoid existing utilities during construction.

Microwave beams are used to transmit long distance communications on straight-line vectors between microwave dishes. Transmissions are regulated by the FCC. Microwave beam paths near the project area were mapped and maximum beam widths for maintaining normal operation were calculated (EAPC, 2016) (Appendix E). There are 20 microwave beam paths within one mile of the project area. The proposed WTG sites are outside the recommended buffers from crossing microwave beams.

Communications towers/signals in the near the project area are summarized in **Table 7-6**.

Table 7-6: Communication Systems Near Project Area

Communication System Type	Number of Signals/Towers
ASR (Antenna Structure Registration)(1)	5
FM (FM Radio Signals)(2)	2
Microwave Beams (Radio wave Transmission) (3)	20
AM (AM Radio Signals)(2)	0

(1) FCC Antenna Structure Registration Search completed February 6, 2017 based on state, county, and city (Granite Falls, MN).
(2) FCC FM and AM Queries completed February 6, 2017 based on Granite Falls, MN.
(3) EAPC Palmer's Creek Wind Project Microwave Beam Study, October 15, 2016.

A FCC television (TV) query for broadcast TV station information in the VHF and UHF broadcast bands for Granite Falls, Minnesota, accessed February 6, 2017, resulted in 12 TV call signs as listed in

Table 7-7.

Table 7-7: TV Signals Near the Project Area

Call Sign	Transmit Channel	Frequency
K14OL-D	14	470-476 MHz
K16CP-D	16	482-488 MHz
K21LF-D	21	512-518MHz
K22DO-D	22	518-524 MHz
K24CS-D	24	530-536 MHz
K29JW-D	29	560-566 MHz
K32DR-D	32	578-584 MHz
K35DK-K	35	596-602 MHz
K40MC-D	40	626-632 MHz
K41MF-D	41	632-638 MHz
K45DJ-D	45	656-662 MHz
K49LV-D	49	680-686 MHz

Source: FCC, 2016

7.7.1.3 Other Infrastructure and Services

The existing Granite Falls (WAPA) Substation, is within the project area boundary. Existing overhead powerlines parallel most of the county roads within the project area as shown on **Figure 5**. These powerlines also cut across agricultural land starting from the substation and routed north, east and west. The overhead powerlines include high voltage transmission lines (HVTLs) and other low to medium voltage powerlines.

Emergency services in the project area include fire, law enforcement, and ambulance. The area is served by the Chippewa County Sheriff's Department and a volunteer fire and rescue squad. Granite Falls Police Department consists of six full-time sworn officers and six fully licensed part-time sworn officers. The City of Granite Falls has a police department and volunteer fire department. The City of Montevideo also has a police department and volunteer fire department. The Minnesota State Patrol and Minnesota Department of Natural Resources also have law enforcement that patrol the area as needed. These services are dispatched through the 911 Emergency System on an as needed basis. Medical emergencies are also initially handled by dispatch for first responders or ambulance, which take patients to Granite Falls or Montevideo hospitals and beyond depending on the level of care needed.

There is a railroad located in the southwest of the project area on an alignment somewhat parallel to the Minnesota River. The railroad is operated by Twin Cities and Western Railroad Company. The Burlington Northern Santa Fe (BNSF) runs through the center of the project area from the south to the northeast.

7.7.2 Impacts

7.7.2.1 Roads

Roads could sustain impacts depending on load weights and time of year for construction. Impacts to the existing local roads are anticipated to be minimal. It may be necessary to increase the radius of some corners, but this has not been determined yet. Any damage to the roads cause by turbine delivery and project construction will be repaired. The Applicant will work with the County and Township to obtain necessary permits and minimize and mitigate impacts.

An increase in traffic would occur during the construction phase of the Project resulting in increased use of local roadways for delivery of construction materials and transportation of personnel. Some vehicles would be heavy-duty construction type vehicles. Impacts from construction traffic would be temporary and are anticipated to be negligible. It is estimated that vehicle traffic will increase by approximately 100-125 vehicles both large and small combined. Traffic for operation and maintenance is not anticipated to significantly impact the AADT near the project area; day to day activity in the area will not significantly increase.

7.7.2.2 Communication Systems

Construction and operation of the Project is not anticipated to impact telephone, cable, or internet service in the project area. Prior to construction, the Applicant will review the location of FCC registered towers and existing utilities and will not operate the Project to cause interference with communication systems. The Palmer's Creek Microwave Beam study found that the proposed WTGs are planned to be located outside of the FCC registered existing microwave beam buffer zones (EAPC, 2016). The Applicant will verify locations of licensed microwave transmitters and receivers prior to construction. The Project could create impacts for communication projects in the future, however no known projects are planned at this time.

Wind turbines have the potential to impact broadband communications. However, there are no broadband towers located directly within the project area. Additionally, modern digital TV receivers have undergone significant improvements to mitigate the effects of signal scattering. Television receptions at homes relying on cable or satellite television service will not be impacted by construction or operation of the Project. Therefore, no interference with broadband communications is anticipated. If interference to a residence's or business's television service is reported to the Applicant, they will work with affected parties to determine the cause of interference and, when necessary, reestablish television reception and service.

7.7.2.3 Other Infrastructure and Services

Modification to the existing WAPA substation will be as necessary for Project implementation and interconnection. Overhead powerlines will be avoided during construction of the Project. WTG siting will occur far enough away from overhead powerlines that impacts will be avoided during both construction and operation of the Project.

Impacts to emergency services are not anticipated. During Project construction, emergency services will be used as needed for incidents, but will not result in overall impacts to area residents use of these services.

Impacts to the adjacent railroad by Project construction or operation is not anticipated.

7.7.3 Mitigative Measures

The Applicant has committed to implement several BMPs and conservation measures, derived from the Upper Great Plains Wind Energy Final Programmatic EIS, for the Palmer's Creek Wind Farm Project. The primary Public Service and Infrastructure BMPs include:

- Implementation of a traffic management plan to avoid adverse traffic impacts
- Implementation of a transportation management plan to minimize impacts

- ▲ Access roads
  - Use existing roads to the extent possible
  - Access roads shall be designed and constructed to the appropriate standard necessary to accommodate their intended function
  - For road construction, excess fill shall be used to fill uphill-side swales to reduce slope interruption that would appear unnatural and to reduce fill piles.
  - Apply erosion controls relative to possible soil erosion from vehicular traffic
- ▲ Siting considerations
  - Consult with Federal (including Department of Defense), State, and county agencies; tribes; property owners, and other stakeholders to identify potentially significant issues
  - Minimize the extent of the project footprint, including improved roads and construction staging areas.
  - Avoid skylining to the extent practical
  - As feasible, siting of linear features (ROWs and roads) associated with wind energy developments should follow natural land contours rather than straight lines, particularly up slopes
  - Consolidate infrastructure whenever possible
  - In forested areas and shrublands, openings in vegetation for facilities, structures, roads, etc., should mimic the size, shape, and characteristics of naturally occurring openings to the extent possible
  - Locations for transmission line and ROW road crossings of other roads, streams, and other linear features within a corridor should be chosen to avoid KOP viewsheds and other visually sensitive areas and to minimize disturbance to vegetation and landforms. The ROWs should cross linear features (e.g., trails, roads, and rivers) at right angles whenever possible to minimize the viewing area and duration.
  - Site new roads to avoid crossing streams and wetlands and minimize the number of drainage bottom crossings.
  - Structures and roads should be designed and located to minimize and balance cuts and fills.
  - Maximize setbacks to the extent practical
- ▲ Bury communication and other local utility cables when feasible
- ▲ Construction activities
  - Coordinate with landowners to minimize impacts
  - Conduct construction and maintenance activities when the ground is frozen or when soils are dry and native vegetation is dormant
  - Inspect and clean tires of construction-related vehicles, as necessary, so they are free of dirt prior to entering paved public roadways.
  - Maintain clean facilities, including roads
  - Surface new access roads with aggregate materials, wherever appropriate.
- ▲ Maintenance activities
  - Clean and maintain catch basins, drainage ditches, and culverts regularly
  - Road maintenance activities shall avoid blading of existing forbs and grasses in ditches and adjacent to roads; however, any invasive or noxious weeds shall be controlled as needed.
  - Roads serving the site would need to be properly maintained to avoid erosion impacts.
- ▲ Vehicles shall operate within posted speeds
- ▲ Traffic shall be restricted to designated project roads. Use of other unimproved roads shall be restricted to emergency situations.

- Restrict heavy vehicles and equipment to improved roads to the extent practicable.

The complete, detailed list of BMPs can be found in Appendix A.

7.7.3.1 Roads

Following the Ordinance Section 12 guidelines, local units are authorized to require oversized load permits and collect fees for those permits (Ordinance Section 12.14.1.2). If construction requires exceedance of road limits, upon construction completion, the County or Township may require remediation or road repair (Ordinance Section 12.14.1.1). If road damage occurs, the Applicant may be financially responsible for road repair (Ordinance Section 12.14.1.3).

7.7.3.2 Communication Systems

The Project will operate in compliance with FCC regulations and other applicable regulations. The Project is not anticipated to interfere with communications. However, if communication interference occurs after Project construction, the Applicant will work with affected residents to determine the cause of the interference and resolve the issue as necessary.

7.7.3.3 Other Infrastructure and Services

Impacts to overhead powerlines and emergency services are not anticipated, and therefore, mitigation has not been proposed.

7.8 PUBLIC HEALTH AND SAFETY

Public health and safety associated with the Project is primarily related to wind turbine design and maintenance and aviation. Noise and emergency services may also be associated with public health and safety. Noise is discussed in Section 7.5. Emergency services (i.e., fire, police, ambulance) are discussed in Section 7.7.

7.8.1 Description of Resources

7.8.1.1 Wind Turbine Design and Maintenance

Several safety hazards are associated with wind turbines, including turbine height, high winds, and rotating machinery. Wind turbines are designed with safety features including wind sensors and brakes. Wind sensors prompt the turbine to turn and face oncoming wind to maximize efficiency and prevent damage during high winds. WTGs also include brakes to stop the turbine during emergencies and control rotation speed.

WTG maintenance is ongoing, which requires personnel to inspect and repair the nacelle and other parts of the turbine. Precautions are taken to prevent falls and other injuries. Precautions to prevent accidents including training and use of proper equipment.

7.8.1.2 Substation Design

An existing substation is located in the southern part of the project area. This substation is enclosed by a fence and posted for trespassing as a safety measure. It was constructed to meet industry safety standards.

7.8.1.3 Aviation

The Granite Falls Municipal Airport/Lenzen-Roe-Fagen Memorial Field is located approximately 5.5 miles south of the project area. The Montevideo-Chippewa County Airport, is approximately eight miles northwest of the project area. Both airports are small, regional airports without commercial service. Due to the height of the WTGs, FAA Form

7460-1 must be completed and submitted when a construction permit is filed or at least 45 days before the start date of Project construction, whichever is earliest.

7.8.1.4 EMF and Stray Voltage

Electromagnetic fields (EMF) are created by electrically charged particles associated with electric conductors with an electrical current flow. Electric conductors related to the Project include transmission lines, power collection/distribution lines (feeder lines), substation transformers, inverters, and other related electrical components. The question of whether exposure to power-frequency (60 Hz) magnetic fields can cause biological responses or even health effects has been the subject of considerable research for the past three decades. The National Institute of Environmental Health Sciences (NIEHS) completed a six-year study in 1999 which found little scientific evidence tying EMF exposures with health risks (NIEHS 1999). An additional white paper completed in 2002 by the Minnesota State Interagency Working Group on EMF Issues agreed with the NIEHS 1999 report results (Minnesota State Interagency Working Group on EMF Issues 2002).

Stray voltage in a rural setting can affect farm animals when a small voltage difference exists between two surfaces accessible to the animal. When an animal touches both surfaces, a current will flow through its body (MREC Fact Sheet, 2014). Wind farms are unlikely contributors to stray voltage due to system design standards and electrical connection methods. The WTGs will be connected to a substation transformer and transmission system with no direct connection to the local power distribution system or farm wiring systems.

7.8.2 Impacts

7.8.2.1 Wind Turbine Design and Maintenance

Safety impacts are anticipated to be minimal. WTGs are designed with safety features that require regular maintenance for proper operation. The Applicant has sited the proposed WTGs for the Project a minimum of 1,000 feet from residences. When maintenance of the WTG is conducted, trained personnel are required to use safety equipment to prevent injury and accidents.

7.8.2.2 Substation Design

The proposed substation will be fenced and posted for trespassing to minimize potential public safety impacts. Safety measures will be included in the substation design to comply with industry standards and applicable regulations.

7.8.2.3 Aviation

Based on distance and FAA compliance measures, the Project is not anticipated to cause impacts to the Granite Falls Municipal Airport/Lenzen-Roe-Fagen Memorial Field or the Montevideo-Chippewa County Airport.

7.8.2.4 EMF and Stray Voltage

There is presently no Minnesota statute or rule that pertains to magnetic field exposure. The proposed WTGs will be setback from residences and the proposed Palmer's Creek Substation will be located adjacent to the existing WAPA Substation; the Project is not anticipated to significantly add to the presence of EMF exposure in the project area. Based on the NIEHS report and the Minnesota State Interagency Working Group on EMF Issues white paper, the Project is not anticipated to cause health impacts. The Project is also not anticipated to contribute to stray voltage.

7.8.3 Mitigative Measures

The Applicant has committed to implement several BMPs and conservation measures, derived from the Upper Great Plains Wind Energy Final Programmatic EIS, for the Palmer's Creek Wind Farm Project. The primary Public Health and Safety BMPs include:

- Conduct a safety assessment to describe potential safety issues and the means that will be taken to mitigate them, covering issues such as site access, construction, safe work practices, security, heavy equipment transportation, traffic management, emergency procedures, and fire control.
- Implementation of a health and safety plan for both project workers and the public
- Implementation of a traffic management plan to avoid adverse traffic impacts
- Implementation of a transportation management plan to minimize impacts
- If pesticides/herbicides are to be used on the site, develop an integrated pest and vegetation management plan to ensure that applications will be conducted within the framework of managing agencies and will entail the use of only EPA-registered pesticides/herbicides that are (1) nonpersistent and immobile and (2) applied by licensed applicators in accordance with label and application permit directions, following stipulations regarding suitability for terrestrial and aquatic applications.
- Implementation of safety measures for recreational visitors to adjacent Properties and for the Project area
- Develop a fire management and protection plan to implement measures to minimize the potential for fires associated with substances used and stored at the site.
- All site characterization, construction, operation, and decommissioning activities must be conducted in compliance with applicable Federal and State occupational safety and health standards (e.g., the Occupational Safety and Health Administration's [OSHA's] Occupational Safety and Health Standards, 29 CFR Parts 1910 and 1926, respectively).
  - Vehicles shall operate within posted speeds
  - Avoid or minimize the use of guy wires and where needed, mark with line marking devices
  - Bury communication and other local utility cables when feasible
  - Pollution prevention opportunities shall be identified and implemented, including material substitution of less hazardous alternatives, recycling, and waste minimization.
  - Siting considerations
  - Consult with Federal (including Department of Defense), State, and county agencies; tribes; property owners, and other stakeholders to identify potentially significant issues
  - Site and design wind energy facilities to eliminate glint and glare effects
- Design:
  - Design all electrical systems to meet all applicable safety standards (e.g., the National Electrical Safety Code) and comply with the interconnection requirements of the transmission system operator.
- Access roads
  - Use existing roads to the extent possible
- Construction
  - Coordinate with landowners to minimize impacts
  - Maintain clean facilities, including roads
  - Drainage problems caused by construction shall be corrected to prevent damage to agricultural fields

- Dedicated areas with secondary containment shall be established for off-loading hazardous materials transport vehicles
- ▲ Use proper signage and/or engineered barriers (e.g., fencing) to limit access to electrically energized equipment and conductors in order to prevent access to electrical hazards by unauthorized individuals or wildlife
- ▲ Traffic shall be restricted to designated project roads. Use of other unimproved roads shall be restricted to emergency situations.
- ▲ Cover vehicles transporting loose materials when traveling on public roads, and keep loads sufficiently wet and below the freeboard of the truck in order to minimize wind dispersal.
- ▲ Schedules shall be established for the regular removal of wastes (including sanitary wastewater generated in temporary, portable sanitary facilities) for delivery by licensed haulers to appropriate off-site treatment or disposal facilities
- ▲ Facilities and sites shall be actively and carefully maintained during operation
- ▲ Decommissioning:
  - Remove all above ground and near-ground structures, including turbines and ancillary structures
  - Temporary waste storage areas shall be properly designated, designed, and equipped;
  - and
  - The areas shall be surveyed for contamination and remediated as necessary.

The complete, detailed list of BMPs can be found in Appendix A.

7.8.3.1 Wind Turbine Design and Maintenance

Several safety-related measures will be used including signage, equipment specifications, and safety design features.

Signage will be placed at the base of each WTG including a high voltage warning, the manufacturer's name, emergency phone numbers, and emergency shutdown procedures.

Equipment will conform to applicable industry standards, including the American Wind Energy Association standard for wind turbine design and related standards adopted by the American Standards Institute (ANSI). The equipment manufacturer will certify the equipment is manufactured in compliance with industry standards. Project design will be certified by a professional engineer, licensed in Minnesota. Maintenance and inspections will be performed by qualified wind energy professions.

To reduce the potential for unauthorized climbing, WTGs will be self-supporting tubular towers. All turbines will be equipped with redundant braking systems. This includes both aerodynamic (including variable pitch) overspeed controls and mechanical brakes. Mechanical brakes will be operated in a fail-safe mode, to engage in the case of load loss on the generator.

7.8.3.2 Substation Design

The proposed substation will comply with all applicable regulations and safety standards.

7.8.3.3 Aviation

FAA requires certain types of lighting consistent with FAA AC 70/7460-1K Obstruction *Marking and Lighting*. FAA approval is required once the final WTG sites have been determined. Completion of FAA Form 7460-1 *Notice of Proposed Construction* is required prior to construction. The Applicant will acquire all necessary permits prior to Project construction.

7.9 HAZARDOUS MATERIALS

Potentially hazardous materials are used for construction and operation of wind farm projects. These include lubricants and other materials for proper operation of equipment.

7.9.1 Description of Resources

Hazardous materials may be used for maintenance of the construction and related equipment during construction and operation of the Project. These materials are common to wind farm projects and include diesel fuel, hydraulic fluid, and other fluids and solvents associated with typical construction projects.

7.9.2 Impacts

The use of lubricants and other potentially hazardous materials are necessary for property equipment operation. These materials will be used in small quantities on an as needed basis for equipment maintenance. A small amount of turbine hydraulic fluids and lubricants will be contained within the nacelle of the individual WTGs. A small amount of hydraulic fluid, lubricating oil, grease and solvents will be stored in appropriate containers in the O&M Facility. When fluids or oils are replaced, the waste substances will be disposed of at an appropriate hazardous materials management disposal facility or landfill. Based on the small quantities, use of proper storage, spill cleanup, and regulated disposal methods, impacts from hazardous materials are not anticipated.

7.9.3 Mitigative Measures

The Applicant has committed to implement several BMPs and conservation measures, derived from the Upper Great Plains Wind Energy Final Programmatic EIS, for the Palmer's Creek Wind Farm Project. The primary Hazardous Materials BMPs include:

- All site characterization, construction, operation, and decommissioning activities shall be conducted in compliance with applicable Federal and State laws and regulations, including the Toxic Substances Control Act of 1976, as amended (15 USC 2601, et seq.)
- Prepare a hazardous materials and waste management plan that addresses the selection, transport, storage, and use of all hazardous materials needed for construction, operation, and decommissioning of the facility for local emergency response and public safety authorities and for the regulating agency, and that addresses the characterization, on-site storage, recycling, and disposal of all resulting wastes.
- Any spills of hazardous materials shall be properly documented, cleaned, and reported.
- All vehicles and equipment shall be in proper working condition to ensure that there is no potential for leaks of motor oil, antifreeze, hydraulic fluid, grease, or other hazardous materials
- Authorized users for each type of hazardous material shall be identified.
- Design:
  - Design requirements shall be established for hazardous materials and waste storage areas that are consistent with accepted industry practices as well as applicable Federal, State, and local regulations and that include, at a minimum, containers constructed of compatible materials, properly labeled, and in good condition; secondary containment features for liquid hazardous materials and

wastes; physical separation of incompatible chemicals; and fire-fighting capabilities when warranted.

- Pollution prevention opportunities shall be identified and implemented, including material substitution of less hazardous alternatives, recycling, and waste minimization.
- Hazardous materials and waste storage areas or facilities shall be formally designated and access to them restricted to authorized personnel.
- Procedures shall be established for fuel storage and dispensing.
- Refueling areas shall be located away from surface water locations and drainages and on paved surfaces; features shall be added to direct spilled materials to sumps or safe storage areas where they can be subsequently recovered.
- To the greatest extent practicable, limit the amounts of hazardous materials present on the site to quantities minimally necessary to support continued operations
- Decommissioning:
    - Hazardous materials removed from systems shall be properly containerized and characterized, and recycling options shall be identified and pursued;
    - Off-site transportation of recovered hazardous materials and wastes resulting from decommissioning activities shall be conducted by authorized carriers;
    - Hazardous materials and waste shall be removed from on-site storage and management areas,
    - Emergency response capabilities shall be maintained throughout the decommissioning period if hazardous materials and wastes remain on-site, and emergency response planning shall be extended to any temporary material and equipment storage areas that may have been established; and
    - The areas shall be surveyed for contamination and remediated as necessary.

The complete, detailed list of BMPs can be found in Appendix A.

7.10 SOILS AND TOPOGRAPHY

Wind farms in Minnesota and other areas in the Midwest are typically located in open areas with high quality wind resources. These areas tend to have generally flat topography and primarily have rural and agricultural land use.

7.10.1 Description of Resources

The project area is rural with primarily flat agricultural fields and a few rolling hills and valley drainages. **Figure 4** shows the topography of the project area with the locations of the proposed WTGs. The Minnesota River runs along the western boundary of the project area.

Soils in the area primarily consist of loams and clay loams with zero to six percent slopes. Most of the soils in the project area are considered prime farmland, farmland of statewide importance or prime farmland, if drained as shown on **Figure 7**.

7.10.2 Impacts

Most WTGs will be sited in locations which are currently agricultural land used for cultivated crops or grazing. The wind turbine foundations will typically be spread foundations, which require shallow excavation, generally 8 to 12 feet deep. The base of the foundation will be approximately 60 feet in diameter, and the top of the foundation will be approximately 18 feet in diameter. The excavated area for the turbine foundations will typically be approximately 75 feet by 75 feet (23 meters by 23 meters). During construction, a larger area, approximately 295 feet by 295 feet (90 meters by 90 meters), or two acres, will be used to lay down the rotors and maneuver cranes during turbine assembly. Each WTG will have an estimated permanent footprint of approximately one acre or less (0.65 acre), totaling approximately 12 acres for 18 WTGs. Farming activity will be allowed around the access roads and up to the edge of each WTG. Excavated soils will be placed around the WTG pad radius or next to the foundation hole and used for backfill over the poured concrete foundation. Top soils will be separated from the sub-surface material and spread evenly over the radius once construction is complete.

The proposed substation will be located directly across the road to the south of the existing Granite Falls (WAPA) substation. The proposed substation area is currently agricultural land used for cultivated crops. Before any construction begins, the top soil will be stripped and stockpiled to the side, then used around the perimeter of the substation once completed. Once the top soil is stripped, a grounding grid (copper wire) will be installed, and each piece of equipment located within the perimeter fence will be connected ensuring proper grounding. The area disturbed during construction of the proposed substation will be approximately 175 feet by 225 feet. Inside of the proposed substation construction area, there will be several small excavations for concrete foundations which equipment such as breakers, grounding transformers and steel structures will be placed. There will be one larger excavation approximately 30 feet by 30 feet for a foundation and containment to be poured for the main transformer which will have an approximate final size of 15 feet by 20 feet. In addition to the small foundations, main transformer, breakers, grounding transformers and steel structures, there will be buss welded and/or fastened to the steel. The final dimensions of the proposed substation will be approximately 150 feet by 200 feet with a clean rock ranging in size from one half inch to one and one half inch spread throughout the inside of the fenced area as the final surface covering.

The underground electrical collector and communication systems will connect each WTG to the proposed substation. The electrical collection lines generally will be installed by plowing or trenching the cables in trenches between 18 and 24 inches wide and four feet deep. There will be approximately 14 miles of underground collector lines. Using the trenching method, the disturbed soils and topsoil are typically replaced over the buried cable within one day, and the drainage patterns and surface topography are restored to pre-existing conditions.

The project area is approximately 6,150 acres of which approximately 14 acres will be taken out of agricultural production due to the permanent Project footprint. An additional estimated 178 acres will be temporarily taken out of production during construction for laydown areas. Installation of underground collection lines will also cause temporary soil disturbance.

7.10.3 Mitigative Measures

Initial Project development will include soil removal from areas of permanent disturbance including new access roads and turbine pads. Soil will be salvaged to a depth of as much as 12 inches in order to preserve the desirable physical and chemical properties of the topsoil. The topsoil will be bladed to the side and placed on top of adjacent soils in a manner that will make it available for future reclamation should these facilities ever be removed. A National Pollutant Discharge Elimination System (NPDES) permit application to discharge storm water from construction activities will be acquired prior to construction. As part of this application, a stormwater pollution protection plan (SWPPP) will be developed to minimize soil erosion. This plan will identify best management practices (BMPs) to be employed during construction and operation of the Project to protect topsoil and adjacent resources and to minimize soil erosion. Practices may include a combination of several BMPs including silt fence, temporary seeding and mulching, rock construction entrances, etc. BMPs derived from the Upper Great Plains Wind Energy Final Programmatic EIS will also be used for the Palmer's Creek Wind Farm Project, as appropriate. The complete, detailed list of BMPs can be found in Appendix A.

- Prepare a site restoration plan shall be in place prior to construction. Restoration of the construction areas shall begin immediately after construction to reduce the likelihood of visual contrasts associated with erosion and invasive weed infestation and to reduce the visibility of affected areas as quickly as possible.
- Compaction will be minimized by salvaging topsoil prior to construction and tilling soil as part of the final reclamation treatment measures. In addition, minimizing the total area required by all facilities will limit the area exposed to compaction due to surface activity.
- Decommissioning
  - Soil borrow areas, cut-and-fill slopes, berms, waterbars, and other disturbed areas should be contoured to approximate naturally occurring slopes, thereby avoiding form and line contrasts with the existing landscapes.
  - Facilities constructed on Federal lands should follow the decommissioning recommendations provided in the USFWS's Land-Based Wind Energy Guidelines (USFWS 2012b).
  - Interim restoration shall be undertaken during the operating life of the project as soon as possible after disturbances.
  - Reestablish the original grade and drainage pattern to the extent practicable.

Through implementation of these environmental protection measures, soil erosion, compaction, and other related disturbance will be short-term. With the proper implementation of environmental protection measures intended to prevent, minimize, and/or reclaim soil erosion, compaction, and spill effects, no unmitigated loss of highly productive soil will result from the Project.

7.11 GROUNDWATER RESOURCES

Chippewa County adopted the 2013-2023 Chippewa County Water Plan with 2013-2018 Implementation Plan on January 7, 2014 (Water Plan) under guidance of Minnesota State Statute 103B.314 (Chippewa County 2014). The Water Plan also serves as the Chippewa County Soil and Water Conservation District's Comprehensive District Plan (CCSWSD Plan).

7.11.1 Description of Resources

Wells within the project area were identified through the Minnesota Department of Health (MDH) Minnesota Well Index website, https://apps.health.state.mn.us/cwi/. There are approximately 20 known wells in the project area. Turbine foundation construction is unlikely to affect local water supply. Geotechnical testing will occur at all turbine locations and will consist of core-penetration testing.

Groundwater in the project area is approximately 25 feet below the surface (Bradt and Berg, 2000). The project area is estimated to have a mostly moderate geologic sensitivity of pollution of near-surface groundwater, with an estimate of years to decades for surface contaminants to reach near-surface groundwater (Bradt, 2000).

The Drinking Water Supply Management Area (DWSMA), which includes the Wellhead Protection Area (WHPA), for the community of Granite Falls is located approximately 1.5

miles east of the project area. The DWSMA is considered to have a "Low Vulnerability" to potential pollution and estimated that it takes surface water ten years to reach the aquifer.

7.11.2 Impacts

Excavation will occur for WTG foundations and associated facilities. These excavations will occur at depths of 10 feet or less, and therefore, are not anticipated to reach the groundwater in this area. A well will be drilled for domestic use as part of the O&M facility. This well will be drilled by a licensed contractor per permitting requirements. There will be use and storage of small quantities of potentially hazardous materials. As discussed in Section 7.9, these materials will be handled and disposed of properly. Groundwater contamination from these materials is not anticipated. Additionally, the Project will not impact the DWSMA as it is approximately 1.5 miles away.

7.11.3 Mitigative Measures

The Applicant has committed to implement several BMPs and conservation measures, derived from the Upper Great Plains Wind Energy Final Programmatic EIS, for the Palmer's Creek Wind Farm Project. The primary BMPs related to groundwater resources include:

- Apply erosion controls to all construction activities and disturbed areas, including roads.
- Avoid creating hydrologic conduits between two aquifers (e.g., upper and lower).
- Siting considerations
  - Avoid altering existing drainage systems, especially in sensitive areas such as erodible soils or steep slopes.
  - Identify and avoid unstable slopes and local factors that can cause slope instability (groundwater conditions, precipitation, seismic activity, high slope angles, and certain geologic landforms).
- Hazardous materials and waste storage areas or facilities shall be formally designated and access to them restricted to authorized personnel. Construction debris, especially treated wood, shall not be disposed of or stored in areas where it could come in contact with aquatic habitats.

The complete, detailed list of BMPs can be found in Appendix A.

7.12 SURFACE WATER AND FLOODPLAIN RESOURCES

Surface water and floodplain resources include lakes, rivers and streams in the project area.

7.12.1 Description of Resources

7.12.1.1 Surface Waters

The project area has limited surface water and floodplain resources as it primarily comprised of agricultural land. The Minnesota River is on the west side of the project area boundary. There are also waterbodies and small drainages in several places in or within close proximity to the project area. **Figure 8** shows public waterbodies, streams and ditches in the project area. The waterbodies are identified on the DNR Public Waters Inventory (PWI) as: 32P and 36P, located in the Sween WMA (E ½ Section 6, T116N R39W); 48P, located in the Sparta WMA (E ½ Section 13, T116N R40W); and 32W, located in the NE ¼ Section 19, T116N R39W. Streams identified on the DNR PWI include Palmer Creek (eastern half of the project area) and an unnamed stream connected to a public drainage ditch in the western half of the project area. Several other drainages appear to be part of a larger drain tile system for the agricultural fields. These drainages were not identified on the DNR PWI.

7.12.1.2 Floodplain Resources

The Minnesota River is a designated State Wild and Scenic River. Its shoreline and floodplain areas are managed through special regulations to protect floodplain and other sensitive resources. Federal Emergency Management Agency (FEMA) Maps 2700660155B and 2700660160B were reviewed for the project area (Appendix F). Most the project area is located in Zone C, defined as an area of minimal flooding and outside of the 500-year or 0.2 percent-annual-chance flood (FEMA 1986A, FEMA 1986B). A narrow area along Palmer's Creek and the Minnesota River floodplain are both considered Zone A, defined as areas of 100-year flood.

7.12.2 Impacts

The WTGs will not impact DNR PWI waterbodies, streams or ditches. The foundations and temporary laydown areas are located outside of the PWI waters. The project area occurs outside of the County Designated Flood Zone and Wild and Scenic River regulatory area. No WTGs will be placed within the County-designated Flood Zone or river management area, and therefore, no impacts to floodplain resources are anticipated.

7.12.3 Mitigative Measures

The Applicant has committed to implement several BMPs and conservation measures, derived from the Upper Great Plains Wind Energy Final Programmatic EIS, for the Palmer's Creek Wind Farm Project. The complete, detailed list of BMPs can be found in Appendix A. The primary BMPs related to surface waters and floodplains include:

- Apply erosion controls to all construction activities and disturbed areas, including roads.
- Develop restoration plans to ensure that all temporary use areas are restored.
- Siting considerations
  - Avoid altering existing drainage systems, especially in sensitive areas such as erodible soils or steep slopes.
  - Consolidate infrastructure wherever possible to maximize efficient use of the land and minimize impacts.
  - Identify and avoid unstable slopes and local factors that can cause slope instability (groundwater conditions, precipitation, seismic activity, high slope angles, and certain geologic landforms).
  - Minimize the extent of the project footprint, including improved roads and construction staging areas.
  - Site new roads to avoid crossing streams and wetlands and minimize the number of drainage bottom crossings.
  - Structures, roads, and other project elements should be set as far back from road, trail, and river crossings as possible, and vegetation should be used to screen views from crossings, where feasible.
- Construction considerations
  - Interim restoration shall be undertaken during the operating life of the project as soon as possible after disturbances.
  - Minimize ground-disturbing activities, especially during the rainy season.
  - Use earth dikes, swales, and lined ditches to divert local runoff around the work site.
- Avoid creating hydrologic conduits between two aquifers (e.g., upper and lower).
- Clean and maintain catch basins, drainage ditches, and culverts regularly.

- Dispose of excess excavation materials in approved areas to control erosion and minimize leaching of hazardous materials.
- Do not use fill materials that originate from areas with known invasive vegetation problems.
- Construction debris, especially treated wood, shall not be disposed of or stored in areas where it could come in contact with aquatic habitats.
- Refueling areas shall be located away from surface water locations and drainages and on paved surfaces; features shall be added to direct spilled materials to sumps or safe storage areas where they can be subsequently recovered.
- Regularly inspect access roads, utility and transmission line corridors, and tower site areas for damage from erosion, washouts, and rutting. Initiate corrective measures immediately upon evidence of damage.
- Reseed (non-cropland) disturbed areas with a native seed mix and revegetate disturbed areas immediately following construction.
- Roads serving the site would need to be properly maintained to avoid erosion impacts.
- Spills shall be immediately addressed per the appropriate spill management plan, and cleanup and removal initiated, if needed.

7.13 WETLANDS

Wetlands classified by the National Wetland Inventory (NWI) and identified by the MNDNR PWI. There are wetlands located in and adjacent to the project area. A wetland delineation will be conducted prior to final Project design to determine wetland boundaries. Wetlands will be avoided as possible. The Applicant will work with appropriate agencies to determine potential impacts to wetlands and subsequent regulatory approvals.

7.13.1 Description of Resources

According to the NWI, there are approximately 210 acres of wetlands found within the project area. These wetlands are summarized in **Table 7-8** and shown on **Figure 8**. These wetlands are primarily freshwater emergent wetland found in agricultural fields and along natural waterways. Several of these wetlands have been altered in some way including drained and used for crop production.

Table 7-8: Wetland Summary

Wetland Type	Cowardin Classification	Acreage
Freshwater Emergent Wetland	PEM/FO1C	0.23
	PEMAd	0.31
	PEMB	0.99
	PEMBd	8.53
	PEMC	78.11
	PEMCd	10.49
	PEMF	66.31
Freshwater Forested / Shrub Wetland	PFO1/EMB	2.77
	PFO1A	8.94
	PFO1B	0.80
	PFO1C	16.75

Wetland Type	Cowardin Classification	Acreage
Freshwater Pond	PUBF	4.27
	PUBFh	0.67
	PUBFx	1.02
Riverine	R2UBH	9.75
	Total	**209.93**

Source: NWI

Wetlands have been preliminarily identified using the NWI and MNDNR PWI. Prior to construction, wetlands potentially falling under the jurisdiction of state or federal agencies will be delineated to determine if there will be impacts and whether state or federal wetland permits will be required.

Table 7-9 provides a summary of the watercourses in the project area. These include Palmer's Creek, several county ditches, and the Minnesota River. Wetland areas are associated with these watercourses. There is a total of approximately eight miles of watercourses in the project area.

Table 7-9: Linear Watercourses in Project Area

Watercourse	ID Number	PWI	Length (Miles)
Palmer Creek	M-055-152	Public Ditch/Altered Natural Watercourse	0.50
County Ditch 70	M-055-153.5	Public Water Watercourse	1.02
County Ditch 66	M-055-151.7	Public Ditch/Altered Natural Watercourse	0.11
Minnesota River	M-055-B030	Public Water Watercourse	0.24
County Ditch 70	M-055-153.5	Public Ditch/Altered Natural Watercourse	1.89
County Ditch 66	M-055-151.7	Public Water Watercourse	0.25
Minnesota River	M-055	Public Water Watercourse	0.08
Palmer Creek	M-055-152	Public Water Watercourse	4.15
		Total	8.24

Source: MNDNR PWI

7.13.2 Impacts

Construction of WTGs will occur primarily in upland areas on high portions of the project area. These areas are not typically associated with wetlands. WTGs are anticipated to avoid direct impacts to wetlands. Access roads and gathering lines will be designed to avoid wetland areas as feasible. The proposed substation will also be designed to avoid wetland.

Temporary impacts associated with staging areas or crane walkways will be minimized. Horizontal boring will be used, where feasible, to avoid impacts to wetlands and watercourses.

7.13.3 Mitigative Measures

The Applicant has also committed to implement several BMPs and conservation measures, derived from the Upper Great Plains Wind Energy Final Programmatic EIS, for the Palmer's Creek Wind Farm Project. The primary BMPs related to wetlands include:

- Siting considerations
  - For wetland and grassland easements, coordinate closely with the USFWS or USDA during initial project planning to ensure that wetland and grassland easements are avoided to the extent practicable.
  - Minimize the extent of the project footprint, including improved roads and construction staging areas.
  - Consolidate infrastructure wherever possible to maximize efficient use of the land and minimize impacts
  - Existing roads should be used to the extent possible, but only in safe and environmentally sound locations.
  - Avoid altering existing drainage systems, especially in sensitive areas such as erodible soils or steep slopes.
  - Identify and avoid unstable slopes and local factors that can cause slope instability (groundwater conditions, precipitation, seismic activity, high slope angles, and certain geologic landforms).
  - Siting of facilities and linear facilities, should avoid crossing streams and wetlands and take advantage of natural topographic breaks (i.e., pronounced changes in slope), and siting of facilities on steep side slopes should be avoided.
  - Structures, roads, and other project elements should be set as far back from road, trail, and river crossings as possible, and vegetation should be used to screen views from crossings, where feasible.
  - Use earth dikes, swales, and lined ditches to divert local runoff around the work site.
- Avoid creating hydrologic conduits between two aquifers (e.g., upper and lower).
- Develop restoration plans to ensure that all temporary use areas are restored.
- Dispose of excess excavation materials in approved areas to control erosion and minimize leaching of hazardous materials.
- Construction considerations
  - Where feasible, construction on wet soils shall be avoided to reduce erosion.
  - Do not use fill materials that originate from areas with known invasive vegetation problems.
  - Construction debris, especially treated wood, shall not be disposed of or stored in areas where it could come in contact with aquatic habitats.
  - Minimize ground-disturbing activities, especially during the rainy season.
  - Slash from vegetation removal shall be mulched and spread to cover fresh soil disturbances (preferred) or shall be buried. Slash piles shall not be left in sensitive viewing areas.
  - Stabilize disturbed areas that are not actively under construction using methods such as erosion matting or soil aggregation, as site conditions warrant.
  - Reseed (non-cropland) disturbed areas with a native seed mix and revegetate disturbed areas immediately following construction.
- Refueling areas shall be located away from surface water locations and drainages and on paved surfaces; features shall be added to direct spilled materials to sumps or safe storage areas where they can be subsequently recovered.

- Regularly inspect access roads, utility and transmission line corridors, and tower site areas for damage from erosion, washouts, and rutting. Initiate corrective measures immediately upon evidence of damage.
- Spills shall be immediately addressed per the appropriate spill management plan, and cleanup and removal initiated, if needed.

The complete, detailed list of BMPs can be found in Appendix A.

Additionally, wetland field delineations will be conducted in the project area prior to construction. Layout of turbines, access roads, and other facilities will be designed to avoid and minimize wetland impacts as feasible. If wetland impacts cannot be avoided, the Applicant will secure the necessary Clean Water Act (CWA) Section 404 permits and Minnesota Wetland Conservation Act (WCA) permits prior to project construction.

7.14 VEGETATION

Cover types describe the vegetation in the project area.

7.14.1 Description of Resources

Cover types found within the project area are summarized in

Table 7-10 and shown on **Figure 9**. Cultivated crops comprise the vast majority of cover types in this area. Other cover types include pasture, grassland, and developed open space with some deciduous forest. The cover types other than cultivated crops are typically associated with rural residences including windbreaks, lawn, and pasture and grassland.

Table 7-10: Existing Cover Types Summary

Cover Types	Total Acreage
Barren Land (Rock/Sand/Clay)	1
Cultivated Crops	5,157
Deciduous Forest	134
Developed	213
Emergent Herbaceous Wetlands	160
Grassland/Herbaceous	192
Open Water	5
Pasture/Hay	284
Shrub/Scrub	4
Total	**6,150**

Source: NLCD, 2011

7.14.2 Impacts

Table 7-11 provides a summary of the estimated acres of land disturbance from the Project. Approximately 10 acres of cultivated crop areas will be taken out of agricultural production due to the permanent Project footprint. During construction, approximately 162 acres of agricultural land (cultivated crops and pasture/hay land) will be temporarily taken out of agricultural production for laydown areas and other construction activities. Installation of underground collection lines will also cause temporary soil disturbance in cultivated crop areas and pasture/hay land. After construction is complete, disturbed areas will be restored to their condition prior to construction.

Table 7-11: Temporary and Permanent Land Disturbance

Cover Types	Temporary Disturbance	Permanent Disturbance
Barren Land (Rock/Sand/Clay)	0	0
Cultivated Crops	161	10
Deciduous Forest	1	0
Developed	7	0.6
Emergent Herbaceous Wetlands	1.1	0
Grassland/Herbaceous	0.5	0.1
Open Water	0	0
Pasture/Hay	1.2	0.6
Shrub/Scrub	0.1	0.1
Total	**171.9**	**11.4**

Source: NLCD, 2011

7.14.3 Mitigative Measures

The Applicant has committed to implement several BMPs and conservation measures, derived from the Upper Great Plains Wind Energy Final Programmatic EIS, for the Palmer's Creek Wind Farm Project. The primary vegetation BMPs include:

- A site restoration plan shall be in place prior to construction.
- Access roads shall be designed and constructed to the appropriate standard necessary to accommodate their intended function (e.g., traffic volume and weight of vehicles) and minimize erosion. Access roads that are no longer needed should be recontoured and revegetated.
- Access roads, utility and transmission line corridors, and tower site areas shall be monitored regularly for the establishment of invasive species, and weed control measures should be initiated immediately upon evidence of the introduction of invasive species.
- Siting considerations
  - Consult with Federal (including Department of Defense), State, and county agencies; tribes; property owners, and other stakeholders to identify potentially significant issues
  - For wetland and grassland easements, coordinate closely with the USFWS or USDA during initial project planning to ensure that wetland and grassland easements are avoided to the extent practicable.
  - Minimize the extent of the project footprint, including improved roads and construction staging areas.
  - Siting should take advantage of existing clearings to reduce vegetation clearing and ground disturbance.
  - Do not locate individual meteorological towers in or adjacent to sensitive habitats or in areas where ecological resources known to be sensitive to human activities are present.
  - Existing roads should be used to the extent possible, but only in safe and environmentally sound locations

  - In forested areas and shrublands, openings in vegetation for facilities, structures, roads, etc., should mimic the size, shape, and characteristics of naturally occurring openings to the extent possible.
  - Penalty clauses should be used to protect trees and other sensitive visual resources.
- ▲ Construction considerations:
  - Establish a controlled inspection and cleaning area for trucks and construction equipment are arriving from locations with known invasive vegetation problems.
  - Dispose of excess excavation materials in approved areas to control erosion.
  - Excess cut/fill materials shall be hauled in or out to minimize ground disturbance and impacts from fill piles.
  - For road construction, excess fill shall be used to fill uphill-side swales to reduce slope interruption that would appear unnatural and to reduce fill piles.
  - Valuable trees and other scenic elements can be protected by clearing only to the edge of the designed grade manipulation and not beyond, using retaining walls, and by protecting tree roots and stems from construction activities.
  - Slash from vegetation removal shall be mulched and spread to cover fresh soil disturbances (preferred) or shall be buried. Slash piles shall not be left in sensitive viewing areas.
  - The vegetation-clearing design in forested areas should include the feathering of cleared area edges (i.e., the progressive and selective thinning of trees from the edge of the clearing inward) combined with the mixing of tree heights from the edge to create an irregular vegetation outline.
  - Topsoil from cut/fill activities shall be segregated and spread on freshly disturbed areas to reduce color contrast and aid rapid revegetation.
  - Planting pockets shall be left on slopes, where feasible.
  - Reclaim areas of disturbed soil using weed-free native shrubs, grasses, and forbs.
  - Reseed (non-cropland) disturbed areas with a native seed mix and revegetate disturbed areas immediately following construction.
  - Soil borrow areas, cut-and-fill slopes, berms, waterbars, and other disturbed areas shall be contoured to approximate naturally occurring slopes, thereby avoiding form and line contrasts with the existing landscapes. Contouring to rough texture would trap seed and discourage off-road travel, thereby reducing associated visual impacts.
- ▲ Combining seeding, planting of nursery stock, transplanting of local vegetation within the proposed disturbance areas, and staging of construction shall be considered, enabling direct transplanting
- ▲ Regularly monitor access roads and newly established utility and transmission line corridors for the establishment of invasive species. Initiate weed control measures immediately upon evidence of the introduction or establishment of invasive species.
- ▲ Road maintenance activities shall avoid blading of existing forbs and grasses in ditches and adjacent to roads; however, any invasive or noxious weeds shall be controlled as needed.
- ▲ Vehicles shall be washed outside of active agricultural areas to minimize the possibility of the spread of noxious weeds.
- ▲ Decommissioning
  - Soil borrow areas, cut-and-fill slopes, berms, waterbars, and other disturbed areas should be contoured to approximate naturally occurring slopes, thereby avoiding form and line contrasts with the existing landscapes.

The complete, detailed list of BMPs can be found in Appendix A.

7.15 WILDLIFE

The Minnesota River Valley provides habitat for many birds, waterfowl, and wildlife. It also supports a large fish population. The area also provides potential habitat for several federal and state-listed species.

7.15.1 Description of Resources

7.15.1.1 Wildlife Surveys and Agency Communications

Tier 1 & 2 Analysis Methods and Agency Communications

To assess potential impacts at the project area, the Applicant consulted with agency staff, reviewed recent literature, requested natural heritage database records from the MNDNR Minnesota Natural Heritage Information System (NHIS), examined USFWS data and MNDNR documents for information on Endangered, Threatened and Special Concern (ETSC) species and migratory birds and bats.

NHIS review and records of rare species have been obtained during the development of this Project. On July 5, 2016, the Applicant received the NHIS review for the project area (Appendix G). Results of wildlife surveys are discussed in below.

Additional communications with the MNDNR include a meeting on July 13, 2016 that provided a preliminary review of the Project and proposed wildlife surveys. During the July 2016 meeting, the MNDNR discussed the Project proximity to Sween and Spartan Wildlife Management Area (WMA) and encouraged moving several turbines farther away from the WMAs to avoid potential impacts.

Existing data on bald eagle nest locations was received from the MNDNR on July 5, 2016. Based on historical records, one nest is located in Section 11, T116N R40W. An additional nest was located in Section 20, T116N R39W which was not in the historical database. Both nests are located outside of the project area.

Tier 3 Surveys

Tier 3 surveys began in Fall 2015 and will continue through Summer 2017 to provide data to help address the following questions:

- What bird and bat species are present within the project area?
- What is the distribution, relative abundance, and behavior of bird species in the project area?
- What is the activity level of bat species in the project area?
- How do these factors expose birds and bats to risk from the Project?

Completed and proposed avian surveys are listed in **Table 7-12** and **Table 7-13** below. Avian point count surveys consist of point-count surveys of 20 minutes in length. These surveys are designed to describe passerine activity in the project area. All avian species are recorded. Eagle point count surveys consist of 60-minute surveys outside of the avian point count surveys and are designed to describe eagle activity in the project area. Passerine species are not recorded during the eagle surveys. Avian point count and Eagle surveys are conducted at all eight points within the project area. Overall, the total survey effort is approximately 256 hours.

Table 7-12: Completed Point Count Survey Effort For Project Area

Survey Season	Survey Type	Number of Points	Number of Surveys	Minutes Per Count	Total Survey Hours
Summer 2016	Avian Point Count	8	5	20	13.3
Summer 2016	Eagle Point Counts	8	2	60	16.0
Fall 2016	Avian Point Count	8	10	20	26.7
Fall 2016	Eagle Point Counts	8	6	60	48.0
Totals		**8**	**26**		**104.0**

Table 7-13: Continuing Point Count Survey Effect For Project Area

Survey Season	Survey Type	Number of Points	Number of Surveys	Minutes Per Count	Total Survey Hours
Fall 2016	Avian Point Count	8	2	20	5.3
Fall 2016	Eagle Point Counts	8	1	60	8.0
Winter 2016-2017	Avian Point Count	8	6	20	16.0
Winter 2016-2017	Eagle Point Counts	8	6	60	48.0
Spring 2017	Avian Point Count	8	10	20	26.7
Spring 2017	Eagle Point Counts	8	3	60	24.0
Summer 2017	Avian Point Count	8	3	20	8.0
Summer 2017	Eagle Point Counts	8	2	60	16.0
Totals		**8**	**31**		**152.0**

Bat surveys consist of acoustic monitoring with full-spectrum monitoring devices at five locations throughout the project area. Acoustic monitoring began Fall 2015 and continued through October 15, 2016 (see Appendix I for the Final Acoustic Bat Summary Report).

7.15.1.2 Wildlife Species

Regional Wildlife

Wildlife within the vicinity of the project area includes white-tailed deer, raccoons, skunk, coyotes, beavers, muskrats, and other small mammals. These species can be found in the project area, but will seek good habitat for forging, breeding, and shelter. Good habitat is found along the Minnesota River floodplain, nearby WMAs, and along some of the drainages in the project area. Agricultural production areas, such as cultivated crops, may be used on a temporary basis by birds and wildlife for foraging or short-term shelter.

The project area is primarily agricultural lands and does not contain significant wetland habitats. The project area is adjacent to the Minnesota River, which provides large riverine and wetland habitats. The project area is approximately 16 miles southeast of the Lac qui Parle Dam, Lac qui Parle State Park, and Lac qui Parle WMA, approximately 33,000 acres, and managed by the MNDNR. The Lac qui Parle WMA includes a state game refuge, wildlife sanctuary, migratory waterfowl feeding and resting area, and controlled hunting zone. The agricultural landscape and developments of the region have determined the type of wildlife present.

Birds
Migratory birds and waterfowl travel through Minnesota during the spring and fall of each year, as they alternate between summer breeding grounds in the northern portion of the continent and winter feeding ground in the southern half of the continent. The project area is located within the Mississippi River Flyway, which results in large spring and fall migrations of various bird species. During spring and fall migrations flocks of migratory birds can number in the tens of thousands at traditional migratory staging areas and refuges. Migratory birds and waterfowl typically stage and rest in areas with significant amounts of wetland and open water habitats that provide sufficient food sources for the migration. The Minnesota River corridor is highly used by nesting, over-wintering, and migratory bald eagles.

The project area is adjacent to the Minnesota River and its floodplain. The Minnesota River valley provides a corridor of habitat for many birds and waterfowl. The project area is predominantly cropland, and the most common birds observed during the completed surveys (see **Table 7-12** above) were red-winged blackbird (*Agelaius phoeniceus*) (270 individuals), American crow (*Corvus brachyrhynchos*) (266 individuals), brown-headed cowbird (*Molothrus ater*) (239 individuals), and barn swallow (*Hirundo rustica*) (180 individuals). These species comprised 45.6 percent of all individual birds observed. Overall, during the completed surveys 56 species were observed. Details of the survey results as of November 20, 2016, can be found in Appendix H.

One Minnesota Listed Special Concern Species, the American white pelican (*Pelecanus erythrorhynchos*), and one MNDNR rare species, Bald Eagle (*Haliaeetus leucocephalus*), was observed during the field surveys in the project area. One observation of the American white pelican was made that had four individuals in flight. Eight observations of the Bald Eagle were made totaling ten individuals. Additional eagles were observed during the eagle point count surveys.

Bats
There are seven bat species known to occur in Minnesota – big brown bat (*Eptesicus fuscus*), silver-haired bat (*Lasionycteris noctivagans*), eastern red bat (*Lasiurus borealis*), hoary bat (*Lasiurus cinereus*), little brown bat (*Myotis lucifugus*), northern long-eared bat (*Myotis septentrionalis*) and tri-colored bat (*eastern pipistrelle, Perimyotis subflavus*) (MNDNR 2016). The northern long-eared bat (*Myotis septentrionalis*), tricolored bat (*Perimyotis subflavus*), big brown bat (*Eptesicus fuscus*), and little brown bat (*Myotis lucifugus*) are all state-listed species of special concern.

There was a total of six bat species documented throughout the course of the surveys (Fall 2015 and Fall 2016). Three species of concern in the state of Minnesota were observed during the acoustic bat monitoring (tricolored bat, big brown bat, and little brown bat). The northern long-eared bat is a federally threatened species with a species range that includes the majority of the eastern United States, extending west through Minnesota to the western borders of the Dakotas. No confirmed documentation of the northern long-eared bat in the project area was recorded during the Fall 2015 to Fall 2016 acoustic bat monitoring (see Appendix I for the Final Acoustic Bat Summary Report).

7.15.1.3 MNDNR Waterfowl Feeding And Resting Areas
There are no MNDNR Waterfowl Feeding and Resting Areas within or adjacent to the project area.

7.15.1.4 Important Bird Areas Within And Adjacent To Project Area

Part of the western side of the project area, near the Minnesota River, overlaps with the Upper Minnesota River Valley Important Bird Area (IBA). IBAs, identified by Audubon Minnesota in partnership with the MNDNR, are part of an international conservation effort aimed at conserving critical bird habitats. The Upper Minnesota River Valley IBA incorporates the riparian corridor and adjacent river valley and upland communities along the Minnesota River and provides excellent habitat for a wide variety of bird species. This IBA contains significant bird habitat in an intensely agricultural area and is a natural corridor for migrating birds. Over 200 species, including state-listed species and Species in Greatest Conservation Need (SGCN) are known to use the IBA.

7.15.2 Impacts

Project siting will occur primarily on agricultural land that have been previously disturbed for cultivated crops and other agricultural practices. Minnesota Biological Survey (MBS) sites, native prairie, and wetland areas will be avoided if possible.

The Project could affect birds due to collision mortality, displacement due to disturbance, habitat fragmentation, and habitat loss. Collision mortality rates are anticipated to be low. The Project will not directly impact habitat in the project area. The Applicant is currently conducting wildlife surveys of the project area to evaluate the potential presence of threatened and endangered species. The Applicant has been coordinating with the MNDNR and USFWS. The results of the surveys will be used by permitting authorities to determine permit conditions based on the potential for impacts to wildlife.

Migratory birds and waterfowl will be most susceptible to impacts from the Project when taking off and landing at staging and resting areas, because these are the times they will be flying at heights that could cause collisions with WTGs. At other times during their migration, migratory birds and waterfowl will be flying at heights well above the maximum height of the WTGs.

WTGs closest to the Minnesota River are WTGs 1, 5, 9 and 12. Avian collisions and subsequent mortality may be more likely with these WTGs than other WTGs in the project area. Lac qui Parle Dam is located about 16 miles north, and therefore, impacts to migration routes and patterns, resting and staging areas at the State Park or WMA are not anticipated.

Bats typically utilize farm buildings and dead and dying trees with cavities and loose bark as roosting and maternity habitat. Bats typically use forests, riparian corridors and wetlands as feeding habitats due to higher nocturnal insect densities in these areas. There is minimal native vegetation that serves as wildlife habitat within the project area near direct areas of Project impact. For bats, the mean mortality rate at seventeen wind energy facilities in the Midwest is 9.6 bats per turbine per year (s.d. 24.1) (Stantec 2012). There are bats in the project area and some wind turbine collision bat mortality is likely to occur because of the Project. Compared to birds less is known about bat populations and habitat preferences on a local, regional or national level. Bat mortality is likely to be greatest for migratory tree bat species, including hoary, eastern red and silver-haired bats during the fall migration period (Johnson 2005, Arnett et al. 2008).

7.15.3 Mitigative Measures

The Applicant has committed to implement several BMPs and conservation measures for the Palmer's Creek Wind Farm Project, derived from the Upper Great Plains Wind Energy Final Programmatic EIS. The primary BMPs related to wildlife include:

- Prepare a Bird and Bat Conservation Strategy (BBCS).
- The responsible federal agency will use the Programmatic EIS to complete a tiered NEPA evaluation to document avoidance, minimization, or mitigation of impacts to important bird habitat (e.g., established private, State, or federal special management areas for birds, IBAs, Regional Western Hemisphere Shorebird Reserve Network, [http://www.whsrn.org/whsrn-sites], etc.) to achieve no significant impact to avian resources.
- Siting considerations
  - Consult with Federal (including Department of Defense), State, and county agencies; tribes; property owners, and other stakeholders to identify potentially significant issues
  - Minimize the extent of the project footprint, including improved roads and construction staging areas.
  - Avoid constructing turbines in areas of concentrated prey base for raptors (e.g., prairie dog towns).
  - Avoid locating wind energy developments in areas of unique or important recreation, wildlife, or visual resources. When feasible, a wind energy development should be sited on already altered landscapes.
  - Do not locate individual meteorological towers in or adjacent to sensitive habitats or in areas where ecological resources known to be sensitive to human activities are present.
  - Evaluate potential avian and bat use (including the locations of active nest sites, colonies, roosts, and migration corridors) of the project and use data to plan turbine (and other structure/infrastructure) locations to minimize impacts.
  - If significant impacts on Important Bird Areas (IBAs) or similar ecologically important avian areas are not avoided, minimized, or mitigated, then this Final PEIS will not apply and a separate project specific NEPA evaluation must be developed and approved by the appropriate responsible federal agency prior to project construction.
- Construction considerations
  - Minimize the use of guy wires on permanent meteorological towers or use designs for towers that do not require guy wires. If guy wires are necessary, they shall be equipped with line marking devices.
  - Locate stationary construction equipment (e.g., compressors or generators) as far as practical from nearby sensitive receptors.
  - The transmission lines shall be designed and constructed with regard to the recommendations in Avian Protection Plan Guidelines (APLIC and USFWS 2005), in conjunction with Suggested Practices for Avian Protection on Power Lines (APLIC 2006) and Reducing Avian Collisions with Power Lines (APLIC 2012), to reduce the operational and avian risks that result from avian interactions with electric utility facilities.
- If pesticides/herbicides are to be used on the site, develop an integrated pest and vegetation management plan to ensure that applications will be conducted within the framework of managing agencies and will entail the use of only EPA-registered pesticides/herbicides that are (1) nonpersistent and immobile and (2) applied by

licensed applicators in accordance with label and application permit directions, following stipulations regarding suitability for terrestrial and aquatic applications.

- Increasing turbine cut-in speeds (i.e., prevent turbine rotation at lower wind velocity) in areas of bat conservation concern during times when active bats may be at particular risk from turbines.
- Lighting for facilities shall not exceed the minimum required for safety and security, and full cutoff designs that minimize upward light scattering (light pollution) shall be selected.
- Turn off unnecessary lighting at night to limit attraction of migratory birds. Follow lighting guidelines, where applicable, from the Wind Energy Guidelines Handbook.
- Place marking devices on any newly constructed or upgraded transmission lines, where appropriate, within suitable habitats for sensitive bird species.
- Decommissioning
  - Facilities constructed on Federal lands should follow the decommissioning recommendations provided in the USFWS's Land-Based Wind Energy Guidelines (USFWS 2012b).

The complete, detailed list of BMPs can be found in Appendix A, which is attached.

Based on the preliminary turbine array, the Project will not impact the wildlife habitat within natural areas such as the WMAs or high quality native prairie tracts along the Minnesota River. As feasible, WTGs and other associated facilities will be located a distance far enough away from native prairie to allow for prairie management, such as prescribed burning, by the MNDNR and other agencies. The Applicant was originally considering different arrays and a larger project area. Based on consultations with agencies such as the MNDNR, the Applicant modified the array and project area to avoid and minimize potential impacts to habitat and natural resources.

The Applicant is conducting a pre-construction inventory of existing biological resources, native prairie, and wetlands in the project area (Appendix H). The Applicant will use the results of the pre-construction biological survey to minimize and avoid impacts to wildlife and sensitive native habitats during final Project engineering and design of WTGs and access roads. The Applicant has also initiated an acoustic survey to gather information on bat passage rates in the various habitats of the project area. The Applicant will analyze the results of the acoustic bat monitoring surveys during final design and engineering to minimize impacts to bats.

Using information from the surveys and in consultation with the MNDNR and USFWS, the Applicant will prepare an Avian and Bat Protection Plan, which will include measures to minimize impacts to rare birds and bats. The MNDNR has also recommended the following measures to minimize impacts to bats:

- place turbines an adequate distance from the river corridor and forested areas,
- feather turbine blades below cut-in speeds, and
- conduct post-construction fatality monitoring.

The Applicant will conduction post-construction monitoring surveys, which will include estimates of mortality for birds and bats and any unexpected impacts. If significant bird or bat mortality from WTG collision is documented after construction, it is recommended that the Applicant consult the MNDNR or other appropriate agency to determine if modifications to the Project can be made to reduce mortality or if an alternate acceptable mitigation strategy can be developed.

Other mitigation measures include implementing effective erosion and sedimentation controls as part of stormwater management during construction to minimize potential impacts to water quality and mussels in nearby waterbodies and streams. Erosion control measures will use wildlife friendly materials as possible to minimize potential impacts to snakes and other ground-dwelling wildlife.

The Project will primarily impact agricultural land, which provides limited habitat. Several MBS Sites are in proximity to the project area. These sites will be avoided by Project construction. To further avoid and minimize potential impacts to MBS and other sensitive habitat, indirect impacts from surface runoff or the spread of invasive species will be considered during project design and implementation, including stormwater management plans during construction and use of weed-free, native seed mixes for restoration areas.

Areas that are impacted by temporary construction will be restored with weed-free, native seed mixes. Site and vegetation restoration measures are consistent with the MNDNR's recommendation for prairie and grassland restoration in the Prairie Core Areas. Other sensitive habitat areas will be avoided by the Project.

7.16 RARE AND UNIQUE NATURAL RESOURCES

Rare and unique natural resources within the vicinity of the project area include native prairie, floodplain forest, and the Minnesota River valley.

7.16.1 Description of Resources

Since the mid-1800s, native prairie in Minnesota has been significantly reduced to about one percent of its extent. This is due to settlement and conversion of native prairie to agriculture, housing and other land uses. Conversion of prairie to farmland also typically included draining and ditching of wetlands. Additionally, fire suppression and planting of tress for windbreaks and other purposes, established trees in some areas where prairie or wetland may have been originally. Prairie and wetland habitats are a fraction of what they were before the mid-1800s, making these a unique resource in Chippewa County. In general, only about one percent of the original native prairie in Minnesota remains. Specifically, Dry Hill Prairie (native prairie) is identified on the MNDNR Minnesota Biological Survey (MBS) (2007) map in several narrow areas along the railroad in the western portion of the project area.

The Silver Maple – (Virginia Creeper) Floodplain Forest (rare wetland) has a conservation status rank of S3 by the MNDNR, which may qualify this habitat as a rare natural community. Silver Maple – (Virginia Creeper) Floodplain Forest is typically composed of silver maple (*Acer saccharinum*) and cottonwoods (*Populus deltoides*). Other trees such as willows (*Salix* sp.), green ash (*Fraxinus pennsylvanica*), hackberry (*Celtis occidentalis*), American elm (*Ulmus americana*) and basswood (*Tilia americana*) can also be present. This type of rare wetland is identified on the MNDNR MBS map as located in the Spartan WMA, which is outside of the project area boundary, as shown on **Figure 10**.

The Minnesota River is a significant and unique natural resource in Chippewa County and for the state of Minnesota. The River corridor provides rare and unique habitat to many species of birds, waterfowl and wildlife (see Section 7.15). The River corridor also has granite outcroppings, known as some of the oldest rocks discovered in North America, approximately three billion years old. The Minnesota River provides recreational opportunities, is a centerpiece for many communities, and connects people with nature.

7.16.1.1 Minnesota NHIS Data

A query of the MNDNR Natural Heritage Information System (NHIS) was completed to determine if there are rare species or other significant features in the project area (Appendix G). The results of the NHIS query indicated the presence of Ecologically Significant Areas (**Figure 10**): Prairie Core Area (Upper Minnesota River Valley); MBS sites of moderate biodiversity including Dry Hill Prairie remnants (native prairie), and Silver Maple – (Virginia Creeper) Floodplain Forest (rare wetland).

A Prairie Core Area (MN Prairie Conservation Plan), Upper Minnesota River Valley, is an area identified for prairie or grassland restoration after project construction. Core Areas retain some features of a functioning prairie landscape and include 71% of Minnesota's remaining native prairie (MNDNR 2011). This Core Area overlaps the project area (**Figure 10**).

The Dry Hill Prairie (native prairie) is considered to have well-drained soils that formed from glacial till on slopes and hilltops in large river valleys, such as the Minnesota River. There are several narrow areas of native prairie identified on the MNDNR MBS map near the southwestern edge of the project area along the railroad tracks, as shown on **Figure 10.**

The Silver Maple – (Virginia Creeper) Floodplain Forest (rare wetland) has a conservation status rank of S3 by the MNDNR, which may qualify this habitat as a rare natural community. Minnesota Rules, part 8420.0515 subpart 3, and the Wetland Conservation Act (WCA) do not allow modification of a rare natural community. This type of rare wetland is identified on the MNDNR MBS map as located in the Spartan WMA, which is located outside of the project area boundary (**Figure 10**).

The NHIS query also identified state-listed bird and wildlife species in the project vicinity. The Minnesota River provides habitat for several state-listed mussels. State-listed snakes in this area include the gopher snake (*Pituophis catenifer*), a state-listed species of special concern, and the western foxsnake (*Pantherophis vulpina*) a Species in Greatest Conservation Need as identified in Minnesota's State Wildlife Action Plan.

Although there are no NHIS records for bats near the Project, the MNDNR indicated that all seven of Minnesota's bats can be found throughout Minnesota. The northern long-eared bat (*Myotis septentrionalis*), tricolored bat (*Perimyotis subflavus*), big brown bat (*Eptesicus fuscus*), and little brown bat (*Myotis lucifugus*) are all state-listed species of special concern. There was a total of six bat species documented throughout the course of the surveys (Fall 2015 and Fall 2016) (NCE 2016). Three species of concern in the State of Minnesota were observed during the acoustic bat monitoring. These species included the tricolored bat, big brown bat, and the little brown bat. The northern long-eared bat is a federally threatened species with a species range that includes the majority of the eastern United States, extending west through Minnesota to the western borders of the Dakotas. No confirmed documentation of the northern long-eared bat in the project area was recorded during the Fall 2015 to Fall 2016 acoustic bat monitoring (see Appendix H for the Final Acoustic Bat Summary Report).

The NHIS query indicates a documented bald eagle (*Haliaeetus leucocephalus*) nest located just outside the project area (Section 11, T116N R40W) along the Minnesota River. This nest was active when checked in 2000, 2001, and 2005. The current status of this nest is unknown. An additional nest was located in Section 20, T116N R39W which was not in the historical database and is located outside of the project area. The Applicant is completing point count surveys of bald eagles and plans to conduct aerial eagle nest surveys with 10 miles of the project area in Spring 2017. This information will be used to further evaluate eagle activity in the area.

The project area overlaps with the Upper Minnesota River Valley Important Bird Area (IBA). IBAs, identified by Audubon Minnesota in partnership with the DNR, are part of an international conservation effort aimed at conserving critical bird habitats (Audubon 2016). IBAs are voluntary and non-regulatory, but the MNDNR has indicated the designation demonstrates the biological value of this area. This particular IBA incorporates the riparian corridor and adjacent river valley and upland communities along the Minnesota River and provides excellent habitat for a wide variety of bird species. This IBA contains significant bird habitat in an intensely agricultural area and is a natural corridor for migrating birds. Over 200 species, including state-listed species and Species in Greatest Conservation Need (SGCN; as identified in Minnesota's State Wildlife Action Plan - http://www.dnr.state.mn.us/cwcs/index.html) are known to use the IBA.

The NHIS indicated breeding season observations of two rare grassland birds: the lark sparrow (*Chondestes grammacus*), a state-listed species of concern, and the upland sandpiper (*Bartramia longicauda*), a SGCN. A minimum of 20 SGCN are known to use grassland habitat within the Minnesota River Prairie Ecological Subsection (where the Project is located). Potential impacts to grassland birds are a concern because many of these species are declining in number nationwide. There are small areas of grassland located within the project area, which may provide habitat for these species. The primary land disturbance for the Project will occur on cultivated, agricultural land, and as feasible, avoid grassland areas. As of November 20, 2016, the lark sparrow and upland sandpiper have not been identified during the avian point count surveys. Details of the survey results, as of November 20, 2016, can be found in Appendix H.

7.16.1.2 Federal Species Known From County Records

A list of federally threatened, endangered, candidate and proposed species was obtained for Chippewa County, Minnesota from the USFWS Information for Planning and Conservation (IPaC) website (USFWS 2016). Federal species with potential to occur are described in **Table 7-14**.

Table 7-14: Federally-listed Species

Species/Critical Habitat	Status[1]	Potential to Occur in the Project Area	*Habitat Description and Range in Minnesota*
Northern Long-Eared Bat (*Myotis septentrionalis*)	T	Yes	*Forested habitats, emergent wetlands, agricultural fields, caves and mines*
Dakota Skipper (*Hesperia dacotae*)	T/CH	No	*High-quality mixed and tallgrass prairie*
Poweshiek Skipperling *(Oarisma poweshiek)*	E/CH	No	*High-quality mixed and tallgrass prairie*

[1] Status Codes: E=federally listed endangered; T=federally listed threatened; P=federally proposed for listing; C=federal candidate for listing; and CH=designated critical habitat

7.16.1.3 State Endangered, Threatened or Special Concern Species Identified in Tier 3 Surveys.

As of November 20, 2016, two state special concern species (bald eagle (*Haliaeetus leucocephalus*) and American white pelican (*Pelecanus erythrorhynchos*)) were observed during the avian surveys. None of these species are protected by the federal Endangered Species Act.

Bald Eagle

In 2007, the bald eagle (State Special Concern) was delisted from its federally threatened status in the lower 48 states, but it is still federally protected under the Bald and Golden Eagle Protection Act ("BGEPA"). It was also delisted in Minnesota in 2013.

Bald eagles associate with distinct geographic areas and landscape features, including nest sites, foraging areas, communal roost sites, migration corridors and migration stopover sites (USFWS 2013). They are typically found near water bodies, natural and manmade, due to the presence of fish. They prefer to nest, perch, and roost in old-growth or mature stands of trees, and they usually select a nesting tree that is the tallest among those in its vicinity, to provide visibility. Nesting trees are usually situated near a water body that supports fish, their main preferred prey.

Existing data on bald eagle nest locations was received from the MNDNR on July 5, 2016. Based on historical records, one nest is in Section 11, T116N R40W, estimated to be greater than one mile west of the nearest WTG. During field surveys, another eagle's nest was located in the Minnesota River Valley, approximately one mile southeast of the nearest WTG (WTG 12). This nest was not recorded in the NHIS database. Both nests are located outside of the project area.

As of November 20, 2016, eight eagle observations consisting of ten individuals were identified during the Avian Point Count Surveys (Wenck 2016). Additional eagles were observed during the Eagle Point Count Surveys. At this time, the Applicant has met with the USFWS and MNDNR and has provided preliminary avian point count data. Based on agency discussions, eagle nesting areas will be avoided, as feasible, and Palmer's Creek will continue to conduct point count surveys of bald eagles, and conduct aerial eagle nest surveys within 10 miles of the project area in Spring 2017. This information will be used to further evaluate eagle activity in the area. Additionally, due to the Minnesota River Valley being a significant migration corridor, MNDNR has recommended post-construction avian fatality monitoring, which the Applicant will implement as part of this Site Permit.

American White Pelican

The MNDNR currently lists this species as special concern, and several studies have shown this species increasing in abundance across its range over the past 20-25 years (Wires et al. 2001; Evans and Knopf 1993). This species is a colonial nesting species that selects large, shallow bodies of water with flat bare islands isolated from human disturbance (Coffin and Pfannmueller 1988).

As of November 20, 2016, American white pelicans (State Special Concern) were observed on one occasion during the Avian Point Count Surveys. One flock was observed consisting of four individuals. Overall 0.1 individuals per hour were observed during the avian point count surveys. The observation was made within the RSA (see Appendix H).

7.16.1.4 Identify Native Prairie Within Or Adjacent To Project Area

Dry Hill Prairie (native prairie) is identified on the MNDNR Minnesota Biological Survey (MBS) (2007) map in several narrow areas along the railroad in the southwestern portion of the project area. Dry Hill Prairie is considered to have well-drained soils that formed from glacial till on slopes and hilltops in large river valleys, such as the Minnesota River. Dominant grasses in Dry Hill Prairie typically include little bluestem (*Schizachyrium scoparium*), side-oats grama (*Bouteloua curtipendula*), porcupine grass (*Hesperostipa spartea*), and prairie dropseed (*Sporobolus heterolepis*), with much Indian grass (*Sorghastrum nutans*), big bluestem (*Andropogon gerardii*), and Leiberg's panic grass (*Dichanthelium leibergii*) in dry-mesic areas such as mid-slopes. Common shrubs include leadplant (*Amorpha canescens*), wolfberry (*Symphoricarpos occidentalis*), and prairie rose (*Rosa arkansana*). Common forbs are rough blazing star (*Liatris aspera*), alumroot (*Heuchera richardsonii*) silverleaf scurf pea (*Psoralea argophylla*), heart-leaved alexanders (*Zizia aptera*), prairie milk vetch (*Astragalus adsurgens*), purple prairie clover (purple prairie clover), heath aster (*Symphyotrichum ericoides*), prairie smoke (*Geum triflorum*), and hairy golden aster (*Chrysopsis villosa*). MNDNR has indicated the native prairie areas may contain Missouri milk-vetch (*Astragalus missouriensis* var. *missouriensis*), a state-listed plant species of special concern, and Sullivant's milkweed (*Asclepias sullivantii*), a state-listed threatened plant.

Visual observations of the prairie areas indicated native prairie species are present, but have been heavily invaded by eastern red cedar (*Juniperus virginiana*) and smooth brome (*Bromus inermis*).

The project area includes approximately 476 acres of pasture/hay land and grassland (NLCD 2011) as summarized in **Table 7-10** in Section 7.15. None of the pasture/hay land nor grassland is classified as native prairie as shown on **Figure 10**. The Project is not expected to disturb native prairie.

7.16.2 Impacts

Project siting would occur primarily on agricultural land that has been previously disturbed for cultivated crops and other agricultural practices. MBS, native prairie, and wetland areas will be avoided during siting or horizontal boring will be used to avoid impacts from disturbance. Visual impacts, as discussed in Section 7.6 could occur for users of the River. These impacts would be dependent on vantage point and individual perceptions of the Project. The Project is not anticipated to directly impact rare and unique resources.

7.16.3 Mitigative Measures

The Applicant has committed to implement several BMPs and conservation measures, derived from the Upper Great Plains Wind Energy Final Programmatic EIS, for the Palmers Creek Wind Farm Project. The primary BMPs related to rare and unique natural resources include:

- ▲ Siting considerations
  - Consult with Federal (including Department of Defense), State, and county agencies; tribes; property owners, and other stakeholders to identify potentially significant issues
- ▲ Disturbed surfaces shall be restored to their original contours as closely as possible and revegetated immediately after, or contemporaneously with, construction

The complete, detailed list of applicable BMPs can be found in Appendix A.

Based on the preliminary turbine array, the Project will not impact the wildlife habitat within natural areas such as the WMAs or native prairie tracts. As feasible, WTGs and other associated facilities would be located a distance far enough away from native prairie to allow for prairie management, such as prescribed burning, by the MNDNR and other agencies. The Applicant was originally considering different arrays and a larger project area. Based on consultations with agencies such as the MNDNR, the Applicant modified the array and project area to avoid and minimize potential impacts to habitat and natural resources.

The Project will primarily impact agricultural land, which provides limited habitat. Several MBS Sites are in proximity to the project area. These sites will be avoided by Project construction. To further avoid and minimize potential impacts to MBS and other sensitive habitat, indirect impacts from surface runoff or the spread of invasive species will be considered during project design and implementation, including stormwater management plans during construction and use of weed-free, native seed mixes for restoration areas.

The Applicant will work with the DOC and MNDNR to develop a Native Prairie Protection Plan. The Applicant has considered the location of native prairie during Project design. Site and vegetation restoration measures are consistent with the MNDNR's recommendation for prairie and grassland restoration in the Prairie Core Areas. Areas that are impacted by temporary construction will be restored with weed-free, native seed mixes. Other sensitive habitat areas will be avoided by the Project.

7.17 CULTURAL AND ARCHAEOLOGICAL RESOURCES

The project area is in the Prairie Lake Region (Region 2), which is in southwestern and south central Minnesota. From a regional perspective, material from any cultural period (Paleo-Indian to modern) could be expected to be encountered in any archaeological region.

This area was first inhabited by Paleo-Indian tribes that moved through the area as they hunted native herding animals, such as bison. As time went on, tribes diversified their technologies to allow them to hunt, trap, fish, forage, craft wood products, and process plants. Eventually tribes became less migratory and settled into areas of Minnesota including areas near the Minnesota River, where sources of food and building materials were readily available.

The Homestead Act of 1862 and the development of railroads started moving European settlers west into Minnesota. The US Dakota Conflict of 1862 pushed the Dakota people out of the area an onto reservations. Granite Falls became a city in 1889, growing from the construction of a dam and operation of a flour mill. In 1938, approximately 746 acres of land south of Granite Falls was returned to the Dakota Oyate Nation and the Upper Sioux Indian Community was created. An additional 654 acres of land was later added for a total of 1,440 acres comprising the Upper Sioux Community Reservation. (BCA 2017)

7.17.1 Description of Resources

A records search of the Minnesota State Historic Preservation Office (SHPO) files was conducted for the Project on May 24, 2106, to identify known archeological sites, historic period structures, previous archeological surveys, and other cultural resources data within the area of potential effects (APE) for the Project (Appendix G). Cultural resources consist of any historic and prehistoric district, site, building, structure, or object (usually) over 50 years of age.

A cultural resources study (Appendix K) was conducted beginning in late 2016 and completing a preliminary draft report in March 2017 (BCA 2017). This study defined an Area of Potential Effect (APE) for the Project as the combined construction area of all Project components. The cultural resources survey area encompassed the entire APE. At the time of survey, vegetation within the APE consisted primarily of plowed agricultural fields with some rangeland as well as fallow grasslands.

The cultural resources report and fieldwork preparation included a review of previously identified cultural resources, intensive pedestrian survey of the APE, and shovel tests. The layout of the windfarm changed during the course of fieldwork, and the results were divided into the Stage I inventory (the original design), and the Stage II inventory (the updated design). The project area was inventoried to comply with state and federal regulations to locate any historic properties within or around the proposed project area, which may be affected by the Project. This allowed the Applicant to plan construction to minimize impact to any National Register of Historic Places (NRHP) eligible historic properties.

The literature search revealed 12 archaeological sites and 90 historical/architectural sites within a one-mile radius of the APE. Of these, one archaeological site (21CP11), one site lead (21CPa), and no historical/architectural sites were located within the final (Stage II) APE. During the Stage I field inventory (November 14-17, 2016), BCA archaeologists identified two sites (21CP77 and 21CP78). In addition, three previously recorded mound sites (21CP9, 21CP10 and 21CP11) and one unidentifiable site lead 21CPa were located within the APE. During the Stage II field inventory (February 15-16, 2017), one site (21CP79) was identified. One previously recorded site (21CP11) and one site lead (21CPa) were within the APE. As a result of the Stage II pedestrian inventory, one new historical and architectural site (21CP79) was recorded. The site has been recommended ineligible to the NRHP. In addition, a light scatter of historic cultural material and a piece of workable lithic raw material were found but were not recorded as sites, following SHPO site form instructions. **Table 7-15** provides a summary of the previously recorded sites located in the Stage I and Stage II APEs.

Table 7-15: Previously Recorded Cultural Resources Sites Within Stage I and Stage II Project APEs

Site Number	Affiliation	Description	NRHP Evaluation
21CPa	Unknown	Site Lead: Gravel Pit NW of Granite Falls	Unevaluated
21CP9	Unknown	Mounds	Unevaluated
21CP10	Unknown	Mounds	Unevaluated
21CP11	Unknown	Mounds	Ineligible
21CP77	Historical/Archtectural	Six foundations and one barn	Not eligible
21CP78	Historical/Architectural	One flake	Not eligible
21CP79	Historical/Architectural		Not eligible

Source: BCA 2017

The final design avoids all known eligible or unevaluated sites in the project area, but shovel tests need to be conducted in high probability areas, such as uplands overlooking stream crossings. The ground was frozen, so shovel tests were unable to be conducted. In addition, one turnout was submerged in water from melting snow and could not be surveyed.

7.17.2 Impacts

During Project construction and operation activities, Palmer's Creek would physically avoid NRHP-eligible properties and unevaluated properties, which are being treated as eligible for purpose of this Project. If cultural resources were to be found during construction activities, all work would cease at that location and the notification and protocols identified in Appendix A would be followed. As such, the Project is not anticipated to adversely affect historic resources. However, since shovel tests were not conducted and the inundated turnout was not surveyed, additional work is required to make a recommendation if the project will impact historic properties. As such, an addendum to the cultural resources report including the turnout APE survey and shovel tests results will be submitted at a later date.

7.17.3 Mitigative Measures

Due to the presence of unevaluated mound sites in the Stage I APE, the project design was updated to avoid these sites, and additional fieldwork was conducted. An additional site was found in the Stage II APE and fieldwork. This site was recommended as ineligible for the NRHP, and no avoidance is required.

In addition to the Phase I inventory, BCA will conduct an architectural inventory of historic properties near the project area and a viewshed analysis evaluating the potential visual impact to historic properties and tribally significant properties near the project area. The results of these studies will be included in separate reports at a later date.

Table 7-16: Avoidance Measures for Previously Recorded Cultural Resources Sites

Site Number	Avoidance Measures
21CPa	No avoidance necessary
21CP9	Avoidance
21CP10	Avoidance
21CP11	No avoidance
21CP77	No avoidance necessary
21CP78	No avoidance necessary
21CP79	No avoidance necessary

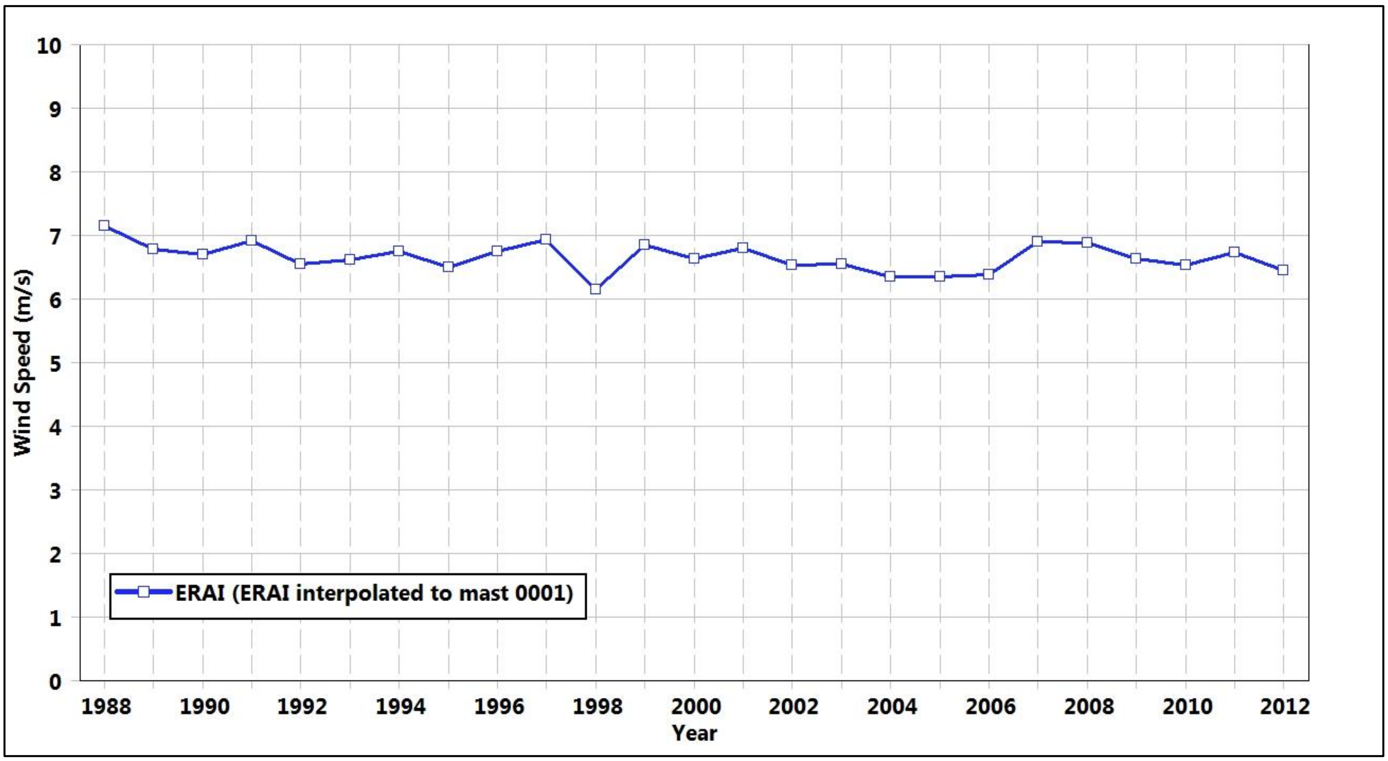
Source: BCA 2017

8.1 SITE WIND CHARACTERISTICS

AWS Truepower, LLC (AWST) was retained by the Applicant to assess the wind resource for the Project. For this analysis, AWST has validated and analyzed approximately 13 months of data collected at one, 60 m, meteorological tower located within the project area (Figure **2**), designated as Mast 0001. The mast data was adjusted to the long term using the measure-correlate-predict (MCP) method with a Modern-Era Retrospective Analysis for Research Applications (MERRA-2) data set interpolated to the mast location.

8.1.1 Interannual Variation

There is only one full year of on-site data at Mast 0001, so alternative data sources are necessary to estimate Interannual Variation (IAV). Wind speed IAV was studied and an IAV map was produced using the global ERA-Interim reanalysis dataset1[1]. The map suggests that the standard deviation of annual mean wind speeds for the Project is about 3%.

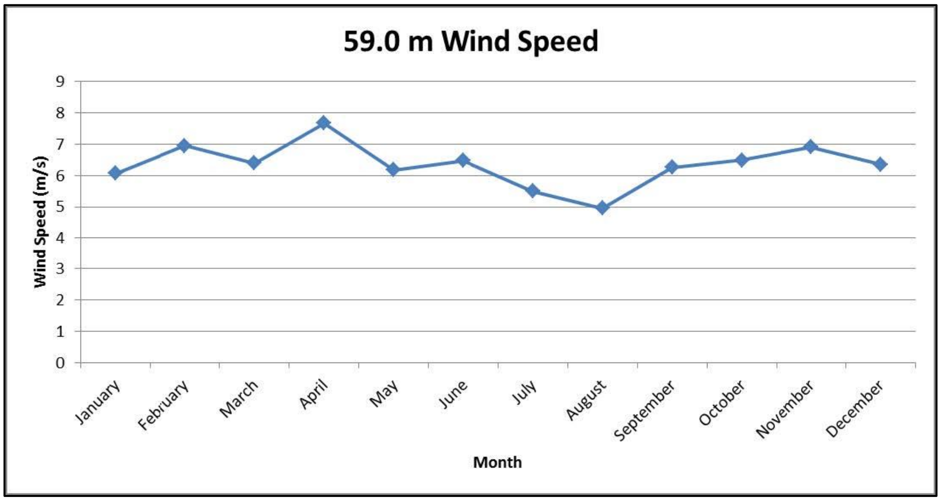


Graphic 1: ERAI Annual Trend Data for Palmer's Creek

[1] Michael C. Brower, et al., "A Study of Wind Speed Variability Using Global Reanalysis Data", AWS Truepower, May 2013.

8.1.2 Seasonal Variation

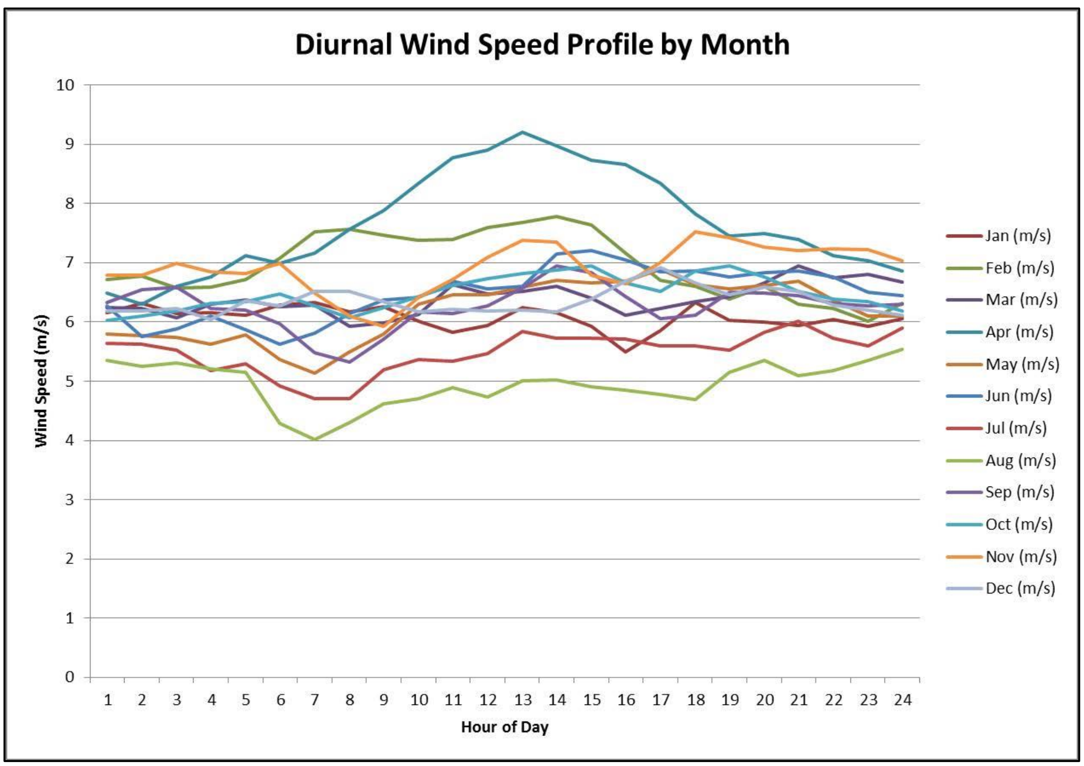
Graphic 2 shows the weighted mean winds at Mast 0001 during the period September 2015 to October 2016. Winds are strongest in late winter and early spring, and are weakest in summer.



Graphic 2: Seasonal Wind Variation

8.1.3 Diurnal Conditions

Diurnal wind speeds tend to have little variation throughout the day. In winter months, wind speeds tend to be higher during daylight hours. Highest diurnal variation in wind speed is observed in April (**Graphic 3**).



Graphic 3: Diurnal Wind Speeds

8.1.4 Hub Height Turbulence

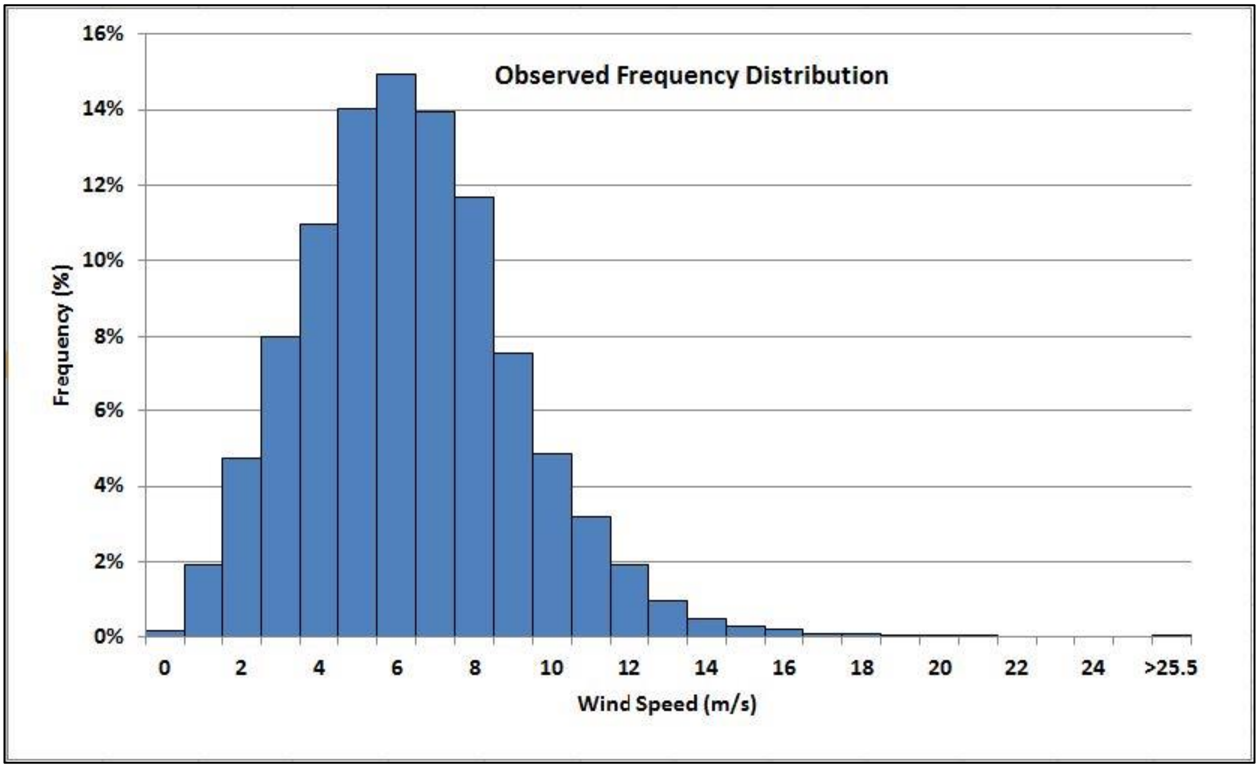
The turbulence intensity is defined as the standard deviation of the wind speed divided by its concurrent mean wind speed for a given averaging period, in this case ten minutes. For wind speeds greater than 4 m/s (8.9 mph), the average turbulence intensity at 80 m (262 feet) is estimated to be 0.11. The 15 m/s TI at 80 m is estimated to be 0.13.

8.1.5 Extreme Wind Conditions

The maximum 10-minute mean wind speed recorded by Mast 0001 at 59 m was 30.20 m/s (67.56 mph), and the maximum gust was 42.15 m/s (94.29 mph).

8.1.6 Wind Speed Frequency Distribution

An annualized wind speed frequency distribution based on Mast 0001 at 59 m is presented in **Graphic 4**.



Graphic 4: Wind Speed Frequency Distribution

8.1.7 Wind Variation with Height

Wind shear is the relative change in wind speed as a function of height. Wind shear is calculated using a power function based upon the relative distance from the ground. The general equation used for calculating wind shear is,

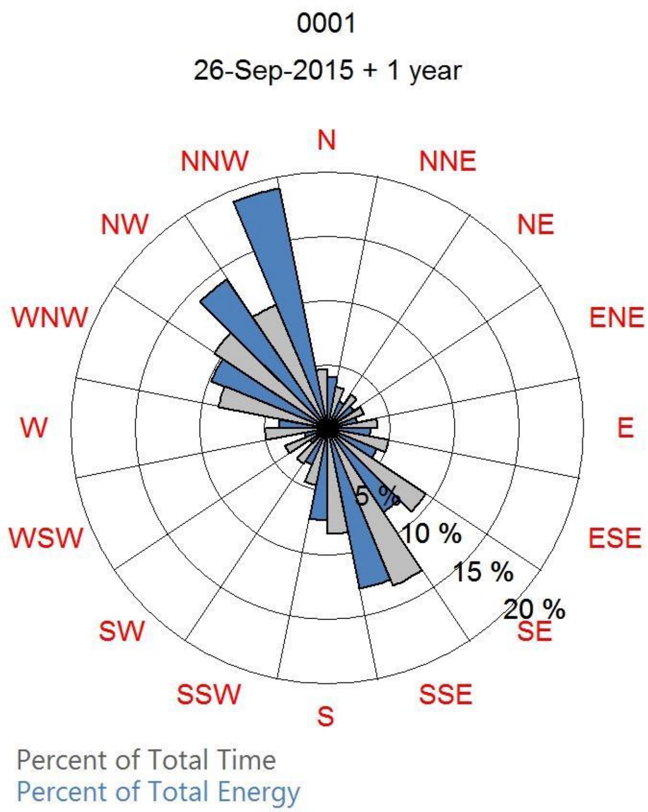
$$\alpha = \frac{ln\left(\frac{V_{TH}}{V_{LH}}\right)}{ln\left(\frac{h_{TH}}{h_{LH}}\right)}$$

where VTH and VLH, and hTH and hLH are the measured wind speeds and height, respectively of the installed sensors at the upper and lower level heights.

The power coefficient can vary greatly due to the terrain roughness and atmospheric stability, and will also change slightly with variation in height. The meteorological tower measures wind speed at a three levels, 59.0 m, 40.0 m, and 30.0 m. The annualized 30.0 m to 59.0 m wind shear is 0.29, the shear varies diurnally from 0.17 to 0.39, and monthly averages vary from 0.224 to 0.338.

8.1.8 Spatial Wind Variation
The range of expected long-term mean annual wind speeds at hub height (80 and 90 m) at the proposed turbine sites range from 6.97 to 7.41 m/s.

8.1.9 Wind Rose
A complete year wind rose for Mast 0001 is presented in **Graphic 5**. Prevailing frequency and energy direction sectors are SSE and NNW respectively.



Graphic 5: Wind Rose

8.1.10 Other Meteorological Conditions
At the Minneapolis-St Paul observation station, there are long-term annual averages of 95 clear days, 101 partly cloudy days and 169 cloudy days. On average there are 51 inches of

snowfall and 26 inches of rainfall annually.[2] There are nine lightning flashes per square kilometer annually at this site. There are an average of 36 tornadoes annually in the state of Minnesota (measured between 1950 and 2015), according to the MNDNR.[3]

8.2 LOCATION OF OTHER WIND TURBINES WITHIN FOUR MILES OF PROJECT AREA

There were no surrounding wind farms within 50 rotor diameters, about 3.5 miles or six kilometers, of the project area, and therefore not modeled in the energy production estimate.

[2] http://www.usclimatedata.com

[3] http://www.dnr.state.mn.us

9.0 Project Construction

Section 3 of the Final UGP Wind Energy PEIS describes the activities likely to occur during each of the major phases of a typical wind energy project's life cycle – site testing and monitoring, construction, operation, maintenance, and decommissioning. The same project phases, with similar types of activities for each phase, will occur for this Project. Leases for the Project are for the life of the PPA with a 20-year option to extend.

The WTGs and associated facilities will be sited on agricultural land in Chippewa County, Minnesota. The Applicant's proposed siting layout (included) optimizes wind and land resources at the site while minimizing Project impacts. The WTGs will have a rotor diameter (RD) of 116 meters (380 ft.) and the Project will have, on average, east-west spacing between individual turbines of 6 RD and north-south spacing of 10 RD. A final as-built siting layout and site plan will be provided for approval prior to the pre-construction meeting.

9.1 ROADS AND INFRASTRUCTURE

Tower section, nacelles, blades, pad-mount transformers, and all other hardware components will be delivered via semi-truck from US Highway 212. The staging area for the hardware will be located within the Project Area so the parts can be unloaded and stored until they are needed at the individual site locations.

Impacts to the existing local roads will be minimal. It may be necessary to increase the radius of some corners, but this has not been determined yet. Any damage to the roads cause by turbine delivery and project construction will be repaired. It is estimated that vehicle traffic will increase by approximately 100-125 vehicles both large and small combined.

The Applicant will work with Chippewa County to develop road maintenance and encroachment agreements prior to Project construction. Coordination with County staff will include standards for use of the existing local roads, including County and township roads, and any road maintenance needed because of Project construction.

9.2 ACCESS ROADS

Graveled access roads branching from existing graveled section line roads that cross the project area will provide access to the various turbines (**Figure 2**). In some areas, new roads will be designed to allow for the transportation of heavy equipment to the Project Area, and will be used throughout the life of the wind farm to allow access to and from the wind turbines, substation and meteorological towers. The turbine access roads typically may be constructed two different ways. On arid sites where there is substantial subgrade bearing capacity and little danger of precipitation challenging the soil properties, a narrow (approximately 16-foot wide) road will be constructed, with an additional 24-ft width graded and compacted to support the other crawler crane track. The vegetative subgrade will be removed for the depth of the rock to be replaced, approximately 6 inches deep. The soils will be treated prior to gravel placed on the road and compacted. The treated or stabilized soils replace the use of geotextile fabric.

Project road construction will involve the use of several pieces of heavy machinery including bulldozers, track-how excavators, front-end loaders, dump trucks, motor graders, water trucks and rollers for compaction. Storm water controls, such as hay bales, silt fences and diversion ditches in some areas will control storm water runoff during construction in accordance with local, state and federal regulations.

9.3 ASSOCIATED FACILITIES

9.3.1 Operational and Maintenance Facility

An O&M building will be constructed on the site for storage and access for the Project operations (**Figure 2**). The building will be approximately 4,000 square feet with an adjacent parking lot. The O&M facility will also have a new septic system and well installed for domestic purposes. The parking lot is estimated to be approximately 44,000 square feet around the O&M building.

9.3.2 Step-Up Substation

The Project will have a step-up substation (Palmer's Creek Substation) consisting of breakers, transformer, meters, controllers and communication systems to convert the electricity from 34.5kV to 115kV (**Figure 2**). The substation will be engineered to comply with the Independent Systems Operator needs (Southwest Power Pool) along with the transmission owner. Total acreage needed for the proposed substation is approximately one to two acres.

9.3.3 Electrical Collector and Communication Systems

The collector lines from each turbine (Figure **2**) will be comprised of approximately 14 miles of underground, insulated electrical cable. The 34.5-kilovolt (kV) electric collection grid and fiber optic communication network will terminate at the new substation. The underground collector system will be placed in one trench, approximately 18-24 inches wide, and will connect each of the turbines to the Palmer's Creek Substation. The estimate trench length, is approximately 73,920 feet (approximately 14 miles).

The underground collector circuits will consist of three power cables contained in an insulated jacket and buried at a minimum depth of four feet that will not interfere with farming operations. Access to the underground lines will be located at each turbine site, and where the cables enter the Palmer's Creek Substation.

The underground electrical collector and communication systems generally will be installed by plowing or trenching the cables. Using this method, the disturbed soils and topsoil are typically replaced over the buried cable within one day, and the drainage patterns and surface topography are restored to pre-existing conditions. In grassland/rangeland areas, disturbed soils will be re-vegetated with a weed-free native plant seed mix.

The fiber optic communication cables for the Project will be installed in the same trenches as the underground electrical collector cables and will connect the communication channels from each turbine to the control room in the Palmer's Creek Substation.

9.3.4 Transmission Line

A 115 kV, 3-phase transmission line, approximately 1,000 feet (304 Meters) in length, will be installed to connect the proposed Palmer's Creek Substation for the delivery of electric power to the 115 kV Granite Falls Substation.

9.3.5 Laydown and Staging Areas

A laydown yard will be cleared of grub and topsoil creating a flat area with gravel for temporary construction offices and facilities (**Figure 2**). The total laydown and staging area will be approximately 3 acres. The area will house construction items such as wire, rebar, anchor bolts and other related objects for distribution as construction activities are scheduled.

9.3.6 Meteorological Tower

One permanent meteorological tower will be installed at the Project site to monitor the wind during the operation of the wind farm (**Figure 2**). This tower will be approximately 90 meters in height (295 ft.) tall. The tower will have a grounding system similar to that of the wind turbines with a buried copper ring and grounding rod or rod installed at the top of the tower to provide an umbrella of protection for the upper sensors. The tower will be connected to the wind farms central Supervisory Control and Data Acquisition (SCADA) system. In addition, the previously permitted temporary meteorological test tower may be kept in place for approximately one year after construction.

9.4 TURBINE SITE LOCATION

The Project will require several foundations, including bases for each turbine and pad transformer, and the substation equipment. Once the roads are complete for a particular set of turbines, turbine foundation construction will commence. Foundation construction occurs in several stages including excavation, form setting, rebar and bolt cage assembly, casting and finishing of the concrete, removal of the forms, backfilling and compacting, construction of the pad transformer foundation, and foundation site area restoration. The dimensions of the dirt crane pads are approximately 50 feet by 100 feet. The pad radius is graded to one percent or less.

9.4.1 Foundation Design

Footings are planned to be placed approximately ten feet deep. Freestanding tubular wind towers will be erected on reinforced concrete spread foundations. The foundation design will be based upon geotechnical data, turbine load and cost considerations. The foundation will be approximately 10 feet in depth and 60 feet in diameter and contain rebar, high strength anchor bolts embedded in the concrete.

9.4.2 Tower

The towers are cylinder-shaped in three or four sections totaling a height of 80 meters to 90 meters (262 to 308 feet). The towers are manufactured per American National Standards Institute (ANSI) specifications. The base of the tower will have a steel door for access into the tower and a ladder inside the towers to access the Nacelle.

9.5 POST CONSTRUCTION CLEAN-UP AND SITE RESTORATION

Post Construction Clean-Up and Site Restoration Post construction clean-up and restoration generally consists of landscaping and earthwork, it can be very weather and season sensitive. Landscaping clean-up is generally completed during the first allowable and suitable weather conditions after all the heavy construction activities have been completed. Disturbed areas outside of the graveled areas will be reseeded to control erosion by water and wind. Soil decompaction in agricultural production areas will also occur by salvaging topsoil prior to construction and tilling soils during restoration. All construction clean-up work and permanent erosion control measures will be done in accordance with the formal SWPPP for the Project.

Other project clean-up activities might include landscaping around the substation area as well as other miscellaneous tasks that are part of normal construction clean-up.

Construction clean-up will require the use of a motor grader, dump trucks, front-end loaders, and light trucks for transportation of any waste materials or packaging.

Palmer's Creek is committed to cleaning up construction debris and restoring temporarily impacted areas to the extent practicable, and to the satisfaction of landowners, following turbine installation. Post-construction cleanup and site restoration will be completed as soon as possible once construction in that area is completed. As noted above, it can be weather and season sensitive. Landscaping cleanup is generally completed during the first allowable and suitable weather conditions after all the heavy construction activities have been completed.

9.6 COSTS

The total Project installed capital cost is currently estimated to be $70,000,000, which includes land leases, turbine payments and EPC construction costs. The final installed capital cost of the Project is dependent on site conditions including ease of access, and turbine layout. Most Project costs are attributed to the wind turbine equipment. Operation and Maintenance cost is estimated to be $1,100,000 a year.

9.7 SCHEDULE

A tentative schedule has been proposed for Project activities, as summarized in **Table 9-1**. This includes anticipated timing for land acquisition, issuance of site permit, start of construction, construction completion, and commercial operation.

Table 9-1: Anticipated Project Schedule

Project Activity	Anticipated Date
Land Acquisition	Finalized November 2016
LWECS Site Permit Issued	July 2017
Commence Construction	July 2017
On-line/Construction Completion[1]	February 2018
Commercial Operation Date	March 2018

[1]It is anticipated the Project will come on-line and interconnect at the WAPA-Granite Falls Substation in February 2018. Commercial Operation Date (COD) of the Project is anticipated on or before March 2018.

9.7.1 Land Acquisition

The Applicant has entered into options to lease land and wind rights for all of the property required to support the Project. However, the Applicant may pursue additional land to optimize the Project.

9.7.2 Equipment Procurement, Manufacture and Delivery

Upon issuance of the Site Permit and completion of the pre-construction meeting, equipment deliveries and site mobilization will be initiated and will continue through construction.

9.7.3 Construction

Construction of the access roads, turbine foundations, and electrical collection system will take approximately 5-6 months to complete. The turbine erection schedule will overlap the civil and electrical installations and take approximately 2-3 months to complete. The entire construction and commissioning of the Project should take approximately 7-8 months.

9.7.4 Construction Financing

The Applicant has already secured both construction financing through its balance sheet and parent company equity investment.

9.7.5 Permanent Financing

The Applicant has already secured both construction and permanent financing.

9.7.6 Expected Commercial Operation Date

The anticipated commercial operation date (COD) is March 2018 following installation of the permanent tap.

9.8 ENERGY PROJECTIONS

When built, the Project will have a nameplate capacity of 44.6 MW. Assuming net capacity factors of approximately 39.2 percent, projected average annual output will be approximately 153,400 MWh. Net calculations take into account, among other factors, energy losses in the gathering system, mechanical availability, array losses and system losses.

9.8.1 Proposed Array Spacing for Wind Turbines

The turbines and associated facilities will be sited on agricultural land in Chippewa County, Minnesota. The Applicant's proposed siting layout (included) optimizes wind and land resources at the site while minimizing Project impacts. The turbines will have a rotor diameter (RD) of 116 meters (380 ft.), and the Project will have, on average, east-west spacing between individual turbines of 6 RD and north-south spacing of 10 RD. A final as-built siting layout and site plan will be provided for approval prior to the pre-construction meeting.

9.8.2 Base Energy Projections

When built, the Project will have a nameplate capacity of 44.6 MW. Assuming net capacity factors of approximately 39.2 percent, projected average annual output will be approximately 153,400 MWh. Net calculations consider, among other factors, energy losses in the gathering system, mechanical availability, array losses and system losses.

9.9 DECOMMISSIONING AND RESTORATION

Decommissioning will occur at the end of the project life or facility abandonment. For the purposes of this section, "facility abandonment" shall mean the ceasing of electricity generation for a period of not less than 12 continuous months, unless the company produces evidence of mitigating circumstances. Such evidence may include long delays in spare part procurement or a force majeure event that interrupts the generation of electricity. As used here, a "force majeure" event means an instance such as fire, earthquake, flood, tornado, or other act of God and natural disasters; strikes or labor disputes; war; any law, order, proclamation, regulation, ordinance, action, demand or requirement of any government agency; suspension of operations of all or a portion of the project for overhaul, upgrade, or reconditioning; or any other act or condition beyond the reasonable control of the Project Sponsor.

All decommissioning and restoration activities will adhere to requirements of appropriate governing authorities and will be in accordance with all applicable federal, state, and local laws.

The decommissioning plan and anticipated costs shall be reviewed and updated every five years by the Applicant.

9.9.1 Anticipated Life of the Project

The expected life of the Project is approximately 30 years (leases for the Project are for the life of the PPA, with an option to upgrade turbines and extend leases for an additional 20 years).

9.9.2 Cost to Decommission

The estimated cost to decommission Palmer's Creek Wind Farm was provided by Fagen, Inc., construction contractor, in a letter dated November 16, 2016. The estimate is considered to be the current dollar value (at time of approval) of salvage value and removal costs.

The estimated salvage value of each turbine will be based upon the worst-case scenario assuming the only salvage value of the turbine is from scrapping the steel. The estimate was based upon the total weight of one turbine, which is 275 tons consisting primarily of steel. Because it does not separate the scrap value of all the constituent materials, the estimate is very conservative. Also, it is highly likely that there would be opportunities for re-sale for reuse of all or some of the turbines or turbine components.

Based on the current estimate, the cost of decommissioning is $7,385,822 with a potential scrap return value of $445,500. These anticipated costs shall be reviewed and updated every five years by the Applicant.

9.9.3 List of Decommissioning and Restoration Activities

The decommissioning and restoration process includes the removal of above- ground structures (turbines); removal of below-ground structures (foundations and underground cables); and topsoil restoration.

9.9.3.1 Wind Turbines

Dismantling the wind turbines will require the use of cranes and heavy equipment. Electronic components, controls and internal cables will be disconnected and removed. The rotor and nacelle will be lowered to the ground for disassembly. The tower sections will be lowered to the ground where they will be further disassembled for transporting. The Applicant will attempt to identify a purchaser of the intact wind turbine components. If a buyer cannot be found, the rotor, nacelle, and tower sections will be reduced to shipping dimensions for transport to an offsite facility for reconditioning, salvage, recycling, or disposal.

If resold and not scrapped, tower sections and rotors will be transported in the same manner as their delivery to the site. It is assumed that transportation costs will be the responsibility of the purchaser of the scrap material.

9.9.3.2 Transformers

Transformer removal will consist of disconnecting the electrical connection system from the base transformer. Any sellable components will be removed and transported offsite.

9.9.3.3 Turbine foundations

Turbine foundations will be excavated to a depth of 48 inches below grade to sufficiently expose and remove all anchor bolts, rebar, conduits and pedestal concrete. The excavation will be filled with clean sub-grade material, compacted to a density similar to surrounding sub-grade material, and finished with topsoil.

9.9.3.4 Substation

The Applicant does not intend to decommission the substation.

9.9.3.5 Underground Cables

All underground cables at depths less than 36 inches below finished grade will be removed. All underground cables at depths greater than 48 inches below finished grade will be abandoned in place if it is determined that their presence does not adversely impact land use and they do not pose a safety hazard.

9.9.3.6 Road Materials

All road materials will be allowed to remain on-site. All township, county, or state roads, impacted by Project decommissioning activity, if any, will be restored to original condition upon completion of decommissioning.

9.9.3.7 Soil Restoration

Soil decompaction in agricultural production areas will also occur by salvaging topsoil prior to construction and tilling soils during restoration. Once all of the above and below ground components designated for disposal or salvage have been removed, the remaining decommissioning work will consist of regrading and reseeding disturbed areas. All disturbed areas will be restored to pre-existing conditions and contours. All construction clean-up work and permanent erosion control measures will be done in accordance with the formal SWPPP for the Project.

9.9.3.8 Access

During decommissioning activities, appropriate agencies, such as Chippewa County, Department of Commerce, and other appropriate agency staff, shall have access to the site, pursuant to reasonable notice, to inspect the results of complete decommissioning. All decommissioning and restoration activities will be in accordance will all applicable federal, state, and local permits and requirements.

10.0 Identification of Permits

10.1 PROJECT AND ASSOCIATED FACILITIES PERMITTING

There are several federal, state, and local permits that may be needed for construction and operation of the Project. **Table 10-1** provides a summary of the different permits that may be required for construction and operation of the Project.

Table 10-1: Project Permits

Permitting Agency	Permit	Status
Federal Aviation Administration (FAA)	FAA Form 7460-1 Proposed Construction or Alteration	In progress
U.S. Army Corps of Engineers (USACE	Section 404 permit	To be applied for, if needed
Minnesota Public Utilities Commission	Site Permit	In progress
Minnesota Pollution Control Agency	National Pollutant Discharge Elimination System (NPDES) stormwater for construction permit	To be applied for, if needed
Minnesota Department of Natural Resources	Public Waters Work Permit	To be applied for, if needed
	License to Cross Public Lands and Waters	To be applied for, if needed
Minnesota Department of Transportation (MnDOT)	Utility Permit	To be applied for, if needed
	Highway Access Permit	To be applied for, if needed
	Oversize/Overweight Permit	To be applied for, if needed
Chippewa County	Utility Permit	To be applied for, if needed
	Access Permit	To be applied for, if needed
	Moving Permit	To be applied for, if needed
	Building Permit	To be applied for, if needed
Chippewa Soil and Water Conservation District	Wetland Conservation Act Permit	To be applied for, if needed

10.1.1 Federal Aviation Administration

Form 7460-1: Proposed Construction or Alteration

The Federal Aviation Administration (FAA), per 49 Code of Federal Regulations (CFR) Title 14 part 77, requires a permit for construction any time a new structure or altered structure will exceed a 100:1 sloped surface from the nearest point of the nearest runway out to 20,000 feet or if the structure exceeds 200 feet AGL (above ground level). The FAA requires that Form 7460-1 (Notice of Proposed Construction or Alteration) be submitted at least 45 days before the date the proposed construction is to begin, or the date an application for a construction permit is to be filed.

10.1.2 U.S. Army Corps of Engineers

Section 404 Permit

A Section 404 permit is required by the USACE to discharge dredged or fill material into U.S. waters under the Clean Water Act. This permit is applied for after the final siting and layout of the Project has been determined, if wetland would be impacted by the Project. Development of an acceptable mitigation plan to offset impacts to wetlands will be required under this permit.

10.1.3 Public Utilities Commission

Site Permit

The Public Utilities Commission (PUC) is responsible for issuing permits for large electric power plants, electric transmission lines, oil or gas pipelines, storage facilities, solar energy generating systems and wind energy conversion systems. Wind farms greater than five MW require a site permit from the PUC. As part of the site permit application process, the Minnesota Department of Commerce (DOC) conducts an environmental review, provides technical expertise and submits recommendations to the PUC after analysis of siting applications. This Site Permit Application serves as the primary state environmental review document prepared for the proposed project.

The PUC's procedures for review of proposed large energy facilities incorporate compliance with the Minnesota Environmental Policy Act (MEPA) and provide for public participation, including public notice, public comment, public meetings, and a public hearing.

10.1.4 Minnesota Pollution Control Agency

NPDES/SDS Construction Stormwater Permit

The Minnesota Pollution Control Agency (MPCA) administers the Clean Water Act. Under the Clean Water Act, the MPCA regulates discharges associated with stormwater affected by construction activity to waters of the state of Minnesota. A National Pollutant Discharge Elimination System (NPDES)/State Disposal System (SDS) Construction Stormwater General Permit covers stormwater discharges for construction activity that results in land disturbance of equal to or greater than one acre. A stormwater pollution prevention plan (SWPPP) is required for the NPDES/SDS permit that outlines how stormwater will be managed.

10.1.5 Minnesota Department of Natural Resources

Pubic Waters Work

MNDNR Public Waters Work Permits apply to all public waters identified in the Public Waters Inventory. If a project might affect the course, current, or cross-section of a listed water body, a Public Waters Work Permit may be required by the MNDNR. According to Minnesota Statutes 103G.245, subdivision 1 (except as provided in subdivisions 2, 11, and 12), any state, political subdivision of the state, public or private corporation or person must have a Public Waters Work Permit to:

1. Construct, reconstruct, remove, abandon, transfer ownership of, or make any change in a reservoir, dam, or waterway obstruction on public waters; or
2. Change or diminish the course, current, or cross section of public waters that is entirely or partially within the state; changes including filling, excavating, or placing of materials in or on the beds of public waters.

License to Cross Public Lands and Waters
A license from the MNDNR is required to install a utility over, under or across any state land or public water, under Minnesota Statue 84.415. A utility includes electrical or other lines. The utility crossing rules require that the route design avoid impacts to natural features to the maximum extent possible, including vegetation, steep slopes, riparian areas or sensitive lands (i.e., designated scenic and natural areas). The utility crossing rules state that existing road or bridge crossings over public waters should be utilized for new utility crossing locations whenever possible.

10.1.6 Minnesota Department of Transportation

Utility Permit
A utility permit is necessary for construction, placement, or maintenance of utility lines that are located adjacent or across the highway ROW. These permits are acquired after completion of HVTL designs.

Highway Access Permit
Permits of this nature are required in an effort to maintain the effective flow of traffic while accommodating access needs of land development projects. This permit will be required for the Project to deliver construction materials to the project area.

Oversize/Overweight Permit
Oversize/overweight permits may be required to move oversized and heavy loads on state highways. There are restrictions on travel as to not impede travel at high traffic times or during seasons of the year when road damage is more likely to occur from heavy loads.

10.1.7 Chippewa County

Chippewa County has a zoning ordinance in place that regulates land use and wind management. Section 12.0 of the County ordinance, adopted February 2005, outlines standards for wind management. Ordinance Section 12.1 states, "A site permit from the Environmental Quality Board (EQB) is required to construct a large WECS." The County has indicated to the Applicant that the PUC process will be sufficient to satisfy County regulations of LWECS (**Appendix G**).

PUC permits prevail over local planning and zoning, meaning the PUC site permit is the only site approval required. Local governments can comment during the state permitting process. Under Minnesota Statute 216F.081, the PUC, "in considering a permit application for LWECS in a county that has adopted more stringent standards, shall consider and apply those more stringent standards, unless the [PUC] finds good cause not to apply the standards."

Building Permit
A building permit may be required for construction of the associated facilities, such as the O&M facility or substation.

Utility Permit, Access Permit, and Moving Permit
Permits for utilities, access, and moving of oversized loads may also be required from the County for Project construction. These permits may be required to cross occupy County road right-of-way, construct access points to County roads, and/or cross County roads with utilities associated with the Project.

10.1.8 Chippewa Soil and Water Conservation District

WCA Permit

Wetland Conservation Act (WCA) is a way to preserve the wetlands in Minnesota and the benefits that they provide by regulating the draining, filling, and in some cases excavating of wetlands and requiring some type of mitigation for wetland impacts. WCA is implemented locally by cities, counties, watershed management organizations, soil and water conservation districts, and townships. For the Project, the Chippewa Soil and Water Conservation District administers WCA which may require a permit under Minnesota Rules 8420.

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Figures

Figure 1: Site Location Map
Figure 2: Site Detail Map
Figure 3: Recreation and Conservation Areas
Figure 4: Topographic Map
Figure 5: Existing Infrastructure Map
Figure 6: Occupied Buildings
Figure 7: Prime Farmland
Figure 8: Waterbodies and Wetlands
Figure 9: Land Cover
Figure 10: Ecologically Significant Areas

Appendices

Appendix A

Best Management Practices From The Programmatic EIS

Appendix B

Noise Analysis

Appendix C

Viewshed Analysis

Appendix D

Shadow Flicker Assessment

Appendix E

Microwave Beam Study

Appendix F

FEMA Flood Insurance Rate Maps

Appendix G

Agency Correspondence

Appendix H

Wildlife Assessment and Field Studies Report

Appendix I

Acoustic Bat Summary Report

Appendix J

Avian and Bat Protection Plan (ABPP)

Appendix K

Phase I Reconnaissance Survey of the Palmer’s Creek Wind Project

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BMP	References	Socio (7.1)	Land-Based Econ (7.2)	Rec & Tourism (7.3)	Land Use (7.4)	Noise (7.5)	Visual Impacts (7.6)	Public Service & Infra. (7.7)	Public Health & Safety (7.8)	Haz. Mat. (7.9)	Soils & Topo (7.10)	Ground-water Resources (7.11)	Surface Water & Flood-plains (7.12)	Wetlands (7.13)	Veg. (7.14)	Wildlife (7.15)	Rare & Unique Natural Resources (7.16)	Cultural & Archae (7.17)	Air
Air: Dust abatement measures shall be implemented in arid environments to minimize the impacts of vehicular and pedestrian traffic, construction, and wind on exposed surface soils.	VR-31, VRP 5-194						X	X			X								X
Air: Install wind fences around disturbed areas if windborne dust is likely to impact sensitive areas beyond the site boundaries (e.g., nearby residences).	AQ-9, AQP 5-44				X		X	X			X			X					X
Air: Limit idling of diesel equipment to no more than 10 minutes unless necessary for proper operation.	AQ-6, AQP 5-43								X										X
Air: Minimize potential environmental impacts from the use of dust palliatives by taking the necessary measures to keep the chemicals out of sensitive terrestrial habitats and streams. The application of dust palliatives must comply with Federal, State, and local laws and regulations.	AQ-3, AQP 5-43						X			X		X	X	X					X
Air: Post and enforce lower speed limits on dirt and gravel access roads to minimize airborne fugitive dust.	AQ-2, AQP 5-43							X	X		X								X
Air: Use surface access roads, on-site roads, and parking lots with aggregates or that maintain compacted soil conditions to reduce dust generation.	AQ-1,AQP 5-43							X	X		X								X
Air: Water unpaved roads, disturbed areas (e.g., scraping, excavation, backfilling, grading, and compacting), and loose materials generated during project activities as necessary to minimize fugitive dust generation.	AQ-8, AQP 5-44																		X
Construction: Clean (e.g., through street vacuum sweeping) visible trackout or runoff dirt from the construction site off public roadways.	AQ-14, AQP 5-44							X	X										
Construction: Communication and other local utility cables shall be buried, where feasible.	VR-26, VRP 5-194						X		X										
Construction: Construct drainage ditches only where necessary; use appropriate structures at culvert outlets to prevent erosion.	WR-3, WR 5-33							X			X								
Construction: Construction activities shall be coordinated with landowners to minimize interference with farming or livestock operations. Issues that would need to be addressed could include installation of gates and cattle guards where access roads cross existing fencelines, access control, signing of open range areas, traffic management (e.g., vehicle speed management), and location of livestock water sources.	LU-2, LUP 5-14				X			X	X										
Construction: Construction debris shall be removed from the site.	LU-3,LUP 5-14				X				X										
Construction: Cultural resources discovered during construction shall immediately be brought to the attention of the responsible Federal agency. Work shall be immediately halted in the vicinity of the find to avoid further disturbance to the resources while they are being evaluated and appropriate mitigation plans are being developed.	CR-1, CRP 5-224				X													X	
Construction: Drainage problems caused by construction shall be corrected to prevent damage to agricultural fields.	LU-7, LUP 5-14				X								X						
Construction: Employ fuel diesel engines in facility construction and maintenance that use ultra-low sulfur diesel, with a maximum 15 ppm sulfur content.	AQ-5, AQ 5-43								X										X

BMP	References	Socio (7.1)	Land-Based Econ (7.2)	Rec & Tourism (7.3)	Land Use (7.4)	Noise (7.5)	Visual Impacts (7.6)	Public Service & Infra. (7.7)	Public Health & Safety (7.8)	Haz. Mat. (7.9)	Soils & Topo (7.10)	Ground-water Resources (7.11)	Surface Water & Flood-plains (7.12)	Wetlands (7.13)	Veg. (7.14)	Wildlife (7.15)	Rare & Unique Natural Resources (7.16)	Cultural & Archae (7.17)	Air
Construction: Establish a controlled inspection and cleaning area for trucks and construction equipment are arriving from locations with known invasive vegetation problems. Visually inspect construction equipment arriving at the project area and remove and contain seeds that may be adhering to tires and other equipment surfaces.	ER-12, ERP 5-130														X	X			
Construction: Excess cut/fill materials shall be hauled in or out to minimize ground disturbance and impacts from fill piles.	VR-22, VRP 5-193						X				X				X				
Construction: Excess fill material shall not be disposed of downslope in order to avoid creating color contrast with existing vegetation/soils.	VR-21, VRP 5-193				X			X	X										
Construction: For road construction, excess fill shall be used to fill uphill-side swales to reduce slope interruption that would appear unnatural and to reduce fill piles.	VR-15, VRP 5-193				X		X				X								
Construction: If needed during construction, only use explosives within specified times and at specified distances from sensitive wildlife or surface waters as established by the appropriate Federal and State agencies.	ER-7, ERP 5-130					X			X				X			X			
Construction: In the unlikely event that blasting or pile driving would be needed during the construction period, notify nearby residents in advance.	NI-8, NIP 5-57				X			X	X										
Construction: Inspect and clean tires of construction-related vehicles, as necessary, so they are free of dirt prior to entering paved public roadways.	AQ-13, AQP 5-44						X	X											
Construction: Litter must be controlled and removed regularly during construction.	VR-30, VRP 5-194			X			X	X											
Construction: Locate stationary construction equipment (e.g., compressors or generators) as far as practical from nearby sensitive receptors.	NI-7, NIP 5-57						X									X			
Construction: Minimize the area disturbed during the installation of meteorological towers (i.e., the footprint needed for meteorological towers and associated laydown areas).	ER-2, ERP 5-129				X		X												
Construction: Schedule noisy activities to occur at the same time whenever feasible, since additional sources of noise generally do not greatly increase noise levels at the site boundary. Less frequent but noisy activities would generally be less annoying than lower-level noises occurring more frequently.	NI-3, NIP 5-57					X		X	X										
Construction: Schedule the installation of meteorological towers and other characterization activities to avoid disruption of wildlife reproductive activities or other important behaviors (e.g., do not install towers during periods of sage-grouse nesting).	ER-3, ERP 5-129															X			
Construction: Slash from vegetation removal shall be mulched and spread to cover fresh soil disturbances (preferred) or shall be buried. Slash piles shall not be left in sensitive viewing areas.	VR-13, VRP 5-193						X								X				

BMP	References	Socio (7.1)	Land-Based Econ (7.2)	Rec & Tourism (7.3)	Land Use (7.4)	Noise (7.5)	Visual Impacts (7.6)	Public Service & Infra. (7.7)	Public Health & Safety (7.8)	Haz. Mat. (7.9)	Soils & Topo (7.10)	Ground-water Resources (7.11)	Surface Water & Flood-plains (7.12)	Wetlands (7.13)	Veg. (7.14)	Wildlife (7.15)	Rare & Unique Natural Resources (7.16)	Cultural & Archae (7.17)	Air
Construction: Soil borrow areas, cut-and-fill slopes, berms, waterbars, and other disturbed areas shall be contoured to approximate naturally occurring slopes, thereby avoiding form and line contrasts with the existing landscapes. Contouring to rough texture would trap seed and discourage offroad travel, thereby reducing associated visual impacts.	VR-40, VRP 5-195						X				X				X				
Construction: Spray stockpiles of soils with water, cover with tarpaulins, and/or treat with appropriate dust suppressants, especially when high wind or storm conditions are likely. Vegetative plantings may also be used to limit dust generation for stockpiles that will be inactive for relatively long periods.	AQ-10, AQP 5-44														X				X
Construction: Stabilize disturbed areas that are not actively under construction using methods such as erosion matting or soil aggregation, as site conditions warrant.	SR-6, SRP 5-26										X			X					
Construction: Stage construction activities to limit the area of disturbed soils exposed at any particular time.	AQ-7, AQP 5-44				X						X								
Construction: The burning of trash shall be prohibited during construction; trash shall be stored in containers and/or hauled off-site.	VR-29, VRP 5-194						X												
Construction: When possible, limit noisy construction activities to times when nearby sensitive receptors are least likely to be disturbed.	NI-5, NIP 5-57					X		X	X										
Cultural Resources: If a development is within the viewshed of a national historic trail eligible for listing on the NRHP, the developer should evaluate the potential visual impacts on the trail associated with the proposed project. If impacts were to occur, mitigation measures such as vegetation or landscape screening could be employed.	CRP 5-224						X											X	
Cultural resources: If an area has a strong potential for containing fossil remains and those remains are exposed on the surface for potential collection, steps should be taken to educate workers and the public on the consequences of unauthorized collection.	CRP 5-217																	X	

BMP	References	Socio (7.1)	Land-Based Econ (7.2)	Rec & Tourism (7.3)	Land Use (7.4)	Noise (7.5)	Visual Impacts (7.6)	Public Service & Infra. (7.7)	Public Health & Safety (7.8)	Haz. Mat. (7.9)	Soils & Topo (7.10)	Ground-water Resources (7.11)	Surface Water & Flood-plains (7.12)	Wetlands (7.13)	Veg. (7.14)	Wildlife (7.15)	Rare & Unique Natural Resources (7.16)	Cultural & Archae (7.17)	Air
Cultural resources: If cultural resources are known to be present at the site, or if areas with a high potential to contain cultural material have been identified, consultation with the SHPO should be undertaken by the appropriate Federal agency (e.g., Western, USFWS, USFS, or BLM). In instances where Federal oversight is not appropriate, developers can interact directly with the SHPO. Avoidance of these resources is always the preferred mitigation option. Other mitigation options include archaeological survey, excavation, data recovery, and monitoring (as warranted). If an area exhibits a high potential but no artifacts are observed during an archaeological survey, monitoring by a qualified archaeologist could be required during all excavation and earthmoving in the high-potential area. A report should be prepared documenting these activities. Other steps include the identification and implementation of measures to prevent potential looting/vandalism or erosion impacts, as well as educating workers and the public to make them aware of the consequences of unauthorized collection of artifacts.	CRP 5-224																	X	
Cultural Resources: If human remains are found on a development site, work shall cease immediately in the vicinity of the find. The appropriate law enforcement officials and the appropriate Federal agency shall be contacted. No material shall be removed from the find location. Once it is determined that the remains belong to an archaeological site, the appropriate SHPO shall be contacted to determine how the remains shall be addressed.	CR-2, CRP 5-224								X									X	
Cultural Resources: Placement of wind energy structures in fossil-rich areas, such as outcrops, should be avoided.	CRP 5-217																	X	
Cultural resources: Significant cultural resources can be affected by soil erosion. Minimization of soil erosion would protect important resources from damage.	CRP 5-224																	X	
Cultural Resources: The appropriate Federal agency should consult with federally recognized Native American governments early in the planning process for a wind energy development to identify issues and areas of concern. Consultation is required under the NHPA. Consultation is necessary to establish whether the project is likely to disturb traditional cultural properties, affect access rights to particular locations, disrupt traditional cultural practices, affect trust resources such as eagles, and/or visually impact areas important to the tribe(s).	CRP 5-223																	X	
Cultural Resources: The presence of archaeological sites and historic properties in the area of potential effect should be determined on the basis of a records search of recorded sites and properties in the area and/or an archaeological survey. The SHPO is the primary repository for cultural resource information. The National Register of Historic Places could also be consulted at http://www.nps.gov/nr/research/index.htm.	CRP 5-223																	X	

BMP	References	Socio (7.1)	Land-Based Econ (7.2)	Rec & Tourism (7.3)	Land Use (7.4)	Noise (7.5)	Visual Impacts (7.6)	Public Service & Infra. (7.7)	Public Health & Safety (7.8)	Haz. Mat. (7.9)	Soils & Topo (7.10)	Ground-water Resources (7.11)	Surface Water & Flood-plains (7.12)	Wetlands (7.13)	Veg. (7.14)	Wildlife (7.15)	Rare & Unique Natural Resources (7.16)	Cultural & Archae (7.17)	Air
Cultural Resources: Whether paleontological resources exist in a project area should be determined on the basis of the sedimentary context and soil surveys of the area, a records search of Federal, State, and local inventories for past paleontological finds in the area, review of past paleontological surveys, and/or a paleontological survey.	CRP 5-217																	X	
Decommissioning: Soil borrow areas, cut-and-fill slopes, berms, waterbars, and other disturbed areas should be contoured to approximate naturally occurring slopes, thereby avoiding form and line contrasts with the existing landscapes. Contouring to rough texture would trap seed and discourage off-road travel, thereby reducing associated visual impacts.	VR-40, VRP 5-195		X	X	X		X		X		X				X				
Decommissioning: All aboveground and near-ground structures, including turbines and ancillary structures, shall be removed from the site during decommissioning.	ER-23, ERP 5-132, VR-39, VRP 5-195				X				X										
Decommissioning: During facility decommissioning, the following shall occur: emergency response capabilities shall be maintained throughout the decommissioning period as long as hazardous materials and wastes remain on-site, and emergency response planning shall be extended to any temporary material and equipment storage areas that may have been established; temporary waste storage areas shall be properly designated, designed, and equipped; hazardous materials removed from systems shall be properly containerized and characterized, and recycling options shall be identified and pursued; off-site transportation of recovered hazardous materials and wastes resulting from decommissioning activities shall be conducted by authorized carriers; hazardous materials and waste shall be removed from on-site storage and management areas, and the areas shall be surveyed for contamination and remediated as necessary.	HM-20, HMP 5-249				X					X									
Decommissioning: Facilities constructed on Federal lands should follow the decommissioning recommendations provided in the USFWS's Land-Based Wind Energy Guidelines (USFWS 2012b).	ERP 5-132						X				X					X			
Decommissioning: Salvage and reapply topsoil excavated during decommissioning activities to disturbed areas during final restoration activities.	ER-24, ERP 5-132										X								
Decommissioning: When decommissioning sites, ensure that any wells are properly filled and capped.	WR-10, WRP 5-33				X			X	X										
Decommissioning; Excess concrete (excluding below ground portions of decommissioned turbine foundations intentionally left in place) shall not be buried or left in active agricultural areas.	LU-4, LUP 5-14				X				X	X									
Design: Color selections for turbines shall be made to reduce visual impact and shall be applied uniformly to tower, nacelle, and rotor, unless gradient or other patterned color schemes are used.	VR-2, VRP 5-191						X												

BMP	References	Socio (7.1)	Land-Based Econ (7.2)	Rec & Tourism (7.3)	Land Use (7.4)	Noise (7.5)	Visual Impacts (7.6)	Public Service & Infra. (7.7)	Public Health & Safety (7.8)	Haz. Mat. (7.9)	Soils & Topo (7.10)	Ground-water Resources (7.11)	Surface Water & Flood-plains (7.12)	Wetlands (7.13)	Veg. (7.14)	Wildlife (7.15)	Rare & Unique Natural Resources (7.16)	Cultural & Archae (7.17)	Air
Design: Commercial messages and symbols (such as logos, trademarks) on wind turbines shall be avoided and shall not appear on sites or ancillary structures of wind energy projects. Similarly, billboards and advertising messages shall also be discouraged.	VR-8, VRP 5-192						X												
Design: Culvert ends shall be painted or coated to reduce color contrasts with existing landscape.	VR-27, VRP 5-194						X												
Design: Electricity transmission projects associated with wind energy facilities should utilize nonspecular conductors and nonreflective coatings on insulators.	VRP 5-192						X	X											
Design: Existing rocks, vegetation, and drainage patterns shall be preserved to the maximum extent possible.	VR-12, VRP 5-193						X				X				X				
Design: For ancillary buildings and other structures, low-profile structures shall be chosen whenever possible to reduce their visibility	VR-1, VRP 5-190						X												
Design: For ancillary facilities, multiple-color camouflage technology applications should be considered for projects within sensitive viewsheds and with a visibility distance between 0.25 to 2 mi (0.4 to 3.2 km).	VRP 5-191						X												
Design: For ancillary structures, materials and surface treatments shall repeat and/or blend with the existing form, line, color, and texture of the landscape. If the project will be viewed against an earthen or other non-sky background, appropriately colored materials shall be selected for structures, or appropriate stains/coatings shall be applied to blend with the project's backdrop.	VR-4, VRP 5-191						X	X			X								
Design: Grouped structures shall all be painted the same color to reduce visual complexity and color contrast.	VR-3, VRP 5-191						X												
Design: Minimize the use of guy wires on permanent meteorological towers or use designs for towers that do not require guy wires. If guy wires are necessary, they shall be equipped with line marking devices.	ER-8, ERP 5-130						X	X	X							X			
Design: Power collection cables or lines on the site should be buried in a manner that minimizes additional surface disturbance (e.g., collocating them with access roads).	VR-26, VRP 5-194, ERP 5-129						X	X											
Design: Surface new roads with aggregate materials, wherever appropriate.	SR-2, SRP 5-25							X			X								
Design: The geometry of road ditch design shall consider visual objectives; rounded slopes are preferred to V-shaped and U-shaped ditches.	VR-16, VRP 5-193						X												
Design: The use of monopole structures is recommended. Truss or lattice-style wind turbine structures with lacework or pyramidal or prismatic shapes should be avoided. Monopole structures present a simpler profile, and less complex surface characteristics and reflective/shading properties.	VIP 5-191						X												
During construction, operations and maintenance, and decommissioning phases, traffic shall be restricted to designated project roads. Use of other unimproved roads shall be restricted to emergency situations.	LU-14, LUP 5-16							X											

BMP	References	Socio (7.1)	Land-Based Econ (7.2)	Rec & Tourism (7.3)	Land Use (7.4)	Noise (7.5)	Visual Impacts (7.6)	Public Service & Infra. (7.7)	Public Health & Safety (7.8)	Haz. Mat. (7.9)	Soils & Topo (7.10)	Ground-water Resources (7.11)	Surface Water & Flood-plains (7.12)	Wetlands (7.13)	Veg. (7.14)	Wildlife (7.15)	Rare & Unique Natural Resources (7.16)	Cultural & Archae (7.17)	Air
Erosion: Apply erosion controls relative to possible soil erosion from vehicular traffic.	WR-2, WRP 5-33							X				X	X						
Erosion: Apply standard erosion control BMPs to all construction activities and disturbed areas (e.g., sediment traps, water barriers, erosion control matting) as applicable to minimize erosion and protect water quality.	WR-1, WRP 5-33						X					X	X	X					
Erosion: Dispose of excess excavation materials in approved areas to control erosion.	WR-7, WRP 5-33						X				X		X	X	X				
Erosion: Facilities, structures, and roads should be located in stable fertile soils to reduce visual contrasts from erosion and to better support rapid and complete regrowth of affected vegetation. Site hydrology should also be carefully considered in siting operations to avoid visual contrasts from erosion. Strip, stockpile, and stabilize topsoil from the site before excavating earth for facility construction.	VRP 5-190										X		X	X	X				
Erosion: Where feasible, construction on wet soils shall be avoided to reduce erosion.	VR-25, VRP 5-194						X				X			X					
General: Conduct construction and maintenance activities when the ground is frozen or when soils are dry and native vegetation is dormant.	SR-5, SRP 5-25				X										X				
General: Ensure that all pieces of heavy equipment meet emission standards specified in the State Code of Regulations, and conduct routine preventive maintenance, including tune-ups to manufacturer specification to ensure efficient combustion and minimum emissions. If possible, equipment with more stringent emission controls should be leased or purchased.	AQ-4, AQP 5-43					X													X
General: Facilities and off-site surrounding areas shall be kept clean of debris, "fugitive" trash or waste, and graffiti. Scrap heaps and materials dumps shall be prohibited and prevented. Materials storage yards, even if thought to be orderly, shall be kept to an absolute minimum. Surplus, broken, disused materials and equipment of any size shall not be allowed to accumulate.	VR-35, VRP 5-194						X												
General: Gravel and other surface treatments shall be removed or buried.	VR-43, VRP 5-195						X												
General: Pollution prevention opportunities shall be identified and implemented, including material substitution of less hazardous alternatives, recycling, and waste minimization.	HM-5, HMP 5-248								X	X									

BMP	References	Socio (7.1)	Land-Based Econ (7.2)	Rec & Tourism (7.3)	Land Use (7.4)	Noise (7.5)	Visual Impacts (7.6)	Public Service & Infra. (7.7)	Public Health & Safety (7.8)	Haz. Mat. (7.9)	Soils & Topo (7.10)	Ground-water Resources (7.11)	Surface Water & Flood-plains (7.12)	Wetlands (7.13)	Veg. (7.14)	Wildlife (7.15)	Rare & Unique Natural Resources (7.16)	Cultural & Archae (7.17)	Air
General: Procedures shall be established for fuel storage and dispensing, including shutting off vehicle (equipment) engines; using only authorized hoses, pumps, and other equipment in good working order; maintaining appropriate fire and spill response materials at equipment-fueling stations; providing emergency shutoffs for fuel pumps; ensuring that fueling stations are paved; ensuring that both aboveground fuel tanks and fueling areas have adequate secondary containment; prohibiting smoking, welding, or open flames in fuel storage and dispensing areas; equipping the area with fire suppression devices, as appropriate; conducting routine inspections of fuel storage and dispensing areas; requiring prompt recovery and remediation of all spills, and providing for the prompt removal of all fuel and fuel tanks used to support construction vehicles and equipment at the completion of facility construction and decommissioning phases.	HM-11, HMP 5-248								X	X									
Haz. Materials: All site characterization, construction, operation, and decommissioning activities shall be conducted in compliance with applicable Federal and State laws and regulations, including the Toxic Substances Control Act of 1976, as amended (15 USC 2601, et seq.). In addition, any release of toxic substances (leaks, spills, and the like) in excess of the reportable quantity established by 40 CFR Part 117 shall be reported as required by the Comprehensive Environmental Response, Compensation, and Liability Act of 1980, Section 102b. A copy of any report required or requested by any Federal agency or State government as a result of a reportable release or spill of any toxic substances shall be furnished to the authorized officer concurrent with the filing of the reports to the involved Federal agency or State government.	HM-4, HMP 5-247								X	X									
Haz. Materials: All vehicles and equipment shall be in proper working condition to ensure that there is no potential for leaks of motor oil, antifreeze, hydraulic fluid, grease, or other hazardous materials.	HM-15, HMP 5-249								X	X									
Haz. Materials: Authorized users for each type of hazardous material shall be identified.	HM-10, HMP 5-248									X									
Haz. Materials: Dedicated areas with secondary containment shall be established for off-loading hazardous materials transport vehicles.	HM-7, HMP-5-248								X	X									
Haz. Materials: Design requirements shall be established for hazardous materials and waste storage areas that are consistent with accepted industry practices as well as applicable Federal, State, and local regulations and that include, at a minimum, containers constructed of compatible materials, properly labeled, and in good condition; secondary containment features for liquid hazardous materials and wastes; physical separation of incompatible chemicals; and fire-fighting capabilities when warranted.	HM-17, HMP 5-249								X	X									
Haz. Materials: Dispose of excess excavation materials in approved areas to control erosion and minimize leaching of hazardous materials.	SR-8, SRP 5-26									X	X		X	X					

BMP	References	Socio (7.1)	Land-Based Econ (7.2)	Rec & Tourism (7.3)	Land Use (7.4)	Noise (7.5)	Visual Impacts (7.6)	Public Service & Infra. (7.7)	Public Health & Safety (7.8)	Haz. Mat. (7.9)	Soils & Topo (7.10)	Ground-water Resources (7.11)	Surface Water & Flood-plains (7.12)	Wetlands (7.13)	Veg. (7.14)	Wildlife (7.15)	Rare & Unique Natural Resources (7.16)	Cultural & Archae (7.17)	Air
Haz. Materials: Hazardous materials and waste storage areas or facilities shall be formally designated and access to them restricted to authorized personnel. Construction debris, especially treated wood, shall not be disposed of or stored in areas where it could come in contact with aquatic habitats.	HM-16, HM 5-249									X		X	X	X					
Wildlife/Vegetation: If pesticides/herbicides are to be used on the site, develop an integrated pest and vegetation management plan to ensure that applications will be conducted within the framework of managing agencies and will entail the use of only EPA-registered pesticides/herbicides that are (1) nonpersistent and immobile and (2) applied by licensed applicators in accordance with label and application permit directions, following stipulations regarding suitability for terrestrial and aquatic applications.	HM-3, HMP 5-247								X						X	X			
Haz. Materials: In the event of an accidental release of hazardous substances to the environment, document the event, including a root cause analysis, a description of appropriate corrective actions taken, and a characterization of the resulting environmental or health and safety impacts. Documentation of the event shall be provided to permitting agencies and other appropriate Federal and State agencies within 30 days, as required.	HS-6, HSP 5-256								X	X									
Haz. Materials: Limit herbicide and pesticide use to nonpersistent, immobile compounds and apply them using a properly licensed applicator in accordance with label requirements.	WR-6, WRP 5-33								X					X	X				

BMP	References	Socio (7.1)	Land-Based Econ (7.2)	Rec & Tourism (7.3)	Land Use (7.4)	Noise (7.5)	Visual Impacts (7.6)	Public Service & Infra. (7.7)	Public Health & Safety (7.8)	Haz. Mat. (7.9)	Soils & Topo (7.10)	Ground-water Resources (7.11)	Surface Water & Flood-plains (7.12)	Wetlands (7.13)	Veg. (7.14)	Wildlife (7.15)	Rare & Unique Natural Resources (7.16)	Cultural & Archae (7.17)	Air
Haz. Materials: Prepare a hazardous materials and waste management plan that addresses the selection, transport, storage, and use of all hazardous materials needed for construction, operation, and decommissioning of the facility for local emergency response and public safety authorities and for the regulating agency, and that addresses the characterization, on-site storage, recycling, and disposal of all resulting wastes. The plan shall include a comprehensive hazardous materials inventory; Material Safety Data Sheets (MSDSs) for each type of hazardous material; emergency contacts and mutual aid agreements, if any; site map showing all hazardous materials and waste storage and use locations; copies of spill and emergency response plans (see below), and hazardous materials-related elements of a decommissioning/ closure plan. The waste management plan shall identify the waste streams that are expected to be generated at the site during construction and operation and address hazardous waste determination procedures, waste storage locations, waste-specific management and disposal requirements (e.g., selecting appropriate waste storage containers, appropriate off-site treatment, storage, and disposal facilities), inspection procedures, and waste minimization procedures. The plan shall address solid and liquid wastes that may be generated at the site in compliance with CWA requirements if a NPDES permit is needed.	HM-1, HMP 5-247								X	X									
Haz. Materials: Systems containing hazardous materials shall be designed and operated in a manner that limits the potential for their release, and constructed of compatible materials in good condition (as verified by periodic inspections), including provision of secondary containment features (to the extent practical); installation of sensors or other devices to monitor system integrity; installation of strategically placed valves to isolate damaged portions and limit the amount of hazardous materials in jeopardy of release; and robust inspection and use of repair procedures.	HM-6, HMP 5-248								X	X									
Haz. Materials: To the greatest extent practicable, "just-in-time" ordering procedures shall be employed that would limit the amounts of hazardous materials present on the site to quantities minimally necessary to support continued operations. Excess hazardous materials shall receive prompt disposition.	HM-8, HMP 5-248								X	X									
Haz. Materials: Written procedures for the storage, use, and transportation of each type of hazardous material present shall be provided, including all vehicle and equipment fuels.	HM-9, HMP 5-248								X	X									
Haz. Materials: Written procedures shall be established for inspecting hazardous materials and waste storage areas and for plant systems containing hazardous materials; identified deficiencies and their resolution shall be documented.	HM-18, HMP 5-249								X	X									

BMP	References	Socio (7.1)	Land-Based Econ (7.2)	Rec & Tourism (7.3)	Land Use (7.4)	Noise (7.5)	Visual Impacts (7.6)	Public Service & Infra. (7.7)	Public Health & Safety (7.8)	Haz. Mat. (7.9)	Soils & Topo (7.10)	Ground-water Resources (7.11)	Surface Water & Flood-plains (7.12)	Wetlands (7.13)	Veg. (7.14)	Wildlife (7.15)	Rare & Unique Natural Resources (7.16)	Cultural & Archae (7.17)	Air
Invasive Species: Access roads, utility and transmission line corridors, and tower site areas shall be monitored regularly for the establishment of invasive species, and weed control measures should be initiated immediately upon evidence of the introduction of invasive species.	ER-17, ERP 5-131							X							X				X
Invasive Species: Develop a plan for control of noxious weeds and invasive plants that could occur as a result of new surface disturbance activities at the site. The plan shall address monitoring, weed identification, the manner in which weeds spread, and methods for treating infestations. Require the use of certified weed-free mulching.	ER-11, ERP 5-130								X						X				
Invasive species: Do not use fill materials that originate from areas with known invasive vegetation problems.	E-16, ERP 5-131														X				
Invasive species: Regularly monitor access roads and newly established utility and transmission line corridors for the establishment of invasive species. Initiate weed control measures immediately upon evidence of the introduction or establishment of invasive species.	ER-13, ERP 5-131														X				
Invasive species: Vehicles shall be washed outside of active agricultural areas to minimize the possibility of the spread of noxious weeds.	LU-5, LUP 5-14														X				
Mainteance: Promptly dispose of all garbage or human waste generated on site in order to avoid attracting nuisance wildlife.	ER-15, ERP 5-131								X							X			
Maintenance: Clean and maintain catch basins, drainage ditches, and culverts regularly.	WR-5, WRP 5-33							X					X	X					
Maintenance: Maintain all equipment in good working order in accordance with manufacturer specifications. Suitable mufflers and/or air-inlet silencers should be installed on all internal combustion engines and certain compressor components.	NIP 5-56					X	X												X
Maintenance: Maintenance activities shall include dust abatement (in arid environments), litter cleanup, and noxious weed control.	VR-36, VRP 5-195								X		X				X				X
Maintenance: Nacelles and towers shall be cleaned regularly (yearly, at minimum) to remove spilled or leaking fluids and the dirt and dust that accumulates, especially in seeping lubricants.	VR-34, VRP 5-194						X		X	X									
Maintenance: Refueling areas shall be located away from surface water locations and drainages and on paved surfaces; features shall be added to direct spilled materials to sumps or safe storage areas where they can be subsequently recovered.	HM-12, HMP 5-248									X	X	X	X	X					
Maintenance: Regularly inspect access roads, utility and transmission line corridors, and tower site areas for damage from erosion, washouts, and rutting. Initiate corrective measures immediately upon evidence of damage.	ER-18, ERP 5-131							X	X		X		X	X					
Maintenance: Restrict heavy vehicles and equipment to improved roads to the extent practicable.	SR-3, SRP 5-25							X			X								
Maintenance: Roads serving the site would need to be properly maintained to avoid erosion impacts.	LUP 5-13				X			X			X		X		X				

BMP	References	Socio (7.1)	Land-Based Econ (7.2)	Rec & Tourism (7.3)	Land Use (7.4)	Noise (7.5)	Visual Impacts (7.6)	Public Service & Infra. (7.7)	Public Health & Safety (7.8)	Haz. Mat. (7.9)	Soils & Topo (7.10)	Ground-water Resources (7.11)	Surface Water & Flood-plains (7.12)	Wetlands (7.13)	Veg. (7.14)	Wildlife (7.15)	Rare & Unique Natural Resources (7.16)	Cultural & Archae (7.17)	Air
Maintenance: Schedules shall be established for the regular removal of wastes (including sanitary wastewater generated in temporary, portable sanitary facilities) for delivery by licensed haulers to appropriate off-site treatment or disposal facilities.	HM-19, HMP 5-249								X	X									
Maintenance: Spills shall be immediately addressed per the appropriate spill management plan, and cleanup and removal initiated, if needed. Operations and maintenance personnel shall be trained in spill prevention and containment, and spill containment supplies shall be located on site and be readily available.	HM-14, HMP 5-249								X	X									
Maintenance: Wind facilities and sites shall be actively and carefully maintained during operation. Wind energy projects shall evidence environmental care, which would also reinforce the expectation and impression of good management for benign or clean power.	VR-32, VRP 5-194						X		X										
Maintenance: Inoperative or incomplete turbines cause the misperception in viewers that “wind power does not work” or that it is unreliable. Inoperative turbines shall be repaired, replaced, or removed quickly. Nacelle covers and rotor nose cones shall always be in place and undamaged.	VR-33, VRP 5-194						X												
Minimize ground-disturbing activities, especially during the rainy season.	SR-1, SRP 5-25										X		X	X					
Noise: Establish a process for documenting, investigating, evaluating, and resolving project-related noise complaints.	NI-4, NIP 5-57					X													
Noise: If a transformer becomes a noise issue, a new transformer with reduced flux density generating noise levels as much as 10–20 dB lower than National Electrical Manufacturers Association (NEMA) standard values could be installed. Alternatively, barrier walls, partial enclosures, or full enclosures could be adopted to shield or contain the transformer noise, depending on the degree of noise control needed.	NIP 5-57					X													
Noise: Select equipment with the lowest noise levels available and no prominent discrete tones, when possible.	NI-1, NP 5-56					X													
Cultural Resources: A paleontological resources management plan should be developed for areas where there is a high potential for paleontological material to be present. Management options may include avoidance, removal of the fossils, or monitoring. If the fossils are to be removed, a mitigation plan should be drafted identifying the strategy for collection of the fossils in the project area. Often it is unrealistic to remove all of the fossils, in which case a sampling strategy can be developed. If an area exhibits a high potential, but no fossils were observed during surveying, monitoring could be required. A qualified paleontologist should monitor all excavation and earthmoving in the sensitive area. Whether the strategy chosen is excavation or monitoring, a report detailing the results of the efforts should be produced.	CRP 5-217																	X	
Recreation: Adequate safety measures (e.g., access control and traffic management) shall be established for recreational visitors to adjacent properties.	LU-9, LUP 5-14			X	X				X										X

BMP	References	Socio (7.1)	Land-Based Econ (7.2)	Rec & Tourism (7.3)	Land Use (7.4)	Noise (7.5)	Visual Impacts (7.6)	Public Service & Infra. (7.7)	Public Health & Safety (7.8)	Haz. Mat. (7.9)	Soils & Topo (7.10)	Ground-water Resources (7.11)	Surface Water & Flood-plains (7.12)	Wetlands (7.13)	Veg. (7.14)	Wildlife (7.15)	Rare & Unique Natural Resources (7.16)	Cultural & Archae (7.17)	Air
Restoration: A site restoration plan shall be in place prior to construction. Restoration of the construction areas shall begin immediately after construction to reduce the likelihood of visual contrasts associated with erosion and invasive weed infestation and to reduce the visibility of affected areas as quickly as possible.	VR-9, VRP 5-192						X				X				X				
Restoration: Develop restoration plans to ensure that all temporary use areas are restored.	LU-1, LUP 5-14				X								X	X					
Restoration: Disturbed surfaces shall be restored to their original contours as closely as possible and revegetated immediately after, or contemporaneously with, construction. Prompt action shall be taken to limit erosion and to accelerate restoring the preconstruction color and texture of the landscape.	VR-10, VRP 5-192						X				X				X				
Restoration: Initiate habitat restoration of disturbed soils and vegetation as soon as possible after construction activities are completed. Restore areas of disturbed soil using weed-free native grasses, forbs, and shrubs, in consultation with land managers and appropriate agencies such as State or County extension offices or weed boards.	ER-9, ERP 5-130						X				X				X				
Restoration: Interim restoration shall be undertaken during the operating life of the project as soon as possible after disturbances.	VR-38, VRP 5-195										X				X				
Restoration: Reclaim areas of disturbed soil using weed-free native shrubs, grasses, and forbs. Restore the vegetation cover, composition, and diversity to values commensurate with the ecological setting.	ER-25, ERP 5-132														X				
Restoration: Reseed (non-cropland) disturbed areas with a native seed mix and revegetate disturbed areas immediately following construction.	WR-9, WRP 5-33														X				
Restoration: Reseed disturbed areas with a native seed mix and revegetate disturbed areas immediately following construction.	SR-12, SRP 5-26														X				
Restoration: Road-cut slopes shall be rounded, and the cut/fill pitch shall be varied to reduce contrasts in form and line; the slope shall be varied to preserve specimen trees and nonhazardous rock outcroppings.	VR-17, VRP 5-193						X				X				X				
Restoration: Rocks, brush, and forest debris shall be restored, whenever possible, to approximate preexisting visual conditions.	VR-44, VRP 5-195										X								
Restoration: Salvage topsoil from all excavation and construction activities to reapply to disturbed areas once construction is completed.	SR-7, SRP 5-26										X								X
Restoration; Reestablish the original grade and drainage pattern to the extent practicable.	SR-11, SRP 5-26, WR-8, WRP 5-33										X								

BMP	References	Socio (7.1)	Land-Based Econ (7.2)	Rec & Tourism (7.3)	Land Use (7.4)	Noise (7.5)	Visual Impacts (7.6)	Public Service & Infra. (7.7)	Public Health & Safety (7.8)	Haz. Mat. (7.9)	Soils & Topo (7.10)	Ground-water Resources (7.11)	Surface Water & Flood-plains (7.12)	Wetlands (7.13)	Veg. (7.14)	Wildlife (7.15)	Rare & Unique Natural Resources (7.16)	Cultural & Archae (7.17)	Air
Revegetation: Combining seeding, planting of nursery stock, transplanting of local vegetation within the proposed disturbance areas, and staging of construction shall be considered, enabling direct transplanting. Generally, native vegetation shall be used for revegetation, establishing a composition consistent with the form, line, color, and texture of the surrounding undisturbed landscape. Seed mixes shall be coordinated with local authorities, such as country extension services, weed boards, or land management agencies.	VR-42, VRP 5-195						X				X				X				
Safety: All site characterization, construction, operation, and decommissioning activities must be conducted in compliance with applicable Federal and State occupational safety and health standards (e.g., the Occupational Safety and Health Administration's [OSHA's] Occupational Safety and Health Standards, 29 CFR Parts 1910 and 1926, respectively).	HM-4, HMP 5-247								X	X									
Safety: All vehicles traveling within and around the project area should operate in accordance with posted speed limits.	NI-3, NP 5-57					X		X	X										
Safety: As needed, the health and safety program must address OSHA standard practices for the safe use of explosives and blasting agents (if needed for site development); measures for reducing occupational EMF exposures; the establishment of fire safety evacuation procedures; and required safety performance standards (e.g., electrical system standards and lighting protection standards). The program shall include training requirements for applicable tasks for workers and establish procedures for providing required training to all workers. Documentation of training and a mechanism for reporting serious accidents to appropriate agencies shall be established.	HS-4, HSP 5-256								X	X									
Safety: Conduct a safety assessment to describe potential safety issues and the means that would be taken to mitigate them, covering issues such as site access, construction, safe work practices, security, heavy equipment transportation, traffic management, emergency procedures, and fire control.	HS-2, HSP 5-255							X											
Safety: Control vehicle and equipment speed on unpaved surfaces.	SR-4, SRP 5-25								X										
Safety: Cover vehicles transporting loose materials when traveling on public roads, and keep loads sufficiently wet and below the freeboard of the truck in order to minimize wind dispersal.	AQ-12, AQP 5-44						X												X
Safety: Design all electrical systems to meet all applicable safety standards (e.g., the National Electrical Safety Code) and comply with the interconnection requirements of the transmission system operator.	HS-5, HSP 5-256								X										
Safety: Develop a fire management and protection plan to implement measures to minimize the potential for fires associated with substances used and stored at the site. The flammability of the specific chemicals used at the facility shall be considered.	HS-11, HSP 5-257								X										

BMP	References	Socio (7.1)	Land-Based Econ (7.2)	Rec & Tourism (7.3)	Land Use (7.4)	Noise (7.5)	Visual Impacts (7.6)	Public Service & Infra. (7.7)	Public Health & Safety (7.8)	Haz. Mat. (7.9)	Soils & Topo (7.10)	Ground-water Resources (7.11)	Surface Water & Flood-plains (7.12)	Wetlands (7.13)	Veg. (7.14)	Wildlife (7.15)	Rare & Unique Natural Resources (7.16)	Cultural & Archae (7.17)	Air
Safety: Develop a health and safety program to protect workers during site characterization, construction, operation, and decommissioning of a wind energy project. The program shall identify all applicable Federal and State occupational safety standards and establish safe work practices addressing all hazards, including requirements for developing the following plans: general injury prevention; PPE requirements and training; respiratory protection; hearing conservation; electrical safety; hazardous materials safety and communication; housekeeping and material handling; confined space entry; hand and portable power tool use; gas-filled equipment use; and rescue response and emergency medical support, including on-site first-aid capability.	HS-3, HSP 5-255								X										
Safety: Develop a project health and safety program that addresses protection of public health and safety during site characterization, construction, operation, maintenance, and decommissioning activities for a wind energy project. The program shall establish a safety zone or setback for wind energy facilities and associated transmission lines from residences and occupied buildings, roads, ROWs, and other public access areas that is sufficient to prevent accidents resulting from various hazards during all phases of development. It shall identify requirements for temporary fencing around staging areas, storage yards, and excavations during construction or decommissioning activities. It shall also identify measures to be taken during the operations phase to limit public access to facilities (e.g., equipment with access doors shall be locked to limit public access, and permanent fencing with slats shall be installed around electrical substations).	HS-7, HSP 5-256				X		X		X										
Safety: Drip pans shall be used under the fuel pump and valve mechanisms of any bulk fueling vehicles and during on-site refueling to contain accidental releases.	HM-13, HMP 5-248								X		X								
Safety: Project personnel and contractors shall be instructed and required to adhere to speed limits commensurate with road types, traffic volumes, vehicle types, and site-specific conditions to ensure safe and efficient traffic flow.	LU-13, LUP 5-16							X	X										
Safety: Train workers to comply with speed limits, use good engineering practices, minimize the drop height of excavated materials, and minimize disturbed areas.	AQ-11, AQP 5-44								X										
Safety: Use proper signage and/or engineered barriers (e.g., fencing) to limit access to electrically energized equipment and conductors in order to prevent access to electrical hazards by unauthorized individuals or wildlife.	HS-9, HSP 5-257								X							X			
Siting: Establish sufficient setback distances from sensitive receptors wherever feasible. Based on previous experience, noise complaints seldom exist for people living more than 1–1.5 mi (1.6–2.4 km) from a wind farm (Stewart 2006).	NIP 5-56					X													

BMP	References	Socio (7.1)	Land-Based Econ (7.2)	Rec & Tourism (7.3)	Land Use (7.4)	Noise (7.5)	Visual Impacts (7.6)	Public Service & Infra. (7.7)	Public Health & Safety (7.8)	Haz. Mat. (7.9)	Soils & Topo (7.10)	Ground-water Resources (7.11)	Surface Water & Flood-plains (7.12)	Wetlands (7.13)	Veg. (7.14)	Wildlife (7.15)	Rare & Unique Natural Resources (7.16)	Cultural & Archae (7.17)	Air
Siting: Although wind turbines may sometimes be located on ridgelines, skylining of substations, transmission structures, communication towers, and other structures associated with wind energy developments should be avoided; that is, they should not be placed on ridgelines, summits, or other locations where they will be silhouetted against the sky from important viewing locations. Siting should avoid skylining by taking advantage of opportunities to use topography as a backdrop for views of facilities and structures. The presence of these structures should be concealed or made less conspicuous by siting and designing them to harmonize with desirable or acceptable characteristics of the surrounding environment.	VRP 5-188						X	X											
Siting: As feasible, siting of linear features (ROWs and roads) associated with wind energy developments should follow natural land contours rather than straight lines, particularly up slopes. Fall-line cuts should be avoided. Where it can be accomplished without introducing unacceptable impacts on other resources, following natural contours echoes the lines found in the landscape and often reduces cut-and-fill requirements; straight lines can introduce conspicuous linear contrasts that appear unnatural.	VRP 5-188						X	X			X								
Siting: Avoid altering existing drainage systems, especially in sensitive areas such as erodible soils or steep slopes.	WR-4, WRP 5-33										X	X	X	X					
Siting: Avoid locating wind energy developments in areas of unique or important recreation, wildlife, or visual resources. When feasible, a wind energy development should be sited on already altered landscapes.	LUP 5-14			X	X		X									X	X		
Siting: Avoid placement of wind energy facilities in areas with unsuitable seismic, liquefaction, slope, subsidence, settling, and flooding conditions.	SRP 5-25										X								
Siting: Because the landscape setting observed from national historic sites, national trails, and tribal cultural resources may be a part of the historic context contributing to the historic significance of the site or trail, project siting should avoid locating facilities that would alter the visual setting such as would reduce the historic significance or function.	VRP 5-187																	X	
Siting: Because visual impacts are usually lessened when vegetation and ground disturbances are minimized, where possible, in forested areas or shrublands, siting should take advantage of existing clearings to reduce vegetation clearing and ground disturbance.	VRP 5-189						X				X				X				
Siting: Consolidate infrastructure wherever possible to maximize efficient use of the land and minimize impacts. Existing transmission and market access should be evaluated and use of existing facilities should be maximized.	LUP 5-14							X			X		X	X					

BMP	References	Socio (7.1)	Land-Based Econ (7.2)	Rec & Tourism (7.3)	Land Use (7.4)	Noise (7.5)	Visual Impacts (7.6)	Public Service & Infra. (7.7)	Public Health & Safety (7.8)	Haz. Mat. (7.9)	Soils & Topo (7.10)	Ground-water Resources (7.11)	Surface Water & Flood-plains (7.12)	Wetlands (7.13)	Veg. (7.14)	Wildlife (7.15)	Rare & Unique Natural Resources (7.16)	Cultural & Archae (7.17)	Air
Siting: Consult with Federal, State, and county agencies; tribes; property owners; and other stakeholders as early as possible in the planning process to identify potentially significant land use conflicts and issues and State and local rules that govern wind energy development.	LUP 5-14				X														
Siting: Consult with the DOD during initial project planning to evaluate the potential impact of a proposed development on military airspace in order to identify and address any DOD concerns.	LUP 5-15				X				X										
Siting: Existing roads should be used to the extent possible, but only in safe and environmentally sound locations. If new access roads are necessary, they should be designed and constructed to the appropriate standard necessary to accommodate their intended function (e.g., traffic volume and weight of vehicles) and minimize erosion. Access roads that are no longer needed should be recontoured and revegetated.	LUP 5-15						X	X			X			X	X				
Siting: Identify and avoid unstable slopes and local factors that can cause slope instability (groundwater conditions, precipitation, seismic activity, high slope angles, and certain geologic landforms).	WRP 5-33										X	X	X	X					
Siting: If operation of the wind energy facility and associated transmission lines and substations could cause potential adverse impacts on nearby residences and occupied buildings as a result of noise, sun reflection, or EMF, incorporate recommendations for addressing these concerns into the project design (e.g., establishing a sufficient setback from transmission lines).	HSP 5-257							X	X	X									
Siting: Locations for transmission line and ROW road crossings of other roads, streams, and other linear features within a corridor should be chosen to avoid KOP viewsheds and other visually sensitive areas and to minimize disturbance to vegetation and landforms. The ROWs should cross linear features (e.g., trails, roads, and rivers) at right angles whenever possible to minimize the viewing area and duration.	VIP 5-189						X	X											
Siting: Minimize the extent of land disturbance to the extent possible.	WRP 5-33				X			X			X								
Siting: Minimize the extent of the project footprint, including improved roads and construction staging areas.	SRP 5-25			X	X		X	X			X		X	X	X	X			
Siting: Minimize the number of road miles of new road construction needed for the project.	ERP 5-129							X			X				X				
Siting: Minimize the size of areas in which soil would be disturbed or vegetation would be removed.	ERP 5-129										X				X				
Siting: Plan and site the wind energy development to minimize impacts on other land uses.	LUP 5-14				X														
Siting: Prepare the FAA-required notice of proposed construction during initial project planning in order to identify any air safety issues and required mitigation measures.	LUP 5-15				X				X										
Siting: Project design should provide visual order and unity among clusters of turbines (visual units) to avoid visual disruptions and perceived “disorder, disarray, or clutter.”	VRP 5-189						X												

BMP	References	Socio (7.1)	Land-Based Econ (7.2)	Rec & Tourism (7.3)	Land Use (7.4)	Noise (7.5)	Visual Impacts (7.6)	Public Service & Infra. (7.7)	Public Health & Safety (7.8)	Haz. Mat. (7.9)	Soils & Topo (7.10)	Ground-water Resources (7.11)	Surface Water & Flood-plains (7.12)	Wetlands (7.13)	Veg. (7.14)	Wildlife (7.15)	Rare & Unique Natural Resources (7.16)	Cultural & Archae (7.17)	Air
Siting: Project developers shall work with appropriate agencies (e.g., DOE and TSA) to address critical infrastructure and key resource vulnerabilities at wind energy facilities, and to minimize and plan for potential risks from natural events, sabotage, and terrorism.	HS-12, HSP 5-257							X	X										
Siting: Site and design the project to comply with FAA regulations, including lighting requirements, and to avoid potential safety issues associated with proximity to airports, military bases or training areas, or landing strips.	HS-10, HSP 5-257						X		X										
Siting: Site and design wind energy facilities to eliminate glint and glare effects on roadway users, nearby residences, commercial areas, or other highly sensitive viewing locations, or reduce it to the lowest achievable levels.	HSP 5-257						X		X										
Siting: Site new roads to avoid crossing streams and wetlands and minimize the number of drainage bottom crossings.	SRP 5-25							X					X	X					
Siting: Site new roads to follow natural land contours; excessive slopes should be avoided.	SRP 5-25										X								
Siting: Siting of facilities, especially linear facilities, should take advantage of natural topographic breaks (i.e., pronounced changes in slope), and siting of facilities on steep side slopes should be avoided. Facilities sited on steep slopes are often more visible (particularly if either the project or viewer is elevated); in addition, they may be more susceptible to soil erosion, which could contribute to negative visual impacts.	VRP 5-188						X				X			X					
Siting: Siting should take advantage of both topography and vegetation (where possible) as screening devices to restrict views of projects from visually sensitive areas.	VRP 5-189						X				X				X				
Siting: Spatially accurate and realistic photo simulations of wind turbines in the proposed location should be prepared as part of the siting process. Simulations should show views from sensitive visual resource areas; highly sensitive viewing locations, such as residences; and more representative typical viewing locations. Stakeholders should be involved in selecting KOPs for simulations. Where feasible, simulations should portray a range of lighting conditions and sun angles. Simulations should be based on accurate spatial information, particularly elevation data, and must account for screening vegetation and structures. Simulations should show enough of the surrounding landscape to show the project in the appropriate spatial context and should be reproduced at a large enough size to be comfortably viewed from the appropriate specified distance to accurately depict the apparent size of the facility in a real setting.	VRP 5-188			X			X												
Siting: Structures and roads should be designed and located to minimize and balance cuts and fills. Reducing cut and fill has numerous visual benefits, including fewer fill piles, landforms and vegetation that appear more natural, fewer or reduced color contrasts with disturbed soils, and reduced visual disturbance from erosion and the establishment of invasive species.	VRP 5-190						X	X			X								

BMP	References	Socio (7.1)	Land-Based Econ (7.2)	Rec & Tourism (7.3)	Land Use (7.4)	Noise (7.5)	Visual Impacts (7.6)	Public Service & Infra. (7.7)	Public Health & Safety (7.8)	Haz. Mat. (7.9)	Soils & Topo (7.10)	Ground-water Resources (7.11)	Surface Water & Flood-plains (7.12)	Wetlands (7.13)	Veg. (7.14)	Wildlife (7.15)	Rare & Unique Natural Resources (7.16)	Cultural & Archae (7.17)	Air
Siting: Structures, roads, and other project elements should be set as far back from road, trail, and river crossings as possible, and vegetation should be used to screen views from crossings, where feasible.	VRP 5-191			X			X	X					X	X					
Siting: Take advantage of topography and the distance to nearby sensitive receptors when positioning potential sources of noise.	NIP 5-56					X													
Siting: The eye is naturally drawn to prominent landscape features (e.g., knobs and waterfalls); thus, projects and their elements should not be sited next to such features, where possible.	VRP 5-187						X				X								
Siting: The eye naturally follows strong natural lines in the landscape, and these lines and associated landforms can “focus” views on particular landscape features. For this reason, linear facilities associated with a wind energy project, such as transmission lines and roads, generally should not be sited so that they bisect ridge tops or run down the center of valley bottoms.	VRP 5-187						X				X								
Siting: The only way to completely avoid any adverse impacts on radar involves methods that avoid locating turbines in the radar line of sight (e.g., achieved by distance, terrain masking, or terrain relief; DOD 2006). An additional solution could be to replace aging radar equipment with modern and flexible equipment that can better distinguish wind farm clutter from aircraft or weather (Brenner et al. 2008). Turbine operations could also be curtailed during significant weather events. Western generally advises developers submitting nterconnection requests to avoid areas that would potentially conflict with radar facilities.	LUP 5-15				X				X										
Siting: The siting and design of facilities, structures, roads, and other project elements should match and repeat the form, line, color, and texture of the existing landscape.	VRP 5-190						X				X								
Siting: Through site design, the number of structures required should be minimized. Activities should be combined and carried out in one structure, or structures should be collocated to share pads, fences, access roads, lighting, etc.	VRP 5-190				X		X												
Siting: To the extent possible, given the terrain of a site, wind turbines should be clustered or grouped when placed in large numbers, but a cluttering effect should be avoided by separating otherwise overly long lines of turbines or large arrays, and breaks or open zones should be inserted to create distinct visual units or groups of turbines.	VRP 5-189						X				X								
Siting: To the extent possible, transmission lines and roads associated with wind energy facilities should be collocated within a corridor to use existing/shared ROWs, existing/shared access and maintenance roads, and other infrastructure in order to reduce visual impacts associated with new construction.	VRP 5-189						X	X											
Siting: Use existing roads and disturbed areas to the extent possible.	SRP 5-25, WRP 5-33				X		X				X		X	X	X	X		X	

BMP	References	Socio (7.1)	Land-Based Econ (7.2)	Rec & Tourism (7.3)	Land Use (7.4)	Noise (7.5)	Visual Impacts (7.6)	Public Service & Infra. (7.7)	Public Health & Safety (7.8)	Haz. Mat. (7.9)	Soils & Topo (7.10)	Ground-water Resources (7.11)	Surface Water & Flood-plains (7.12)	Wetlands (7.13)	Veg. (7.14)	Wildlife (7.15)	Rare & Unique Natural Resources (7.16)	Cultural & Archae (7.17)	Air
Siting: Use existing roads to the maximum extent feasible to access a proposed project area. Install meteorological towers and conduct other characterization activities (e.g., geotechnical testing) as close as practicable to existing access roads.	VR-12, VRP 5-193			X	X		X	X			X				X	X			
Siting: Where possible, developments should be sited in already industrialized and developed landscapes, with due consideration for visual absorption capacity and possible cumulative effects.	VRP 5-187				X		X												
Siting: Wind turbine siting should be sensitive to and respond to the surrounding landscape in a visually pleasing way. For example, in rolling landscapes, a less rectilinear and rigid configuration of turbines that follows local topography may be appropriate. In flatter agricultural landscapes with rectilinear patterns of road and fields, a more geometric or linear wind turbine configuration may be preferred.	VRP 5-189			X			X	X											
Siting: Wind turbines should be sited properly to eliminate shadow flicker effects on nearby residences or other highly sensitive viewing locations, or reduce them to the lowest achievable levels, as calculated using appropriate siting software and procedures. Accurately determined shadow flicker estimates should be made available to stakeholders in advance of project approval. If turbine locations are changed during the siting process, shadow flicker effects should be recalculated and made available to potentially affected stakeholders.	VRP 5-188						X												
Soils: Following completion of construction and during decommissioning, subsoil shall be decompacted.	LU-8, LUP 5-14										X								
Soils: Topsoil from cut/fill activities shall be segregated and spread on freshly disturbed areas to reduce color contrast and aid rapid revegetation. Topsoil piles shall not be left in sensitive viewing areas.	VR-20, VRP 5-193						X				X				X				
Soils: Topsoil shall be stripped from any agricultural area used for traffic or vehicle parking— segregating topsoil from excavated rock and subsoil—and replaced during restoration activities.	LU-6, LUP 5-14				X			X			X				X				X
Topography: Benches shall be provided in rock cuts to accent natural strata.	VR-19, VRP 5-193						X				X								
Topography: Cut slopes shall be randomly scarified and roughened to reduce texture contrasts with existing landscapes and to aid in revegetation.	VR-41, VRP 5-195						X				X								
Topography: Natural or previously excavated bedrock landforms shall be sculpted and shaped when excavation of these landforms is required. A percentage of backslope, benches, and vertical variations shall be integrated into a final landform that repeats the natural shapes, forms, textures, and lines of the surrounding landscape. The earthen landform shall be integrated and transitioned into the excavated bedrock landform. Sculpted rock face angles, bench formations, and backslope need to adhere to the natural bedding planes of the natural bedrock geology. Half-case drill traces from pre-split blasting shall not remain evident in the final rock face. Where feasible, the color contrast shall be removed from the excavated rock faces by color-treating with a rock stain.	VR-24, VRP 5-193						X				X								

BMP	References	Socio (7.1)	Land-Based Econ (7.2)	Rec & Tourism (7.3)	Land Use (7.4)	Noise (7.5)	Visual Impacts (7.6)	Public Service & Infra. (7.7)	Public Health & Safety (7.8)	Haz. Mat. (7.9)	Soils & Topo (7.10)	Ground-water Resources (7.11)	Surface Water & Flood-plains (7.12)	Wetlands (7.13)	Veg. (7.14)	Wildlife (7.15)	Rare & Unique Natural Resources (7.16)	Cultural & Archae (7.17)	Air
Transportation: A traffic management plan shall be prepared for the site access roads to ensure that no hazards would result from increased truck traffic and that traffic flow would not be adversely impacted. This plan shall identify measures that will be implemented to comply with any State or Federal DOT requirements, such as informational signs, flaggers when equipment may result in blocked throughways, and traffic cones to identify any necessary changes in temporary lane configurations. Signs shall be placed along roads to identify speed limits, travel restrictions, and other standard traffic control information. To minimize impacts on local communities, consideration shall be given to limiting construction vehicles on public roadways during the morning and late afternoon commute times.	HS-8, HSP 5-256							X	X										X
Transportation: A transportation plan shall be prepared that identifies measures the developer will implement to comply with State or Federal requirements and to obtain the necessary permits. This will address the transport of turbine components, main assembly crane, and other large pieces of equipment. The plan shall consider specific object size, weight, origin, destination, and unique handling requirements and shall evaluate alternative means of transportation (e.g., rail or barge).	LU-11, LUP 5-15				X			X	X										
Transportation: Access roads shall be designed and constructed to the appropriate standard necessary to accommodate their intended function (e.g., traffic volume and weight of vehicles) and minimize erosion. Access roads that are no longer needed should be recontoured and revegetated.	LU-10, LUP 5-15				X			X			X				X				X
Transportation: Develop a traffic management plan for the site access roads to control hazards that could result from increased truck traffic (most likely during construction or decommissioning), ensuring that traffic flow would not be adversely affected and that specific issues of concern (e.g., the locations of school bus routes and stops) are identified and addressed. This plan shall incorporate measures such as informational signs, flaggers (when equipment may result in blocked throughways), and traffic cones to identify any necessary changes in temporary lane configurations. The plan shall be developed in coordination with local planning authorities.	HS-8, HSP 5-256						X	X	X										
Vegetation: Planting pockets shall be left on slopes, where feasible.	VR-18, VRP 5-193						X								X				
Vegetation: Reduce habitat disturbance by keeping vehicles on access roads and minimizing foot and vehicle traffic through undisturbed areas.	ER-4, ERP 5-130															X			
Vegetation: Road maintenance activities shall avoid blading of existing forbs and grasses in ditches and adjacent to roads; however, any invasive or noxious weeds shall be controlled as needed.	VR-37, VRP 5-195						X	X							X				

BMP	References	Socio (7.1)	Land-Based Econ (7.2)	Rec & Tourism (7.3)	Land Use (7.4)	Noise (7.5)	Visual Impacts (7.6)	Public Service & Infra. (7.7)	Public Health & Safety (7.8)	Haz. Mat. (7.9)	Soils & Topo (7.10)	Ground-water Resources (7.11)	Surface Water & Flood-plains (7.12)	Wetlands (7.13)	Veg. (7.14)	Wildlife (7.15)	Rare & Unique Natural Resources (7.16)	Cultural & Archae (7.17)	Air
Vegetation: The vegetation-clearing design in forested areas should include the feathering of cleared area edges (i.e., the progressive and selective thinning of trees from the edge of the clearing inward) combined with the mixing of tree heights from the edge to create an irregular vegetation outline. These actions would result in a more natural-appearing edge, thereby avoiding the very high linear contrasts associated with straight-edged, clear-cut areas.	VRP 5-190						X								X				
Visual: In addition to mitigation measures that directly reduce the visual resource impacts of wind energy and associated facilities, aesthetic offsets present a mitigation option in some situations. Aesthetic offsets should be considered in situations where visual impacts are unavoidable or where alternative mitigation options are only partially effective or uneconomical. An aesthetic offset is a correction or remediation of an existing condition located in the same viewshed of the proposed development that has been determined to have a negative visual or aesthetic impact. For example, aesthetic offsets could include reclamation of unnecessary roads in the area, removal of abandoned buildings, cleanup of illegal dumps or trash, or the rehabilitation of existing erosion or disturbed areas.	VRP 5-196						X	X											
Visual: In forested areas and shrublands, openings in vegetation for facilities, structures, roads, etc., should mimic the size, shape, and characteristics of naturally occurring openings to the extent possible.	VRP 5-190						X	X							X				
Visual: In forested areas or shrublands, where possible, linear facilities should follow the edges of clearings (where they would be less conspicuous) rather than pass through their center.	VRP 5-189						X				X				X				
Visual: Installation of gravel and pavement shall be avoided where possible to reduce color and texture contrasts with the existing landscape.	VR-14, VRP 5-193						X	X											
Visual: Lighting for facilities shall not exceed the minimum required for safety and security, and full cutoff designs that minimize upward light scattering (light pollution) shall be selected. If possible, site design shall be accomplished to make security lights nonessential. Where they are necessary, security lights shall be extinguished except when activated by motion detectors (e.g., only around the substation).	VR-7, VRP 5-192						X									X			
Visual: Minimize the amount of lighting installed on project turbines; all outdoor lighting on project buildings shall be downshielded.	ER-10, ERP 5-130						X												
Visual: Penalty clauses should be used to protect trees and other sensitive visual resources.	VRP 5-192						X								X				
Visual: Signage shall be minimized; reverse sides of signs and mounts shall be painted or coated to reduce color contrasts with the existing landscape.	VR-28, VRP 5-194						X												
Visual: Soil disturbance shall be minimized in areas with highly contrasting subsoil color.	VR-23, VRP 5-193						X				X								
Visual: The operator shall use nonreflective paints and coatings on wind turbines, visible ancillary structures, and other equipment to reduce reflection and glare.	VR-5, VRP 5-191						X												

BMP	References	Socio (7.1)	Land-Based Econ (7.2)	Rec & Tourism (7.3)	Land Use (7.4)	Noise (7.5)	Visual Impacts (7.6)	Public Service & Infra. (7.7)	Public Health & Safety (7.8)	Haz. Mat. (7.9)	Soils & Topo (7.10)	Ground-water Resources (7.11)	Surface Water & Flood-plains (7.12)	Wetlands (7.13)	Veg. (7.14)	Wildlife (7.15)	Rare & Unique Natural Resources (7.16)	Cultural & Archae (7.17)	Air
Visual: Turbines, visible ancillary structures, and other equipment shall be painted before or immediately after installation.	VR-6, VRP 5-191						X												
Visual: Valuable trees and other scenic elements can be protected by clearing only to the edge of the designed grade manipulation and not beyond through the use of retaining walls, and by protecting tree roots and stems from construction activities. Brush-beating or mowing rather than vegetation removal should be done, where feasible.	VRP 5-193						X								X				
Visual: Visual impact mitigation objectives and activities shall be discussed with equipment operators before construction activities begin.	VR-11, VRP 5-192						X												
Visual: Where possible, projects should be sited outside the viewsheds of key observation points (KOPs), highly sensitive viewing locations, and/or areas with limited visual absorption capability and/or high scenic integrity. When wind energy developments and associated facilities must be sited within view of KOPs, they should be sited as far away as possible, since visual impacts generally diminish as viewing distance increases.	VRP 5-187			X			X												
Visual: Where possible, staging and laydown areas should be sited outside the viewsheds of KOPs and not in visually sensitive areas; they should be sited in swales, around bends, and behind ridges and vegetative screens, where these screening opportunities exist.	VRP 5-192			X			X				X								
Visual: Where screening topography and vegetation are absent, natural-looking earthwork berms and vegetative or architectural screening should be used to minimize visual impacts associated with ancillary facilities. Vegetative screening can be particularly effective along roadways.	VRP 5-190						X				X				X				
Visual: Wind turbines should exhibit visual uniformity in the shape, color, and size of rotor blades, nacelles, and towers.	VRP 5-190						X												
Water Resources: Avoid creating hydrologic conduits between two aquifers (e.g., upper and lower).	WRP 5-33											X	X	X					
Water Resources: Identify areas of groundwater recharge and discharge and evaluate their potential relationship with surface water bodies and groundwater quality.	WRP 5-33											X	X	X					
Water resources: Isolate excavation areas (and soil piles) from surface water bodies using silt fencing, bales, or other accepted appropriate methods to prevent sediment transport by surface runoff.	SR-9, SRP 5-26						X				X								
Water resources: Use earth dikes, swales, and lined ditches to divert local runoff around the work site.	SR-10, SRP 5-26										X		X	X					
Wetlands/Vegetation: For wetland and grassland easements, coordinate closely with the USFWS or USDA during initial project planning to ensure that wetland and grassland easements are avoided to the extent practicable.	LUP 5-15						X							X	X				

BMP	References	Socio (7.1)	Land-Based Econ (7.2)	Rec & Tourism (7.3)	Land Use (7.4)	Noise (7.5)	Visual Impacts (7.6)	Public Service & Infra. (7.7)	Public Health & Safety (7.8)	Haz. Mat. (7.9)	Soils & Topo (7.10)	Ground-water Resources (7.11)	Surface Water & Flood-plains (7.12)	Wetlands (7.13)	Veg. (7.14)	Wildlife (7.15)	Rare & Unique Natural Resources (7.16)	Cultural & Archae (7.17)	Air
Wildlife/Vegetation: Contact appropriate Federal and State agencies (including State entities responsible for permitting energy development projects) early in the planning process to identify potentially sensitive ecological resources known to be present or likely to be present in the vicinity of the wind energy development.	WRP 5-128							X			X								
Wildlife/Vegetation: Do not locate individual meteorological towers in or adjacent to sensitive habitats or in areas where ecological resources known to be sensitive to human activities are present.	WRP 5-129			X	X										X	X			
Wildlife/Vegetation: Review existing information on species and habitats in the project area. Identify important, sensitive, or unique habitat (including large contiguous tracts of grassland habitat) and biota in the project site and vicinity, and design the project to avoid, minimize, or mitigate potential impacts on these resources. Avoidance is the typically the most effective, and therefore preferred, choice for minimizing impacts. The design and siting of the facility should follow appropriate guidance and requirements from Western and the USFWS (as specified for each species in the selected alternative in the Final PEIS) as well as those required by State permitting agencies, and other resource agencies, as available and applicable. For birds specifically, attention should be given to project placement that may be within or near Important Bird Areas (http://netapp.audubon.org/iba) or Hemispheric or Regional Western Hemisphere Shorebird Reserve Network sites (http://www.whsrn.org/whsrn-sites), or where bird species or habitats of conservation concern are known to occur. The IBA Program has identified the most essential areas for birds, and conservation of these areas will provide for long-term protection of biodiversity. Sources of information on these important habitats can be found at http://ecos.fws.gov/ipac, http://www.avianknowledge.net, and http://web4.audubon.org/bird/iba.	WRP 5-127															X			
Wildlife: Avoid constructing turbines in areas of concentrated prey base for raptors (e.g., prairie dog towns).	ERP 5-130															X			
Wildlife: Consult with the appropriate natural resource agencies to avoid scheduling construction activities during important periods for wildlife courtship, breeding, nesting, lambing, or calving that are applicable to sensitive species within the project area.	ERP 5-130				X											X			
Wildlife: Establish buffer zones around known raptor nests, bat roosts, and biota and habitats of concern if site evaluations show that proposed construction activities would pose a significant risk to avian or bat species of concern.	ER-6, ERP 5-130															X			
Wildlife: Evaluate potential avian and bat use (including the locations of active nest sites, colonies, roosts, and migration corridors) of the project and use data to plan turbine (and other structure/infrastructure) locations to minimize impacts.	ERP 5-128															X			

BMP	References	Socio (7.1)	Land-Based Econ (7.2)	Rec & Tourism (7.3)	Land Use (7.4)	Noise (7.5)	Visual Impacts (7.6)	Public Service & Infra. (7.7)	Public Health & Safety (7.8)	Haz. Mat. (7.9)	Soils & Topo (7.10)	Ground-water Resources (7.11)	Surface Water & Flood-plains (7.12)	Wetlands (7.13)	Veg. (7.14)	Wildlife (7.15)	Rare & Unique Natural Resources (7.16)	Cultural & Archae (7.17)	Air
Wildlife: Evaluate the potential for the wind energy project to adversely affect bald and golden eagles in a manner consistent with the Eagle Conservation Plan Guidance (USFWS 2013a). Early in the planning of transmission interconnection and wind farm location, coordination with USFWS Field Offices regarding the guidance is highly recommended. Documented occurrence of eagles can be acquired from the local USFWS Ecological Services office, State wildlife agencies, or State natural heritage databases in some cases, although on-site surveys may be needed. In accordance with the USFWS's Land-Based Wind Energy Guidelines (USFWS 2012b), surveys during early project development should identify all important eagle use areas (nesting, foraging, and winter roost areas) within the project's footprint. If recent data are available on the spacing of occupied eagle nests for the project-area nesting population, these data can be used to delineate an appropriate boundary for the project area. If appropriate survey data are unavailable, the USFWS suggests that the project area, for the purpose of evaluating potential effects on eagles, be defined as the project footprint together with areas within 10 mi (16 km) of the footprint boundary. As described in the USFWS's Land-Based Wind Energy Guidelines (USFWS 2012b), project developers should evaluate the need to develop an ECP.	ERP 5-128															X			
Wildlife: Follow the recommendations provided in the USFWS's Land-Based Wind Energy Guideline (USFWS 2012b) and, as appropriate, the Eagle Conservation Plan Guidance (USFWS 2013a). In addition, follow guidelines or recommendations developed by individual States (e.g., IDNR 2011; Kempema 2009; Nebraska Wind and Wildlife Working Group 2011) to address potential effects of wind energy development on ecological resources.	WRP 5-126				X											X			
Wildlife: If appropriate, conduct surveys for presence of Federal- and State-protected species and other species of concern and the habitats for such species that have a reasonable potential to occur within the project area based on habitat characteristics. Consult with the USFWS and/or appropriate State agency to identify species likely to be present and appropriate survey techniques, determine permit needs, and identify/apply species-specific avoidance and minimization measures.	WRP 5-128															X	X		
Wildlife: If significant impacts on Important Bird Areas (IBAs) or similar ecologically important avian areas are not avoided, minimized, or mitigated, then this Final PEIS would not apply and a separate project specific NEPA evaluation must be developed and approved by the appropriate responsible federal agency prior to project construction.	WRP 5-128															X			

BMP	References	Socio (7.1)	Land-Based Econ (7.2)	Rec & Tourism (7.3)	Land Use (7.4)	Noise (7.5)	Visual Impacts (7.6)	Public Service & Infra. (7.7)	Public Health & Safety (7.8)	Haz. Mat. (7.9)	Soils & Topo (7.10)	Ground-water Resources (7.11)	Surface Water & Flood-plains (7.12)	Wetlands (7.13)	Veg. (7.14)	Wildlife (7.15)	Rare & Unique Natural Resources (7.16)	Cultural & Archae (7.17)	Air
Wildlife: In the absence of long-term mortality studies, monitor regularly for potential wildlife problems including wildlife mortality. Report observations of potential wildlife problems, including wildlife mortality, to the appropriate State or Federal agency in a timely manner, and work with the agencies to utilize this information to avoid/minimize/offset impacts. The Ecological Services Division of the USFWS shall be contacted. Development of additional mitigation measures may be necessary.	ER-22, ERP 5-131															X			
Wildlife: Increasing turbine cut-in speeds (i.e., prevent turbine rotation at lower wind velocity) in areas of bat conservation concern during times when active bats may be at particular risk from turbines.	ER-20, ERP 5-131															X			
Wildlife: Instruct employees, contractors, and site visitors to avoid harassment and disturbance of wildlife, especially during reproductive (e.g., courtship and nesting) seasons. Pets shall not be allowed on the project area.	ER-21, ERP 5-131															X			
Wildlife: Place marking devices on any newly constructed or upgraded transmission lines, where appropriate, within suitable habitats for sensitive bird species.	ER-14, ERP 5-131															X			

BMP	References	Socio (7.1)	Land-Based Econ (7.2)	Rec & Tourism (7.3)	Land Use (7.4)	Noise (7.5)	Visual Impacts (7.6)	Public Service & Infra. (7.7)	Public Health & Safety (7.8)	Haz. Mat. (7.9)	Soils & Topo (7.10)	Ground-water Resources (7.11)	Surface Water & Flood-plains (7.12)	Wetlands (7.13)	Veg. (7.14)	Wildlife (7.15)	Rare & Unique Natural Resources (7.16)	Cultural & Archae (7.17)	Air
Wildlife: Prepare a Bird and Bat Conservation Strategy (BBCS). The overall goal of such a plan is to reduce or eliminate avian and bat mortality; implementation of a BBCS builds support for a FONSI when projects tier from the PEIS. The wind energy facility developer should work closely with the USFWS and the appropriate State wildlife agencies to identify protective measures to include in the plan. These would include project design measures, construction phase measures, operational phase measures, and decommissioning phase measures. A minimum of 1 yr of post-construction monitoring is needed to validate the preconstruction risk assessment and allow the facility owner to adjust operations based on identified problems. Based on project location in proximity to occupancy, habitat, and other ttributes that may increase the risk to birds and bats, multiyear post-construction monitoring may be necessary at some project sites. It is of paramount importance that post-construction surveys are accurate estimates of fatality at wind power facilities. Simple carcass counts at wind energy facilities are inaccurate and underestimate the total number of fatalities because not all carcasses are found due to factors such as unsearchable terrain, carcass removal by scavengers, and less than perfect searcher efficiency. Post-construction surveys for mortality must be robust and standardized to provide reliable results upon which to base adaptive management decisions. For these reasons, using a fatality estimator model is critical. The USFWS recommends a model like the Evidence of Absence model developed by Huso et al. (2014). The user's guide and software developed to estimate bird and bat fatalities at wind-power facilities (Dalthorp et al. 2014) can be found at http://pubs.usgs.gov/ds/0881. The Evidence of Absence software provides for comparison of various combinations of search coverage, search interval, and searcher efficiency that all produce the same overall level of carcass detection probability. Results of monitoring activities shall be reported to the appropriate State or Federal agencies in a timely manner. If bat monitoring is appropriate for the site, installation of bat acoustic monitors should be considered at the time meteorological towers are installed to reduce costs and minimize delays by collecting data early	WRP 5-126															X			
Wildlife: The transmission lines shall be designed and constructed with regard to the recommendations in Avian Protection Plan Guidelines (APLIC and USFWS 2005), in conjunction with Suggested Practices for Avian Protection on Power Lines (APLIC 2006) and Reducing Avian Collisions with Power Lines (APLIC 2012), to reduce the operational and avian risks that result from avian interactions with electric utility facilities.	ER-1, ERP 5-128															X			

BMP	References	Socio (7.1)	Land-Based Econ (7.2)	Rec & Tourism (7.3)	Land Use (7.4)	Noise (7.5)	Visual Impacts (7.6)	Public Service & Infra. (7.7)	Public Health & Safety (7.8)	Haz. Mat. (7.9)	Soils & Topo (7.10)	Ground-water Resources (7.11)	Surface Water & Flood-plains (7.12)	Wetlands (7.13)	Veg. (7.14)	Wildlife (7.15)	Rare & Unique Natural Resources (7.16)	Cultural & Archae (7.17)	Air
Wildlife: Tier to the Final Programmatic EIS. The responsible federal agency will use a tiered NEPA evaluation to document avoidance, minimization, or mitigation of impacts to important bird habitat (e.g., established private, State, or federal special management areas for birds, IBAs, Regional Western Hemisphere Shorebird Reserve Network, [http://www.whsrn.org/whsrn-sites], etc.) to achieve no significant impact to avian resources. On a project-by-project basis, developers should contact local USFWS offices early in the planning process to identify areas of conflict with specific avian species or important bird habitat. Developers shall work with USFWS and Western to develop avoidance, minimization, or mitigation measures to adequately demonstrate their project will have no significant impact on avian resources. In these cases, individual projects determined to be consistent with the selected alternative in the Final PEIS will require a FONSI to document consistency.	ER 5-127															X			
Wildlife: Turn off unnecessary lighting at night to limit attraction of migratory birds. Follow lighting guidelines, where applicable, from the Wind Energy Guidelines Handbook. This includes using lights with timed shutoff, downward-directed lighting to minimize horizontal or skyward illumination, and avoidance of steady-burning, high-intensity lights.	ER-19, ERP 5-131															X			

Noise Analysis

Proposed Palmer's Creek Wind Farm

Prepared for:

Palmer’s Creek Wind Farm, LLC

February 3, 2017

Prepared by:

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Definitions

A-Weighting: A-weighting is applied to instrument-measured sound levels in an effort to account for the relative loudness perceived by the human ear

C-Weighting: C-weighting measures uniformly over the frequency range of 30 to 10,000 Hz. This weighting scale is useful for monitoring sources such as engines, and machinery

dBA: A-weighted decibel level

dBC: C-weighted decibel level

L_{10}: Statistical noise level that is exceeded 10% of the time in a defined time frame

L_{50}: Statistical noise level that is exceeded 50% of the time in a defined time frame, or the arithmetic mean of all data in a defined time frame.

L_{eq}: When a noise varies over time, the Leq is the equivalent continuous sound which would contain the same sound energy as the time varying sound

LA_{eq}: A-weighted equivalent continuous sound

LC_{eq}: C-weighted equivalent continuous sound

MW: Megawatt, unit of power equivalent to 1 million watts, commonly used for classifying outputs of wind turbines.

NOAA: National Oceanic and Atmospheric Administration

Pascal (Pa): Unit of air pressure, normal atmosphere is equal to 101,325 Pa

I. Purpose

Palmer's Creek Wind Farm, LLC has proposed the installation of 18 wind turbines for the Palmer's Creek Wind Farm Project just north of Granite Falls, MN. The boundaries of the proposed wind farm are 100th Street SE to the north, 30th Avenue SE to the east, Palmer Creek Road to the south, and Palmer Creek to the west. The area of study can be found in **Figure 1**. This report details the existing conditions found within the proposed project limits and also the modeled results for two configurations of turbines upon the identified receptors.

II. Noise

Any unwanted sound is called noise. Sound is carried through the air in compression waves of measurable frequency and amplitude. Sound can be tonal, predominating at a few frequencies, or it can contain a random mix of a broad range of frequencies and lack any tonal quality. This type of noise is often called white noise.

The human ear is sensitive to only a relatively narrow frequency range of air pressure changes – approximately 20-20,000 cycles per second or Hertz (Hz). Sub-audible frequency sound is often called infrasound. It cannot be heard, but it may be sensed as a vibration. Humans are also sensitive to changes in the amplitude of the air compression waves. Increasing amplitude, or increasing sound pressure, is perceived as increasing volume or loudness. The sound pressure level (SPL) is measured in micro Pascals (μPa). SPLs are typically converted to decibels (dB), which is a log scale, relative to a reference air pressure value of 20 μPa. When measuring sound, A-weighted decibels (dBA) are typically used to normalize readings to equal loudness over the audible range of frequencies at low loudness. **Table 1** shows a range of sound pressure levels and the associated Noise sources.

Table 1 – Decibel Levels of Common Noise Sources

Sound Pressure Level (dBA)	Noise Source
140	Jet Engine (at 25 meters)
130	Jet Aircraft (at 100 meters)
120	Rock and Roll Concert
110	Pneumatic Chipper
100	Jointer/Planer
90	Chainsaw
80	Heavy Truck Traffic
70	Business Office
60	Conversational Speech
50	Library
40	Bedroom
30	Secluded Woods
20	Whisper
Source: "A Guide to Noise Control in Minnesota," MPCA	

Along with the volume of the noise source there are other factors (such as topography of the area) that contribute to the loudness of noise. The distance of a receptor from a sound's source is also an important factor. Sound levels decrease as distance from a source increases. The following rule of thumb regarding sound decreases due to distance is commonly used: beyond approximately 50 feet, each time the distance between a source and a receptor is doubled, sound levels decrease by three decibels over hard ground (such as pavement or water) and by 4.5 decibels over vegetated areas.

A. Noise from Wind Turbines

Mechanical Noise

Mechanical noise from a wind turbine is sound that originates in the generator, gearbox, yaw motors (that intermittently turn the nacelle and blades to face the wind), tower ventilation system, and transformer. Generally, theses sounds are limited in new wind turbines so that they are a negligible fraction of the aerodynamic noise. Mechanical noise from the turbine or gearbox would only be heard above aerodynamic noise when they are not functioning properly.

Aerodynamic Noise

Aerodynamic noise is caused by wind passing over the blade of the wind turbine. As wind passes over a moving blade, the blade interrupts the laminar flow of air, causing turbulence and noise. Unexpectedly high aerodynamic noise can be caused by improper blade angle or improper alignment of the rotor to the wind. This is correctable and is usually adjusted during the turbine break-in period. This is the primary source of noise produced by wind turbines. Wind turbines are generally quiet enough for people to hold a normal conversation while standing at the base of the tower.

Modulation of Aerodynamic Noise

Rhythmic modulation of noise, especially low frequency noise, is also perceptible by the human ear. To a receptor on the ground in front of the wind turbine, the detected blade noise is loudest as the blade is at the bottom of its rotation, and quietest when the blade is at the top of its rotation. For a modern 3-blade turbine, this distance-to-blade effect can cause a pulsing of the blade noise about once per second (1 Hz). The distance-to-blade effect diminishes as receptor distance increases because the relative difference in distance from the receptor to the top or bottom of the blade becomes smaller.

Another source of rhythmic modulation may occur if the wind through the rotor is not uniform. Horizontal layers with different wind speeds or directions can form in the atmosphere. This wind condition is called shear. If the winds at the top and bottom of the blade rotation are different, blade noise will vary between the top and bottom of blade rotation, causing modulation of aerodynamic noise.

Wind Farm Noise

The noise from multiple turbines similarly distant from a residence can be noticeably louder than a lone turbine through the addition of multiple noise sources. Under steady wind conditions, noise from a wind turbine farm may be greater than noise from the nearest turbine due to synchrony between noise from more than one turbine. If the dominant frequencies of different turbines vary by small amounts, an audible dissonance may be heard when wind conditions are stable.

B. Assessment and Regulation

The Minnesota Pollution Control Agency (MPCA) is given power to adopt noise standards in Minnesota Statute 116.07 Subd. 2. The adopted standards are given in Minnesota Administrative Rules Chapter 7030. The MPCA standards require A-weighted noise measurements. Different standards are specified for daytime (7:00 AM – 10:00 PM) and nighttime (10:00 PM – 7:00 AM) hours. The noise standards specify the maximum allowable noise volumes that may not be exceeded for more than 10 percent of any hour (L_{10}) and 50 percent of any hour (L_{50}). Household units, including farm houses, are included in Noise Area Classification (NAC)-1. **Table 2** shows the MPCA State noise standards. All the land within the project area is considered NAC-1.

Table 2 - MPCA State Noise Standards – Hourly A-Weighted Sound Levels

Land Use	NAC: Noise Area Classification	Exterior Hourly Noise Livel Limit, dBA			
		Daytime		Nighttime	
		7:00 am to 10:00 pm		10:00 pm to 7:00 am	
		L10	L50	L10	L50
Residential	NAC-1	65	60	55	50
Commercial	NAC-2	70	65	70	65
Industrial	NAC-3	80	75	80	75
Notes,					
1. NAC-1 includes household units, transient lodging and hotels, educational, religious, cultural entertainment, camping, and picnicking land uses					
2. NAC-2 includes retail and resturants, transportation terminals, professional offices, parks, recreational and amusement land uses					
3. NAC-3 includes industrial, manufacturing, transportation facilities (except terminals), and utilities land uses					
4. From Minnesota Pollution Control Agency, Minn. Rules sec 7030.0040					

Since wind farms generate a relatively constant noise volume, the anticipated noise from wind farms are typically reported in terms of an equivalent sound level (L_{eq}) that has the same energy and A-weighted level as the community noise over a given time interval rather than reporting both L_{10} and L_{50}. When describing relatively constant sound levels, the L_{10} and L_{50} values will be roughly equal. This equivalent sound level is most appropriately compared to the State L_{50} standards. The difference between L_{eq} and L_{50} is mathematically similar to the difference between the mean and the median for a data set. These values will be roughly equal for data sets without extreme values or statistical outliers (such as wind turbine noise).

III. Monitoring Conditions & Methodology

Noise monitoring was conducted at four sites; three within the project area and a fourth that is outside (but nearby) the project area. All four noise monitors were left to collect data for seven days (January 3 to January 10, 2017) at locations that represent the receptors within the project area. The monitoring locations can be found in **Figure 1**. The conditions for the seven days were typical of a Minnesota winter, with temperatures in the single digits and snow on two of the seven days.

Each of the three locations within the project limits (M1-M3) was picked to represent typical distances from receptors to the proposed turbines and were all within public road right-of-way. As required by the LWECS Guidance for Noise Study Protocol and Report, one of the monitoring locations (M1) was located in proximity to the worst-case receptor as predicted by the model (R36). Since the topographical surroundings of the project area are predominately flat, distance from the proposed turbines was the most important factor in collecting the existing conditions. Monitoring location M2 was selected because it represents a total of six receptors in proximity to five proposed turbines on the east edge of the project boundary. Monitoring location M3 was selected because it represents a receptor that may be impacted by at least six proposed turbines. Monitoring location M4 was selected for its similarity to the existing conditions found at the other three monitoring locations, such as near an impacted receptor on a township road.

Each of the monitoring sites was equipped with a Larson Davis 831 Precision Integrating Sound Level Meter that meets compliance with the following American National Standards Institute (ANSI) regulations:

- S1.4-1983 (R2006) Type1
- S1.4A-185 (10Hz-26kHz)
- S1.43-1997 (R2007) Type 1

- S1.11-2004: 1/1 & 1/3 Octave Band Class 0
- S1.25-1991 (R2002)

The microphones attached to the monitoring units were mounted to tripods at a height of at least 3 feet above the ground. Monitoring units were calibrated prior to, and following, the monitoring period. A Vaisala weather station was attached to each of the monitoring locations to record not only wind speed and direction, but also temperature, barometric pressure, humidity, and precipitation. The weather data are included in each of the noise measurements recorded by the Larson Davis 831 units. The average wind speed for the one-hour measurement histories varied between calm conditions and 19 miles per hour with gusts over 30 miles per hour in some cases. Wind direction was typically out of the west or west-southwest. Temperatures remained low and varied from -16°F to 27°F with the coldest conditions in the first three days of collection. There was no rain recorded but the M1 weather station recorded trace amounts of precipitation on January 10. NOAA data reported up to an inch of snow falling in the area between January 9 and January 10.

The instrumentation was set up to collect the following noise values:

- 1/3 Octave Band Data
- A – Weighted Time History (60 second)
- A-Weighted Measurement History (1 hour)
- C-Weighted Time History (60 second, L_{min}, L_{max} and L_{eq} only)
- C-Weighted Measurement History (1 hour, L_{min}, L_{max} and L_{eq} only)

All data from the noise monitors were downloaded and exported to Excel spreadsheets for analysis. Data points were collected every 60 seconds and supplemented with a 60-minute measurement history that is used to represent the monitoring data results.

Graphs were created from the seven days of data for each monitoring location to compare noise levels to wind speed and create a reasonable expectation for background noise while modeling the proposed turbine locations. The following values were used for the graphs based on protocol found in the Minnesota Department of Commerce's LWECS Guidance for Noise Study Protocol and Report:

- LA_{eq}
- LC_{eq}
- L_{10} (A-Weighted)
- L_{50} (A-Weighted)
- L_{90} (A-Weighted)
- Wind Speed

The graphs can be found in **Figures 2, 3, 4,** and **5.**

The 21-amp batteries powering the noise monitors had to be replaced on January 7 due to the extreme cold conditions experienced at each of the sites. During this process, it was found that the off-site monitor (site M4) had stopped recording data for a period of nearly 54 hours. This was due to battery failure caused by the cold conditions. The unit was able to resume recording data after the batteries were exchanged, but then failed again during the afternoon of January 9. The data in **Figure 5** indicates these gaps. Data gaps are not uncommon when monitoring noise for long periods of time. These gaps in data can be caused by natural events that the MPCA requests be removed from data analysis (e.g., wind speeds in excess of 11 mph, rain events) or mechanical failure. Although some data loss was experienced, there was enough data collected on January 3, 4, 7, 8 and 9 to provide an accurate portrayal of ambient noise for this off-site location. Site M1 also experienced a short gap in data near the end of the collection period on the afternoon of January 9 and during the morning of January 10. This was found to be also due to low battery power caused by cold weather over the course of the final three days of data collection. The data collected during between January 3 and January 9 is sufficient to provide an accurate portrayal of the ambient noise in that location.

Figure 2 – Noise Monitoring Results, Site M1

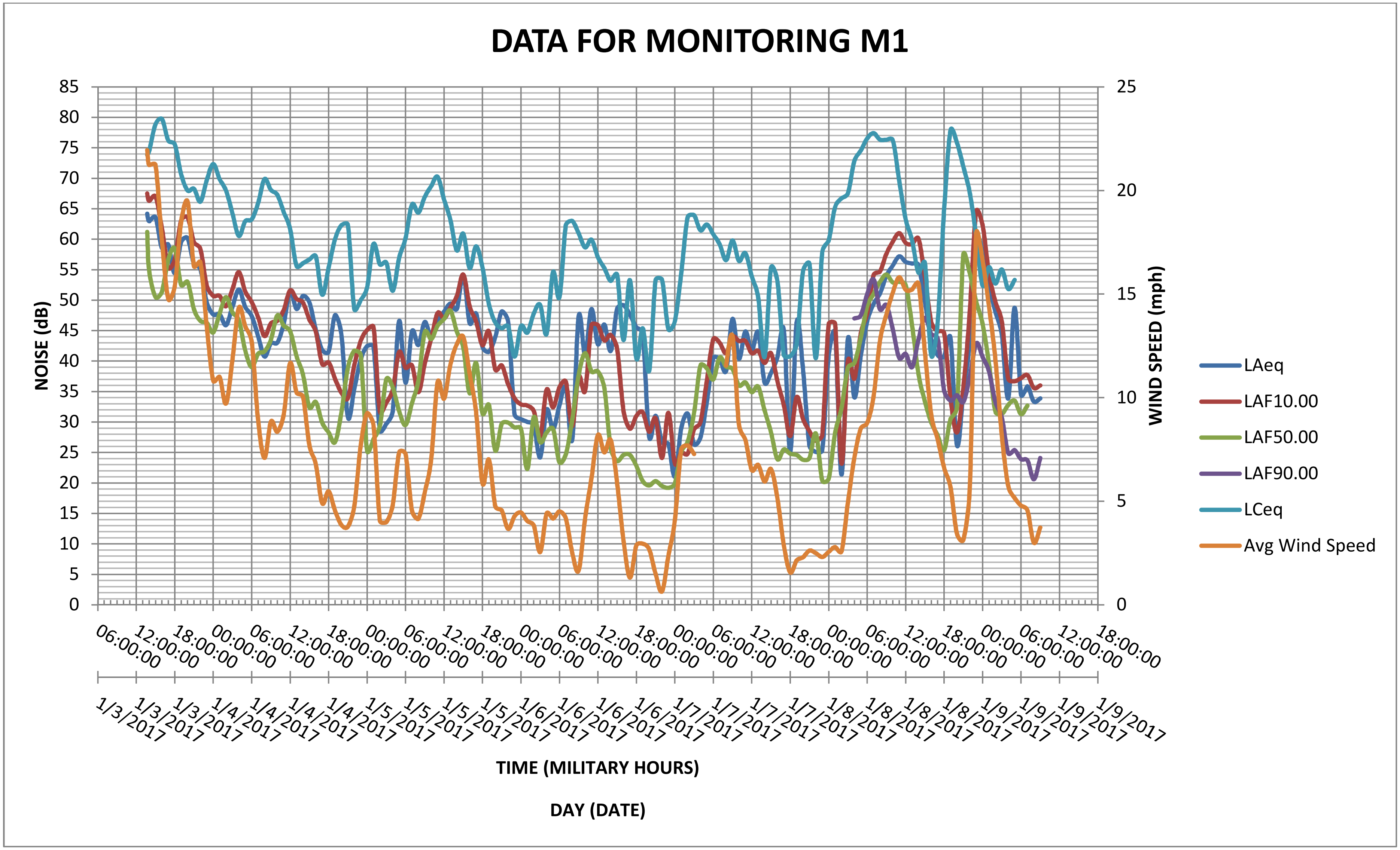


Figure 3 – Noise Monitoring Results, Site M2

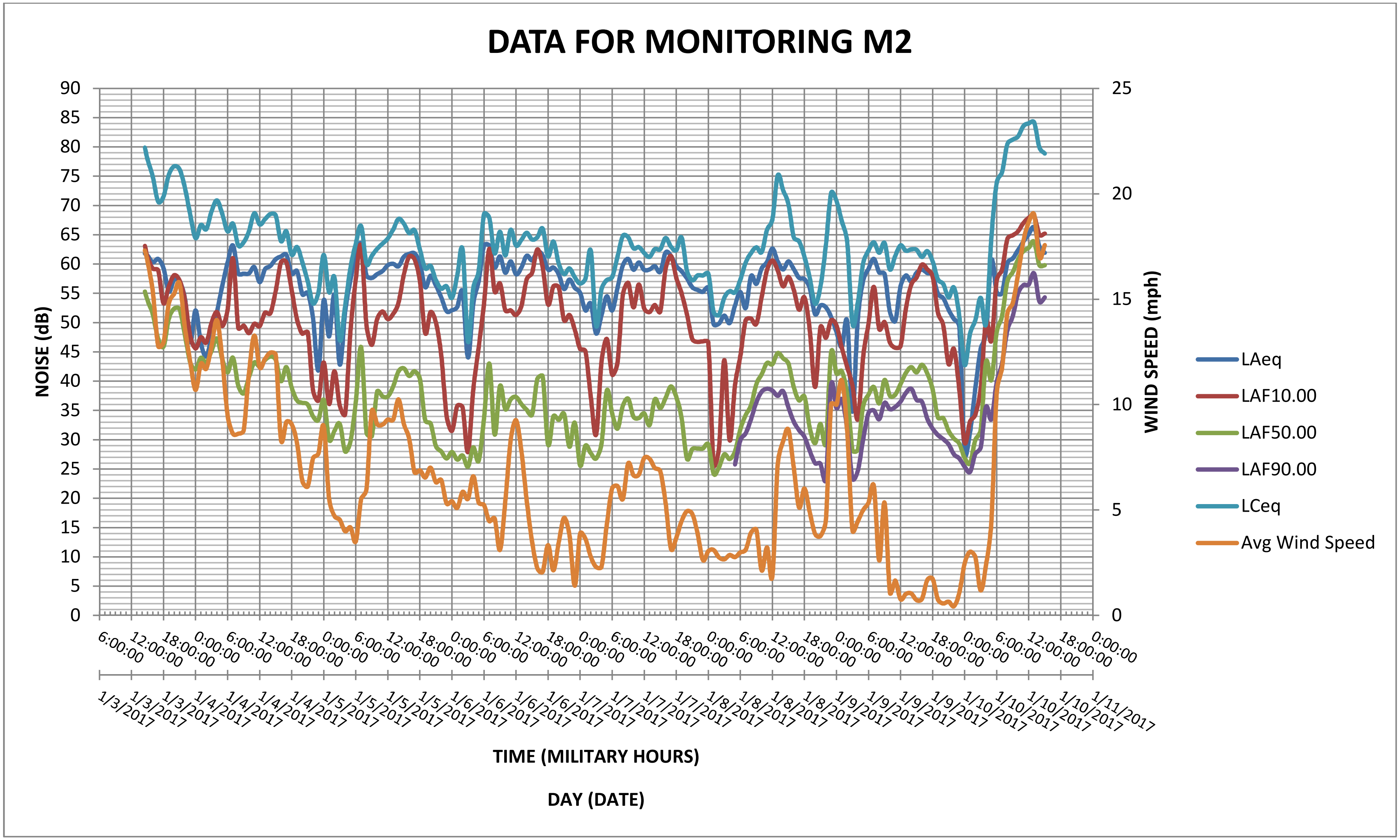


Figure 4 – Noise Monitoring Results, Site M3

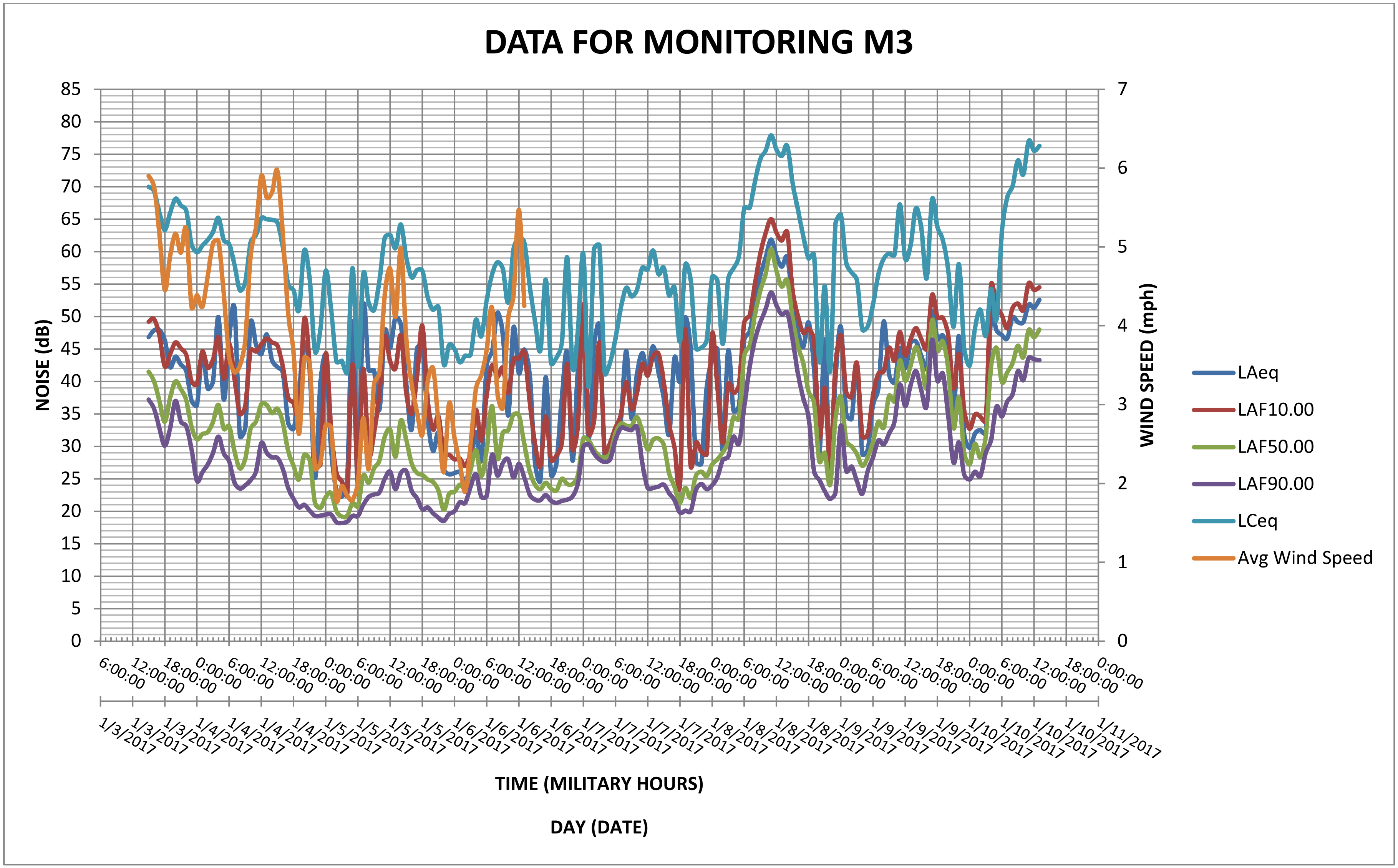
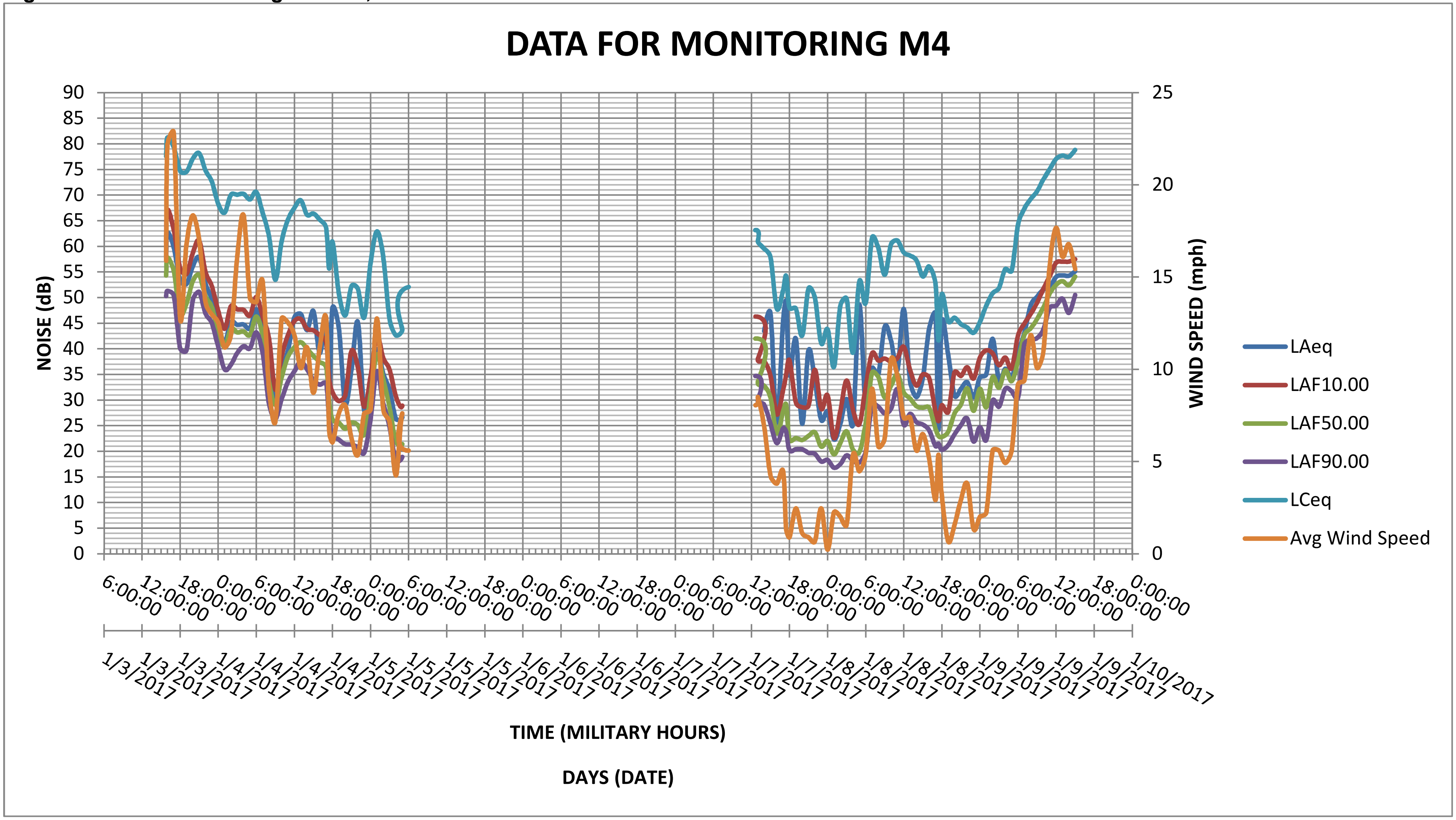


Figure 5 – Noise Monitoring Results, Site M4



IV. Comparison to Minnesota Noise Standards

Figures 6, 7, 8 and **9** show the hourly L_{10} and L_{50} values over the seven days with any measurements indicating wind speeds over 11 miles-per-hour (mph) removed. Wind speeds in excess of 11 mph may distort sound; therefore those measurements are removed at the request of MPCA. With a few exceptions, the existing sound levels at most sites are below Minnesota standards for daytime and nighttime L_{10} and L_{50} values. Site M3 experiences a spike in noise around noon on January 8. This spike in noise reaches the threshold for the daytime L_{10} standard and exceeds the L_{50} standard. Nighttime standards are also already exceeded at two of the four monitoring locations. The L_{10} and L_{50} range for each of the monitoring sites is found below in **Table 3**. Existing sound levels that exceed the State Noise Standards are bolded.

Table 3 – Daytime and Nighttime Noise Monitoring Results

Time Period	Location	L_{10} Range (dBA)	L_{50} Range (dBA)
Daytime 7:00 AM to 10:00 PM	M1	27.7 - **67**	20.3 – **61.2**
	M2	39 - 63.1	26.8 - 45.8
	M3	24 - 65	21.3 - **60.4**
	M4	25.9 - 51.7	22.2 - 48.1
Nighttime 10:00 PM to 7:00 AM	M1	23.2 - **57.7**	18.2 - **51.2**
	M2	25.9 - **57.4**	24.2 - 48.4
	M3	22.6 - 54.8	19.2 - 45.2
	M4	22.6 - 42.6	19.4 - 37.5
MN State Standards		L_{10}	L_{50}
Daytime		65	60
Nighttime		55	50

Figure 6 - Noise Monitoring Results, Site M1 L_{10} and L_{50} Values Only

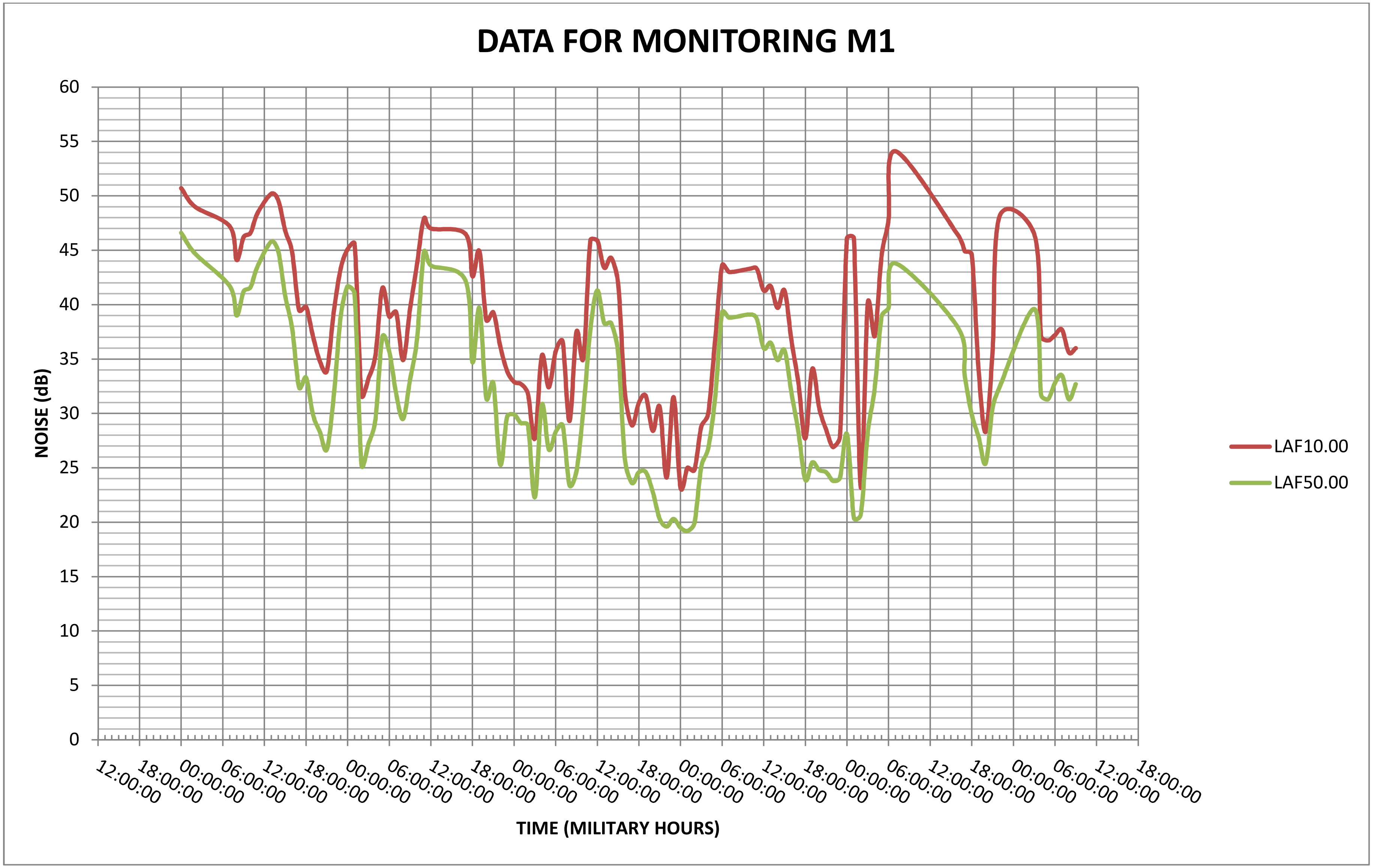


Figure 7 - Noise Monitoring Results, Site M2 L_{10} and L_{50} Values Only

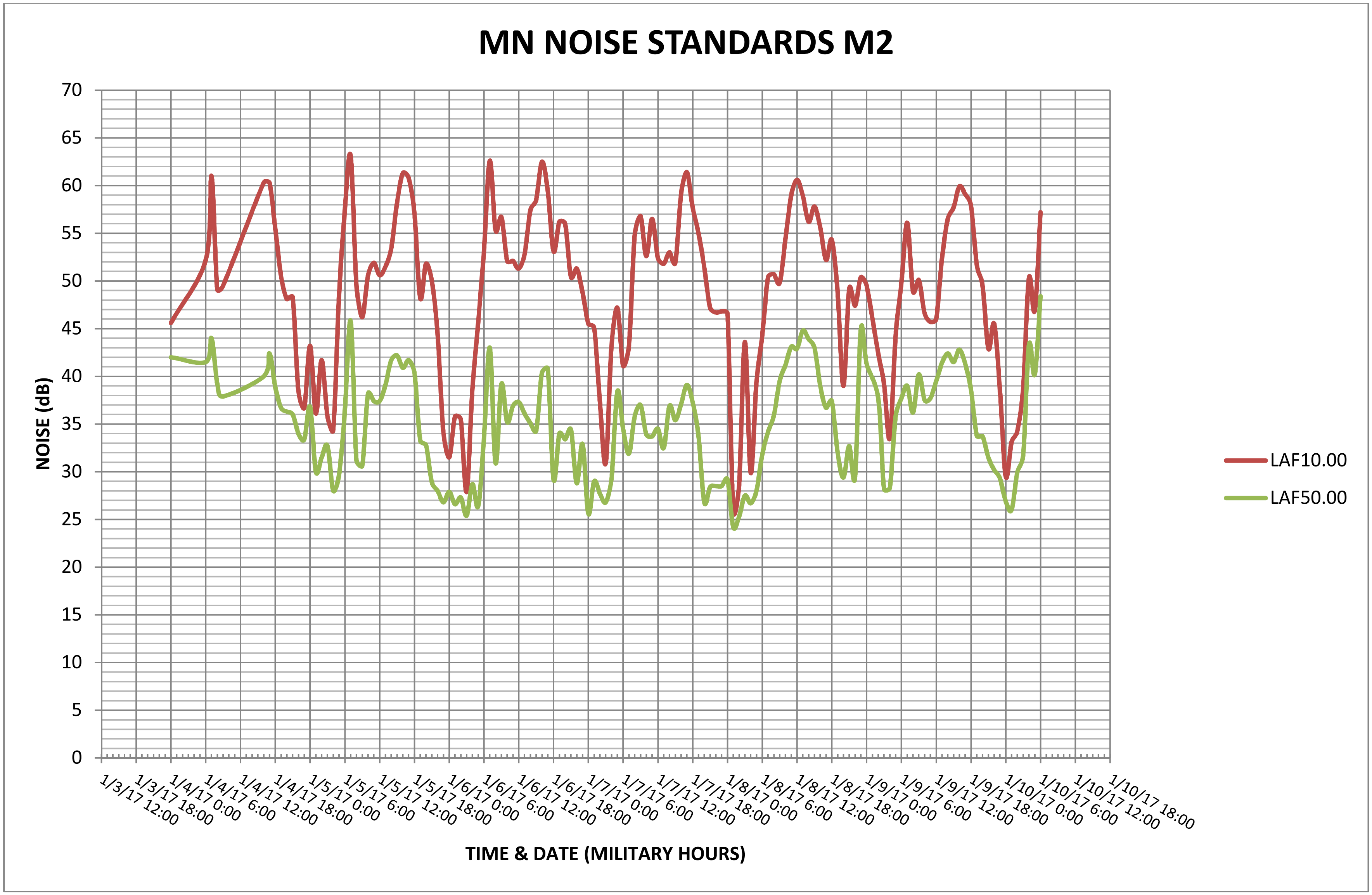


Figure 8 - Noise Monitoring Results, Site M3 L_{10} and L_{50} Values Only

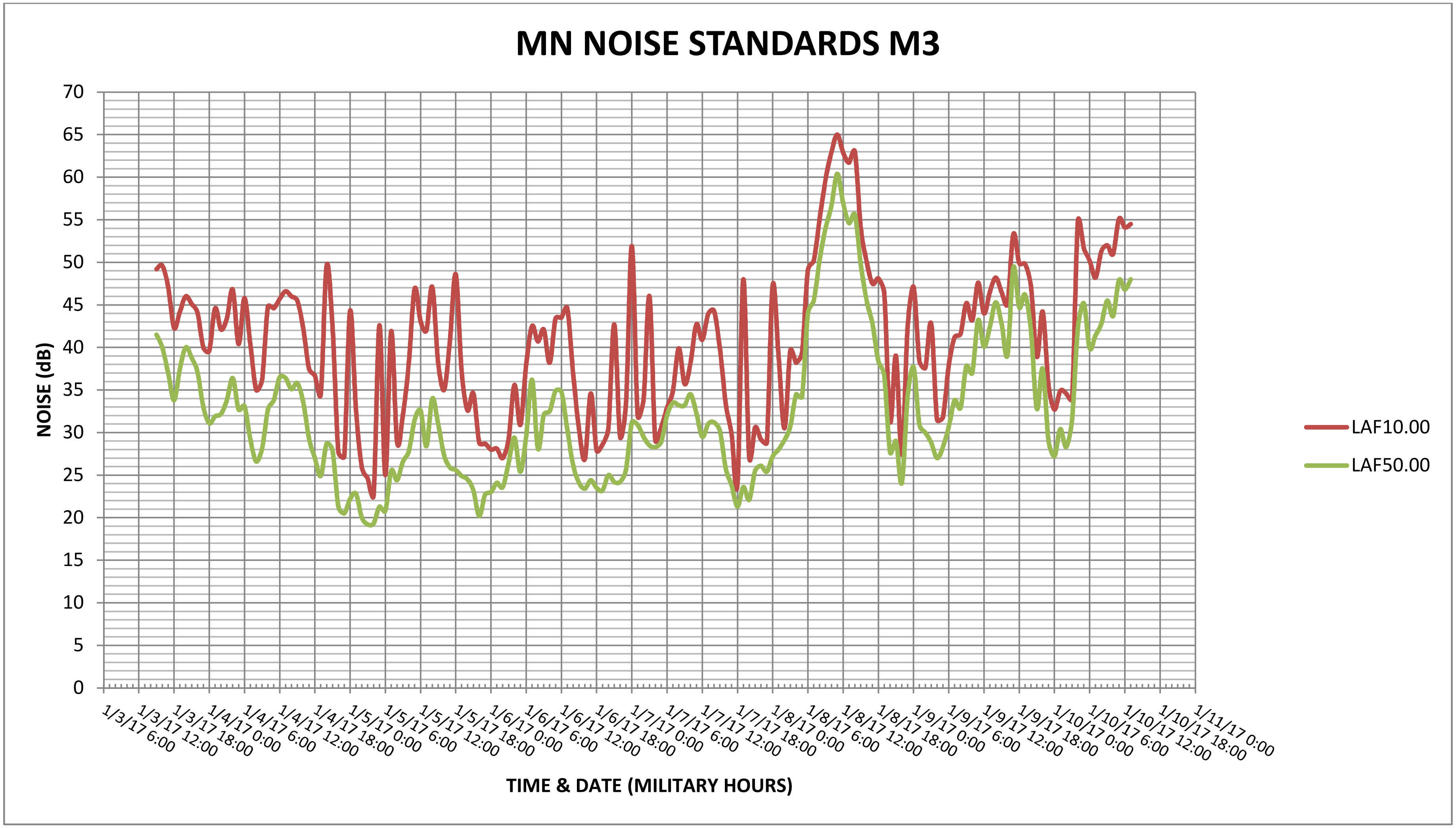
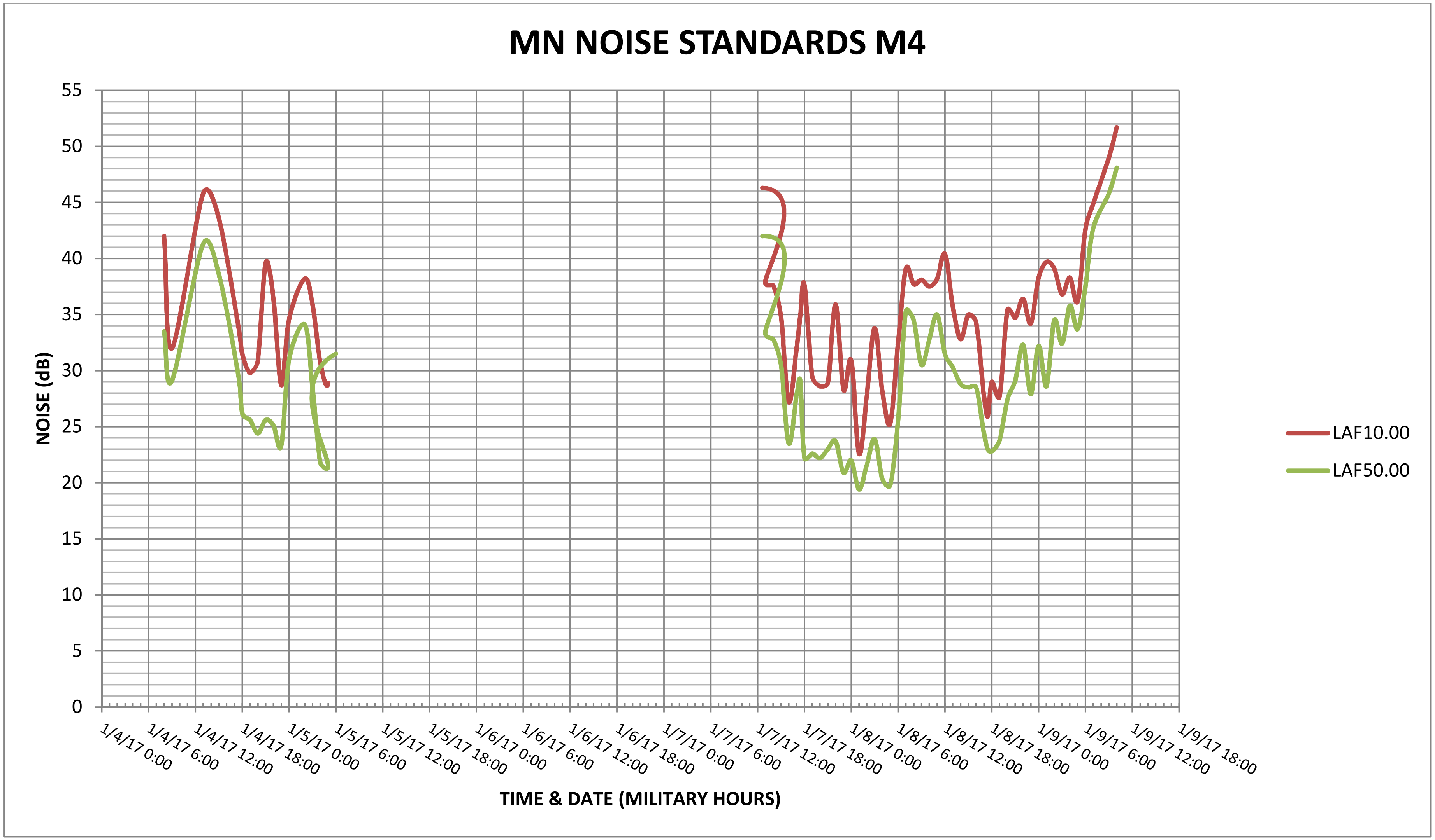


Figure 9 - Noise Monitoring Results, Site M4 L_{10} and L_{50} Values Only



V. Modeling and Results

Along with the noise data collected in the field, a model of the proposed turbines and existing receptors was created to determine the impact of the proposed wind farm. Cadna A software was used for analysis and assumes the attenuation of sound propagation as specified by the International Organization for Standardization (ISO) Standard 9613-2 and a ground attenuation factor of 0.5. Turbine locations were provided by Palmer's Creek Wind Farm, LLC. The turbines modeled were 16 General Electric (GE) 2.5-116 and two GE 2.3-116 that produce 2.5 and 2.3 MW respectively. The models included two scenarios:

1. All 18 turbines with an 80-meter hub-height
2. Two 2.3 MW turbines at an 80-meter hub-height (Turbine 14 and Turbine 15) with the remaining 2.5 MW turbines at a 90-meter hub-height.

The 2.5 MW turbines are projected to generate an apparent maximum sound level of 107 dB per the manufacturer's specifications adjacent to the turbine hub, and the 2.3 MW turbines will generate a maximum 107.5 dB output per the manufacturer's specifications (also adjacent to the turbine hub). All conditions were modeled slightly above these specifications at 109 dB.

For a single 2.3 MW turbine at an 80-meter hub-height, the worst-case noise output would produce the sound contours found in **Figure 10**. The resultant noise produced drops below 50 dBA at distances greater than approximately 160 meters (500 feet). Turbine WTG 08 was found to be the closest to any of the proposed receptors, and is 1,076 feet away from Receptor R36.

Figures 11 and **12** represent the sound contours predicted by the construction of the 18 turbines in the two scenarios. These contours only represent the turbine-generated sound and do not include any cumulative noise from existing background sources. The existing background noise is not known for each specific receptor. Due to this unknown, values of 35, 40, 45, 50, 55 and 60 dBA were used to depict varying degrees of existing noise. This is consistent with the results of the noise monitoring data in the previous section of the report, which showed the existing noise levels at monitoring locations within the project area to range between 45.2 and 60.4 dBA. The resultant noise from the turbines on each receptor was added to the six projected background noise levels, and the summaries of Scenario 1 and 2 can be found in **Tables 4** and **5**.

With background noise levels of 45 dBA and above, the largest increase is predicted to be 2.8 decibels at R36 (Scenario 2) which is considered to be barely perceptible to the human ear.

Table 4 – Noise Modeling Results (Scenario 1)

Receptor ID	Turbine Impact (dBA) (Calculated)	Background Sound Levels + Turbine Impact (dBA)					
		35.0	40.0	45.0	50.0	55.0	60.0
R01	30.9	36.4	40.5	45.2	50.1	55.0	60.0
R02	31.4	36.6	40.6	45.2	50.1	55.0	60.0
R03	32.9	37.1	40.8	45.3	50.1	55.0	60.0
R04	34.4	37.7	41.1	45.4	50.1	55.0	60.0
R05	36.6	38.9	41.6	45.6	50.2	55.1	60.0
R06	38	39.8	42.1	45.8	50.3	55.1	60.0
R07	38.7	40.2	42.4	45.9	50.3	55.1	60.0
R08	38.5	40.1	42.3	45.9	50.3	55.1	60.0
R09	39.8	41.0	42.9	46.1	50.4	55.1	60.0
R10	29.6	36.1	40.4	45.1	50.0	55.0	60.0

Receptor ID	Turbine Impact (dBA) (Calculated)	Background Sound Levels + Turbine Impact (dBA)					
		35.0	40.0	45.0	50.0	55.0	60.0
R11	37.3	39.3	41.9	45.7	50.2	55.1	60.0
R12	34.8	37.9	41.1	45.4	50.1	55.0	60.0
R13	34.8	37.9	41.1	45.4	50.1	55.0	60.0
R14	32.5	36.9	40.7	45.2	50.1	55.0	60.0
R15	33.2	37.2	40.8	45.3	50.1	55.0	60.0
R16	29.9	36.2	40.4	45.1	50.0	55.0	60.0
R17	28.4	35.9	40.3	45.1	50.0	55.0	60.0
R18	27.9	35.8	40.3	45.1	50.0	55.0	60.0
R19	28.6	35.9	40.3	45.1	50.0	55.0	60.0
R20	32.2	36.8	40.7	45.2	50.1	55.0	60.0
R21	32.9	37.1	40.8	45.3	50.1	55.0	60.0
R22	36.6	38.9	41.6	45.6	50.2	55.1	60.0
R23	32.5	36.9	40.7	45.2	50.1	55.0	60.0
R24	40.4	41.5	43.2	46.3	50.5	55.1	60.0
SWENSEN MUSEUM	35.8	38.4	41.4	45.5	50.2	55.1	60.0
R25	38.5	40.1	42.3	45.9	50.3	55.1	60.0
R26	38.8	40.3	42.5	45.9	50.3	55.1	60.0
R27	35.2	38.1	41.2	45.4	50.1	55.0	60.0
R28	30.1	36.2	40.4	45.1	50.0	55.0	60.0
R29	36.8	39.0	41.7	45.6	50.2	55.1	60.0
R30	32.5	36.9	40.7	45.2	50.1	55.0	60.0
R31	41.9	42.7	44.1	46.7	50.6	55.2	60.1
R32	42.4	43.1	44.4	46.9	50.7	55.2	60.1
R33	36.6	38.9	41.6	45.6	50.2	55.1	60.0
R34	37.4	39.4	41.9	45.7	50.2	55.1	60.0
R35	37.7	39.6	42.0	45.7	50.2	55.1	60.0
R36	42.5	43.2	44.4	46.9	50.7	55.2	60.1
R37	39.8	41.0	42.9	46.1	50.4	55.1	60.0
R38	37.1	39.2	41.8	45.7	50.2	55.1	60.0
R39	41	42.0	43.5	46.5	50.5	55.2	60.1
R40	38.7	40.2	42.4	45.9	50.3	55.1	60.0
R41	39.1	40.5	42.6	46.0	50.3	55.1	60.0
R42	41.5	42.4	43.8	46.6	50.6	55.2	60.1
R43	39.1	40.5	42.6	46.0	50.3	55.1	60.0
R44	39	40.5	42.5	46.0	50.3	55.1	60.0
R45	35.8	38.4	41.4	45.5	50.2	55.1	60.0
R46	34.9	38.0	41.2	45.4	50.1	55.0	60.0
R47	32.2	36.8	40.7	45.2	50.1	55.0	60.0

Guide to Reading **Tables 4** and **5**:

At receptor 11, we can predict that the sound impact from the proposed turbines will be 37.3 dBA. However, the existing sound levels at this specific location can only be estimated based on the sound monitoring results presented earlier. If the existing sound level is 45 dBA, the resulting cumulative sound level (background noise + turbine noise) at receptor 11 will be 45.7 dBA, an imperceptible increase.

Receptor ID	Turbine Impact (dBA) (Calculated)	Background Sound Levels + Turbine Impact (dBA)					
		35.0	40.0	45.0	50.0	55.0	60.0
SUBSTATION	32.1	36.8	40.7	45.2	50.1	55.0	60.0

Table 5– Noise Modeling Results (Scenario 2)

Receptor ID	Turbine Impact (Calculated)	Background Sound Levels + Turbine Impact (dBA)					
		35.0	40.0	45.0	50.0	55.0	60.0
R01	32.5	36.9	40.7	45.2	50.1	55.0	60.0
R02	33	37.1	40.8	45.3	50.1	55.0	60.0
R03	34.5	37.8	41.1	45.4	50.1	55.0	60.0
R04	36	38.5	41.5	45.5	50.2	55.1	60.0
R05	38.2	39.9	42.2	45.8	50.3	55.1	60.0
R06	39.6	40.9	42.8	46.1	50.4	55.1	60.0
R07	40.3	41.4	43.2	46.3	50.4	55.1	60.0
R08	40.2	41.3	43.1	46.2	50.4	55.1	60.0
R09	41.5	42.4	43.8	46.6	50.6	55.2	60.1
R10	31.5	36.6	40.6	45.2	50.1	55.0	60.0
R11	39.3	40.7	42.7	46.0	50.4	55.1	60.0
R12	36.8	39.0	41.7	45.6	50.2	55.1	60.0
R13	36.7	38.9	41.7	45.6	50.2	55.1	60.0
R14	34.4	37.7	41.1	45.4	50.1	55.0	60.0
R15	35.2	38.1	41.2	45.4	50.1	55.0	60.0
R16	31.9	36.7	40.6	45.2	50.1	55.0	60.0
R17	30.3	36.3	40.4	45.1	50.0	55.0	60.0
R18	29.9	36.2	40.4	45.1	50.0	55.0	60.0
R19	30.6	36.3	40.5	45.2	50.0	55.0	60.0
R20	34.2	37.6	41.0	45.3	50.1	55.0	60.0
R21	34.9	38.0	41.2	45.4	50.1	55.0	60.0
R22	38.6	40.2	42.4	45.9	50.3	55.1	60.0
R23	34.4	37.7	41.1	45.4	50.1	55.0	60.0
R24	42.4	43.1	44.4	46.9	50.7	55.2	60.1
SWENSEN MUSEUM	37.7	39.6	42.0	45.7	50.2	55.1	60.0
R25	40.5	41.6	43.3	46.3	50.5	55.2	60.0
R26	40.8	41.8	43.4	46.4	50.5	55.2	60.1
R27	37.2	39.2	41.8	45.7	50.2	55.1	60.0
R28	32.1	36.8	40.7	45.2	50.1	55.0	60.0
R29	38.8	40.3	42.5	45.9	50.3	55.1	60.0
R30	34.5	37.8	41.1	45.4	50.1	55.0	60.0
R31	43.9	44.4	45.4	47.5	51.0	55.3	60.1

Receptor ID	Turbine Impact (Calculated)	Background Sound Levels + Turbine Impact (dBA)					
		35.0	40.0	45.0	50.0	55.0	60.0
R32	44.3	44.8	45.7	47.7	51.0	55.4	60.1
R33	38.6	40.2	42.4	45.9	50.3	55.1	60.0
R34	39.4	40.7	42.7	46.1	50.4	55.1	60.0
R35	39.7	41.0	42.9	46.1	50.4	55.1	60.0
R36	44.5	45.0	45.8	47.8	51.1	55.4	60.1
R37	41.8	42.6	44.0	46.7	50.6	55.2	60.1
R38	39	40.5	42.5	46.0	50.3	55.1	60.0
R39	43	43.6	44.8	47.1	50.8	55.3	60.1
R40	40.7	41.7	43.4	46.4	50.5	55.2	60.1
R41	41	42.0	43.5	46.5	50.5	55.2	60.1
R42	43.4	44.0	45.0	47.3	50.9	55.3	60.1
R43	41.1	42.1	43.6	46.5	50.5	55.2	60.1
R44	40.9	41.9	43.5	46.4	50.5	55.2	60.1
R45	37.8	39.6	42.0	45.8	50.3	55.1	60.0
R46	36.8	39.0	41.7	45.6	50.2	55.1	60.0
R47	33.9	37.5	41.0	45.3	50.1	55.0	60.0
SUBSTATION	33.9	37.5	41.0	45.3	50.1	55.0	60.0

VI. Conclusion

WSB collected noise and meteorological data at four different sites representing the proposed Palmer's Creek Wind Farm. For monitoring locations within the proposed project area, the current L_{50} sound levels range from 45.1 dBA to 60.4 dBA for both daytime and nighttime. The existing sound levels met or exceeded State daytime noise standards at monitoring location 3, and met or exceeded nighttime noise standards at monitoring locations 1 and 2.

Two turbine layout scenarios were modeled to determine the sound-related impact of the proposed wind farm. **Tables 6** and **7** provide a summary of the sound impacts predicted under both turbine layout scenarios. The highest predicted change in sound level above 45 dBA is 2.8 dBA. Changes in sound levels less than 3 dBA are barely perceptible to the human ear.

Table 6: Summary of Scenario 1 Sound Impacts

Background Sound (dBA)	Highest Cumulative Sound (dBA)	Change in Sound Level (dBA)
45	46.9	1.9
50	50.7	0.7
55	55.2	0.2
60	60.1	0.1

Table 7: Summary of Scenario 2 Sound Impacts

Background Sound (dBA)	Highest Cumulative Sound (dBA)	Change in Sound Level (dBA)
45	47.8	2.8
50	51.1	1.1
55	55.4	0.4
60	60.1	0.1

In Minnesota, the MPCA State Noise Standards (L_{50}) restrict noise levels to 60 dBA during the daytime and 50 dBA during the nighttime. The analysis indicates that construction of the Palmer's Creek Wind Farm project will not have an impact of 60 dBA or greater on any modeled receptor, nor will the cumulative impact on any receptor exceed 60 dBA when assuming a 35 dBA, 40 dBA, 45 dBA, 50 dBA, or 55 dBA background sound level. During the daytime, and only with a background sound level already approaching or exceeding the 60 dBA threshold would the cumulative sound level (background and wind turbine sound) exceed 60 dBA. The same is true for the nighttime threshold; only with a background sound level already approaching or exceeding the 50 dBA threshold would the cumulative sound level exceed 50 dBA.

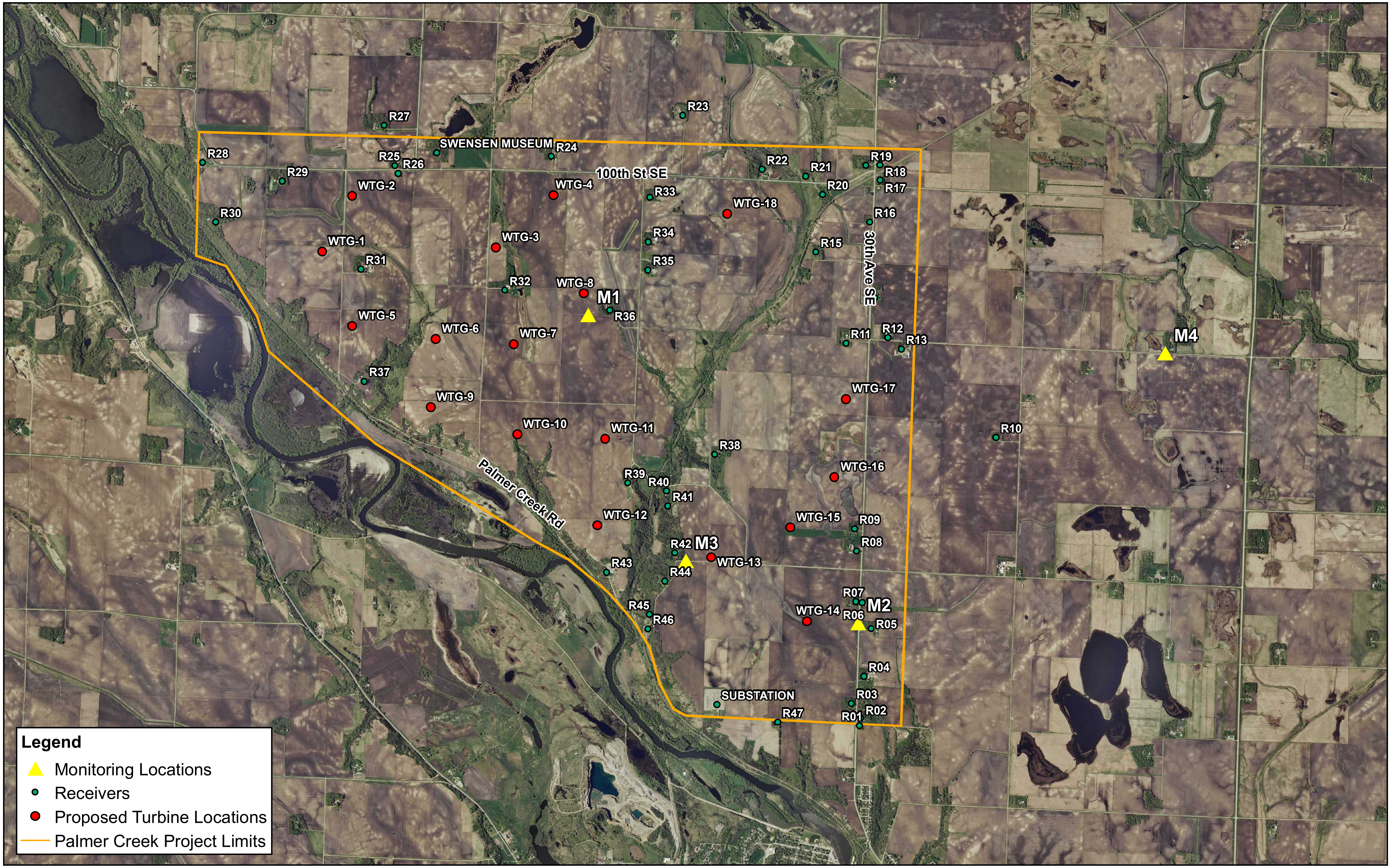


Figure 1 - Project Limits & Monitoring Locations

Palmer's Creek Wind Farm

Fagen Engineering

N

0 3,600 Feet

1 inch = 3,600 feet

Document Path: K:\02196-020\GIS\Maps\Figure1.mxd Date Saved: 1/25/2017 8:45:41 AM

Document Path: K:\02196-020\GIS\Maps\Figure10.mxd Date Saved: 1/24/2017 10:29:47 AM

Figure 10 - Closest Reciever to Turbine Impact

Palmer's Creek Wind Farm

Fagen Engineering

N

0 650 Feet

1 inch = 650 feet

WSB

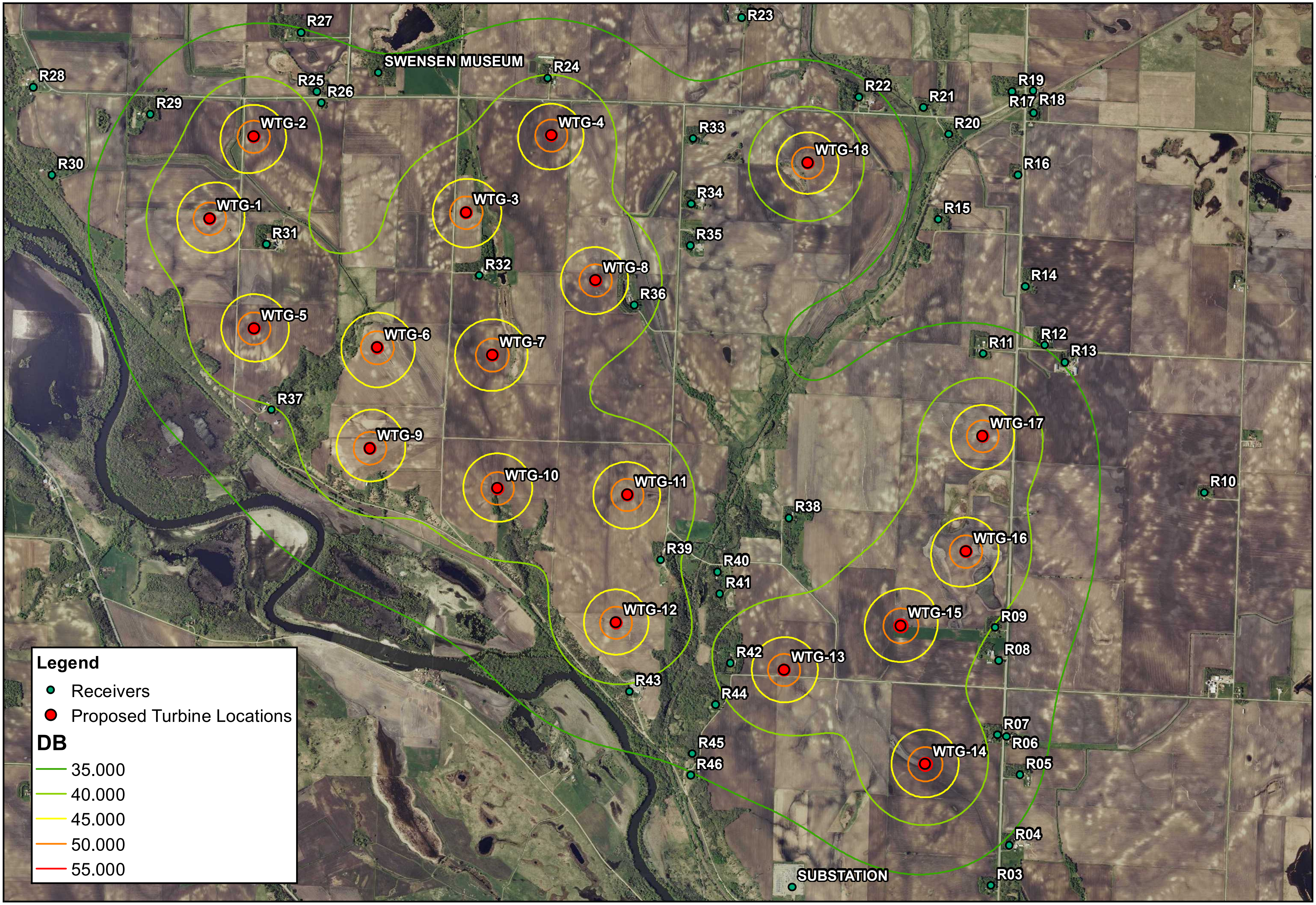


Figure 11 - Turbine Scenario 1,
All Turbines at 80m Hub Height
Palmer's Creek Wind Farm
Fagen Engineering

N

0 3,000 Feet
1 inch = 3,000 feet

WSB

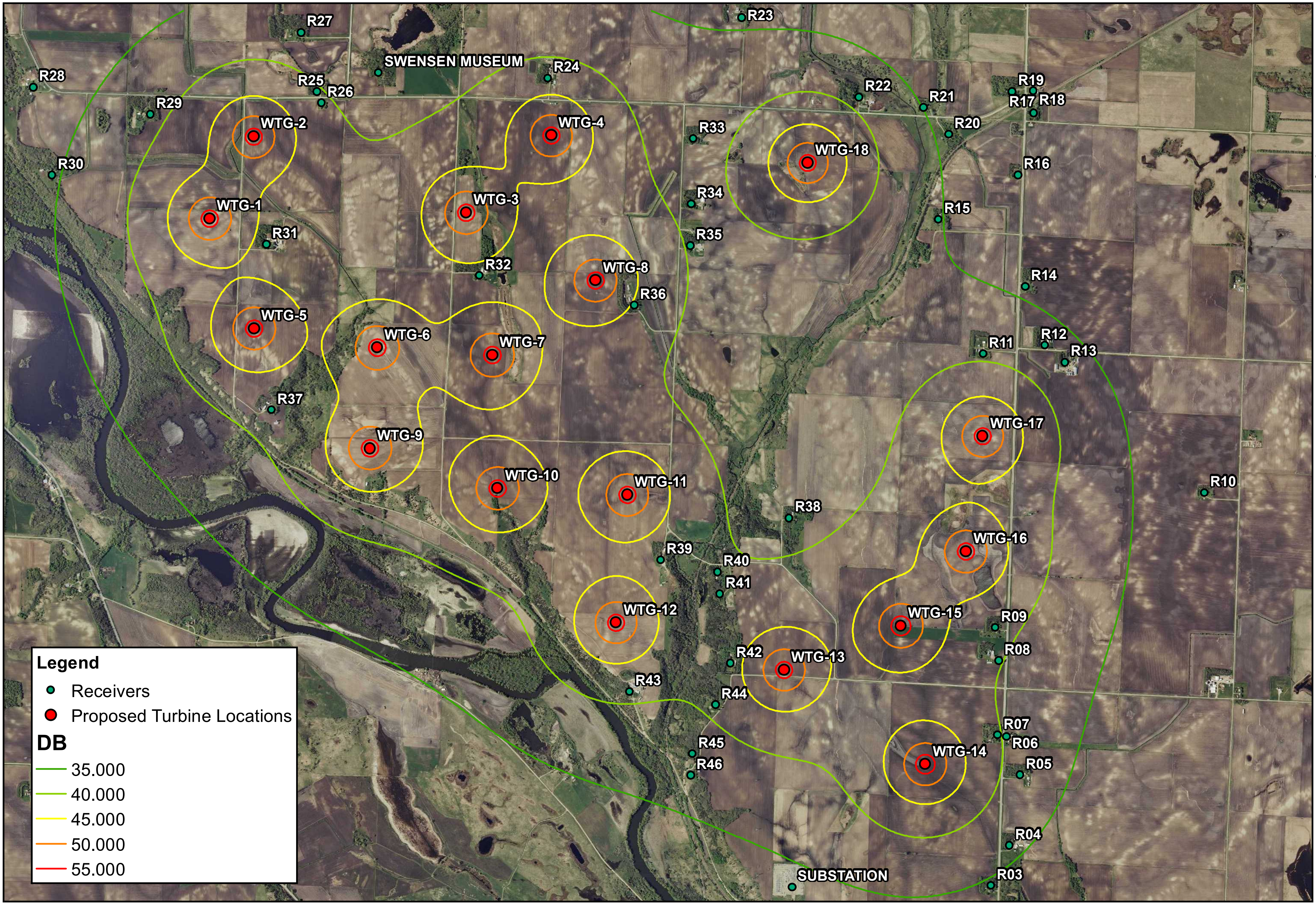


Figure 12 - Turbine Scenario 2

2.3 WM Turbines at 80m Hub Height, 2.5 MW Turbines at 90m Hub Height

Palmer's Creek Wind Farm

Fagen Engineering

N

0 3,000 Feet

1 inch = 3,000 feet

WSB

An elevation raster based viewshed analysis was employed in the area to help Beaver Creek Archaeology, Inc. investigate the inter-visibility relationship between the wind turbines from the wind farm and three observer points, the city center of Granite Falls and two observation points (OP 1 & OP 2) on the Upper Sioux Reservation. The viewshed was calculated using a standard wind turbine offset height of 130 m (426.5') (tip of blade) and observer's eye level height of 1.83 m (6') for each observer point (city center, OP 1 & OP 2). The viewshed analysis showed that the wind farm would be visible from all three observer points.

The inter-visibility between the observer points and the wind turbine locations were also analyzed using Line of Sight (LOS) tool. The LOS is a straight line comprising of two vertices representing observer point and the target location for which visibility was determined. The LOS were created by adding offset heights for observer and wind turbine to the surface elevation. The areas visible from the observer points are shown in green while the areas not visible due to the obstructions from topography are shown in red on the viewshed map (see Figures 1 & 2).

According to Sullivan, et al. (2012), in an ideal setting, under optimal viewing conditions (e.g., flat ground, clear skies), a wind farm is visible to the unaided eye at a distance of 36 miles and a major visual focus at distances up to 12 miles. The proposed impact threshold distances in the Sullivan, et al. (2012) report indicate that the wind farm would not be visible at distances greater than 36 miles. At 30-34 miles, the wind farm would have a minimal visual impact (Sullivan, et al. 2012). At 20-23 miles, the wind farm would have a low to moderate visual impact (Sullivan et al. 2012). And at 10 to 12 miles, the wind farm would have a high visual impact (Sullivan et al. 2012).

Looking to the Sullivan, et al. (2012) model and applying it to the proposed Palmers Creek Wind project, Figures 1-3 show areas where portions of the wind farm would be visible from either the city center of Granite Falls and/or from two observation points (OP 1 & OP 2) on the Upper Sioux Reservation.

Figure 1 is a viewshed analysis between the three observation points and the proposed wind farm with 426' wind turbines. In Figure 1, areas that are visible from the three observation points are colored in green, whereas areas that are not visible from the observation points are colored red.

Figure 1 is a viewshed analysis between the three observation points and the proposed wind farm. In Figure 2, areas in green are areas that are visible from all the proposed wind turbines, while areas in red are not visible from all of the proposed wind turbines. Moreover, this indicates that the city center of OP 2 could potentially see all of the proposed wind turbines.

Figure 3 is a viewshed analysis between the three observation points and the proposed wind farm. Areas color-coded in red are areas of the landscape that are not visible from any of the observation points. Areas color-coded in green are areas of the landscape that are visible from OP1. Areas color-coded in blue are areas of the landscape that are visible from OP 2. Areas color-coded in purple are areas of the landscape that are visible from the city center. Areas color-coded in yellow are visible from at least two of the three observation points.

Additional support to this model is supplied by the original Thomas Matrix (Table 1), which has been converted and applied to this project and illustrates similar results.

Figure 4 shows the location of the proposed wind farm (survey area and wind turbines), the location of the Upper Sioux Reservation, the viewshed analysis boundary (red and green areas), and the visual impact zones of the proposed Palmer Creek Wind project. Areas color-coded in dark green is the high (0-12 mi) visual impact range. Areas color-coded in yellow is the moderate to low (12-23 mi.) visual impact range. Areas color-coded in white is the low to no (23-36 mi.) visual impact range.

Table 1. The original Thomas Matrix applied to a 426.5' wind turbine (Sullivan et al 2012: Table 1).

Descriptors	Approximate Distance Range
Dominant impact due to large scale, movement, and proximity	0-3.47 mi
Major impact due to proximity; capable of dominating landscape	3.47-5.49 mi
Clearly visible with moderate impact; potentially intrusive	5.49-7.22 mi
Clearly visible with moderate impact; becoming less distinct	7.22-10.69 mi
Less distinct; size is reduced, but movement still is discernible	10.69-17.92 mi
Low impact, movement noticeable in good light; becoming noticeable components in the overall landscape	17.92-21.69 mi
Becoming indistinct with negligible impact on the wider landscape	21.69-32.36 mi
Noticeable in good light, but negligible impact	32.36-35.83 mi
Negligible or no impact	35.83 mi
Suggested radius for zone of visual impact analysis	**26.87 mi**

In summary, several wind turbines would be visible from the city center of Granite Falls. Several wind turbines would be visible from observation point 1 on the Upper Sioux Reservation. And several wind turbines would be visible from observation point 2 on the Upper Sioux Reservation. A more in-depth viewshed analysis, visual impact assessment, and ground truthing will be provided in the cultural resource report.

EAPC WIND ENERGY

Final Report
Palmers Creek Wind Farm, LLC
Shadow Flicker

Palmers Creek Wind Project

October 31,

2016

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Legal Notice and Disclaimer

Report Update

EAPC bears no responsibility to update this report for any changes occurring subsequent to the final issuance of this report.

Revision History

Revision No.	Revision Purpose	Date	Revised By
0	Original	10/12/2016	N.Laskovski
1	Final	10/31/2016	N.Laskovski

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Executive Summary

EAPC Wind Energy was hired by Palmers Creek Wind Farm, LLC to provide estimates of the potential shadow flicker from a wind farm consisting of GE wind turbines located north of Granite Falls, MN. The project consists of 18 General Electric (GE) wind turbines with rated capacities of 2.3 Megawatts (MW) and 2.5 MW. Hub heights (HH) of 80m and 94m were analyzed and the different configurations are presented below. 49 receptors were provided by the client to be analyzed. On site wind data representative of one year from an 80m met tower were also provided. A WindPRO model was built combining digital elevation data with the information supplied by the client to generate a model suitable for determining potential shadow flicker at the provided receptors.

Based on the shadow flicker calculation, six options have been presented; a site-wide "worst case" scenario for 80m, 80m + 90m, and 80m + 94m turbines and a site-wide "realistic" scenario for 80m, 80m + 90m, and 80m + 94m turbines.

1. Introduction

Palmers Creek Wind Farm, LLC (Palmers Creek) hired EAPC Wind Energy (EAPC) to conduct a shadow flicker analysis for a wind turbine layout consisting of 18 GE wind turbines. Two locations utilized the GE 2.3-116 with an 80m HH. The remaining 16 locations utilized a GE 2.5-116 with hub heights of either 80m, 90m, or 94m. The wind project, named Palmers Creek Wind Project, is located north of Granite Falls, MN. Coordinates for 49 receptors, located within one mile (1600m) of the nearest turbine, were supplied by the client.

Both theoretical worst case and realistic case analyses were performed. The theoretical worst case model identifies all areas that could possibly experience shadow flicker given the size and shape of the turbines, terrain of the land around them and sun angles throughout the year. This case assumes that it is never cloudy and that there is always sufficient wind to operate the turbine and that the turbine is always perpendicular to the sun. The realistic scenario incorporates weather probabilities based upon long-term average weather conditions to more precisely model when the turbine is likely to be operational and the angle at which the rotor is oriented. Repetitive on site wind data was also included in the realistic model to determine operational time for the turbine as well as rotor direction. Sunshine probability is also included as a realistic model variable because shadow flicker can only occur when the sun is shining with no cloud cover.

2. Site Overview

The area of interest is located in South Central Minnesota approximately 100 mi (160 km) west of Minneapolis. The project site is open crop fields with several nearby houses within the project. The turbines have an elevation ranging from 1,010 ft – 1,050 ft (308 – 320m).

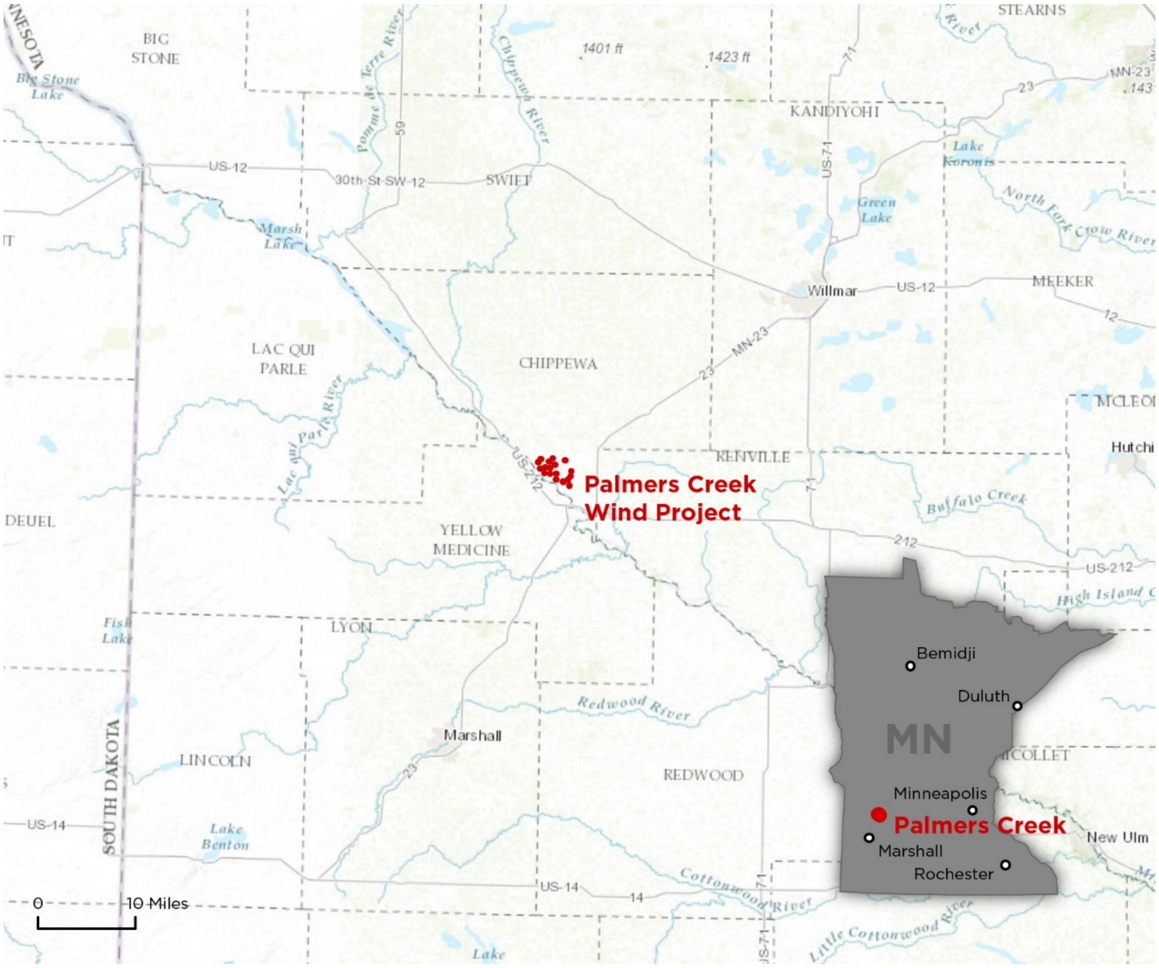


Figure 1. Site Overview Map

3. *Shadow Flicker*

3.1. *Background*

Shadow flicker from wind turbines occur when rotating wind turbine blades move between the sun and the observer. Shadow flicker is generally experienced in areas near wind turbines where the distance between the observer and wind turbine blade is short enough that sunlight has not been significantly diffused by the atmosphere. When the blades rotate, this shadow creates a pulsating effect, known as shadow flicker. If the blade's shadow is passing over the window of a building, it will have the effect of increasing and decreasing the light intensity in the room at a low frequency in the range of 0.5 to 1.2 Hz, hence the term "flicker." This flickering effect can also be experienced outdoors, but the effect is typically less intense and becomes even less intense when farther from the wind turbine causing the flicker. The moving shadow of a wind turbine blade on the ground is similar to the effect one experiences when driving on a road when there are shadows cast across the road by an adjacent row of trees.

The flickering effect is most noticeable within approximately 1,000 m of the turbine, and becomes more and more diffused as distance increases. There are no uniform standards defining what distance from the turbine is regarded as an acceptable limit beyond which the shadow flicker is considered to be insignificant. The same applies to the number of hours of flicker that is deemed to be acceptable. Thirty is the standard allowed maximum hours of shadow per year in other places such as Germany. A distance of 1,600m was used for each iteration of shadow flicker modeling for this report.

Shadow flicker is typically greatest in winter months when the angle of the sun is lower and casts longer shadows. The effect is also more pronounced around sunrise and sunset when the sun is near the horizon and shadows are longer. A number of factors influence the amount of shadow flicker on the shadow receptors (simulated windows). One consideration is the environment around the shadow receptor. Obstacles such as terrain, trees or buildings between the wind turbine and the receptor can significantly reduce or eliminate shadow flicker effects. Deciduous trees may block some degree of shadow flickering depending on the tree density, species present and time of year. They can lead to a reduction of shadow flicker during the summer when the trees are bearing leaves. However, during the winter months, these trees are without their leaves and their impact on shadow flicker is not as significant. Coniferous trees may provide shading year round. For this study, no credit was given to potential shading from any type of tree or other obstacles that would reduce the number of shadow flickering hours at the structures.

Another consideration is the time of day when shadow flicker occurs. For example, a factory or office building would not be significantly affected if all the shadow flicker impact occurred before or after business hours. In contrast, it may be more acceptable for private homes to experience shadow flickering during working hours when family members may be at work or school.

The climate also needs be considered when assessing shadow flicker. In areas with high incidence of overcast weather there would be less shadow flicker. Also, if the wind is not blowing, the turbines would not be operational and therefore not creating shadow flickering.

3.2. Study Methodology

This shadow flicker analysis was performed using WindPRO, a sophisticated wind modeling software program. WindPRO is used to calculate detailed shadow flicker maps across an entire area of interest or at site-specific locations using shadow receptors.

Shadow maps, which indicate where shadows will be cast and for how long, can be calculated at varying resolutions. The Fine resolution setting with WindPRO was used for this study; it represents shadow flicker calculations that determine the sun angle every 2 minutes, every 3rd day, over the period of an entire year, over a grid resolution of 10 meters, measured at a height of 1.5 meters.

Point-specific shadow flicker calculations are modeled at a higher resolution than the shadow flicker maps to include the highest precision possible within WindPRO. Shadow flicker at each shadow receptor location is calculated every minute of every day throughout the entire year. Shadow receptors can be configured to represent an omni-directional plane of a specific size (greenhouse mode) or a plane facing a single direction (single direction mode). The shadow receptors used in this analysis were configured as greenhouse-mode receptors. All receptors were modeled as 2-meter-wide by 1.5-meter-high, 1 meter from the ground, directly facing the wind turbine. Shadow flicker exposure is recorded by the model if the turbine casts a shadow on any part of this receptor during any minute of any day throughout the year.

As part of the calculation method, WindPRO must determine whether or not the turbine will be visible at the receptor locations due to local topography. It does this by performing a preliminary Zones of Visual Influence (ZVI) calculation using a terrain model with 10-meter x 10-meter grid spacing. If there is no line-of-sight to the turbine within the 10-meter x 10-meter area containing the shadow receptor, the receptor is not included in the shadow flicker calculation.

The inputs for the WindPRO shadow flicker calculation include the following:

- Turbine Coordinates
- Turbine Specifications
- Shadow Receptor Coordinates
- USGS Digital Elevation Model (DEM) (height contour data)
- Sunshine Probability
- Sector-wise Annual Frequency

A description of each input variable and how they affect the shadow flicker calculation are included below.

Turbine Coordinates: The location of a wind turbine in relation to a shadow receptor is one of the most important factors in determining shadow flicker impacts. A line-of-site is required for shadow flicker to occur. The intensity of the shadow flicker is dependent upon the distance from the wind turbine and weather conditions. The coordinates and elevations of the wind turbines used in this study are included in Appendix A.

Turbine Specifications: A wind turbine's total height and rotor diameter are included in the WindPRO shadow flicker model. The taller the wind turbine, the more likely shadow flicker could have an impact on local shadow receptors as the likelihood of clearing obstacles (such as hills or trees) is greater. The larger the rotor diameter is, the wider the area where shadows will be cast. Also included with the turbine specifications are the cut-in and cut-out wind speeds within which the wind turbine is operational. If the wind speed is below the cut-in threshold or above the cut-out threshold, the turbine rotor will not be spinning and thus shadow flicker will not occur. The specifications of the turbine model used in this study are included in Table 1 below.

Table 1: Palmers Creek Wind Project Turbine Specifications for Shadow Flicker.

Manufacturer	Model	Hub Heights (m)	Rotor Diameter (m)
GE	2.3-116	80	116
GE	2.5-116	80, 90, 94	116

Shadow Receptor Coordinates: As with the wind turbine coordinates, the elevation, distance and orientation of a shadow receptor in relation to wind turbines and the sun are the main factors in determining the impact of shadow flicker. EAPC was provided with coordinates for 49 structures; the coordinates of these shadow receptors are included in Appendix B.

USGS Digital Elevation Model (DEM) (height contour data): For this study, 10m x 10m USGS National Elevation Database (NED 1/3 arc-second) DEMs were used to construct 10 m interval height contour lines for the WindPRO shadow flicker model. The height contour information is important to the shadow flicker calculation since it allows the model to place the wind turbines and the shadow receptors at the correct elevations. The height contour lines also allow the model to include the topography of the site when calculating the zones of visual influence surrounding the wind turbine and shadow receptor locations. A map of the project area which includes the height contour lines is included in Appendix C.

Sunshine Probability: Shadow flicker is only produced when the sun is shining. To calculate a more realistic scenario, EAPC input the sunshine data to reduce worst case shadow flicker hours, achieving a more 'realistic' scenario. Using data from a climate database within WindPRO, EAPC assumed sunshine percentages showing in the following table.

Table 2: Sunshine Probability for Madison, WI

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
4.43	5.24	5.95	7.01	8.58	9.67	9.71	8.48	7.21	5.48	3.66	3.19

Sector-wise Frequency: Shadow flicker is only produced when sunshine is hitting the turbine from a certain direction. To calculate a more realistic scenario, EAPC input the operational hours from 12 sectors. These hours were calculated using on-site met data from an 80m tower. The data was supplied by the client and not validated by EAPC. Using WindPro, a shear exponent of 0.25 was used to shear the 80m data to 90m and 94m.

Table 3: Sector-wise Operational Hours

N	NNE	ENE	E	ESE	SSE	S	SSW	WSW	W	WNW	NNW
528	300	300	396	610	1529	1,184	403	333	542	951	1,392

3.3. Results of Shadow Flicker Analysis

The term *theoretical worst case*, as used in this report, means that turbine operational hours, wind direction, and local sunshine probabilities have not been accounted for. As such, *theoretical worst case* estimates are conservative. The term *realistic*, as used in this report, means that turbine operational time, rotor orientation, and sunshine probabilities are factored into the model. **Blocking or shading effects due to trees or structures have not been accounted for.** Both *theoretical worst case* and *realistic* values are estimates based on model inputs.

A total of 49 receptors (primary structures) were analyzed, and a *fine* resolution shadow flicker map was generated for both *theoretical worst case* and *realistic* modeling scenarios, utlizing two different hub heights within the turbine layouts. The fine resolution shadow flicker maps are included in Appendix B and also shown in the figures below.

4. Conclusions

The conservative results of this study indicate that of the 49 receptors modeled, 10 modeled zero shadow flicker across all scenarios, 17 modeled 30 or more hours per year *theoretical worst case with 80m HH*, 16 modeled 30 hours or per year *theoretical worst case* with 80m + 90m HH, 18 modeled 30 hours or per year *theoretical worst case* with 80m + 94m HH and 1 receptor modeled over 30 hours per year under *realistic conditions* for 80m, 80m and 90m HH, and 80 + 94m HH. The *realistic* shadow flicker impacts on receptors were calculated with consideration for turbine operational time and orientation (using on-site wind data provided by the client) and sunshine probabilities. This analysis is based on a number of other assumptions including:

- A human would always be present at the receptor to observe the effect.
- A human would be situated in an area where the flickering occurs.
- The receptors are omni-directional rather than modeling specific aspects of building facades or window openings.
    - Receptor windows are 2m in width x 1.5m in height x 1m above ground level; 90 deg vertical.

The overall effect of using these assumptions indicates that the actual number of hours of shadow flicker that would be observed will likely be less than those predicted by this study.

Appendix A: Wind Turbine Coordinates

Turbine	Coordinates (WGS 84)		Turbine	Hub Height (m)
	Latitude	Longitude		
1	44.869294°	-95.606875°	GE 2.5-116	80, 90, 94
2	44.874328°	-95.601897°	GE 2.5-116	80, 90, 94
3	44.870217°	-95.583817°	GE 2.5-116	80, 90, 94
4	44.875264°	-95.576389°	GE 2.5-116	80, 90, 94
5	44.859956°	-95.602481°	GE 2.5-116	80, 90, 94
6	44.861392°	-95.591403°	GE 2.5-116	80, 90, 94
7	44.861153°	-95.581006°	GE 2.5-116	80, 90, 94
8	44.866139°	-95.571917°	GE 2.5-116	80, 90, 94
9	44.853119°	-95.592247°	GE 2.5-116	80, 90, 94
10	44.852608°	-95.580111°	GE 2.5-116	80, 90, 94
11	44.852469°	-95.568378°	GE 2.5-116	80, 90, 94
12	44.844250°	-95.569025°	GE 2.5-116	80, 90, 94
13	44.841564°	-95.553758°	GE 2.5-116	80, 90, 94
14	44.835808°	-95.540764°	GE 2.3-116	80
15	44.844631°	-95.543356°	GE 2.3-116	80
16	44.849525°	-95.537703°	GE 2.5-116	80, 90, 94
17	44.856922°	-95.536517°	GE 2.5-116	80, 90, 94
18	44.872581°	-95.550994°	GE 2.5-116	80, 90, 94

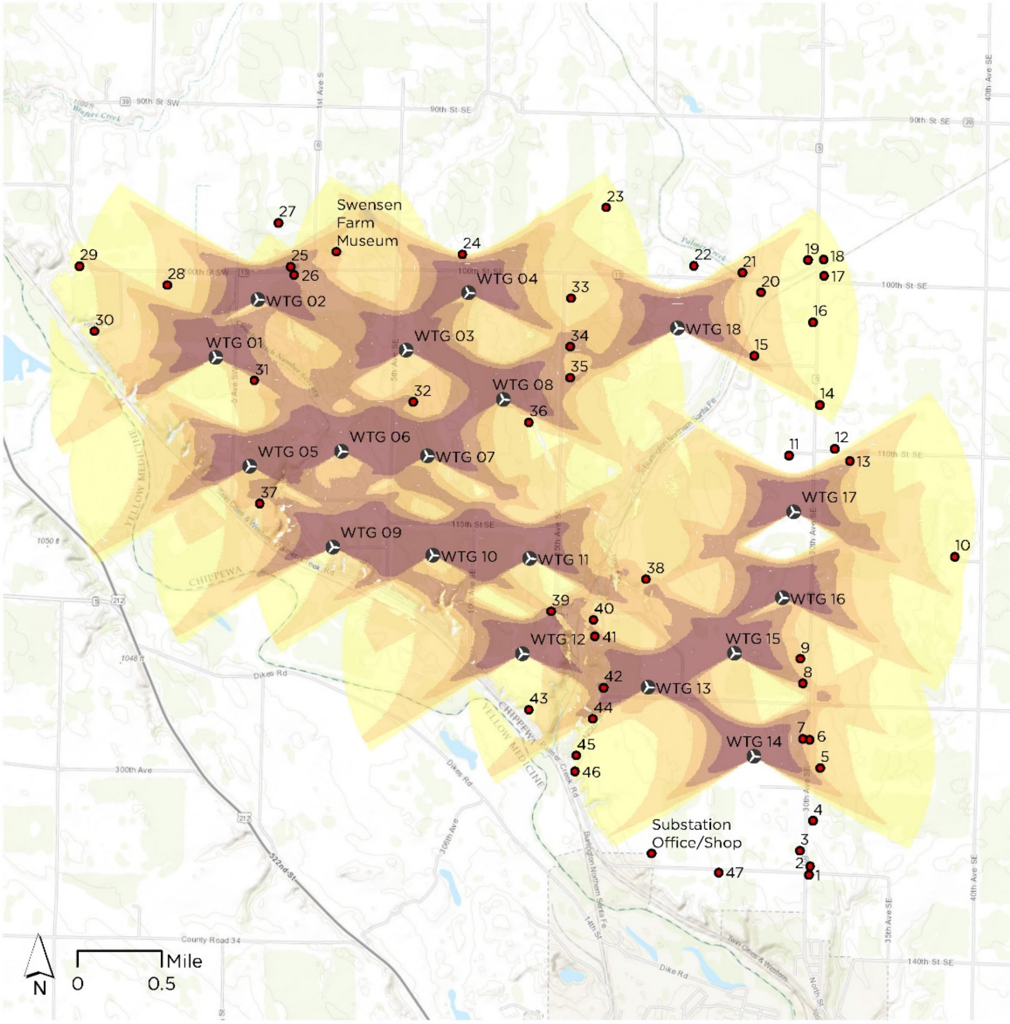
Appendix B: Turbine/Receptor Coordinates and Flicker Results

Receptor	Coordinates (UTM WGS 84)		Elevation (m)	Description	Flicker (h:m/ year) **80m** HH **- Worst Case**	Flicker (h:m/ year) **80m** HH **+ 90m** HH - **Worst Case**	Flicker (h:m/ year) **80m** HH **+ 94m** HH - **Worst Case**	Flicker (h:m/ year) **80m** HH - ***Realistic Case***	Flicker (h:m/ year) **80m** HH **+ 94m** HH - ***Realistic* Case**	Flicker (h:m/ year) **80m** HH **+ 94m** HH - ***Realistic* Case**
1	44.825638°	-95.533842°	319.3	Resident 01	0:00	0:00	0:00	0:00	0:00	0:00
2	44.826359°	-95.533704°	318.5	Resident 02	0:00	0:00	0:00	0:00	0:00	0:00
3	44.827696°	-95.534989°	317.9	Resident 03	0:00	0:00	0:00	0:00	0:00	0:00
4	44.830307°	-95.533451°	317.9	Resident 04	0:00	0:00	0:00	0:00	0:00	0:00
5	44.834853°	-95.532683°	319.8	Resident 05	29:30	0:00	29:30	11:14	11:23	11:24
6	44.837284°	-95.534019°	321.1	Resident 06	37:51	2:45	38:46	10:19	10:42	10:50
7	44.837363°	-95.534825°	322.5	Resident 07	48:37	3:11	49:37	13:00	13:27	13:36
8	44.842124°	-95.534954°	318.1	Resident 08	52:31	53:05	53:19	23:11	23:41	23:47
9	44.844227°	-95.535337°	319.2	Resident 09	31:09	31:47	31:59	11:06	11:25	11:29
10	44.853297°	-95.516886°	321.2	Resident 10	3:32	4:36	4:59	1:12	1:35	1:43
11	44.861760°	-95.537188°	319.8	Resident 11	0:00	0:00	0:00	0:00	0:00	0:00
12	44.862421°	-95.531666°	318	Resident 12	0:00	0:00	0:00	0:00	0:00	0:00
13	44.861382°	-95.529807°	318.6	Resident 13	36:35	40:46	42:06	6:25	7:18	7:34
14	44.866156°	-95.533598°	319.5	Resident 14	7:19	10:40	11:34	3:22	4:48	5:24
15	44.870285°	-95.541625°	316.8	Resident 15	28:29	32:20	33:46	12:10	14:01	14:42
16	44.873292°	-95.534581°	318.3	Resident 16	4:05	4:54	5:07	1:21	1:39	1:43
17	44.877298°	-95.533334°	317.7	Resident 17	2:52	3:31	3:46	0:44	0:55	0:59
18	44.878708°	-95.533434°	318.7	Resident 18	2:52	3:31	3:49	0:38	0:48	0:53
19	44.878631°	-95.535326°	320.9	Resident 19	4:08	5:02	5:21	0:54	1:07	1:11
20	44.875754°	-95.540947°	313.6	Resident 20	15:55	17:14	17:41	3:59	4:23	4:31
21	44.877427°	-95.543273°	312.7	Resident 21	35:04	37:52	39:02	6:18	6:56	7:10
22	44.877963°	-95.549112°	313.6	Resident 22	0:00	0:00	0:00	0:00	0:00	0:00
23	44.882819°	-95.559915°	319.5	Resident 23	3:45	4:38	5:03	0:46	0:58	1:04
24	44.878542°	-95.577203°	316.3	Resident 24	0:00	10:50	19:31	0:00	2:38	4:54
25	44.877208°	-95.597991°	318.1	Resident 25	95:56	104:34	107:16	17:56	20:04	20:40
26	44.876494°	-95.597527°	317.5	Resident 26	112:50	109:37	105:17	24:55	25:15	24:36
27	44.880968°	-95.599588°	317.5	Resident 27	0:00	0:00	0:00	0:00	0:00	0:00
28	44.875402°	-95.612918°	315.9	Resident 28	12:17	13:37	14:08	4:21	4:54	5:05
29	44.876903°	-95.623577°	317.5	Resident 29	4:02	4:52	5:08	1:17	1:35	1:40
30	44.871308°	-95.621627°	315.3	Resident 30	8:11	9:34	10:07	2:45	3:16	3:28
31	44.867319°	-95.602094°	318.2	Resident 31	61:33	56:35	52:27	24:52	22:26	20:21
32	44.865745°	-95.582822°	319.9	Resident 32	44:33	48:51	50:14	10:40	11:58	12:22

33	44.874963°	-95.563933°	316.9	Resident 33	19:38	22:21	23:33	6:43	7:43	8:08
34	44.870771°	-95.563925°	315.1	Resident 34	71:38	78:15	80:23	20:18	22:28	23:06
35	44.868106°	-95.563889°	317.4	Resident 35	52:17	57:41	59:29	14:55	16:41	17:14
36	44.864178°	-95.568776°	316.4	Resident 36	18:29	20:34	21:16	6:33	7:22	7:37
37	44.856727°	-95.601147°	308.7	Resident 37	27:42	29:53	30:15	9:19	10:15	10:25
38	44.850846°	-95.554238°	314.7	Resident 38	43:07	47:26	49:10	13:31	15:05	15:40
39	44.847905°	-95.565658°	311.4	Resident 39	52:42	68:27	74:28	14:13	18:13	19:45
40	44.847249°	-95.560488°	307.3	Resident 40	30:29	36:05	38:52	8:14	10:04	10:58
41	44.845851°	-95.560249°	311.1	Resident 41	69:24	74:41	76:11	20:53	22:51	23:23
42	44.841427°	-95.559105°	318.2	Resident 42	106:00	110:46	116:21	39:01	42:44	44:17
43	44.839398°	-95.568088°	310.7	Resident 43	8:00	9:04	9:31	2:31	2:54	3:03
44	44.838731°	-95.560323°	315.8	Resident 44	24:25	20:53	20:28	7:37	7:16	6:30
45	44.835534°	-95.562243°	309.2	Resident 45	1:51	0:00	1:51	0:37	0:38	0:38
46	44.834158°	-95.562369°	309.5	Resident 46	1:44	0:00	1:44	0:34	0:34	0:34
47	44.825700°	-95.544746°	319.2	Resident 47	0:00	0:00	0:00	0:00	0:00	0:00
48	44.827202°	-95.552901°	313.1	Substation-OfficeShop	0:00	0:00	0:00	0:00	0:00	0:00
49	44.878552°	-95.592478°	319.2	Swensen-Farm-Museum	22:43	25:12	26:25	5:19	6:01	6:20

Red numbers indicate hours/ year at or greater than 30.

Appendix C: Palmers Creek Wind Shadow Flicker Map



Palmers Creek Wind Project - Granite Falls, MN

Worst Case Shadow Flicker Modeling

Shadow Flicker Hours/Year

- 0 - 10
- 10 - 30
- 30 - 50
- 50 - 100
- 100 - 1200

- Proposed WTG Site
- Receptor Site

EAPC WIND ENERGY

Appendix D: WindPRO Shadow Flicker Reports

Project:
Palmers Creek Wind Farm

Description:
Mike Rutledge
Environmental Services Dept. Head
FAGEN ENGINEERING, LLC
P.O. Box 159
Granite Falls, MN 56241
320-564-3324 Main
320-564-2625 Direct
320-564-4861 Fax

Licensed user:
EAPC Wind Energy
3100 DeMers Avenue
US-GRAND FORKS, ND 58201
+1 701 775 3000
Nicholas Laskovski / n.laskovski@eapcwindenergy.com
Calculated:
10/11/2016 3:29 PM/3.0.654

SHADOW - Main Result

Calculation: Worst Case - Greehouse Mode - 80m HH

Assumptions for shadow calculations

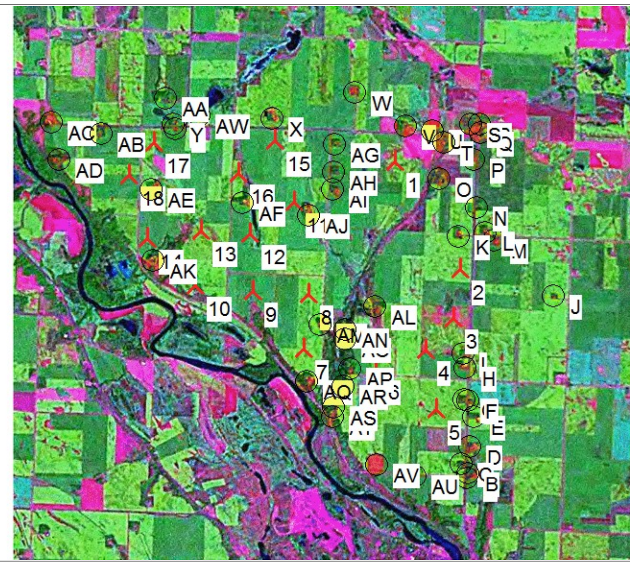
Maximum distance for influence
Calculate only when more than 20 % of sun is covered by the blade
Please look in WTG table

Minimum sun height over horizon for influence	3 °
Day step for calculation	1 days
Time step for calculation	1 minutes

The calculated times are "worst case" given by the following assumptions:
- The sun is shining all the day, from sunrise to sunset
- The rotor plane is always perpendicular to the line from the WTG to the sun
- The WTG is always operating

A ZVI (Zones of Visual Influence) calculation is performed before flicker calculation so non visible WTG do not contribute to calculated flicker values. A WTG will be visible if it is visible from any part of the receiver window. The ZVI calculation is based on the following assumptions:
Height contours used: Project Wizard Elevation Data Grid (US NED 1/3 arc-secon
Obstacles used in calculation
Eye height: 1.5 m
Grid resolution: 10.0 m

All coordinates are in
Geo [deg]-WGS84



Scale 1:125,000
New WTG — Shadow receptor

WTGs

	Longitude	Latitude	Z	Row data/Description	WTG type Valid	Manufact.	Type-generator	Power, rated	Rotor diameter	Hub height	Shadow data Calculation distance	RPM
			[m]					[kW]	[m]	[m]	[m]	[RPM]
1	-95.550994° E	44.872581° N	316.5	WTG 18	Yes	GE WIND ENERGY	GE 2.3-116-2,300	2,300	116.0	80.0	1,732	15.7
2	-95.536517° E	44.856922° N	316.3	WTG 17	Yes	GE WIND ENERGY	GE 2.3-116-2,300	2,300	116.0	80.0	1,732	15.7
3	-95.537703° E	44.849525° N	315.7	WTG 16	Yes	GE WIND ENERGY	GE 2.3-116-2,300	2,300	116.0	80.0	1,732	15.7
4	-95.543356° E	44.844631° N	314.6	WTG 15 - GE 2.3-116...	Yes	GE WIND ENERGY	GE 2.3-116-2,300	2,300	116.0	80.0	1,732	15.7
5	-95.540764° E	44.835808° N	312.5	WTG 14 - GE 2.3-116...	Yes	GE WIND ENERGY	GE 2.3-116-2,300	2,300	116.0	80.0	1,732	15.7
6	-95.553758° E	44.841564° N	316.5	WTG 13	Yes	GE WIND ENERGY	GE 2.5-116-2,500	2,500	116.0	80.0	1,732	15.7
7	-95.569025° E	44.844250° N	310.9	WTG 12	Yes	GE WIND ENERGY	GE 2.5-116-2,500	2,500	116.0	80.0	1,732	15.7
8	-95.568378° E	44.852469° N	313.3	WTG 11	Yes	GE WIND ENERGY	GE 2.5-116-2,500	2,500	116.0	80.0	1,732	15.7
9	-95.580111° E	44.852608° N	309.1	WTG 10	Yes	GE WIND ENERGY	GE 2.5-116-2,500	2,500	116.0	80.0	1,732	15.7
10	-95.592247° E	44.853119° N	317.3	WTG 09	Yes	GE WIND ENERGY	GE 2.5-116-2,500	2,500	116.0	80.0	1,732	15.7
11	-95.571917° E	44.866139° N	314.6	WTG 08	Yes	GE WIND ENERGY	GE 2.5-116-2,500	2,500	116.0	80.0	1,732	15.7
12	-95.581006° E	44.861153° N	316.1	WTG 07	Yes	GE WIND ENERGY	GE 2.5-116-2,500	2,500	116.0	80.0	1,732	15.7
13	-95.591403° E	44.861392° N	313.0	WTG 06	Yes	GE WIND ENERGY	GE 2.5-116-2,500	2,500	116.0	80.0	1,732	15.7
14	-95.602481° E	44.859956° N	311.1	WTG 05	Yes	GE WIND ENERGY	GE 2.5-116-2,500	2,500	116.0	80.0	1,732	15.7
15	-95.576389° E	44.875264° N	315.5	WTG 04	Yes	GE WIND ENERGY	GE 2.5-116-2,500	2,500	116.0	80.0	1,732	15.7
16	-95.583817° E	44.870217° N	313.8	WTG 03	Yes	GE WIND ENERGY	GE 2.5-116-2,500	2,500	116.0	80.0	1,732	15.7
17	-95.601897° E	44.874328° N	310.5	WTG 02	Yes	GE WIND ENERGY	GE 2.5-116-2,500	2,500	116.0	80.0	1,732	15.7
18	-95.606875° E	44.869294° N	315.7	WTG 01	Yes	GE WIND ENERGY	GE 2.5-116-2,500	2,500	116.0	80.0	1,732	15.7

Shadow receptor-Input

No.	Name	Longitude	Latitude	Z	Width	Height	Height a.g.l.	Degrees from south cw	Slope of window	Direction mode
				[m]	[m]	[m]	[m]	[°]	[°]	
A	Resident 01	-95.533842° E	44.825638° N	319.3	2.0	1.5	1.0	0.0	90.0	"Green house mode"
B	Resident 02	-95.533704° E	44.826359° N	318.5	2.0	1.5	1.0	0.0	90.0	"Green house mode"
C	Resident 03	-95.534989° E	44.827696° N	317.9	2.0	1.5	1.0	0.0	90.0	"Green house mode"
D	Resident 04	-95.533451° E	44.830307° N	317.9	2.0	1.5	1.0	0.0	90.0	"Green house mode"
E	Resident 05	-95.532683° E	44.834853° N	319.8	2.0	1.5	1.0	0.0	90.0	"Green house mode"
F	Resident 06	-95.534019° E	44.837284° N	321.1	2.0	1.5	1.0	0.0	90.0	"Green house mode"
G	Resident 07	-95.534825° E	44.837363° N	322.5	2.0	1.5	1.0	0.0	90.0	"Green house mode"

To be continued on next page...

Description:
Mike Rutledge
Environmental Services Dept. Head
FAGEN ENGINEERING, LLC
P.O. Box 159
Granite Falls, MN 56241
320-564-3324 Main
320-564-2625 Direct
320-564-4861 Fax

Licensed user:
EAPC Wind Energy
3100 DeMers Avenue
US-GRAND FORKS, ND 58201
+1 701 775 3000
Nicholas Laskovski / n.laskovski@eapcwindenergy.com
Calculated:
10/11/2016 3:29 PM/3.0.654

SHADOW - Main Result

Calculation: Worst Case - Greehouse Mode - 80m HH

...continued from previous page

No.	Name	Longitude	Latitude	Z [m]	Width [m]	Height [m]	Height a.g.l. [m]	Degrees from south cw [°]	Slope of window [°]	Direction mode
H	Resident 08	-95.534954° E	44.842124° N	318.1	2.0	1.5	1.0	0.0	90.0	"Green house mode"
I	Resident 09	-95.535337° E	44.844227° N	319.2	2.0	1.5	1.0	0.0	90.0	"Green house mode"
J	Resident 10	-95.516886° E	44.853297° N	321.2	2.0	1.5	1.0	0.0	90.0	"Green house mode"
K	Resident 11	-95.537188° E	44.861760° N	319.8	2.0	1.5	1.0	0.0	90.0	"Green house mode"
L	Resident 12	-95.531666° E	44.862421° N	318.0	2.0	1.5	1.0	0.0	90.0	"Green house mode"
M	Resident 13	-95.529807° E	44.861382° N	318.6	2.0	1.5	1.0	0.0	90.0	"Green house mode"
N	Resident 14	-95.533598° E	44.866156° N	319.5	2.0	1.5	1.0	0.0	90.0	"Green house mode"
O	Resident 15	-95.541625° E	44.870285° N	316.8	2.0	1.5	1.0	0.0	90.0	"Green house mode"
P	Resident 16	-95.534581° E	44.873292° N	318.3	2.0	1.5	1.0	0.0	90.0	"Green house mode"
Q	Resident 17	-95.533334° E	44.877298° N	317.7	2.0	1.5	1.0	0.0	90.0	"Green house mode"
R	Resident 18	-95.533434° E	44.878708° N	318.7	2.0	1.5	1.0	0.0	90.0	"Green house mode"
S	Resident 19	-95.535326° E	44.878631° N	320.9	2.0	1.5	1.0	0.0	90.0	"Green house mode"
T	Resident 20	-95.540947° E	44.875754° N	313.6	2.0	1.5	1.0	0.0	90.0	"Green house mode"
U	Resident 21	-95.543273° E	44.877427° N	312.7	2.0	1.5	1.0	0.0	90.0	"Green house mode"
V	Resident 22	-95.549112° E	44.877963° N	313.6	2.0	1.5	1.0	0.0	90.0	"Green house mode"
W	Resident 23	-95.559915° E	44.882819° N	319.5	2.0	1.5	1.0	0.0	90.0	"Green house mode"
X	Resident 24	-95.577203° E	44.878542° N	316.3	2.0	1.5	1.0	0.0	90.0	"Green house mode"
Y	Resident 25	-95.597991° E	44.877208° N	318.1	2.0	1.5	1.0	0.0	90.0	"Green house mode"
Z	Resident 26	-95.597527° E	44.876494° N	317.5	2.0	1.5	1.0	0.0	90.0	"Green house mode"
AA	Resident 27	-95.599588° E	44.880968° N	317.5	2.0	1.5	1.0	0.0	90.0	"Green house mode"
AB	Resident 28	-95.612918° E	44.875402° N	315.9	2.0	1.5	1.0	0.0	90.0	"Green house mode"
AC	Resident 29	-95.623577° E	44.876903° N	317.5	2.0	1.5	1.0	0.0	90.0	"Green house mode"
AD	Resident 30	-95.621627° E	44.871308° N	315.3	2.0	1.5	1.0	0.0	90.0	"Green house mode"
AE	Resident 31	-95.602094° E	44.867319° N	318.2	2.0	1.5	1.0	0.0	90.0	"Green house mode"
AF	Resident 32	-95.582822° E	44.865745° N	319.9	2.0	1.5	1.0	0.0	90.0	"Green house mode"
AG	Resident 33	-95.563933° E	44.874963° N	316.9	2.0	1.5	1.0	0.0	90.0	"Green house mode"
AH	Resident 34	-95.563925° E	44.870771° N	315.1	2.0	1.5	1.0	0.0	90.0	"Green house mode"
AI	Resident 35	-95.563889° E	44.868106° N	317.4	2.0	1.5	1.0	0.0	90.0	"Green house mode"
AJ	Resident 36	-95.568776° E	44.864178° N	316.4	2.0	1.5	1.0	0.0	90.0	"Green house mode"
AK	Resident 37	-95.601147° E	44.856727° N	308.7	2.0	1.5	1.0	0.0	90.0	"Green house mode"
AL	Resident 38	-95.554238° E	44.850846° N	314.7	2.0	1.5	1.0	0.0	90.0	"Green house mode"
AM	Resident 39	-95.565658° E	44.847905° N	311.4	2.0	1.5	1.0	0.0	90.0	"Green house mode"
AN	Resident 40	-95.560488° E	44.847249° N	307.3	2.0	1.5	1.0	0.0	90.0	"Green house mode"
AO	Resident 41	-95.560249° E	44.845851° N	311.1	2.0	1.5	1.0	0.0	90.0	"Green house mode"
AP	Resident 42	-95.559105° E	44.841427° N	318.2	2.0	1.5	1.0	0.0	90.0	"Green house mode"
AQ	Resident 43	-95.568088° E	44.839398° N	310.7	2.0	1.5	1.0	0.0	90.0	"Green house mode"
AR	Resident 44	-95.560323° E	44.838731° N	315.8	2.0	1.5	1.0	0.0	90.0	"Green house mode"
AS	Resident 45	-95.562243° E	44.835534° N	309.2	2.0	1.5	1.0	0.0	90.0	"Green house mode"
AT	Resident 46	-95.562369° E	44.834158° N	309.5	2.0	1.5	1.0	0.0	90.0	"Green house mode"
AU	Resident 47	-95.544746° E	44.825700° N	319.2	2.0	1.5	1.0	0.0	90.0	"Green house mode"
AV	Substation-OfficeShop	-95.552901° E	44.827202° N	313.1	2.0	1.5	1.0	0.0	90.0	"Green house mode"
AW	Swensen-Farm-Museum	-95.592478° E	44.878552° N	319.2	2.0	1.5	1.0	0.0	90.0	"Green house mode"

Calculation Results

Shadow receptor

No.	Name	Shadow, worst case Shadow hours per year [h/year]	Shadow days per year [days/year]	Max shadow hours per day [h/day]
A	Resident 01	0:00	0	0:00
B	Resident 02	0:00	0	0:00
C	Resident 03	0:00	0	0:00
D	Resident 04	0:00	0	0:00
E	Resident 05	29:30	62	0:42
F	Resident 06	37:51	85	0:49
G	Resident 07	48:37	95	0:55
H	Resident 08	52:31	119	0:40
I	Resident 09	31:09	77	0:43

To be continued on next page...

Description:
Mike Rutledge
Environmental Services Dept. Head
FAGEN ENGINEERING, LLC
P.O. Box 159
Granite Falls, MN 56241
320-564-3324 Main
320-564-2625 Direct
320-564-4861 Fax

Licensed user:
EAPC Wind Energy
3100 DeMers Avenue
US-GRAND FORKS, ND 58201
+1 701 775 3000
Nicholas Laskovski / n.laskovski@eapcwindenergy.com

Calculated:
10/11/2016 3:29 PM/3.0.654

SHADOW - Main Result

Calculation: Worst Case - Greehouse Mode - 80m HH

...continued from previous page

No.	Name	Shadow, worst case Shadow hours per year [h/year]	Shadow days per year [days/year]	Max shadow hours per day [h/day]
J	Resident 10	3:32	34	0:10
K	Resident 11	0:00	0	0:00
L	Resident 12	0:00	0	0:00
M	Resident 13	36:35	64	0:40
N	Resident 14	7:19	52	0:12
O	Resident 15	28:29	69	0:36
P	Resident 16	4:05	23	0:16
Q	Resident 17	2:52	20	0:13
R	Resident 18	2:52	22	0:12
S	Resident 19	4:08	28	0:15
T	Resident 20	15:55	45	0:32
U	Resident 21	35:04	68	0:37
V	Resident 22	0:00	0	0:00
W	Resident 23	3:45	30	0:13
X	Resident 24	0:00	0	0:00
Y	Resident 25	95:56	107	1:16
Z	Resident 26	112:50	149	1:22
AA	Resident 27	0:00	0	0:00
AB	Resident 28	12:17	38	0:29
AC	Resident 29	4:02	30	0:13
AD	Resident 30	8:11	48	0:20
AE	Resident 31	61:33	146	0:49
AF	Resident 32	44:33	144	0:34
AG	Resident 33	19:38	79	0:25
AH	Resident 34	71:38	202	0:36
AI	Resident 35	52:17	175	0:41
AJ	Resident 36	18:29	88	0:25
AK	Resident 37	27:42	93	0:35
AL	Resident 38	43:07	177	0:25
AM	Resident 39	52:42	117	0:53
AN	Resident 40	30:29	102	0:37
AO	Resident 41	69:24	131	0:42
AP	Resident 42	106:00	173	1:04
AQ	Resident 43	8:00	32	0:22
AR	Resident 44	24:25	92	0:30
AS	Resident 45	1:51	16	0:10
AT	Resident 46	1:44	16	0:09
AU	Resident 47	0:00	0	0:00
AV	Substation-OfficeShop	0:00	0	0:00
AW	Swensen-Farm-Museum	22:43	84	0:31

Total amount of flickering on the shadow receptors caused by each WTG

No.	Name	Worst case [h/year]	Expected [h/year]
1	WTG 18	135:08	
2	WTG 17	44:30	
3	WTG 16	5:45	
4	WTG 15 - GE 2.3-116 80m HH	119:22	
5	WTG 14 - GE 2.3-116 80m HH	90:56	
6	WTG 13	164:06	
7	WTG 12	100:50	
8	WTG 11	7:11	
9	WTG 10	13:58	
10	WTG 09	23:17	
11	WTG 08	75:49	
12	WTG 07	21:04	
13	WTG 06	50:12	

To be continued on next page...

SHADOW - Main Result

Calculation: Worst Case - Greehouse Mode - 80m HH

...continued from previous page

No.	Name	Worst case [h/year]	Expected [h/year]
14	WTG 05	1:23	
15	WTG 04	42:42	
16	WTG 03	28:58	
17	WTG 02	179:34	
18	WTG 01	48:08	

Project:
Palmers Creek Wind Farm

Description:
Mike Rutledge
Environmental Services Dept. Head
FAGEN ENGINEERING, LLC
P.O. Box 159
Granite Falls, MN 56241
320-564-3324 Main
320-564-2625 Direct
320-564-4861 Fax

Licensed user:
EAPC Wind Energy
3100 DeMers Avenue
US-GRAND FORKS, ND 58201
+1 701 775 3000
Nicholas Laskovski / n.laskovski@eapcwindenergy.com
Calculated:
10/17/2016 6:00 PM/3.0.654

SHADOW - Main Result

Calculation: Worst Case - Greehouse Mode - 80m HH + 90m HH

Assumptions for shadow calculations

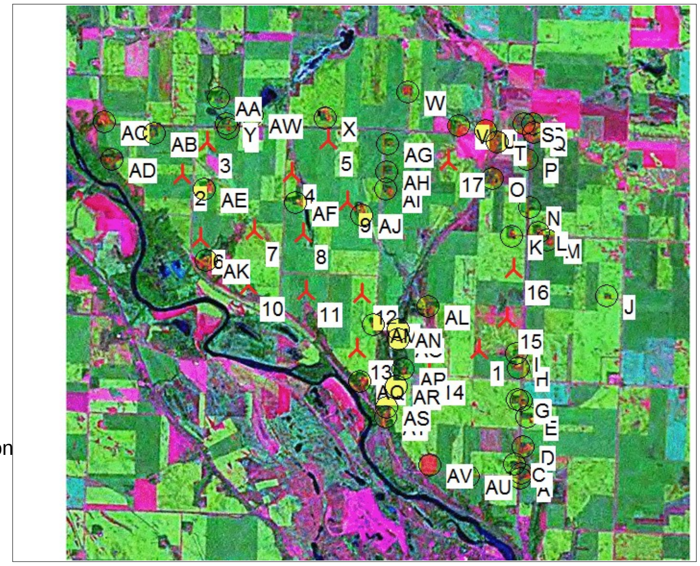
Maximum distance for influence
Calculate only when more than 20 % of sun is covered by the blade
Please look in WTG table

Minimum sun height over horizon for influence 3 °
Day step for calculation 1 days
Time step for calculation 1 minutes

The calculated times are "worst case" given by the following assumptions:
- The sun is shining all the day, from sunrise to sunset
- The rotor plane is always perpendicular to the line from the WTG to the sun
- The WTG is always operating

A ZVI (Zones of Visual Influence) calculation is performed before flicker calculation so non visible WTG do not contribute to calculated flicker values. A WTG will be visible if it is visible from any part of the receiver window. The ZVI calculation is based on the following assumptions:
Height contours used: Project Wizard Elevation Data Grid (US NED 1/3 arc-secon
Obstacles used in calculation
Eye height: 1.5 m
Grid resolution: 10.0 m

All coordinates are in
Geo [deg]-WGS84



Scale 1:125,000
New WTG   Shadow receptor

WTGs

	Longitude	Latitude	Z	Row data/Description	WTG type Valid	Manufact.	Type-generator	Power, rated	Rotor diameter	Hub height	Shadow data Calculation distance	RPM
			[m]					[kW]	[m]	[m]	[m]	[RPM]
1	-95.543356° E	44.844631° N	314.6	WTG 15 - GE 2.3-116...	Yes	GE WIND ENERGY	GE 2.3-116-2,300	2,300	116.0	80.0	1,732	15.7
2	-95.606875° E	44.869294° N	315.7	WTG 01	Yes	GE WIND ENERGY	GE 2.5-116-2,500	2,500	116.0	90.0	1,732	15.7
3	-95.601897° E	44.874328° N	310.5	WTG 02	Yes	GE WIND ENERGY	GE 2.5-116-2,500	2,500	116.0	90.0	1,732	15.7
4	-95.583817° E	44.870217° N	313.8	WTG 03	Yes	GE WIND ENERGY	GE 2.5-116-2,500	2,500	116.0	90.0	1,732	15.7
5	-95.576389° E	44.875264° N	315.5	WTG 04	Yes	GE WIND ENERGY	GE 2.5-116-2,500	2,500	116.0	90.0	1,732	15.7
6	-95.602481° E	44.859956° N	311.1	WTG 05	Yes	GE WIND ENERGY	GE 2.5-116-2,500	2,500	116.0	90.0	1,732	15.7
7	-95.591403° E	44.861392° N	313.0	WTG 06	Yes	GE WIND ENERGY	GE 2.5-116-2,500	2,500	116.0	90.0	1,732	15.7
8	-95.581006° E	44.861153° N	316.1	WTG 07	Yes	GE WIND ENERGY	GE 2.5-116-2,500	2,500	116.0	90.0	1,732	15.7
9	-95.571917° E	44.866139° N	314.6	WTG 08	Yes	GE WIND ENERGY	GE 2.5-116-2,500	2,500	116.0	90.0	1,732	15.7
10	-95.592247° E	44.853119° N	317.3	WTG 09	Yes	GE WIND ENERGY	GE 2.5-116-2,500	2,500	116.0	90.0	1,732	15.7
11	-95.580111° E	44.852608° N	309.1	WTG 10	Yes	GE WIND ENERGY	GE 2.5-116-2,500	2,500	116.0	90.0	1,732	15.7
12	-95.568378° E	44.852469° N	313.3	WTG 11	Yes	GE WIND ENERGY	GE 2.5-116-2,500	2,500	116.0	90.0	1,732	15.7
13	-95.569025° E	44.844250° N	310.9	WTG 12	Yes	GE WIND ENERGY	GE 2.5-116-2,500	2,500	116.0	90.0	1,732	15.7
14	-95.553758° E	44.841564° N	316.5	WTG 13	Yes	GE WIND ENERGY	GE 2.5-116-2,500	2,500	116.0	90.0	1,732	15.7
15	-95.537703° E	44.849525° N	315.7	WTG 16	Yes	GE WIND ENERGY	GE 2.5-116-2,500	2,500	116.0	90.0	1,732	15.7
16	-95.536517° E	44.856922° N	316.3	WTG 17	Yes	GE WIND ENERGY	GE 2.5-116-2,500	2,500	116.0	90.0	1,732	15.7
17	-95.550994° E	44.872581° N	316.5	WTG 18	Yes	GE WIND ENERGY	GE 2.5-116-2,500	2,500	116.0	90.0	1,732	15.7

Shadow receptor-Input

No.	Name	Longitude	Latitude	Z	Width	Height	Height a.g.l.	Degrees from south cw	Slope of window	Direction mode
				[m]	[m]	[m]	[m]	[°]	[°]	
A	Resident 01	-95.533842° E	44.825638° N	319.3	2.0	1.5	1.0	0.0	90.0	"Green house mode"
B	Resident 02	-95.533704° E	44.826359° N	318.5	2.0	1.5	1.0	0.0	90.0	"Green house mode"
C	Resident 03	-95.534989° E	44.827696° N	317.9	2.0	1.5	1.0	0.0	90.0	"Green house mode"
D	Resident 04	-95.533451° E	44.830307° N	317.9	2.0	1.5	1.0	0.0	90.0	"Green house mode"
E	Resident 05	-95.532683° E	44.834853° N	319.8	2.0	1.5	1.0	0.0	90.0	"Green house mode"
F	Resident 06	-95.534019° E	44.837284° N	321.1	2.0	1.5	1.0	0.0	90.0	"Green house mode"
G	Resident 07	-95.534825° E	44.837363° N	322.5	2.0	1.5	1.0	0.0	90.0	"Green house mode"
H	Resident 08	-95.534954° E	44.842124° N	318.1	2.0	1.5	1.0	0.0	90.0	"Green house mode"

To be continued on next page...

SHADOW - Main Result

Calculation: Worst Case - Greehouse Mode - 80m HH + 90m HH

...continued from previous page

No.	Name	Longitude	Latitude	Z [m]	Width [m]	Height [m]	Height a.g.l. [m]	Degrees from south cw [°]	Slope of window [°]	Direction mode
I	Resident 09	-95.535337° E	44.844227° N	319.2	2.0	1.5	1.0	0.0	90.0	"Green house mode"
J	Resident 10	-95.516886° E	44.853297° N	321.2	2.0	1.5	1.0	0.0	90.0	"Green house mode"
K	Resident 11	-95.537188° E	44.861760° N	319.8	2.0	1.5	1.0	0.0	90.0	"Green house mode"
L	Resident 12	-95.531666° E	44.862421° N	318.0	2.0	1.5	1.0	0.0	90.0	"Green house mode"
M	Resident 13	-95.529807° E	44.861382° N	318.6	2.0	1.5	1.0	0.0	90.0	"Green house mode"
N	Resident 14	-95.533598° E	44.866156° N	319.5	2.0	1.5	1.0	0.0	90.0	"Green house mode"
O	Resident 15	-95.541625° E	44.870285° N	316.8	2.0	1.5	1.0	0.0	90.0	"Green house mode"
P	Resident 16	-95.534581° E	44.873292° N	318.3	2.0	1.5	1.0	0.0	90.0	"Green house mode"
Q	Resident 17	-95.533334° E	44.877298° N	317.7	2.0	1.5	1.0	0.0	90.0	"Green house mode"
R	Resident 18	-95.533434° E	44.878708° N	318.7	2.0	1.5	1.0	0.0	90.0	"Green house mode"
S	Resident 19	-95.535326° E	44.878631° N	320.9	2.0	1.5	1.0	0.0	90.0	"Green house mode"
T	Resident 20	-95.540947° E	44.875754° N	313.6	2.0	1.5	1.0	0.0	90.0	"Green house mode"
U	Resident 21	-95.543273° E	44.877427° N	312.7	2.0	1.5	1.0	0.0	90.0	"Green house mode"
V	Resident 22	-95.549112° E	44.877963° N	313.6	2.0	1.5	1.0	0.0	90.0	"Green house mode"
W	Resident 23	-95.559915° E	44.882819° N	319.5	2.0	1.5	1.0	0.0	90.0	"Green house mode"
X	Resident 24	-95.577203° E	44.878542° N	316.3	2.0	1.5	1.0	0.0	90.0	"Green house mode"
Y	Resident 25	-95.597991° E	44.877208° N	318.1	2.0	1.5	1.0	0.0	90.0	"Green house mode"
Z	Resident 26	-95.597527° E	44.876494° N	317.5	2.0	1.5	1.0	0.0	90.0	"Green house mode"
AA	Resident 27	-95.599588° E	44.880968° N	317.5	2.0	1.5	1.0	0.0	90.0	"Green house mode"
AB	Resident 28	-95.612918° E	44.875402° N	315.9	2.0	1.5	1.0	0.0	90.0	"Green house mode"
AC	Resident 29	-95.623577° E	44.876903° N	317.5	2.0	1.5	1.0	0.0	90.0	"Green house mode"
AD	Resident 30	-95.621627° E	44.871308° N	315.3	2.0	1.5	1.0	0.0	90.0	"Green house mode"
AE	Resident 31	-95.602094° E	44.867319° N	318.2	2.0	1.5	1.0	0.0	90.0	"Green house mode"
AF	Resident 32	-95.582822° E	44.865745° N	319.9	2.0	1.5	1.0	0.0	90.0	"Green house mode"
AG	Resident 33	-95.563933° E	44.874963° N	316.9	2.0	1.5	1.0	0.0	90.0	"Green house mode"
AH	Resident 34	-95.563925° E	44.870771° N	315.1	2.0	1.5	1.0	0.0	90.0	"Green house mode"
AI	Resident 35	-95.563889° E	44.868106° N	317.4	2.0	1.5	1.0	0.0	90.0	"Green house mode"
AJ	Resident 36	-95.568776° E	44.864178° N	316.4	2.0	1.5	1.0	0.0	90.0	"Green house mode"
AK	Resident 37	-95.601147° E	44.856727° N	308.7	2.0	1.5	1.0	0.0	90.0	"Green house mode"
AL	Resident 38	-95.554238° E	44.850846° N	314.7	2.0	1.5	1.0	0.0	90.0	"Green house mode"
AM	Resident 39	-95.565658° E	44.847905° N	311.4	2.0	1.5	1.0	0.0	90.0	"Green house mode"
AN	Resident 40	-95.560488° E	44.847249° N	307.3	2.0	1.5	1.0	0.0	90.0	"Green house mode"
AO	Resident 41	-95.560249° E	44.845851° N	311.1	2.0	1.5	1.0	0.0	90.0	"Green house mode"
AP	Resident 42	-95.559105° E	44.841427° N	318.2	2.0	1.5	1.0	0.0	90.0	"Green house mode"
AQ	Resident 43	-95.568088° E	44.839398° N	310.7	2.0	1.5	1.0	0.0	90.0	"Green house mode"
AR	Resident 44	-95.560323° E	44.838731° N	315.8	2.0	1.5	1.0	0.0	90.0	"Green house mode"
AS	Resident 45	-95.562243° E	44.835534° N	309.2	2.0	1.5	1.0	0.0	90.0	"Green house mode"
AT	Resident 46	-95.562369° E	44.834158° N	309.5	2.0	1.5	1.0	0.0	90.0	"Green house mode"
AU	Resident 47	-95.544746° E	44.825700° N	319.2	2.0	1.5	1.0	0.0	90.0	"Green house mode"
AV	Substation-OfficeShop	-95.552901° E	44.827202° N	313.1	2.0	1.5	1.0	0.0	90.0	"Green house mode"
AW	Swensen-Farm-Museum	-95.592478° E	44.878552° N	319.2	2.0	1.5	1.0	0.0	90.0	"Green house mode"

Calculation Results

Shadow receptor

No.	Name	Shadow, worst case: Shadow hours per year [h/year]	Shadow days per year [days/year]	Max shadow hours per day [h/day]
A	Resident 01	0:00	0	0:00
B	Resident 02	0:00	0	0:00
C	Resident 03	0:00	0	0:00
D	Resident 04	0:00	0	0:00
E	Resident 05	0:00	0	0:00
F	Resident 06	2:45	22	0:12
G	Resident 07	3:11	23	0:13
H	Resident 08	53:05	119	0:40
I	Resident 09	31:47	79	0:43
J	Resident 10	4:36	38	0:12

To be continued on next page...

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SHADOW - Main Result

Calculation: Worst Case - Greehouse Mode - 80m HH + 90m HH

...continued from previous page

No.	Name	Shadow, worst case Shadow hours per year [h/year]	Shadow days per year [days/year]	Max shadow hours per day [h/day]
K	Resident 11	0:00	0	0:00
L	Resident 12	0:00	0	0:00
M	Resident 13	40:46	70	0:41
N	Resident 14	10:40	65	0:15
O	Resident 15	32:20	74	0:36
P	Resident 16	4:54	25	0:19
Q	Resident 17	3:31	22	0:15
R	Resident 18	3:31	24	0:14
S	Resident 19	5:02	28	0:17
T	Resident 20	17:14	45	0:32
U	Resident 21	37:52	72	0:36
V	Resident 22	0:00	0	0:00
W	Resident 23	4:38	32	0:15
X	Resident 24	10:50	26	0:32
Y	Resident 25	104:34	114	1:20
Z	Resident 26	109:37	143	1:21
AA	Resident 27	0:00	0	0:00
AB	Resident 28	13:37	39	0:31
AC	Resident 29	4:52	33	0:14
AD	Resident 30	9:34	49	0:22
AE	Resident 31	56:35	140	0:46
AF	Resident 32	48:51	152	0:34
AG	Resident 33	22:21	81	0:26
AH	Resident 34	78:15	209	0:36
AI	Resident 35	57:41	177	0:41
AJ	Resident 36	20:34	89	0:27
AK	Resident 37	29:53	97	0:35
AL	Resident 38	47:26	186	0:25
AM	Resident 39	68:27	126	1:01
AN	Resident 40	36:05	122	0:37
AO	Resident 41	74:41	133	0:42
AP	Resident 42	110:46	162	1:06
AQ	Resident 43	9:04	34	0:23
AR	Resident 44	20:53	74	0:29
AS	Resident 45	0:00	0	0:00
AT	Resident 46	0:00	0	0:00
AU	Resident 47	0:00	0	0:00
AV	Substation-OfficeShop	0:00	0	0:00
AW	Swensen-Farm-Museum	25:12	86	0:32

Total amount of flickering on the shadow receptors caused by each WTG

No.	Name	Worst case [h/year]	Expected [h/year]
1	WTG 15 - GE 2.3-116 80m HH	119:22	
2	WTG 01	41:37	
3	WTG 02	190:29	
4	WTG 03	34:18	
5	WTG 04	58:38	
6	WTG 05	1:55	
7	WTG 06	54:49	
8	WTG 07	25:05	
9	WTG 08	82:24	
10	WTG 09	24:19	
11	WTG 10	17:19	
12	WTG 11	8:17	
13	WTG 12	122:06	
14	WTG 13	174:28	

To be continued on next page...

SHADOW - Main Result

Calculation: Worst Case - Greehouse Mode - 80m HH + 90m HH

...continued from previous page

No.	Name	Worst case [h/year]	Expected [h/year]
15	WTG 16	6:48	
16	WTG 17	50:51	
17	WTG 18	153:16	

Project:
Palmers Creek Wind Farm

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Calculated:
10/11/2016 1:34 AM/3.0.654

SHADOW - Main Result

Calculation: Worst Case - Greehouse Mode - 80m HH + 94m HH

Assumptions for shadow calculations

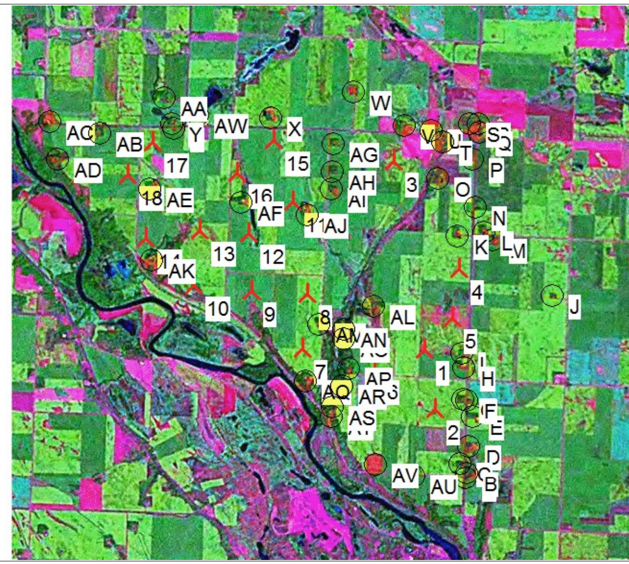
Maximum distance for influence
Calculate only when more than 20 % of sun is covered by the blade
Please look in WTG table

Minimum sun height over horizon for influence	3 °
Day step for calculation	1 days
Time step for calculation	1 minutes

The calculated times are "worst case" given by the following assumptions:
- The sun is shining all the day, from sunrise to sunset
- The rotor plane is always perpendicular to the line from the WTG to the sun
- The WTG is always operating

A ZVI (Zones of Visual Influence) calculation is performed before flicker calculation so non visible WTG do not contribute to calculated flicker values. A WTG will be visible if it is visible from any part of the receiver window. The ZVI calculation is based on the following assumptions:
Height contours used: Project Wizard Elevation Data Grid (US NED 1/3 arc-secon
Obstacles used in calculation
Eye height: 1.5 m
Grid resolution: 10.0 m

All coordinates are in
Geo [deg]-WGS84



Scale 1:125,000
New WTG   Shadow receptor

WTGs

	Longitude	Latitude	Z	Row data/Description	WTG type Valid	Manufact.	Type-generator	Power, rated	Rotor diameter	Hub height	Shadow data Calculation distance	RPM
			[m]					[kW]	[m]	[m]	[m]	[RPM]
1	-95.543356° E	44.844631° N	314.6	WTG 15 - GE 2.3-116...	Yes	GE WIND ENERGY	GE 2.3-116-2,300	2,300	116.0	80.0	1,732	15.7
2	-95.540764° E	44.835808° N	312.5	WTG 14 - GE 2.3-116...	Yes	GE WIND ENERGY	GE 2.3-116-2,300	2,300	116.0	80.0	1,732	15.7
3	-95.550994° E	44.872581° N	316.5	WTG 18	Yes	GE WIND ENERGY	GE 2.5-116-2,500	2,500	116.0	94.0	1,732	15.7
4	-95.536517° E	44.856922° N	316.3	WTG 17	Yes	GE WIND ENERGY	GE 2.5-116-2,500	2,500	116.0	94.0	1,732	15.7
5	-95.537703° E	44.849525° N	315.7	WTG 16	Yes	GE WIND ENERGY	GE 2.5-116-2,500	2,500	116.0	94.0	1,732	15.7
6	-95.553758° E	44.841564° N	316.5	WTG 13	Yes	GE WIND ENERGY	GE 2.5-116-2,500	2,500	116.0	94.0	1,732	15.7
7	-95.569025° E	44.844250° N	310.9	WTG 12	Yes	GE WIND ENERGY	GE 2.5-116-2,500	2,500	116.0	94.0	1,732	15.7
8	-95.568378° E	44.852469° N	313.3	WTG 11	Yes	GE WIND ENERGY	GE 2.5-116-2,500	2,500	116.0	94.0	1,732	15.7
9	-95.580111° E	44.852608° N	309.1	WTG 10	Yes	GE WIND ENERGY	GE 2.5-116-2,500	2,500	116.0	94.0	1,732	15.7
10	-95.592247° E	44.853119° N	317.3	WTG 09	Yes	GE WIND ENERGY	GE 2.5-116-2,500	2,500	116.0	94.0	1,732	15.7
11	-95.571917° E	44.866139° N	314.6	WTG 08	Yes	GE WIND ENERGY	GE 2.5-116-2,500	2,500	116.0	94.0	1,732	15.7
12	-95.581006° E	44.861153° N	316.1	WTG 07	Yes	GE WIND ENERGY	GE 2.5-116-2,500	2,500	116.0	94.0	1,732	15.7
13	-95.591403° E	44.861392° N	313.0	WTG 06	Yes	GE WIND ENERGY	GE 2.5-116-2,500	2,500	116.0	94.0	1,732	15.7
14	-95.602481° E	44.859956° N	311.1	WTG 05	Yes	GE WIND ENERGY	GE 2.5-116-2,500	2,500	116.0	94.0	1,732	15.7
15	-95.576389° E	44.875264° N	315.5	WTG 04	Yes	GE WIND ENERGY	GE 2.5-116-2,500	2,500	116.0	94.0	1,732	15.7
16	-95.583817° E	44.870217° N	313.8	WTG 03	Yes	GE WIND ENERGY	GE 2.5-116-2,500	2,500	116.0	94.0	1,732	15.7
17	-95.601897° E	44.874328° N	310.5	WTG 02	Yes	GE WIND ENERGY	GE 2.5-116-2,500	2,500	116.0	94.0	1,732	15.7
18	-95.606875° E	44.869294° N	315.7	WTG 01	Yes	GE WIND ENERGY	GE 2.5-116-2,500	2,500	116.0	94.0	1,732	15.7

Shadow receptor-Input

No.	Name	Longitude	Latitude	Z	Width	Height	Height a.g.l.	Degrees from south cw	Slope of window	Direction mode
				[m]	[m]	[m]	[m]	[°]	[°]	
A	Resident 01	-95.533842° E	44.825638° N	319.3	2.0	1.5	1.0	0.0	90.0	"Green house mode"
B	Resident 02	-95.533704° E	44.826359° N	318.5	2.0	1.5	1.0	0.0	90.0	"Green house mode"
C	Resident 03	-95.534989° E	44.827696° N	317.9	2.0	1.5	1.0	0.0	90.0	"Green house mode"
D	Resident 04	-95.533451° E	44.830307° N	317.9	2.0	1.5	1.0	0.0	90.0	"Green house mode"
E	Resident 05	-95.532683° E	44.834853° N	319.8	2.0	1.5	1.0	0.0	90.0	"Green house mode"
F	Resident 06	-95.534019° E	44.837284° N	321.1	2.0	1.5	1.0	0.0	90.0	"Green house mode"
G	Resident 07	-95.534825° E	44.837363° N	322.5	2.0	1.5	1.0	0.0	90.0	"Green house mode"

To be continued on next page...

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Calculated:
10/11/2016 1:34 AM/3.0.654

SHADOW - Main Result

Calculation: Worst Case - Greehouse Mode - 80m HH + 94m HH

...continued from previous page

No.	Name	Longitude	Latitude	Z [m]	Width [m]	Height [m]	Height a.g.l. [m]	Degrees from south cw [°]	Slope of window [°]	Direction mode
H	Resident 08	-95.534954° E	44.842124° N	318.1	2.0	1.5	1.0	0.0	90.0	"Green house mode"
I	Resident 09	-95.535337° E	44.844227° N	319.2	2.0	1.5	1.0	0.0	90.0	"Green house mode"
J	Resident 10	-95.516886° E	44.853297° N	321.2	2.0	1.5	1.0	0.0	90.0	"Green house mode"
K	Resident 11	-95.537188° E	44.861760° N	319.8	2.0	1.5	1.0	0.0	90.0	"Green house mode"
L	Resident 12	-95.531666° E	44.862421° N	318.0	2.0	1.5	1.0	0.0	90.0	"Green house mode"
M	Resident 13	-95.529807° E	44.861382° N	318.6	2.0	1.5	1.0	0.0	90.0	"Green house mode"
N	Resident 14	-95.533598° E	44.866156° N	319.5	2.0	1.5	1.0	0.0	90.0	"Green house mode"
O	Resident 15	-95.541625° E	44.870285° N	316.8	2.0	1.5	1.0	0.0	90.0	"Green house mode"
P	Resident 16	-95.534581° E	44.873292° N	318.3	2.0	1.5	1.0	0.0	90.0	"Green house mode"
Q	Resident 17	-95.533334° E	44.877298° N	317.7	2.0	1.5	1.0	0.0	90.0	"Green house mode"
R	Resident 18	-95.533434° E	44.878708° N	318.7	2.0	1.5	1.0	0.0	90.0	"Green house mode"
S	Resident 19	-95.535326° E	44.878631° N	320.9	2.0	1.5	1.0	0.0	90.0	"Green house mode"
T	Resident 20	-95.540947° E	44.875754° N	313.6	2.0	1.5	1.0	0.0	90.0	"Green house mode"
U	Resident 21	-95.543273° E	44.877427° N	312.7	2.0	1.5	1.0	0.0	90.0	"Green house mode"
V	Resident 22	-95.549112° E	44.877963° N	313.6	2.0	1.5	1.0	0.0	90.0	"Green house mode"
W	Resident 23	-95.559915° E	44.882819° N	319.5	2.0	1.5	1.0	0.0	90.0	"Green house mode"
X	Resident 24	-95.577203° E	44.878542° N	316.3	2.0	1.5	1.0	0.0	90.0	"Green house mode"
Y	Resident 25	-95.597991° E	44.877208° N	318.1	2.0	1.5	1.0	0.0	90.0	"Green house mode"
Z	Resident 26	-95.597527° E	44.876494° N	317.5	2.0	1.5	1.0	0.0	90.0	"Green house mode"
AA	Resident 27	-95.599588° E	44.880968° N	317.5	2.0	1.5	1.0	0.0	90.0	"Green house mode"
AB	Resident 28	-95.612918° E	44.875402° N	315.9	2.0	1.5	1.0	0.0	90.0	"Green house mode"
AC	Resident 29	-95.623577° E	44.876903° N	317.5	2.0	1.5	1.0	0.0	90.0	"Green house mode"
AD	Resident 30	-95.621627° E	44.871308° N	315.3	2.0	1.5	1.0	0.0	90.0	"Green house mode"
AE	Resident 31	-95.602094° E	44.867319° N	318.2	2.0	1.5	1.0	0.0	90.0	"Green house mode"
AF	Resident 32	-95.582822° E	44.865745° N	319.9	2.0	1.5	1.0	0.0	90.0	"Green house mode"
AG	Resident 33	-95.563933° E	44.874963° N	316.9	2.0	1.5	1.0	0.0	90.0	"Green house mode"
AH	Resident 34	-95.563925° E	44.870771° N	315.1	2.0	1.5	1.0	0.0	90.0	"Green house mode"
AI	Resident 35	-95.563889° E	44.868106° N	317.4	2.0	1.5	1.0	0.0	90.0	"Green house mode"
AJ	Resident 36	-95.568776° E	44.864178° N	316.4	2.0	1.5	1.0	0.0	90.0	"Green house mode"
AK	Resident 37	-95.601147° E	44.856727° N	308.7	2.0	1.5	1.0	0.0	90.0	"Green house mode"
AL	Resident 38	-95.554238° E	44.850846° N	314.7	2.0	1.5	1.0	0.0	90.0	"Green house mode"
AM	Resident 39	-95.565658° E	44.847905° N	311.4	2.0	1.5	1.0	0.0	90.0	"Green house mode"
AN	Resident 40	-95.560488° E	44.847249° N	307.3	2.0	1.5	1.0	0.0	90.0	"Green house mode"
AO	Resident 41	-95.560249° E	44.845851° N	311.1	2.0	1.5	1.0	0.0	90.0	"Green house mode"
AP	Resident 42	-95.559105° E	44.841427° N	318.2	2.0	1.5	1.0	0.0	90.0	"Green house mode"
AQ	Resident 43	-95.568088° E	44.839398° N	310.7	2.0	1.5	1.0	0.0	90.0	"Green house mode"
AR	Resident 44	-95.560323° E	44.838731° N	315.8	2.0	1.5	1.0	0.0	90.0	"Green house mode"
AS	Resident 45	-95.562243° E	44.835534° N	309.2	2.0	1.5	1.0	0.0	90.0	"Green house mode"
AT	Resident 46	-95.562369° E	44.834158° N	309.5	2.0	1.5	1.0	0.0	90.0	"Green house mode"
AU	Resident 47	-95.544746° E	44.825700° N	319.2	2.0	1.5	1.0	0.0	90.0	"Green house mode"
AV	Substation-OfficeShop	-95.552901° E	44.827202° N	313.1	2.0	1.5	1.0	0.0	90.0	"Green house mode"
AW	Swensen-Farm-Museum	-95.592478° E	44.878552° N	319.2	2.0	1.5	1.0	0.0	90.0	"Green house mode"

Calculation Results

Shadow receptor

No.	Name	Shadow, worst case: Shadow hours per year [h/year]	Shadow days per year [days/year]	Max shadow hours per day [h/day]
A	Resident 01	0:00	0	0:00
B	Resident 02	0:00	0	0:00
C	Resident 03	0:00	0	0:00
D	Resident 04	0:00	0	0:00
E	Resident 05	29:30	62	0:42
F	Resident 06	38:46	87	0:49
G	Resident 07	49:37	97	0:55
H	Resident 08	53:19	120	0:40
I	Resident 09	31:59	79	0:43

To be continued on next page...

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Calculated:
10/11/2016 1:34 AM/3.0.654

SHADOW - Main Result

Calculation: Worst Case - Greehouse Mode - 80m HH + 94m HH

...continued from previous page

No.	Name	Shadow, worst case Shadow hours per year [h/year]	Shadow days per year [days/year]	Max shadow hours per day [h/day]
J	Resident 10	4:59	39	0:13
K	Resident 11	0:00	0	0:00
L	Resident 12	0:00	0	0:00
M	Resident 13	42:06	72	0:41
N	Resident 14	11:34	65	0:15
O	Resident 15	33:46	76	0:37
P	Resident 16	5:07	24	0:19
Q	Resident 17	3:46	23	0:16
R	Resident 18	3:49	24	0:15
S	Resident 19	5:21	30	0:17
T	Resident 20	17:41	45	0:32
U	Resident 21	39:02	74	0:36
V	Resident 22	0:00	0	0:00
W	Resident 23	5:03	34	0:15
X	Resident 24	19:31	34	0:43
Y	Resident 25	107:16	117	1:21
Z	Resident 26	105:17	134	1:20
AA	Resident 27	0:00	0	0:00
AB	Resident 28	14:08	40	0:31
AC	Resident 29	5:08	32	0:15
AD	Resident 30	10:07	50	0:22
AE	Resident 31	52:27	136	0:42
AF	Resident 32	50:14	152	0:35
AG	Resident 33	23:33	82	0:27
AH	Resident 34	80:23	211	0:36
AI	Resident 35	59:29	178	0:41
AJ	Resident 36	21:16	89	0:27
AK	Resident 37	30:15	97	0:35
AL	Resident 38	49:10	186	0:25
AM	Resident 39	74:28	130	1:03
AN	Resident 40	38:52	127	0:37
AO	Resident 41	76:11	134	0:42
AP	Resident 42	116:21	190	1:08
AQ	Resident 43	9:31	36	0:24
AR	Resident 44	20:28	92	0:27
AS	Resident 45	1:51	16	0:10
AT	Resident 46	1:44	16	0:09
AU	Resident 47	0:00	0	0:00
AV	Substation-OfficeShop	0:00	0	0:00
AW	Swensen-Farm-Museum	26:25	86	0:32

Total amount of flickering on the shadow receptors caused by each WTG

No.	Name	Worst case [h/year]	Expected [h/year]
1	WTG 15 - GE 2.3-116 80m HH	119:22	
2	WTG 14 - GE 2.3-116 80m HH	90:56	
3	WTG 18	159:40	
4	WTG 17	52:59	
5	WTG 16	7:16	
6	WTG 13	176:49	
7	WTG 12	130:24	
8	WTG 11	8:44	
9	WTG 10	18:35	
10	WTG 09	24:16	
11	WTG 08	84:26	
12	WTG 07	26:45	
13	WTG 06	56:31	

To be continued on next page...

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Calculated:
10/11/2016 1:34 AM/3.0.654

SHADOW - Main Result

Calculation: Worst Case - Greehouse Mode - 80m HH + 94m HH

...continued from previous page

No.	Name	Worst case [h/year]	Expected [h/year]
14	WTG 05	2:08	
15	WTG 04	69:14	
16	WTG 03	36:02	
17	WTG 02	192:27	
18	WTG 01	36:44	

Project:
Palmers Creek Wind Farm

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3100 DeMers Avenue
US-GRAND FORKS, ND 58201
+1 701 775 3000
Nicholas Laskovski / n.laskovski@eapcwindenergy.com
Calculated:
10/12/2016 11:54 PM/3.0.654

SHADOW - Main Result

Calculation: Realistic Case - 80m HH Turbines

Assumptions for shadow calculations

Maximum distance for influence
Calculate only when more than 20 % of sun is covered by the blade
Please look in WTG table

Minimum sun height over horizon for influence	3 °
Day step for calculation	1 days
Time step for calculation	1 minutes

Sunshine probability S (Average daily sunshine hours) [MADISON]

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
4.43	5.24	5.95	7.01	8.58	9.67	9.71	8.48	7.21	5.48	3.66	3.19

Operational hours are calculated from WTGs in calculation and wind distribution:
Palmers 80m Met

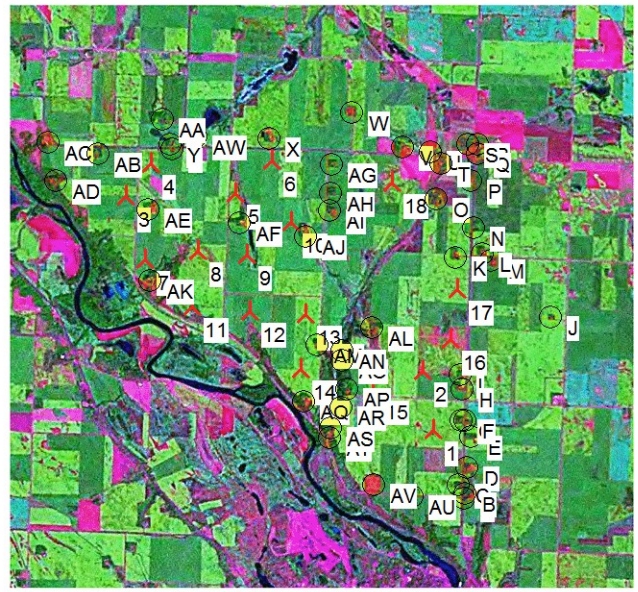
Operational time

N	NNE	ENE	E	ESE	SSE	S	SSW	WSW	W	WNW	NNW	Sum
523	298	298	392	605	1,516	1,174	400	330	537	943	1,380	8,395

Idle start wind speed: Cut in wind speed from power curve

A ZVI (Zones of Visual Influence) calculation is performed before flicker calculation so non visible WTG do not contribute to calculated flicker values. A WTG will be visible if it is visible from any part of the receiver window. The ZVI calculation is based on the following assumptions:
Height contours used: Project Wizard Elevation Data Grid (US NED 1/3 arc-secon
Obstacles used in calculation
Eye height: 1.5 m
Grid resolution: 10.0 m

All coordinates are in
Geo [deg]-WGS84



Scale 1:125,000
New WTG   Shadow receptor

WTGs

	Longitude	Latitude	Z	Row data/Description	WTG type Valid	Manufact.	Type-generator	Power, rated	Rotor diameter	Hub height	Shadow data Calculation distance	RPM
			[m]					[kW]	[m]	[m]	[m]	[RPM]
1	-95.540764° E	44.835808° N	312.5	WTG 14 - GE 2.3-116...	Yes	GE WIND ENERGY	GE 2.3-116-2,300	2,300	116.0	80.0	1,732	15.7
2	-95.543356° E	44.844631° N	314.6	WTG 15 - GE 2.3-116...	Yes	GE WIND ENERGY	GE 2.3-116-2,300	2,300	116.0	80.0	1,732	15.7
3	-95.606875° E	44.869294° N	315.7	WTG 01	Yes	GE WIND ENERGY	GE 2.5-116-2,500	2,500	116.0	80.0	1,732	15.7
4	-95.601897° E	44.874328° N	310.5	WTG 02	Yes	GE WIND ENERGY	GE 2.5-116-2,500	2,500	116.0	80.0	1,732	15.7
5	-95.583817° E	44.870217° N	313.8	WTG 03	Yes	GE WIND ENERGY	GE 2.5-116-2,500	2,500	116.0	80.0	1,732	15.7
6	-95.576389° E	44.875264° N	315.5	WTG 04	Yes	GE WIND ENERGY	GE 2.5-116-2,500	2,500	116.0	80.0	1,732	15.7
7	-95.602481° E	44.859956° N	311.1	WTG 05	Yes	GE WIND ENERGY	GE 2.5-116-2,500	2,500	116.0	80.0	1,732	15.7
8	-95.591403° E	44.861392° N	313.0	WTG 06	Yes	GE WIND ENERGY	GE 2.5-116-2,500	2,500	116.0	80.0	1,732	15.7
9	-95.581006° E	44.861153° N	316.1	WTG 07	Yes	GE WIND ENERGY	GE 2.5-116-2,500	2,500	116.0	80.0	1,732	15.7
10	-95.571917° E	44.866139° N	314.6	WTG 08	Yes	GE WIND ENERGY	GE 2.5-116-2,500	2,500	116.0	80.0	1,732	15.7
11	-95.592247° E	44.853119° N	317.3	WTG 09	Yes	GE WIND ENERGY	GE 2.5-116-2,500	2,500	116.0	80.0	1,732	15.7
12	-95.580111° E	44.852608° N	309.1	WTG 10	Yes	GE WIND ENERGY	GE 2.5-116-2,500	2,500	116.0	80.0	1,732	15.7
13	-95.568378° E	44.852469° N	313.3	WTG 11	Yes	GE WIND ENERGY	GE 2.5-116-2,500	2,500	116.0	80.0	1,732	15.7
14	-95.569025° E	44.844250° N	310.9	WTG 12	Yes	GE WIND ENERGY	GE 2.5-116-2,500	2,500	116.0	80.0	1,732	15.7
15	-95.553758° E	44.841564° N	316.5	WTG 13	Yes	GE WIND ENERGY	GE 2.5-116-2,500	2,500	116.0	80.0	1,732	15.7
16	-95.537703° E	44.849525° N	315.7	WTG 16	Yes	GE WIND ENERGY	GE 2.3-116-2,300	2,300	116.0	80.0	1,732	15.7
17	-95.536517° E	44.856922° N	316.3	WTG 17	Yes	GE WIND ENERGY	GE 2.3-116-2,300	2,300	116.0	80.0	1,732	15.7
18	-95.550994° E	44.872581° N	316.5	WTG 18	Yes	GE WIND ENERGY	GE 2.3-116-2,300	2,300	116.0	80.0	1,732	15.7

SHADOW - Main Result

Calculation: Realistic Case - 80m HH Turbines

Shadow receptor-Input

No.	Name	Longitude	Latitude	Z [m]	Width [m]	Height [m]	Height a.g.l. [m]	Degrees from south cw [°]	Slope of window [°]	Direction mode
A	Resident 01	-95.533842° E	44.825638° N	319.3	2.0	1.5	1.0	0.0	90.0	"Green house mode"
B	Resident 02	-95.533704° E	44.826359° N	318.5	2.0	1.5	1.0	0.0	90.0	"Green house mode"
C	Resident 03	-95.534989° E	44.827696° N	317.9	2.0	1.5	1.0	0.0	90.0	"Green house mode"
D	Resident 04	-95.533451° E	44.830307° N	317.9	2.0	1.5	1.0	0.0	90.0	"Green house mode"
E	Resident 05	-95.532683° E	44.834853° N	319.8	2.0	1.5	1.0	0.0	90.0	"Green house mode"
F	Resident 06	-95.534019° E	44.837284° N	321.1	2.0	1.5	1.0	0.0	90.0	"Green house mode"
G	Resident 07	-95.534825° E	44.837363° N	322.5	2.0	1.5	1.0	0.0	90.0	"Green house mode"
H	Resident 08	-95.534954° E	44.842124° N	318.1	2.0	1.5	1.0	0.0	90.0	"Green house mode"
I	Resident 09	-95.535337° E	44.844227° N	319.2	2.0	1.5	1.0	0.0	90.0	"Green house mode"
J	Resident 10	-95.516886° E	44.853297° N	321.2	2.0	1.5	1.0	0.0	90.0	"Green house mode"
K	Resident 11	-95.537188° E	44.861760° N	319.8	2.0	1.5	1.0	0.0	90.0	"Green house mode"
L	Resident 12	-95.531666° E	44.862421° N	318.0	2.0	1.5	1.0	0.0	90.0	"Green house mode"
M	Resident 13	-95.529807° E	44.861382° N	318.6	2.0	1.5	1.0	0.0	90.0	"Green house mode"
N	Resident 14	-95.533598° E	44.866156° N	319.5	2.0	1.5	1.0	0.0	90.0	"Green house mode"
O	Resident 15	-95.541625° E	44.870285° N	316.8	2.0	1.5	1.0	0.0	90.0	"Green house mode"
P	Resident 16	-95.534581° E	44.873292° N	318.3	2.0	1.5	1.0	0.0	90.0	"Green house mode"
Q	Resident 17	-95.533334° E	44.877298° N	317.7	2.0	1.5	1.0	0.0	90.0	"Green house mode"
R	Resident 18	-95.533434° E	44.878708° N	318.7	2.0	1.5	1.0	0.0	90.0	"Green house mode"
S	Resident 19	-95.535326° E	44.878631° N	320.9	2.0	1.5	1.0	0.0	90.0	"Green house mode"
T	Resident 20	-95.540947° E	44.875754° N	313.6	2.0	1.5	1.0	0.0	90.0	"Green house mode"
U	Resident 21	-95.543273° E	44.877427° N	312.7	2.0	1.5	1.0	0.0	90.0	"Green house mode"
V	Resident 22	-95.549112° E	44.877963° N	313.6	2.0	1.5	1.0	0.0	90.0	"Green house mode"
W	Resident 23	-95.559915° E	44.882819° N	319.5	2.0	1.5	1.0	0.0	90.0	"Green house mode"
X	Resident 24	-95.577203° E	44.878542° N	316.3	2.0	1.5	1.0	0.0	90.0	"Green house mode"
Y	Resident 25	-95.597991° E	44.877208° N	318.1	2.0	1.5	1.0	0.0	90.0	"Green house mode"
Z	Resident 26	-95.597527° E	44.876494° N	317.5	2.0	1.5	1.0	0.0	90.0	"Green house mode"
AA	Resident 27	-95.599588° E	44.880968° N	317.5	2.0	1.5	1.0	0.0	90.0	"Green house mode"
AB	Resident 28	-95.612918° E	44.875402° N	315.9	2.0	1.5	1.0	0.0	90.0	"Green house mode"
AC	Resident 29	-95.623577° E	44.876903° N	317.5	2.0	1.5	1.0	0.0	90.0	"Green house mode"
AD	Resident 30	-95.621627° E	44.871308° N	315.3	2.0	1.5	1.0	0.0	90.0	"Green house mode"
AE	Resident 31	-95.602094° E	44.867319° N	318.2	2.0	1.5	1.0	0.0	90.0	"Green house mode"
AF	Resident 32	-95.582822° E	44.865745° N	319.9	2.0	1.5	1.0	0.0	90.0	"Green house mode"
AG	Resident 33	-95.563933° E	44.874963° N	316.9	2.0	1.5	1.0	0.0	90.0	"Green house mode"
AH	Resident 34	-95.563925° E	44.870771° N	315.1	2.0	1.5	1.0	0.0	90.0	"Green house mode"
AI	Resident 35	-95.563889° E	44.868106° N	317.4	2.0	1.5	1.0	0.0	90.0	"Green house mode"
AJ	Resident 36	-95.568776° E	44.864178° N	316.4	2.0	1.5	1.0	0.0	90.0	"Green house mode"
AK	Resident 37	-95.601147° E	44.856727° N	308.7	2.0	1.5	1.0	0.0	90.0	"Green house mode"
AL	Resident 38	-95.554238° E	44.850846° N	314.7	2.0	1.5	1.0	0.0	90.0	"Green house mode"
AM	Resident 39	-95.565658° E	44.847905° N	311.4	2.0	1.5	1.0	0.0	90.0	"Green house mode"
AN	Resident 40	-95.560488° E	44.847249° N	307.3	2.0	1.5	1.0	0.0	90.0	"Green house mode"
AO	Resident 41	-95.560249° E	44.845851° N	311.1	2.0	1.5	1.0	0.0	90.0	"Green house mode"
AP	Resident 42	-95.559105° E	44.841427° N	318.2	2.0	1.5	1.0	0.0	90.0	"Green house mode"
AQ	Resident 43	-95.568088° E	44.839398° N	310.7	2.0	1.5	1.0	0.0	90.0	"Green house mode"
AR	Resident 44	-95.560323° E	44.838731° N	315.8	2.0	1.5	1.0	0.0	90.0	"Green house mode"
AS	Resident 45	-95.562243° E	44.835534° N	309.2	2.0	1.5	1.0	0.0	90.0	"Green house mode"
AT	Resident 46	-95.562369° E	44.834158° N	309.5	2.0	1.5	1.0	0.0	90.0	"Green house mode"
AU	Resident 47	-95.544746° E	44.825700° N	319.2	2.0	1.5	1.0	0.0	90.0	"Green house mode"
AV	Substation-OfficeShop	-95.552901° E	44.827202° N	313.1	2.0	1.5	1.0	0.0	90.0	"Green house mode"
AW	Swensen-Farm-Museum	-95.592478° E	44.878552° N	319.2	2.0	1.5	1.0	0.0	90.0	"Green house mode"

Calculation Results

Shadow receptor

No.	Name	Shadow, expected values Shadow hours per year [h/year]
A	Resident 01	0:00
B	Resident 02	0:00

To be continued on next page...

SHADOW - Main Result

Calculation: Realistic Case - 80m HH Turbines

...continued from previous page

No.	Name	Shadow, expected values Shadow hours per year [h/year]
C	Resident 03	0:00
D	Resident 04	0:00
E	Resident 05	11:14
F	Resident 06	10:19
G	Resident 07	13:00
H	Resident 08	23:11
I	Resident 09	11:06
J	Resident 10	1:12
K	Resident 11	0:00
L	Resident 12	0:00
M	Resident 13	6:25
N	Resident 14	3:22
O	Resident 15	12:10
P	Resident 16	1:21
Q	Resident 17	0:44
R	Resident 18	0:38
S	Resident 19	0:54
T	Resident 20	3:59
U	Resident 21	6:18
V	Resident 22	0:00
W	Resident 23	0:46
X	Resident 24	0:00
Y	Resident 25	17:56
Z	Resident 26	24:55
AA	Resident 27	0:00
AB	Resident 28	4:21
AC	Resident 29	1:17
AD	Resident 30	2:45
AE	Resident 31	24:52
AF	Resident 32	10:40
AG	Resident 33	6:43
AH	Resident 34	20:18
AI	Resident 35	14:55
AJ	Resident 36	6:33
AK	Resident 37	9:19
AL	Resident 38	13:31
AM	Resident 39	14:13
AN	Resident 40	8:14
AO	Resident 41	20:53
AP	Resident 42	39:01
AQ	Resident 43	2:31
AR	Resident 44	7:37
AS	Resident 45	0:37
AT	Resident 46	0:34
AU	Resident 47	0:00
AV	Substation-OfficeShop	0:00
AW	Swensen-Farm-Museum	5:19

Total amount of flickering on the shadow receptors caused by each WTG

No.	Name	Worst case [h/year]	Expected [h/year]
1	WTG 14 - GE 2.3-116 80m HH	90:56	28:02
2	WTG 15 - GE 2.3-116 80m HH	119:22	45:35
3	WTG 01	48:08	21:02
4	WTG 02	179:34	38:23
5	WTG 03	28:58	9:28
6	WTG 04	42:42	16:53

To be continued on next page...

SHADOW - Main Result

Calculation: Realistic Case - 80m HH Turbines

...continued from previous page

No.	Name	Worst case [h/year]	Expected [h/year]
7	WTG 05	1:23	0:21
8	WTG 06	50:12	12:10
9	WTG 07	21:04	5:00
10	WTG 08	75:49	18:07
11	WTG 09	23:17	7:50
12	WTG 10	13:58	6:02
13	WTG 11	7:11	2:43
14	WTG 12	100:50	29:29
15	WTG 13	164:06	52:37
16	WTG 16	5:45	1:55
17	WTG 17	44:30	9:03
18	WTG 18	135:08	41:03

Project:
Palmers Creek Wind Farm

Description:
Mike Rutledge
Environmental Services Dept. Head
FAGEN ENGINEERING, LLC
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Granite Falls, MN 56241
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Calculated:
10/17/2016 11:09 PM/3.0.654

SHADOW - Main Result

Calculation: Realistic Case - 80m + 90m HH Turbines

Assumptions for shadow calculations

Maximum distance for influence
Calculate only when more than 20 % of sun is covered by the blade
Please look in WTG table

Minimum sun height over horizon for influence	3 °
Day step for calculation	1 days
Time step for calculation	1 minutes

Sunshine probability S (Average daily sunshine hours) [MADISON]

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
4.43	5.24	5.95	7.01	8.58	9.67	9.71	8.48	7.21	5.48	3.66	3.19

Operational hours are calculated from WTGs in calculation and wind distribution:
Palmers 80m Met

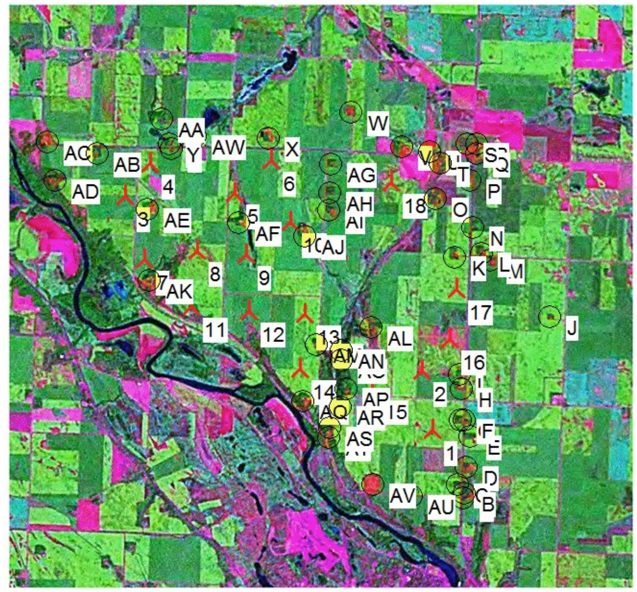
Operational time

N	NNE	ENE	E	ESE	SSE	S	SSW	WSW	W	WNW	NNW	Sum
530	302	302	397	612	1,535	1,189	405	335	544	955	1,398	8,504

Idle start wind speed: Cut in wind speed from power curve

A ZVI (Zones of Visual Influence) calculation is performed before flicker calculation so non visible WTG do not contribute to calculated flicker values. A WTG will be visible if it is visible from any part of the receiver window. The ZVI calculation is based on the following assumptions:
Height contours used: Project Wizard Elevation Data Grid (US NED 1/3 arc-secon
Obstacles used in calculation
Eye height: 1.5 m
Grid resolution: 10.0 m

All coordinates are in
Geo [deg]-WGS84



Scale 1:125,000
New WTG   Shadow receptor

WTGs

	Longitude	Latitude	Z	Row data/Description	WTG type Valid	Manufact.	Type-generator	Power, rated	Rotor diameter	Hub height	Shadow data Calculation distance	RPM
			[m]					[kW]	[m]	[m]	[m]	[RPM]
1	-95.540764° E	44.835808° N	312.5	WTG 14 - GE 2.3-116...	Yes	GE WIND ENERGY	GE 2.3-116-2,300	2,300	116.0	80.0	1,732	15.7
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18	-95.550994° E	44.872581° N	316.5	WTG 18	Yes	GE WIND ENERGY	GE 2.5-116-2,500	2,500	116.0	90.0	1,732	15.7

Description:
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FAGEN ENGINEERING, LLC
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Nicholas Laskovski / n.laskovski@eapcwindenergy.com
Calculated:
10/17/2016 11:09 PM/3.0.654

SHADOW - Main Result

Calculation: Realistic Case - 80m + 90m HH Turbines

Shadow receptor-Input

No.	Name	Longitude	Latitude	Z [m]	Width [m]	Height [m]	Height a.g.l. [m]	Degrees from south cw [°]	Slope of window [°]	Direction mode
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C	Resident 03	-95.534989° E	44.827696° N	317.9	2.0	1.5	1.0	0.0	90.0	"Green house mode"
D	Resident 04	-95.533451° E	44.830307° N	317.9	2.0	1.5	1.0	0.0	90.0	"Green house mode"
E	Resident 05	-95.532683° E	44.834853° N	319.8	2.0	1.5	1.0	0.0	90.0	"Green house mode"
F	Resident 06	-95.534019° E	44.837284° N	321.1	2.0	1.5	1.0	0.0	90.0	"Green house mode"
G	Resident 07	-95.534825° E	44.837363° N	322.5	2.0	1.5	1.0	0.0	90.0	"Green house mode"
H	Resident 08	-95.534954° E	44.842124° N	318.1	2.0	1.5	1.0	0.0	90.0	"Green house mode"
I	Resident 09	-95.535337° E	44.844227° N	319.2	2.0	1.5	1.0	0.0	90.0	"Green house mode"
J	Resident 10	-95.516886° E	44.853297° N	321.2	2.0	1.5	1.0	0.0	90.0	"Green house mode"
K	Resident 11	-95.537188° E	44.861760° N	319.8	2.0	1.5	1.0	0.0	90.0	"Green house mode"
L	Resident 12	-95.531666° E	44.862421° N	318.0	2.0	1.5	1.0	0.0	90.0	"Green house mode"
M	Resident 13	-95.529807° E	44.861382° N	318.6	2.0	1.5	1.0	0.0	90.0	"Green house mode"
N	Resident 14	-95.533598° E	44.866156° N	319.5	2.0	1.5	1.0	0.0	90.0	"Green house mode"
O	Resident 15	-95.541625° E	44.870285° N	316.8	2.0	1.5	1.0	0.0	90.0	"Green house mode"
P	Resident 16	-95.534581° E	44.873292° N	318.3	2.0	1.5	1.0	0.0	90.0	"Green house mode"
Q	Resident 17	-95.533334° E	44.877298° N	317.7	2.0	1.5	1.0	0.0	90.0	"Green house mode"
R	Resident 18	-95.533434° E	44.878708° N	318.7	2.0	1.5	1.0	0.0	90.0	"Green house mode"
S	Resident 19	-95.535326° E	44.878631° N	320.9	2.0	1.5	1.0	0.0	90.0	"Green house mode"
T	Resident 20	-95.540947° E	44.875754° N	313.6	2.0	1.5	1.0	0.0	90.0	"Green house mode"
U	Resident 21	-95.543273° E	44.877427° N	312.7	2.0	1.5	1.0	0.0	90.0	"Green house mode"
V	Resident 22	-95.549112° E	44.877963° N	313.6	2.0	1.5	1.0	0.0	90.0	"Green house mode"
W	Resident 23	-95.559915° E	44.882819° N	319.5	2.0	1.5	1.0	0.0	90.0	"Green house mode"
X	Resident 24	-95.577203° E	44.878542° N	316.3	2.0	1.5	1.0	0.0	90.0	"Green house mode"
Y	Resident 25	-95.597991° E	44.877208° N	318.1	2.0	1.5	1.0	0.0	90.0	"Green house mode"
Z	Resident 26	-95.597527° E	44.876494° N	317.5	2.0	1.5	1.0	0.0	90.0	"Green house mode"
AA	Resident 27	-95.599588° E	44.880968° N	317.5	2.0	1.5	1.0	0.0	90.0	"Green house mode"
AB	Resident 28	-95.612918° E	44.875402° N	315.9	2.0	1.5	1.0	0.0	90.0	"Green house mode"
AC	Resident 29	-95.623577° E	44.876903° N	317.5	2.0	1.5	1.0	0.0	90.0	"Green house mode"
AD	Resident 30	-95.621627° E	44.871308° N	315.3	2.0	1.5	1.0	0.0	90.0	"Green house mode"
AE	Resident 31	-95.602094° E	44.867319° N	318.2	2.0	1.5	1.0	0.0	90.0	"Green house mode"
AF	Resident 32	-95.582822° E	44.865745° N	319.9	2.0	1.5	1.0	0.0	90.0	"Green house mode"
AG	Resident 33	-95.563933° E	44.874963° N	316.9	2.0	1.5	1.0	0.0	90.0	"Green house mode"
AH	Resident 34	-95.563925° E	44.870771° N	315.1	2.0	1.5	1.0	0.0	90.0	"Green house mode"
AI	Resident 35	-95.563889° E	44.868106° N	317.4	2.0	1.5	1.0	0.0	90.0	"Green house mode"
AJ	Resident 36	-95.568776° E	44.864178° N	316.4	2.0	1.5	1.0	0.0	90.0	"Green house mode"
AK	Resident 37	-95.601147° E	44.856727° N	308.7	2.0	1.5	1.0	0.0	90.0	"Green house mode"
AL	Resident 38	-95.554238° E	44.850846° N	314.7	2.0	1.5	1.0	0.0	90.0	"Green house mode"
AM	Resident 39	-95.565658° E	44.847905° N	311.4	2.0	1.5	1.0	0.0	90.0	"Green house mode"
AN	Resident 40	-95.560488° E	44.847249° N	307.3	2.0	1.5	1.0	0.0	90.0	"Green house mode"
AO	Resident 41	-95.560249° E	44.845851° N	311.1	2.0	1.5	1.0	0.0	90.0	"Green house mode"
AP	Resident 42	-95.559105° E	44.841427° N	318.2	2.0	1.5	1.0	0.0	90.0	"Green house mode"
AQ	Resident 43	-95.568088° E	44.839398° N	310.7	2.0	1.5	1.0	0.0	90.0	"Green house mode"
AR	Resident 44	-95.560323° E	44.838731° N	315.8	2.0	1.5	1.0	0.0	90.0	"Green house mode"
AS	Resident 45	-95.562243° E	44.835534° N	309.2	2.0	1.5	1.0	0.0	90.0	"Green house mode"
AT	Resident 46	-95.562369° E	44.834158° N	309.5	2.0	1.5	1.0	0.0	90.0	"Green house mode"
AU	Resident 47	-95.544746° E	44.825700° N	319.2	2.0	1.5	1.0	0.0	90.0	"Green house mode"
AV	Substation-OfficeShop	-95.552901° E	44.827202° N	313.1	2.0	1.5	1.0	0.0	90.0	"Green house mode"
AW	Swensen-Farm-Museum	-95.592478° E	44.878552° N	319.2	2.0	1.5	1.0	0.0	90.0	"Green house mode"

Calculation Results

Shadow receptor

No.	Name	Shadow, expected values Shadow hours per year [h/year]
A	Resident 01	0:00
B	Resident 02	0:00

To be continued on next page...

SHADOW - Main Result

Calculation: Realistic Case - 80m + 90m HH Turbines

...continued from previous page

No.	Name	Shadow, expected values Shadow hours per year [h/year]
C	Resident 03	0:00
D	Resident 04	0:00
E	Resident 05	11:23
F	Resident 06	10:42
G	Resident 07	13:27
H	Resident 08	23:41
I	Resident 09	11:25
J	Resident 10	1:35
K	Resident 11	0:00
L	Resident 12	0:00
M	Resident 13	7:18
N	Resident 14	4:58
O	Resident 15	14:01
P	Resident 16	1:39
Q	Resident 17	0:55
R	Resident 18	0:48
S	Resident 19	1:07
T	Resident 20	4:23
U	Resident 21	6:56
V	Resident 22	0:00
W	Resident 23	0:58
X	Resident 24	2:38
Y	Resident 25	20:04
Z	Resident 26	25:15
AA	Resident 27	0:00
AB	Resident 28	4:54
AC	Resident 29	1:35
AD	Resident 30	3:16
AE	Resident 31	22:26
AF	Resident 32	11:58
AG	Resident 33	7:43
AH	Resident 34	22:28
AI	Resident 35	16:41
AJ	Resident 36	7:22
AK	Resident 37	10:15
AL	Resident 38	15:05
AM	Resident 39	18:13
AN	Resident 40	10:04
AO	Resident 41	22:51
AP	Resident 42	42:44
AQ	Resident 43	2:54
AR	Resident 44	7:16
AS	Resident 45	0:38
AT	Resident 46	0:34
AU	Resident 47	0:00
AV	Substation-OfficeShop	0:00
AW	Swensen-Farm-Museum	6:01

Total amount of flickering on the shadow receptors caused by each WTG

No.	Name	Worst case [h/year]	Expected [h/year]
1	WTG 14 - GE 2.3-116 80m HH	90:56	28:23
2	WTG 15 - GE 2.3-116 80m HH	119:22	46:09
3	WTG 01	41:37	18:05
4	WTG 02	190:29	41:47
5	WTG 03	34:18	11:17
6	WTG 04	58:38	21:36

To be continued on next page...

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Calculated:
10/17/2016 11:09 PM/3.0.654

SHADOW - Main Result

Calculation: Realistic Case - 80m + 90m HH Turbines

...continued from previous page

No.	Name	Worst case [h/year]	Expected [h/year]
7	WTG 05	1:55	0:30
8	WTG 06	54:49	13:34
9	WTG 07	25:05	6:01
10	WTG 08	82:24	20:01
11	WTG 09	24:19	8:22
12	WTG 10	17:19	7:35
13	WTG 11	8:17	3:10
14	WTG 12	122:06	36:04
15	WTG 13	174:28	56:28
16	WTG 16	6:48	2:17
17	WTG 17	50:51	10:42
18	WTG 18	153:16	47:52

Project:
Palmers Creek Wind Farm

Description:
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Nicholas Laskovski / n.laskovski@eapcwindenergy.com
Calculated:
10/11/2016 12:14 PM/3.0.654

SHADOW - Main Result

Calculation: Realistic Case - 80m + 94m HH Turbines

Assumptions for shadow calculations

Maximum distance for influence
Calculate only when more than 20 % of sun is covered by the blade
Please look in WTG table

Minimum sun height over horizon for influence	3 °
Day step for calculation	1 days
Time step for calculation	1 minutes

Sunshine probability S (Average daily sunshine hours) [MADISON]

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
4.43	5.24	5.95	7.01	8.58	9.67	9.71	8.48	7.21	5.48	3.66	3.19

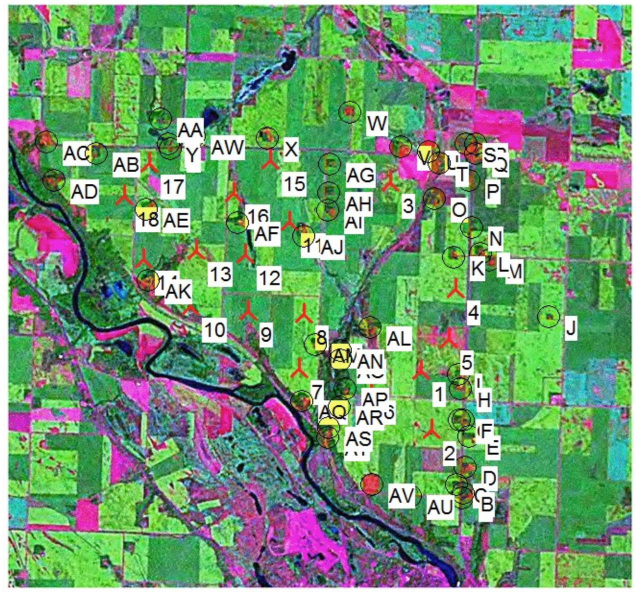
Operational hours are calculated from WTGs in calculation and wind distribution:
Palmers 80m Met

Operational time

N	NNE	ENE	E	ESE	SSE	S	SSW	WSW	W	WNW	NNW	Sum
531	302	302	398	613	1,537	1,191	405	335	545	957	1,400	8,516

Idle start wind speed: Cut in wind speed from power curve

A ZVI (Zones of Visual Influence) calculation is performed before flicker calculation so non visible WTG do not contribute to calculated flicker values. A WTG will be visible if it is visible from any part of the receiver window. The ZVI calculation is based on the following assumptions:
Height contours used: Project Wizard Elevation Data Grid (US NED 1/3 arc-second
Obstacles used in calculation
Eye height: 1.5 m
Grid resolution: 10.0 m



Scale 1:125,000
New WTG   Shadow receptor

All coordinates are in
Geo [deg]-WGS84

WTGs

	Longitude	Latitude	Z [m]	Row data/Description	WTG type Valid	Manufact.	Type-generator	Power, rated [kW]	Rotor diameter [m]	Hub height [m]	Shadow data Calculation distance [m]	RPM [RPM]
1	-95.543356° E	44.844631° N	314.6	WTG 15 - GE 2.3-116...	Yes	GE WIND ENERGY	GE 2.3-116-2,300	2,300	116.0	80.0	1,732	15.7
2	-95.540764° E	44.835808° N	312.5	WTG 14 - GE 2.3-116...	Yes	GE WIND ENERGY	GE 2.3-116-2,300	2,300	116.0	80.0	1,732	15.7
3	-95.550994° E	44.872581° N	316.5	WTG 18	Yes	GE WIND ENERGY	GE 2.5-116-2,500	2,500	116.0	94.0	1,732	15.7
4	-95.536517° E	44.856922° N	316.3	WTG 17	Yes	GE WIND ENERGY	GE 2.5-116-2,500	2,500	116.0	94.0	1,732	15.7
5	-95.537703° E	44.849525° N	315.7	WTG 16	Yes	GE WIND ENERGY	GE 2.5-116-2,500	2,500	116.0	94.0	1,732	15.7
6	-95.553758° E	44.841564° N	316.5	WTG 13	Yes	GE WIND ENERGY	GE 2.5-116-2,500	2,500	116.0	94.0	1,732	15.7
7	-95.569025° E	44.844250° N	310.9	WTG 12	Yes	GE WIND ENERGY	GE 2.5-116-2,500	2,500	116.0	94.0	1,732	15.7
8	-95.568378° E	44.852469° N	313.3	WTG 11	Yes	GE WIND ENERGY	GE 2.5-116-2,500	2,500	116.0	94.0	1,732	15.7
9	-95.580111° E	44.852608° N	309.1	WTG 10	Yes	GE WIND ENERGY	GE 2.5-116-2,500	2,500	116.0	94.0	1,732	15.7
10	-95.592247° E	44.853119° N	317.3	WTG 09	Yes	GE WIND ENERGY	GE 2.5-116-2,500	2,500	116.0	94.0	1,732	15.7
11	-95.571917° E	44.866139° N	314.6	WTG 08	Yes	GE WIND ENERGY	GE 2.5-116-2,500	2,500	116.0	94.0	1,732	15.7
12	-95.581006° E	44.861153° N	316.1	WTG 07	Yes	GE WIND ENERGY	GE 2.5-116-2,500	2,500	116.0	94.0	1,732	15.7
13	-95.591403° E	44.861392° N	313.0	WTG 06	Yes	GE WIND ENERGY	GE 2.5-116-2,500	2,500	116.0	94.0	1,732	15.7
14	-95.602481° E	44.859956° N	311.1	WTG 05	Yes	GE WIND ENERGY	GE 2.5-116-2,500	2,500	116.0	94.0	1,732	15.7
15	-95.576389° E	44.875264° N	315.5	WTG 04	Yes	GE WIND ENERGY	GE 2.5-116-2,500	2,500	116.0	94.0	1,732	15.7
16	-95.583817° E	44.870217° N	313.8	WTG 03	Yes	GE WIND ENERGY	GE 2.5-116-2,500	2,500	116.0	94.0	1,732	15.7
17	-95.601897° E	44.874328° N	310.5	WTG 02	Yes	GE WIND ENERGY	GE 2.5-116-2,500	2,500	116.0	94.0	1,732	15.7
18	-95.606875° E	44.869294° N	315.7	WTG 01	Yes	GE WIND ENERGY	GE 2.5-116-2,500	2,500	116.0	94.0	1,732	15.7

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Calculated:
10/11/2016 12:14 PM/3.0.654

SHADOW - Main Result

Calculation: Realistic Case - 80m + 94m HH Turbines

Shadow receptor-Input

No.	Name	Longitude	Latitude	Z [m]	Width [m]	Height [m]	Height a.g.l. [m]	Degrees from south cw [°]	Slope of window [°]	Direction mode
A	Resident 01	-95.533842° E	44.825638° N	319.3	2.0	1.5	1.0	0.0	90.0	"Green house mode"
B	Resident 02	-95.533704° E	44.826359° N	318.5	2.0	1.5	1.0	0.0	90.0	"Green house mode"
C	Resident 03	-95.534989° E	44.827696° N	317.9	2.0	1.5	1.0	0.0	90.0	"Green house mode"
D	Resident 04	-95.533451° E	44.830307° N	317.9	2.0	1.5	1.0	0.0	90.0	"Green house mode"
E	Resident 05	-95.532683° E	44.834853° N	319.8	2.0	1.5	1.0	0.0	90.0	"Green house mode"
F	Resident 06	-95.534019° E	44.837284° N	321.1	2.0	1.5	1.0	0.0	90.0	"Green house mode"
G	Resident 07	-95.534825° E	44.837363° N	322.5	2.0	1.5	1.0	0.0	90.0	"Green house mode"
H	Resident 08	-95.534954° E	44.842124° N	318.1	2.0	1.5	1.0	0.0	90.0	"Green house mode"
I	Resident 09	-95.535337° E	44.844227° N	319.2	2.0	1.5	1.0	0.0	90.0	"Green house mode"
J	Resident 10	-95.516886° E	44.853297° N	321.2	2.0	1.5	1.0	0.0	90.0	"Green house mode"
K	Resident 11	-95.537188° E	44.861760° N	319.8	2.0	1.5	1.0	0.0	90.0	"Green house mode"
L	Resident 12	-95.531666° E	44.862421° N	318.0	2.0	1.5	1.0	0.0	90.0	"Green house mode"
M	Resident 13	-95.529807° E	44.861382° N	318.6	2.0	1.5	1.0	0.0	90.0	"Green house mode"
N	Resident 14	-95.533598° E	44.866156° N	319.5	2.0	1.5	1.0	0.0	90.0	"Green house mode"
O	Resident 15	-95.541625° E	44.870285° N	316.8	2.0	1.5	1.0	0.0	90.0	"Green house mode"
P	Resident 16	-95.534581° E	44.873292° N	318.3	2.0	1.5	1.0	0.0	90.0	"Green house mode"
Q	Resident 17	-95.533334° E	44.877298° N	317.7	2.0	1.5	1.0	0.0	90.0	"Green house mode"
R	Resident 18	-95.533434° E	44.878708° N	318.7	2.0	1.5	1.0	0.0	90.0	"Green house mode"
S	Resident 19	-95.535326° E	44.878631° N	320.9	2.0	1.5	1.0	0.0	90.0	"Green house mode"
T	Resident 20	-95.540947° E	44.875754° N	313.6	2.0	1.5	1.0	0.0	90.0	"Green house mode"
U	Resident 21	-95.543273° E	44.877427° N	312.7	2.0	1.5	1.0	0.0	90.0	"Green house mode"
V	Resident 22	-95.549112° E	44.877963° N	313.6	2.0	1.5	1.0	0.0	90.0	"Green house mode"
W	Resident 23	-95.559915° E	44.882819° N	319.5	2.0	1.5	1.0	0.0	90.0	"Green house mode"
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AB	Resident 28	-95.612918° E	44.875402° N	315.9	2.0	1.5	1.0	0.0	90.0	"Green house mode"
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AD	Resident 30	-95.621627° E	44.871308° N	315.3	2.0	1.5	1.0	0.0	90.0	"Green house mode"
AE	Resident 31	-95.602094° E	44.867319° N	318.2	2.0	1.5	1.0	0.0	90.0	"Green house mode"
AF	Resident 32	-95.582822° E	44.865745° N	319.9	2.0	1.5	1.0	0.0	90.0	"Green house mode"
AG	Resident 33	-95.563933° E	44.874963° N	316.9	2.0	1.5	1.0	0.0	90.0	"Green house mode"
AH	Resident 34	-95.563925° E	44.870771° N	315.1	2.0	1.5	1.0	0.0	90.0	"Green house mode"
AI	Resident 35	-95.563889° E	44.868106° N	317.4	2.0	1.5	1.0	0.0	90.0	"Green house mode"
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AK	Resident 37	-95.601147° E	44.856727° N	308.7	2.0	1.5	1.0	0.0	90.0	"Green house mode"
AL	Resident 38	-95.554238° E	44.850846° N	314.7	2.0	1.5	1.0	0.0	90.0	"Green house mode"
AM	Resident 39	-95.565658° E	44.847905° N	311.4	2.0	1.5	1.0	0.0	90.0	"Green house mode"
AN	Resident 40	-95.560488° E	44.847249° N	307.3	2.0	1.5	1.0	0.0	90.0	"Green house mode"
AO	Resident 41	-95.560249° E	44.845851° N	311.1	2.0	1.5	1.0	0.0	90.0	"Green house mode"
AP	Resident 42	-95.559105° E	44.841427° N	318.2	2.0	1.5	1.0	0.0	90.0	"Green house mode"
AQ	Resident 43	-95.568088° E	44.839398° N	310.7	2.0	1.5	1.0	0.0	90.0	"Green house mode"
AR	Resident 44	-95.560323° E	44.838731° N	315.8	2.0	1.5	1.0	0.0	90.0	"Green house mode"
AS	Resident 45	-95.562243° E	44.835534° N	309.2	2.0	1.5	1.0	0.0	90.0	"Green house mode"
AT	Resident 46	-95.562369° E	44.834158° N	309.5	2.0	1.5	1.0	0.0	90.0	"Green house mode"
AU	Resident 47	-95.544746° E	44.825700° N	319.2	2.0	1.5	1.0	0.0	90.0	"Green house mode"
AV	Substation-OfficeShop	-95.552901° E	44.827202° N	313.1	2.0	1.5	1.0	0.0	90.0	"Green house mode"
AW	Swensen-Farm-Museum	-95.592478° E	44.878552° N	319.2	2.0	1.5	1.0	0.0	90.0	"Green house mode"

Calculation Results

Shadow receptor

No.	Name	Shadow, expected values Shadow hours per year [h/year]
A	Resident 01	0:00
B	Resident 02	0:00

To be continued on next page...

SHADOW - Main Result

Calculation: Realistic Case - 80m + 94m HH Turbines

...continued from previous page

No.	Name	Shadow, expected values Shadow hours per year [h/year]
C	Resident 03	0:00
D	Resident 04	0:00
E	Resident 05	11:24
F	Resident 06	10:50
G	Resident 07	13:36
H	Resident 08	23:47
I	Resident 09	11:29
J	Resident 10	1:43
K	Resident 11	0:00
L	Resident 12	0:00
M	Resident 13	7:34
N	Resident 14	5:24
O	Resident 15	14:42
P	Resident 16	1:43
Q	Resident 17	0:59
R	Resident 18	0:53
S	Resident 19	1:11
T	Resident 20	4:31
U	Resident 21	7:10
V	Resident 22	0:00
W	Resident 23	1:04
X	Resident 24	4:54
Y	Resident 25	20:40
Z	Resident 26	24:36
AA	Resident 27	0:00
AB	Resident 28	5:05
AC	Resident 29	1:40
AD	Resident 30	3:28
AE	Resident 31	20:21
AF	Resident 32	12:22
AG	Resident 33	8:08
AH	Resident 34	23:06
AI	Resident 35	17:14
AJ	Resident 36	7:37
AK	Resident 37	10:25
AL	Resident 38	15:40
AM	Resident 39	19:45
AN	Resident 40	10:58
AO	Resident 41	23:23
AP	Resident 42	44:17
AQ	Resident 43	3:03
AR	Resident 44	6:30
AS	Resident 45	0:38
AT	Resident 46	0:34
AU	Resident 47	0:00
AV	Substation-OfficeShop	0:00
AW	Swensen-Farm-Museum	6:20

Total amount of flickering on the shadow receptors caused by each WTG

No.	Name	Worst case [h/year]	Expected [h/year]
1	WTG 15 - GE 2.3-116 80m HH	119:22	46:13
2	WTG 14 - GE 2.3-116 80m HH	90:56	28:26
3	WTG 18	159:40	50:07
4	WTG 17	52:59	11:15
5	WTG 16	7:16	2:27
6	WTG 13	176:49	57:16

To be continued on next page...

SHADOW - Main Result

Calculation: Realistic Case - 80m + 94m HH Turbines

...continued from previous page

No.	Name	Worst case [h/year]	Expected [h/year]
7	WTG 12	130:24	38:43
8	WTG 11	8:44	3:21
9	WTG 10	18:35	8:10
10	WTG 09	24:16	8:23
11	WTG 08	84:26	20:34
12	WTG 07	26:45	6:25
13	WTG 06	56:31	14:05
14	WTG 05	2:08	0:33
15	WTG 04	69:14	24:34
16	WTG 03	36:02	11:52
17	WTG 02	192:27	42:30
18	WTG 01	36:44	15:45

Palmers Creek Wind Project
Microwave Beam Study

Granite Falls, MN

October 15, 2016

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Report Update

EAPC bears no responsibility to update this report for any changes occurring subsequent to the final issuance of this report.

Revision History

Revision No.	Revision Purpose	Date	Revised By
0	Original	10/15/2016	C. Harvey

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1. INTRODUCTION

EAPC mapped the locations of microwave beam paths proximate to the Palmers Creek Wind Project site north of Granite Falls, Minnesota. Microwave beams are used by commercial and public service entities to transmit communications over long distances. Beam paths are the straight-line vectors along which microwave signals pass from one microwave dish (typically mounted on a tower) to another dish. Any interruption to a microwave beam could cause disturbances to the microwave service carrier. As a standard practice, EAPC Wind recommends avoiding any potential disturbances to microwave beams when planning a wind farm layout. Defining an exclusion zone consisting of the maximum beam width and a buffer of at least the wind turbine blade length insures that no communications interference results from installed turbines. Developers are also encouraged to consider how the location of cranes and turbine components during turbine installation may affect microwave beam transmission.

This study does not identify unlicensed microwave paths or federal government paths that are not registered with the FCC (such as DOD and Homeland Security).

2. METHODOLOGY

Microwave transmissions are regulated by the FCC, and records of the locations of all operating transmitters and receivers are publically available. EAPC mapped the straight-line vectors between associated transmitters and receivers using an azimuthal map projection centered on the southwest end of the study area, where a number of microwave antennas are located. Beams with frequencies between 800 and 60,000 Mhz were mapped.

EAPC then calculated the maximum beam width which cannot be obstructed while maintaining normal operation of microwave communications. This is defined as the maximum radius of the 1st Fresnel zone, which is a parabolic zone with endpoints at the transmitter and receiver, and whose widest point is at the midpoint of the beam. The maximum radius of the 1st Fresnel zone is calculated based on the frequency of microwave transmission and the overall length of the beam, according to the formula:

$$r = 8.657\sqrt{\frac{D}{f}}$$

where r = radius in meters, D = beam length in kilometers, and f = transmission frequency in gigahertz. Beam paths were offset by this radius along their entire length. This arrives at a slight overestimate of unobstructable space as it does not account for the taper of the 1st Fresnel zone radius at either end of the beam.

In addition to providing a 1st Fresnel zone offset, EAPC provides an additional 58 m offset for each beam representing the blade sweep of the GE wind turbine model with a 116 m rotor diameter that is proposed for this project. A wind turbine of this size would need to be sited outside this offset area in order to avoid interference with the 1st Fresnel zone. Smaller-sized turbines could potentially be located closer, but EAPC highly recommends siting turbines with an additional several blade-lengths of margin to avoid interference associated with construction operations and account for error in microwave beam location. EAPC mapped microwave beam location based on coordinates provided by the FCC public record, and <u>did not ground-truth or correct the location of transmitters or receivers based on aerial photography. As-built locations of transmitters and receivers may differ slightly from licensed positions, and should be verified before final wind turbine layout and construction.</u>

3. RESULTS

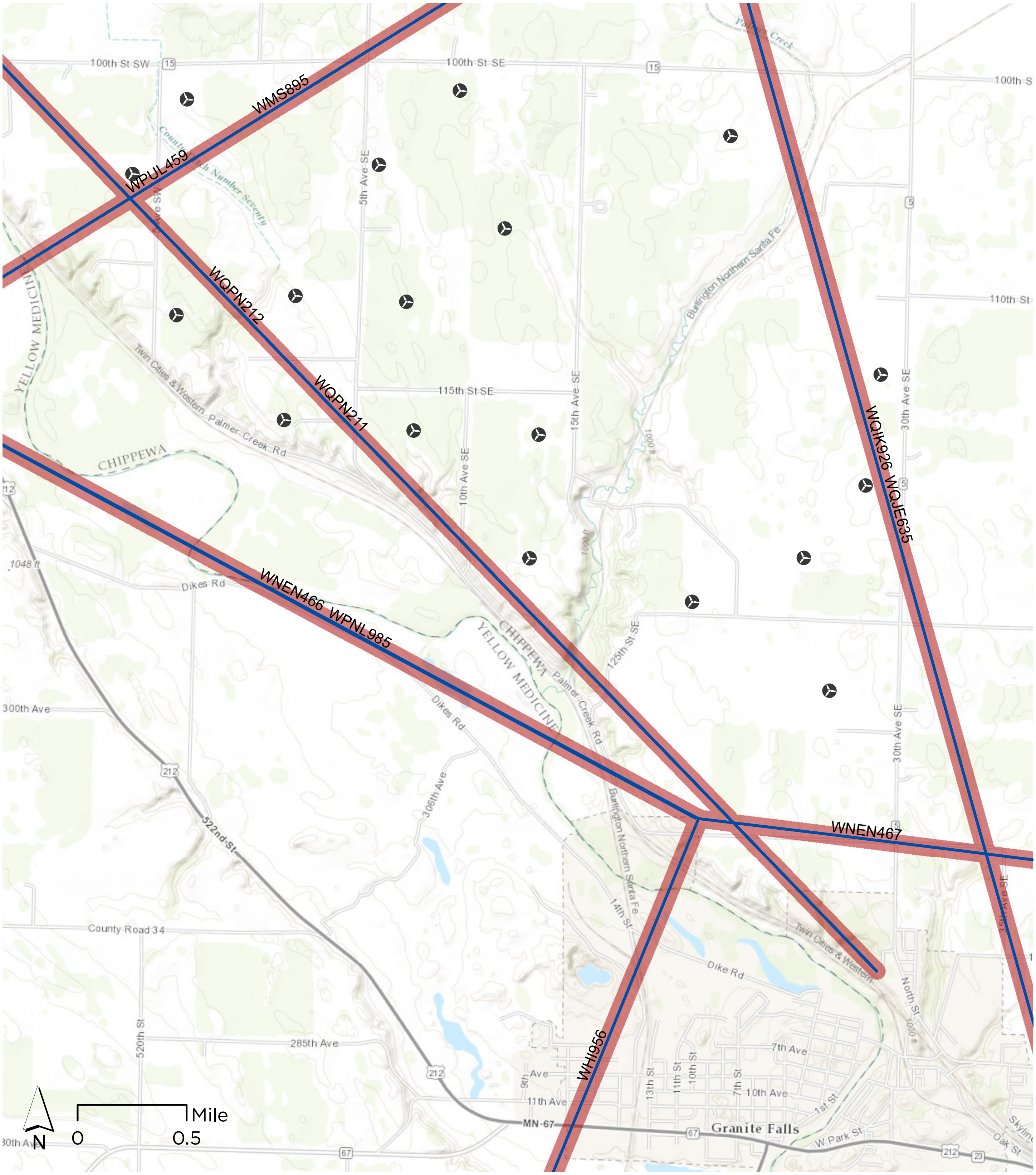
All of the WTG sites provided by the client fall outside the recommended buffers from microwave beams crossing the project area. Information about each of the 20 microwave beam paths passing within one mile of the project area is summarized in Table 1. Redundant call sign and path number combinations are reflective of multiple listings in the FCC database and may be due to multiple transmission frequency assignments or other characteristics.

A map of the microwave beam paths is included in Appendix A.

Table 1: Microwave beams passing within one mile of the project area and their controlling entities.

Call Sign	Path Number	Controlling Entity	Entity City	Entity Telephone
WHI956	2	East River Electric Power Cooperative	Madison, SD	(605) 256-4536
WHI956	2	East River Electric Power Cooperative	Madison, SD	(605) 256-4536
WMS895	7	New Cingular Wireless PCS, LLC	Richardson, TX	(972) 234-7003
WMS895	4	New Cingular Wireless PCS, LLC	Richardson, TX	(972) 234-7003
WNEN466	2	East River Electric Power Cooperative	Madison, SD	(605) 256-4536
WNEN466	1	East River Electric Power Cooperative	Madison, SD	(605) 256-4536
WNEN466	3	East River Electric Power Cooperative	Madison, SD	(605) 256-4536
WNEN467	1	East River Electric Power Cooperative	Madison, SD	(605) 256-4536
WPNL985	1	East River Electric Power Cooperative	Madison, SD	(605) 256-4536
WPNL985	1	East River Electric Power Cooperative	Madison, SD	(605) 256-4536
WPUL459	3	New Cingular Wireless PCS, LLC	Richardson, TX	(972) 234-7003
WPUL459	1	New Cingular Wireless PCS, LLC	Richardson, TX	(972) 234-7003
WQIK926	4	Minnesota, State of	Saint Pail, MN	(651) 234-7973
WQJE635	3	Minnesota, State of	Saint Pail, MN	(651) 234-7973
WQPN211	1	Verizon Wireless (VAW) LLC	Alpharetta, GA	(770) 797-1070
WQPN211	1	Verizon Wireless (VAW) LLC	Alpharetta, GA	(770) 797-1070
WQPN211	1	Verizon Wireless (VAW) LLC	Alpharetta, GA	(770) 797-1070
WQPN211	1	Verizon Wireless (VAW) LLC	Alpharetta, GA	(770) 797-1070
WQPN212	2	Verizon Wireless (VAW) LLC	Alpharetta, GA	(770) 797-1070
WQPN212	2	Verizon Wireless (VAW) LLC	Alpharetta, GA	(770) 797-1070
WQPN212	2	Verizon Wireless (VAW) LLC	Alpharetta, GA	(770) 797-1070
WQPN212	2	Verizon Wireless (VAW) LLC	Alpharetta, GA	(770) 797-1070
WQPN212	2	Verizon Wireless (VAW) LLC	Alpharetta, GA	(770) 797-1070
WQPN212	2	Verizon Wireless (VAW) LLC	Alpharetta, GA	(770) 797-1070
WQPN212	2	Verizon Wireless (VAW) LLC	Alpharetta, GA	(770) 797-1070

Appendix A: Map of microwave beams intersecting the project area



Palmers Creek Wind Project - Granite Falls, MN

Microwave Beam Study

Proposed WTG Site

Microwave Beam Path

Recommended Buffer from Beam Path

EAPC WIND ENERGY