Thunder Spirit Wind Energy Project
Thunder Spirit Wind, LLC
Adams County, North Dakota

Application to the North Dakota Public Service Commission for a Certificate of Site Compatibility



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47 PU-11-601 Filed 09/26/2013 Pages: 458
Exhibit 1 from Sept. 19, 2013 formal hearing
Thunder Spirit Wind, LLC

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MAY 2013

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- Wildlife Baseline Studies Report (WEST, 2013)
- Bat Acoustic Studies Report (WEST, 2013)
- Sharp-tailed Grouse Lek and Raptor Nest Report (WEST, 2013)
- Shadow Flicker Analysis Report (Tetra Tech, 2013)
- Acoustic Modeling Analysis Memorandum (Tetra Tech, 2013)
- AM and FM Radio Report (Comsearch, 2011)
- Cable and Satellite Report (Comsearch, 2011)
- Land Mobile and Emergency Services Report (Comsearch, 2013)
- Microwave Report (Comsearch, 2013)
- Mobile Phone Report (Comsearch, 2011)
- Tower Structures Report (Comsearch, 2011)
- Off-Air TV Analysis Report (Comsearch, 2013)

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1. INTRODUCTION

Thunder Spirit Wind, LLC (Thunder Spirit), an affiliate of Global Winds Harvest, Inc., is submitting this application for a Certificate of Site Compatibility (Certificate) to construct the Thunder Spirit Wind Energy Project (the Project). Thunder Spirit submitted a letter of intent to file this application to the North Dakota Public Service Commission (PSC) first on August 8, 2011 and updated on March 7, 2013. The Project is located in Adams County, North Dakota, (**Figures 1-3**) and will have a nameplate capacity of approximately 150 megawatts (MW) consisting of up to 75 wind turbine generators. Additional facilities will include access roads, electrical collection systems and cabling, a substation, a construction laydown area, and an approximately 0.85 mi overhead radial transmission line.

The Project will interconnect to the Montana-Dakota Utilities (MDU) Hettinger 230kV Substation in the southwest corner of Section 31 in Township 130 North, Range 95 West, and will transmit power into the MISO grid. The Project's collection substation will include a power transformer to step up the voltage from 34.5 kV to 230 kV, enabling the interconnection to the MDU Substation. The Project substation will be located less than a mile away from the MDU Substation in the southeast corner of Section 31, Township 130 North, Range 95 West.

Global Winds Harvest is a privately owned U.S. wind energy company formed in 1999 by engineers and principals of one of the world's leading wind turbine manufacturers. Global Winds Harvest believes that wind energy is a cost competitive alternative to electricity generated from all other fuel sources - with the great advantage to consumers that the costs of producing this power do not include negative impacts to air and water and to the health of children. Wind power is also constant in cost and thus can help to stabilize U.S. energy markets made increasingly volatile by fluctuations in the price and availability of natural gas.

1.1 Compliance with the Energy Conversion and Transmission Facility Siting Act Chapter 49-22

The North Dakota Energy Conversion and Transmission Facility Siting Act ("the Act") requires an application for a certificate to meet the criteria set forth in North Dakota Century Code (NDCC) 49-22 and Article 69-06 of the North Dakota Administrative Code (NDAC). The siting of an energy conversion facility is to be made in an orderly manner compatible with environmental preservation and the efficient use of resources (NDCC 49-22-02).

Exclusion and avoidance areas and selection and policy criteria set forth in Article 69-06 have been considered by Thunder Spirit in the design of the Project and have been provided in this application to the extent available. In addition, sufficient Project design, wind resource and technical information have been provided for a thorough evaluation of the proposed Project. **Table 1** outlines the information required to fulfill the requirements for a certificate with the PSC (PSC 1979) and where these requirements are addressed in this document.

Table 1. Certificate Completion Checklist

State Authority	Description	Section
NDCC 49-22-08	PSC Guidelines: Energy Conversion and Transmission Facility Siting	1.1
Section A	Description	1, 4
1.	Type: Describe the type of energy conversion facility proposed and provide a diagram of the major process system or a flow diagram.	1.0, 4.1, Figures 7 and 8
2.	Product: Describe in general terms and technical terms the products to be produced by the proposed facility.	1.2.3, 4 Figure 6
3.	Size and Design: Provide the following description of the production capacity and design	1.2.1, 1.2.3, 1.5
a.	Gross design capacity;	1.2.3
b.	Net design capacity;	1.2.3
c.	Estimated thermal efficiency of the energy conversion process and the assumptions upon which the estimate is based;	N/A
d.	The number of acres that the proposed facility will occupy; and	1.2.1, 1.5
e.	One (1) copy of all design data reports separate from the application.	Table 13, Appendix C
4.	Time Schedule: Provide the anticipated time schedule for the accomplishment of the following:	1.3
a.	Certificate of Site Compatibility;	1.3
b.	Land acquisition complete;	1.3
c.	Construction start date;	1.3
d.	Construction complete;	1.3
e.	Test operations;	1.3
f.	Commercial production date;	1.3
g.	100 percent capacity factor; and	1.3
h.	Any expansion or additions.	1.3
Section B	Studies	
	Provide a copy of any evaluative studies or assessments of the environmental impact of the proposed facility submitted to any Local, State or Federal agency.	Appendix A
Section C	Need for Facility	2.0
1.	An analysis of the need for the proposed facility based on present and projected demand for the product or products to be produced by the proposed facility, including the most recent system studies supporting the analysis of the need.	2.1
2.	A description of any feasible alternative methods of serving the need.	2.2
3.	A statement justifying any deviations from the most recent Ten-Year Plan which the proposed facility may present.	2.3
Section D	Location	1.3.1
1.	Select a study area, which includes the proposed facility site, of sufficient size to enable the Commission to evaluate the factors addressed in Section 49-22-09, NDCC.	1.2.1, 1.5 8.0-8.12, Figures 1-3
2.	Discuss the utility's policies and commitments to limit the environmental impact of its facilities, including copies of board resolutions and management directives.	Introduction
3.	Identify and map the criteria that led to the proposed facility location within the study area.	1.5, 3.0 Figures 4 and 5
4.	Discuss in detail the relative value of each criteria and how the proposed facility location was selected giving consideration to all criteria.	3.0

State Authority	Description	Section
5.	The criteria to be evaluated shall include at a minimum all of the following which are within the study area:	3
	Exclusion areas;	3.2.1, Figure 5, Table 8
	Avoidance areas;	3.2.2, Figure 5, Table 9
	Selection criteria;	3.2.3, Table 10
	Policy criteria;	3.2.4, Table 11
	Design and construction limitations; and	3.5
	Economic considerations.	3.6
6.	Discuss the mitigative measures that will be taken to minimize adverse impacts which result from the location, construction, and operation of the proposed facility.	5.2.3, 5.3.3, 5.4.3, 5.5.3, 5.6.3, 5.7.3, 5.8.3, 5.9.3, 5.10.3, 5.11.3, 5.12.3, 5.13.3, 5.14.3, 5.15.3, 5.16.3
7.	List the qualifications of the people in the various disciplines that contributed to the facility site location study	9
8.	Maps	Figures
	Map the criteria within the study area showing the proposed facility location. Several different criteria may be shown on each map, depending on the map scale and the density and nature of the criteria. Minimum map scale shall be ½ inch = 1 mile. All maps shall be at the same scale unless otherwise specified.	Figures
	Furnish one Mylar map, separate from the application, of the same scale as the criteria maps and showing the same basic features as the criteria maps, including the study area, but not the proposed facility location.	(PSC Staff supports not providing a Mylar map)
NDCC 49-22-09	Factors to be considered in evaluating applications and designation of sites, corridors, and routes.	8
1.	Available research and investigations relating to the effects of the location, construction, and operation of the proposed facility on public health and welfare, natural resources, and the environment.	5.5, 8.1
2.	The effects of new energy conversion and transmission technologies and systems designed to minimize adverse environmental effects.	5.4.2, 8.2
3.	The potential for beneficial uses of waste energy from a proposed energy conversion facility.	5.5.3, 8.3
4.	Adverse direct and indirect environmental effects which cannot be avoided should the proposed site or route be designated.	8.4
5.	Alternatives to the proposed site, corridor or route which are developed during the hearing process and which minimize adverse effects.	8.5
6.	Irreversible and irretrievable commitments of natural resources should the proposed site, corridor, or route be designated.	8.6
7.	The direct and indirect economic impacts of the proposed facility.	5.2.2, 8.7
8.	Existing plans of the state, local government, and private entities for other developments at or in the vicinity of the proposed site, corridor, or route.	8.8
9.	The effect of the proposed site or route on existing scenic areas, historic sites and structures, and paleontological or archaeological sites.	5.7, 8.9
10.	The effect of the proposed site or route on areas which are unique because of biological wealth or because they are habitats for rare and endangered species.	5.15, 5.16, 8.10
11.	Problems raised by federal agencies, other state agencies, and local entities.	8.12

1.2 Project Summary

Thunder Spirit evaluated wind resources throughout North Dakota for siting an approximately 150 MW wind generation facility. Based on this review, Thunder Spirit selected a Project Area approximately two (2) miles northeast of Hettinger, North Dakota for additional environmental studies and preparation of an application for a Certificate to the PSC. The proposed Project Area was identified as optimal from wind resource, transmission interconnection, environmental, and economic perspectives. The proposed Project Area was selected considering the exclusion and avoidance criteria outlined in NDAC 69-06-08 and the Adams County Wind Energy Facility Ordinance (Article 6.11).

Thunder Spirit consulted with various agencies and conducted a variety of studies in the development process. An optimal area was selected that will balance the needs of the Project along with the need to avoid and/or minimize environmental impacts. Through this iterative process, new information acquired was used to modify the Project footprint as necessary. See **Section 8.5** for more details.

1.2.1 Proposed Project Area

Thunder Spirit is located two (2) miles northeast of Hettinger, North Dakota in Adams County. The Project Area was selected to include all areas necessary for Thunder Spirit to optimize the wind resource while avoiding and minimizing impacts to environmental resources (**Table 2**).

Table 2. Project Area Location

County	Civil Township	Township	Range	Sections
Adams County	Duck Creek	130N	95W	1-36
	Holt	130N	96W	13, 14, 23, 24, 25, 26

For purposes of this application, a subset of the Project Area [Wind Energy Facility Perimeter (WEFP)] as defined in the Adam's County regulations will be used to describe the existing environmental conditions (**Figure 1 and Table 3**). This WEFP is comprised of the lands containing wind farm facilities that are under easement agreements with Thunder Spirit.

Table 3. Project Area Descriptions

Area Descriptions	Area
Project Area Boundary	26,867 acres
WEFP	14,881 acres

1.2.2 Proposed Turbine Types

While the exact turbine manufacturer and model has not been selected for the Project, it is expected that the wind turbine generator to be used will fall between 2.0 and 3.0 MW per unit in generating capacity. **Table 4** shows the three (3) turbine models currently being considered for Thunder Spirit. **Appendix C** contains specifications for these turbines.

Table 4. Specifications for Potential Project Turbines

	Vestas V100 2.0	Siemens SWT-2.3-108	Acciona AW-116/3000
Rated Power	2.0 MW	2.3 MW	3.0 MW
Rotor Diameter	100 m	108 m	116 m
Hub height	80 m	80 m	92 m
Total number of turbines	75	65	50

1.2.3 Projected Output

The Project will have a nameplate (gross) capacity of approximately 150 MW. Assuming a net capacity factor of approximately 51.5 percent (GWH, 2013), the projected average annual output is estimated at 676,710 megawatt hours (MWh) per year. As with all wind projects, output is dependent upon wind resource, final design, site-specific features, and equipment performance.

1.3 Project Schedule

Thunder Spirit is targeting the start of construction for September 2013 provided all pre-construction permits and approvals have been obtained. The target date for commercial operation is October 2014, however this date is dependent upon permitting, equipment deliveries, and other development activities.

a. Certificate of Site Compatibility: Thunder Spirit anticipates the Certificate will be approved in September 2013.
b. Land Acquisition: Thunder Spirit anticipates that all land acquisition will be completed by June 2013.
c. Permits: Thunder Spirit is responsible for undertaking all required environmental studies, and will obtain all permits and licenses that are required following issuance of the Certificate. Completing permits is on the "critical path" for the Project and will allow Thunder Spirit to move forward with other commitments on the Project. See **Section 7.0** for complete list of permits.
d. Equipment Procurement, Manufacture and Delivery: Thunder Spirit will order the wind turbine components as soon as practicable following issuance of the Certificate.
e. Construction: Construction is scheduled to begin as early as September 2013, subject to road restrictions and weather. The engineering, procurement, and construction (EPC) contractor will be responsible for completing all project construction, including roads, wind turbine assembly, electrical, and communications work. The construction will begin in September 2013.
f. Test and Operations: Thunder Spirit anticipates testing and operation to begin around July 2014.
g. Commercial Operation: Thunder Spirit anticipates Commercial Operation Date (COD) in October 2014.

1.4 Project Ownership

Thunder Spirit will own the entire Project and, as a result, will manage the construction of all equipment and associated facilities related to the Project. Thunder Spirit will likely select a third-party contractor to perform the majority of the engineering and construction (E&C) of the wind farm. Thunder Spirit will procure the turbine/tower package directly from a manufacturer.

1.5 Proposed Project Impacts

Permanent impacts are considered to be the Project footprint during operation. Temporary impacts are considered those impacts from construction activities that occur outside of the operational footprint that will remain as the Project footprint during operation. **Table 5** summarizes the estimated impact for each Project component for both construction (temporary) and operation (permanent). The Project Location and Project Areas are shown on **Figures 1-3**. The impact assumptions are shown on **Figure 4**.

Depending on the model selected, the Project could install up to 75 turbines to meet full generation capacity of 150 MW. The layout is representative of the potential locations for any of the turbine models that may be used (i.e. the locations will not change, only the total number of turbines installed). Also, since the impacts for each of the turbine models do not vary significantly, this table accounts for any of the turbine models being considered. Project impact assumptions are listed in **Table 5** and **Table 6**. As described in these tables, all potential impacts presented are "worst-case" estimates, and actual impacts are anticipated to be smaller than presented.

Table 5. Project Impact Assumptions

Project Component	Total Disturbance (Temporary and Permanent)	Permanent Disturbance (Operation)	Temporary Disturbance (Construction Only)
Wind Turbines a/	4.5 acres per turbine	0.75 acres per turbine	3.75 acres per turbine
Access Roads b/	100 foot corridor per linear foot of road	36 foot corridor per linear foot of road	64 feet per linear foot of road*
Collection Lines c/	50 foot corridor per linear foot	0 feet	50 foot corridor per linear foot
O&M Facility d/ Collection Substation e/ Laydown Area f/	20 acres	7 acres	13 acres
Additional Construction Laydown Area f/	Up to 10 acres	0 acres	5-10 acres

a/ Impacts during operation account for a 200-ft diameter compacted pad. Impacts per turbine during construction are estimated at 4.5 acres, so net construction impact is 4.5 - 0.75 = 3.75 acres. For the purposes of the impact analysis using GIS software, a radius of 250 feet and 100 feet was used to approximate the 4.5 acres and 0.75 acres, respectively.

b/ Easement width necessary for construction based on turbine types. Temporary and permanent impacts represent a conservative estimate of disturbance. Roads required to support crane access to turbines during operation would remain up to 36 feet wide; other access roads may be built at 16 feet or reduced later to 16 feet. This table is exhibiting the worst case impacts. Access road impacts also assume all proposed roads are new access roads and do not consider improvements to existing roads separately.

c/ Assuming collection lines are not co-located with access roads. Where collection lines run parallel to access roads, the centerlines in the layout design include a separation distance, and as a result, impact buffers generally do not overlap.

d/ Acreage based on information provided by Thunder Spirit. Estimated temporary disturbance for the O&M facility is between 4-7 acres.

e/ Thunder Spirit will attempt to construct substation near the O&M Facility. Estimated temporary disturbance for the Substation is between 3-6 acres.

f/ There will be up to two laydown areas (up to 5-10 acres each). One laydown area will be located near the O&M/Substation area. The locations and sizes will be determined early in the engineering and project management review of the project.

*Temporary disturbance for access roads is 32' from either side of permanent disturbance corridor. See inset on Figure 4.

Table 6. Estimated Project Impacts

Project Component	Total Disturbance (Temporary and Permanent)	Permanent Disturbance (Operation)	Temporary Disturbance (Construction Only)
Wind Turbines a/	323 acres	56 acres	267 acres
Access Roads b/	309 acres	113 acres	196 acres
Collection Lines c/	155 acres	0	155 acres
O&M Facility d/ Collection Substation e/ Laydown Area f/	20 acres	7 acres	13 acres
Additional Construction Laydown Area f/	Up to 10 acres	0 acres	5-10 acres

a/ Since the final locations of the turbines have not been selected from the 85 optional locations, these impacts assume all 85 turbines x 4.5 acres of ground disturbance during construction, 0.75 acre/turbine of that remaining as permanent based on the layout dated April 26, 2013. This would calculate the worst case scenario for impacts.

b/ Assumes a 100-ft wide impact area for roads during construction, 36 feet of that remaining during operation. Assumes total of approximately 26.8 linear miles of service roads. The overlapping area for turbines and substation were excluded from the impact calculations.

c/ The overlapping areas between the collection line corridor buffer and the access road corridor buffer were removed from impact calculation. Approximately 35.3 miles of collection lines were used to calculate impacts. The impacts also include approximately 19.2 miles of collection lines not co-located with access roads.

d/ Acreage based on information provided by Thunder Spirit. Estimated temporary disturbance for the O&M facility is between 4-7 acres.

e/ Thunder Spirit will attempt to construct substation near the O&M Facility. Estimated temporary disturbance for the Substation is between 3-6 acres.

f/ There will be up to two laydown areas (up to 5-10 acres each). One laydown area will be located near the O&M/Substation area. The locations and sizes will be determined early in the engineering and project management review of the project.

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2. NEED FOR FACILITY

2.1 Need Analysis

Due partly to high heating demand in winter, North Dakota's per capita energy consumption is among the highest in the nation. Nearly three-tenths of North Dakota households use electricity as their primary energy source for home heating. According to the Energy Information Administration (2012), in 2010, 82 percent of North Dakota's net electricity generation came from coal, 12 percent came from wind energy, and 6 percent from conventional hydroelectric power sources. Most of the coal used for power generation is supplied by several large surface mines in the central part of the state. Energy sources such as coal are finite and their combustion has environmental consequences.

In March 2007, North Dakota enacted legislation (H.B. 1506) adopting a voluntary renewable portfolio objective that aims to have ten (10) percent of electricity generated from renewable sources by 2015. North Dakota has abundant wind resources, and ranked sixth in the nation in wind energy potential and installed capacity in 2009 (EIA 2012). In 2010, North Dakota ranked second in the nation in terms of percentage of electricity derived from wind, and ranked ninth in total installed wind energy capacity at almost 2,000 MW (AWEA 2011).

According to a March 2009 report prepared by the EmPower ND Commission, one of the state energy goals is to increase installed wind energy capacity to 5,000 MW by 2025 (EmPower ND 2009). North Dakota's goals include the following:

- general economic development,
- new wind project investments and construction,
- new landowner income, and
- new long-term jobs from broad professional services (such as wind project design, wind resource monitoring, legal and accounting services), from commercial project Operations and Maintenance (O&M), and from the manufacturing of wind turbine components.

In support of this effort, Thunder Spirit is cooperating with regional utilities to add wind generation to their energy portfolios.

North Dakota has been identified as having more available wind for development than almost any other state (AWEA 2011). In recent years, the Mid-Continent Area Power Pool (MAPP) has consistently reinforced the regional need for increased generating capacity in the coming decade. Cost fluctuations and reliability problems serve to reinforce the need for sufficient capacity, low-cost energy, and diverse generation sources. Independent power producers such as Thunder Spirit are widely recognized as essential to meeting regional energy needs, stabilizing energy costs, and enhancing energy reliability. The Project offers North Dakota and the MAPP region the opportunity to add to capacity, to stabilize wholesale power prices, and to provide electricity from a clean, cost-effective renewable energy generation facility.

There is a future need for additional energy production in the MAPP region. The July 1, 2003, MAPP Load and Capability Report stated that, under the minimum reserve requirements, deficits were expected as soon as 2006. MAPP members were urged to build additional capacity in order to

maintain reserve levels higher than the MAPP minimum. The most recent MAPP report available (2009) indicates that deficits are now expected by 2017 (**Table 7**), suggesting that MAPP members answered the call and additional capacity was added in recent years.

Table 7. MAPP (US) Summer Season Surplus/Deficit

Year	MW
2008	2,377.3
2009	1,522.2
2010	1,044.8
2011	939.5
2012	785.7
2013	502.8
2014	657.8
2015	524.4
2016	227.5
2017	-19.3
2018	-367.3

Source: Page III-5 of the MAPP 2009 Load and Capability Report (MAPP, 2009).

North Dakota has a unique opportunity to begin providing capacity to meet those forecasted deficits with clean, efficient, renewable energy. Once completed, the Project will be a significant source of energy for meeting the region's needs over the next 20-30 years.

2.2 Alternatives

Feasible technology alternatives to wind include electricity generation using coal, natural gas, or biomass. None of these alternatives were considered because these technologies do not meet the state's goal of adding new wind energy.

2.3 Ten Year Plan

In accordance with NDCC Section 49-22, Thunder Spirit will file its first Ten-Year Plan with the PSC and the Adams County auditor by July 2013.

3. SITE SELECTION CRITERIA

Thunder Spirit is evaluating the proposed Project Area to determine the best locations for a 150-MW wind energy project. Siting turbines is a process through which input from several different entities is considered. The Project Area was singled out as an optimal site from environmental, wind resource, transmission, and economic perspectives.

Thunder Spirit has secured voluntary wind easement agreements with landowners and identified preliminary turbine locations based on site inspection, topographic maps, known environmentally sensitive areas, review of North Dakota's energy facility siting exclusion and avoidance areas, review of Adams County and state wind siting requirements, and communications with Local, State, and Federal agencies. Through this process, Thunder Spirit will not only address environmental issues that commonly arise during project development, but will also work within the parameters of State rules. North Dakota has several site selection criteria that are considered by the PSC to determine suitability of the site. Thunder Spirit has reviewed the criteria in Chapter 69-06-08 and has considered these criteria in Project design. These criteria are discussed in this section.

3.1 Flexibility in Siting

Thunder Spirit seeks a Certificate of Site Compatibility (Certificate) for the Project Area, not the specific turbine locations (**Figure 1-3)**. Thunder Spirit suggests that the Certificate define the Project Area, number of turbines, and structures related to wind generation to be located within the Project Area. Within the permitted Project Area, Thunder Spirit proposes to locate turbines and other structures related to wind generation subject to required setbacks from environmentally sensitive areas, roads, residences, or other setbacks described in the permit.

Once the PSC issues the Certificate, Thunder Spirit will complete any additional studies required by the Certificate or Thunder Spirit's siting process. Thunder Spirit will also further evaluate the Project Area based on efficient construction of the Project. In addition, Thunder Spirit will seek further input from landowners regarding the location of wind turbines and associated facilities. Once these additional studies and communications are completed, preliminary turbine locations will be re-evaluated for their appropriateness with the Certificate conditions and buffers. A final site plan for the Project will be submitted to the PSC prior to construction and a pre-construction meeting will be held with PSC staff to ensure that the site plan conforms to the Certificate requirements.

3.2 PSC Siting Criteria

3.2.1 Exclusion Areas

In accordance with NDAC Section 69-06-08-01-1, the geographical areas listed in **Table 8** shall be excluded in the consideration of a site for an energy conversion facility. The area of exclusion shall include a buffer zone of a reasonable width to protect the integrity of the area. Exclusion areas are mapped for the Project Area on **Figure 5**.

Table 8. Exclusion Areas

Exclusion Area	Present within Project Area?	Description	Section Addressed
Designated or registered national areas: parks; memorial parks; historic sites and landmarks; natural landmarks; historic districts; monuments; wilderness areas; wildlife areas; wild, scenic, or recreational rivers; wildlife refuges; and grasslands.	Present	Of these exclusion areas, only native prairie (grasslands) are present within the Project Area; however, native prairie as mapped during field surveys represents 30 percent of the WEFP. These are not considered exclusion areas. They are considered avoidance areas.	5.3, 5.7, 5.9, 5.13, 5.14, 5.15, Figures 5 and 10
Designated or registered state areas: parks; forests; forest management lands; historic sites; monuments; historical markers; archaeological sites; grasslands; wild, scenic, or recreational rivers; game refuges; game management areas; management areas; and nature preserves.	Present	Cultural sites that are potentially eligible for the historic register will be avoided.	5.7, 5.8, 5.9, 5.15, 5.17, Figures 5 and 10
County parks and recreational areas; municipal parks; parks owned or administered by other governmental subdivisions; hardwood draws; and enrolled woodlands.	None	N/A	5.8
Prime farmland and unique farmland, as defined by the land inventory and monitoring division of the soil conservation service, United States department of agriculture, in 7 C.F.R. part 657; provided, however, that if the Commission finds that the prime farmland and unique farmland that will be removed from use for the life of the facility is of such small acreage as to be of negligible impact on agricultural productions, such exclusion shall not apply.	Present	Prime farmland has been avoided to the extent practical. Permanent impacts to prime farmland soils from turbine placement and access roads are expected to be up to 3 acres, which is a negligible percentage of the Project Area.	5.9, 5.10, Figure 14
Irrigated land	None	No agricultural irrigation is currently known to take place within the Project Area.	5.3
Areas critical to threatened or endangered animal or plant species	None	N/A	5.16
Areas where animal or plant species that are unique or rare to this state would be irreversibly damaged.	None	N/A	5.13, 5.14, 5.15, 5.16

3.2.2 Avoidance Areas

In accordance with NDAC Section 69-06-08-01-2, the geographical areas listed in **Table 9** shall not be approved as a site for an energy conversion facility unless the applicant shows that, under the circumstances, there is no reasonable alternative. In determining whether an avoidance area should be designated for a facility, the PSC may consider, among other things: the proposed management of adverse impacts; the orderly siting of facilities; system reliability and integrity; the efficient use of resources; and alternative sites. Avoidance areas are also mapped for the Project Area on **Figure 5**.

Table 9. Avoidance Areas

Avoidance Areas	Present within Project Area?	Description and Proposed Buffer	Section Addressed
Historical resources which are not designated as exclusion areas	Present	A Class III cultural resources survey was completed for the Project. Sites with potential cultural significance will be avoided. A Class II Architectural survey was also conducted and a determination of No Historic Properties Affected was determined.	5.7
Areas within the city limits of a city or the boundaries of a military installation	None	N/A	5.3, Figures 1-3
Areas within known floodplains as defined by the geographical boundaries of the 100-year flood	None	The Project Area is located in Flood Hazard Zone D: Areas in which flood hazards are undetermined, but possible.	5.12
Areas that are geologically unstable	Present	Abandoned coal mines are present in and near the Project Area. Subsidence hazards related to the potential presence of abandoned underground coal mines will be mitigated through field studies and geotechnical analyses and subsequent micrositing.	5.11
Wetlands	Present	Permanent impacts to wetlands will be avoided.	5.12, 5.13, Figures 5 and 16
Woodlands	None	The Project has 15.3 acres of deciduous forest mostly comprised of windbreaks around farming facilities.	5.14, Figure 13
Native Prairie	Present	The Project Area has 4,527 acres (30% of the WEFP) of native prairie that may provide habitat suitable for sensitive species such as eagles, sharp tailed grouse, and Sprague's pipit.	5.15, 5.16, Figure 13
Areas of recreational significance which are not designated as exclusion areas	None	N/A	5.8
Areas critical to threatened or endangered animal or plant species which are not designated as exclusion areas	Present	During lek surveys, five sharp tailed grouse leks were identified. Thunder Spirit has included a 0.5 mile setback buffer for the sharp tailed grouse leks to limit surface activities during construction so as to not disturb the grouse. An active golden eagle nest was discovered adjacent to the Project Area in May 2013 during a follow-up survey for eagle/raptor nests. While information is gathered to better inform the Project about the potential use of the Project Area by these eagles, a minimum setback of 2 miles has been established between the nest and the closest turbine.	5.13, 5.14, 5.15, 5.16

3.2.3 Selection Criteria

In accordance with NDAC Section 69-06-08-01-3, a site shall be approved in an area only when it is demonstrated to the PSC by the applicant that any significant adverse effects resulting from the location, construction, and operation of the facility in that area, as they relate to the criteria listed in **Table 10**, will be at an acceptable minimum, or that those effects will be managed and maintained at an acceptable minimum.

Table 10. Selection Criteria

Selection Criteria	Potential Adverse Effects	Section Addressed
The impact upon agriculture:		
Agricultural production	Approximately 92 acres of land will be affected by 85 turbines (up to 75 turbines will be constructed), associated access roads, O&M facility, and a substation during operation. Additional temporary impacts during construction for turbine installation, road construction, cable trenching, and laydown and contractor staging would be approximately 347 acres. These impacts represent a minor portion of the land area within the Project Area that is available for agricultural production. As a result, no adverse effects are expected.	5.3, 5.9, 5.10
Family farms and ranches	The Project will comply with local setbacks for non-participating landowners. Easement agreements and waivers of participating landowners contain language that stipulates landowners acquiescence to setback requirements. Although some land area will be permanently converted to wind turbine foundations and pads, access roads, and a substation, wind lease payments to farmers will provide a compensatory source of income.	3.3, Figure 18
Land which the owner demonstrates has soil, topography, drainage, and an available water supply that cause the land to be economically suitable for irrigation	Participating landowners have not expressed concerns related to economically suitable irrigation on their land. No agricultural irrigation is currently known to occur within the Project Area. No adverse effects are expected.	5.3, 5.9, 5.10, Figures 14 and 15
Surface drainage patterns and ground water flow patterns	No adverse effects are expected.	5.11, 5.12, 5.13, Figure 16
The agricultural quality of the cropland	No impacts to the agricultural quality of the cropland are anticipated (except for areas converted to wind energy facility use). Thunder Spirit will work with the landowners to alleviate the compaction of any soils which occurs during construction,	5.9, 5.10
The impact upon the availability and adequacy of:		
Law enforcement	No adverse effects are expected.	5.4
School systems and education programs	No adverse effects are expected.	5.4
Governmental services and facilities	No adverse effects are expected.	5.4
General and mental health care facilities	No adverse effects are expected.	5.4
Recreational programs and facilities	No adverse effects are expected.	5.4
Transportation facilities and networks	During construction, an increase in vehicle trips per day is anticipated for the duration of the Project construction. During facility operation, no significant impacts are anticipated.	5.4, Figure 11

Selection Criteria	Potential Adverse Effects	Section Addressed
Retail service facilities	Local services such as motels, restaurants, and convenience stores are likely to experience an increase in business during Project construction. During facility operation, no significant impacts are anticipated.	5.2.2
Utility services	No significant impacts are anticipated. Thunder Spirit will purchase station service from both MDU (to satisfy power requirements at the turbines and substation) and from Slope Electric (for requirements at O&M offices). Utilities will suggest appropriate configurations for the electrical system, and Thunder Spirit will abide by the recommendations to prevent impacts to the transmission system.	5.4
The impact upon:		
Local institutions	No impacts are anticipated.	5.4
Noise sensitive land uses	The only noise sensitive land uses within the Project Area are the residences near turbine locations. Based on the results of the sound analysis, two exceedances occurred at residences both identified as abandoned (Receptor 67 which is owned by a participating landowner and Receptor 183, which is an abandoned house with no running water or electricity and hasn't been lived in for over 50 years). The third (Receptor 28) is a participating landowner and the structure is not occupied full time.	5.6
Rural residences and businesses	The Project will comply with local setbacks. No significant impacts are anticipated.	5.2, 5.3, 5.10, Figure 5
Aquifers	No adverse effects are expected.	5.11
The impact upon:		
Human health and safety	No impacts to human health and safety are anticipated based on the implementation of the mitigative measures discussed in Section 5.5.3 and maintenance schedules.	5.5
Animal health and safety	No impacts to livestock are anticipated from construction or operation of the facility. Based on avian and bat surveys performed to date, mean avian raptor and non-raptor and bat use was generally low to low-moderate compared to other wind facilities. Thunder Spirit will implement measures to avoid and minimize impacts to wildlife by siting facilities away from active raptor nests and wetlands to the extent practicable. There will be no permanent impacts to wetlands, reducing impacts to migratory birds. In addition, Thunder Spirit will implement a minimum of one year of post-construction mortality monitoring for birds and bats.	5.9, 5.15, 5.16, Appendix A
Plant life	The Project will result in approximately 176 acres of permanent impact. Project layout would permanently impact 27 acres of native grasslands.	5.9, 5.14, Figure 13
Temporary and permanent housing	No adverse impacts are anticipated. Temporary housing will be utilized during construction.	5.2
Temporary and permanent skilled and unskilled labor	No adverse impacts are anticipated. Local contractors employed for construction will result in increased wages.	5.2
The cumulative effect of the location of the facility in relation to existing and planned facilities and other industrial development	Wind energy development is anticipated to have a positive cumulative impact on air quality and minimal impacts to geology, soils, water, noise, safety and health issues, and cultural resources. Socioeconomic impacts are anticipated to be positive, as the rural economy and energy production is diversified. Wind energy development removes less total land from agricultural use than other forms of development.	8.11

3.2.4 Policy Criteria

In accordance with NDAC Section 69-06-08-01-4, the PSC may give preference to an applicant that will maximize benefits that result from the adoption of the policies and practices listed in **Table 11**, and in a proper case may require the adoption of such policies and practices.

Table 11. Policy Criteria

Policy Criteria	Suitable Policy or Practice of Applicant	Section Addressed
Recycling of the conversion byproducts and effluents	Not applicable. The Project would not create byproducts or effluent.	N/A
Energy conservation through location, process, and design	Thunder Spirit is developing the site to maximize energy output and will develop a site layout that optimizes wind resources while minimizing the impact on land resources and any potentially sensitive areas.	3.7, 4, 8.2
Training and utilization of available labor in this state for the general and specialized skills required	Thunder Spirit will use local labor to the extent practicable.	5.2
Use of a primary energy source or raw material located within the state	The energy generated at the site will utilize the wind resources of the State of North Dakota.	2.1
Non-relocation of residents	No residents will be relocated as a result of the Project.	5.2, 5.3, 5.4
The dedication of an area adjacent to the facility to land uses such as recreation, agriculture, or wildlife management	The Project will not interfere with adjacent land uses. As such, it is not anticipated that areas adjacent will be dedicated to recreation, agriculture, or wildlife management issues.	5.3, 5.8, 5.9, 5.15, Figures 5 and 10
Economies of construction and operation	Thunder Spirit will utilize local contractors to the extent practicable.	5.2
Secondary uses of appropriate associated facilities for recreation and enhancement of wildlife	None.	N/A
Use of citizen coordinating committees	Thunder Spirit will continue to work with landowners of properties for the Project.	5.3, 5.5, 5.9
A commitment of a portion of the energy produced for use in this state	Energy produced will be injected into the MDU 230 kV line at the Hettinger Substation.	3.6, 4.2
Labor relations	No labor relations will be affected.	5.2
The coordination of facilities	Existing facilities and facility corridors were considered in the location of the wind farm and associated facilities.	3.0
Monitoring of impacts	Thunder Spirit and the EPC contractor will employ best management practices (BMPs) during construction to monitor soil impacts and to segregate topsoil. Storm water prevention plans will be prepared for all disturbance sites exceeding size threshold. Environmental monitors will be onsite during construction to ensure there will be no impacts to wetlands and documented archeological sites that require avoidance.	5.5.3, 5.15, 5.16, 5.17

3.3 County Criteria

The Adams County Zoning Ordinance regulates the development of wind energy facilities within the county. **Table 12** lists these zoning criteria setbacks, which were utilized in designing the Project layout. (See **Figure 18**)

Table 12. Adams County Zoning Ordinance Setback Distances for Wind Turbines

Ordinance	Setback Type	Setback Distance
3.8	Section lines	150 feet from section line
6.11.6(b)	Public roadways and overhead transmission/utility lines	200 feet from center of right-of-way
6.11.6(b)	Occupied residences, commercial building or publicly-used structure/facility	0.5 mile buffer (2,640 feet)
6.11.6(b)	Wind Energy Facility Perimeter (buffer for non-participating landowners)	2.5 times the rotor diameter*
Source: Adams County, North Dakota Zoning Ordinance The Project will comply with local setbacks for non-participating landowners. Easement agreements and waivers of participating landowners contain language that stipulates landowners acquiescence to setback requirements. *Using the largest turbine (Acciona), this calculates to 951 feet.		

3.4 Land Rights and Easements

Thunder Spirit is securing easements in both Duck Creek and Holt Townships for the proposed 150-MW Project. The ability to obtain easements from landowners will have a direct impact on the project layout. Thunder Spirit will obtain easements for the proposed wind farm and all associated facilities. Easement agreements and waivers, as necessary, from participating landowners will be obtained.

3.5 Design and Construction Limitations

In general, there are two (2) design and construction limitations when building any wind farm: wind resources and landowner easements. The wind resource is essential to selecting and designing a wind farm. Thunder Spirit has conducted an analysis of the proposed Project Area to ensure that the site has ample wind energy to generate revenue for the wind farm. Easements allowing construction of turbine towers and transmission facilities are also critical to the Project. Thunder Spirit is securing voluntary land agreements with landowners necessary to develop the Project.

As shown on **Figure 5**, there are no federal lands such as U.S. Fish and Wildlife Service (USFWS)-administered Waterfowl Production Areas (WPA) or wetland and grassland easements within the Project Area. Due to the proximity to previous underground mining operations within and adjacent to the Project Area, sinkholes are a potential geologic hazard within the Project Area. One known abandoned underground coal mine is located within the Project Area in the northeast quarter of Section 25, T130N, R96W (see **Section 5.11**, and **Appendix B**). Subsidence hazards related to the potential presence of abandoned underground coal mines will be mitigated by thorough field studies, geotechnical analyses and subsequent micrositing.

3.6 Economic Considerations

Economics were considered when selecting a location for the Project. As discussed above, it is important to select a site with a wind resource capable of generating an economically sustainable amount of energy. The proposed Project Area takes advantage of the wind resource in the area. Information on the wind resource at the site is discussed in **Sections 2.1 and 4.0**.

One of the most important economic considerations related to the Project is the need to qualify for the Federal production tax credit (PTC). The PTC is an income tax credit of 2.2 cents/kilowatt-hour allowed for the production of electricity from utility-scale wind turbines. This incentive was created under the Energy Policy Act of 1992. Congress renewed the PTC as part of the American Taxpayer Relief Act on January 1, 2013 for wind energy projects that begin construction prior to January 1, 2014 (AWEA 2013). Early approval of a Certificate is not only consistent with circumstances unique to wind project siting, but it is also essential to timing, given the uncertainty and limited duration of the Federal PTC available for wind project development.

Another economic factor considered is the availability of a transmission system in the vicinity of the Project, including permission to interconnect to that system. If no transmission system is present, the cost of interconnection increases due to the need of constructing a lengthy transmission line and large substation to an existing electricity service provider. Power generated from the Project will be delivered from the Project collection substation located in the southeast corner of Section 31, Township 130 North, Range 95 West and distributed via a new radial line (less than a mile in length) within the Project Area to the existing MDU Hettinger 230kV Substation located in Section 31 of Township 130N, Range 95W.

3.7 Wind Characteristics in Project Area

Thunder Spirit utilized wind data from meteorological towers in the Project Area to determine the wind characteristics of the Project Area. Thunder Spirit has secured information from other long-term references to aid in correlating the wind data on-site, including 40-year re-analysis data processed by WindLogics. WindPRO and WAsP software were used to analyze the available wind data and to make corrections for site effects (topography, surface roughness, and obstacles) to produce a site independent characterization of the local wind climate. The resulting local wind climate was applied in conjunction with the Project Area effects to predict the spatial wind variations in the Project Area. Various site layouts and wind turbine generator parameters can be tested to predict energy production and array efficiency in order to optimize the site layout and turbine selection. Project site data have been compared to regional wind measurements using a parallel time period. There is good correlation between the long-term wind measurements and the short-term Project-specific wind measurements.

4. DESCRIPTION OF THE PROPOSED FACILITY

Thunder Spirit will develop a wind farm layout that optimizes wind resource while minimizing the impact on land resources and any potentially sensitive areas. Wind-powered electric generation is entirely dependent on the availability of the wind resource at a specific location. The energy available from the wind increases at the third power of the wind speed. In other words, a doubling of the wind speed will increase the available energy by a factor of eight (8) times. Analysis of wind direction data suggests that the optimal turbine string alignments within the Project Area are generally from southwest to northeast (i.e., to capture predominate northwest winds with minimal turbulence losses).

This section provides a description of the Project, which includes a description of the turbines, electrical system, and associated facilities. Additional Project components addressed in this section are construction, schedule, operation, and decommissioning of the site. Design of the turbine array and collection system will minimize energy loss due to wind turbine wakes and turbulence, and electrical line losses.

4.1 Project Layout and Associated Facilities

Electricity will be generated by arrays of turbines as described in Section 4.2. The final layout of the turbines will be determined based on the turbine model chosen and the results of remaining surveys. Turbines will be arranged in lines or "strings" generally oriented southwest to northeast with variations from this overall pattern being mainly attributable to topography, land control, and/or avoidance of sensitive areas. Turbines will be accessible via all-weather, aggregate-surfaced roads between 16 and 36 feet in width which will connect with public roads.

Power from each turbine is collected using a system of underground power collection lines running from the individual transformers to a Project substation inside the Project Area (**Figure 7**). Both power collection lines and communication cables will be direct-buried on private property or public right-of-way, generally adjacent to the Project access roads or public roads. **Figure 7** is a diagram of the path of energy from the wind farm to energy users and **Figure 8** shows a typical wind farm facility layout.

The Project will also include an Operation and Maintenance (O&M) facility as described below, and two permanent meteorological towers.

4.1.1 Turbine

As discussed in **Section 1.2.2**, Thunder Spirit is currently considering three turbine models for the Project. Thunder Spirit reserves the right to select the most appropriate technology for the Project at the time of construction to ensure optimization of wind and land resources and cost efficiency.

The Project will consist of either 75 x 2-MW turbines, 65 x 2.3-MW turbines, or 50 x 3.0-MW turbines, depending on the model that is ultimately selected in order to fill the 150 MW generation capacity. **Table 13** and **Appendix C** summarize the specifications for the three turbine models.

Turbines will have a hub height range of 80-92 meters and a rotor diameter range of 100-116 meters (**Figure 6**).

Table 13. Specifications for Potential Project Turbines

	Vestas V100 2.0	Siemens SWT-2.3-108	Acciona AW-116/3000
Rated Power	2.0 MW	2.3 MW	3.0 MW
Rotor Diameter	100 m	108 m	116 m
Rotor Swept Area	7,854 m^2	9,144 m^2	10,568 m^2
Blade length	49 m	52.6 m	56.7 m
Hub height	80 m	80 m	92 m
Rotor Speed	9.3 to 16.6 rpm	6 to 16 rpm	12.3 rpm (nominal)
Cut-in Speed	3 m/s	3 to 4 m/s	3 m/s
Rated Wind Speed	12 m/s	11 to 12 m/s	11.7 m/s
Cut-out speed	20 m/s	25 m/s	20 m/s

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.

Tower

The towers are conical tubular steel with a hub height of between 80 meters (262 feet) and 92 meters (302 feet) (**Figure 6**). The turbine towers, on which the nacelle is mounted, consist of three to four sections manufactured from certified steel plates. All welds are made by automatically controlled power welding machines and ultrasonically inspected during manufacturing per American National Standards Institute (ANSI) specifications. All surfaces are sandblasted and multi-layer coated for protection against corrosion. Access to the turbine is through a lockable steel door at the base of the tower.

Lightning Protection

Each turbine is grounded and shielded to protect against lightning. The grounding system will be installed during foundation work, and must be designed for local soil conditions. The resistance to neutral earth must be in accordance with local utility or code requirements. Lightning receptors are placed in each rotor blade and in the tower. The electrical components are also protected.

4.1.2 Access Roads

Land will be graded on-site for the turbine pads. Private turbine access roads will be built adjacent to the towers, allowing access to the turbines during and after construction. These roads will be 16 to 36 feet wide and will have an aggregate surface as cover, and will be adequate to support the size and weight of maintenance vehicles. The specific turbine placement will determine the amount of private roadway that will be constructed for the Project.

4.1.3 Electrical and Communication Systems

Communication Cables

The Project will have Supervisory Control and Data Acquisitions (SCADA) communication technology to allow control and monitoring of the wind farm. The SCADA communications system permits automatic, independent operation and remote supervision, thus allowing the simultaneous control of many wind turbines. The computerized data network will provide detailed operating and performance information for each wind turbine. Thunder Spirit will maintain a computer program and database for tracking each wind turbine's operational history.

Each turbine is equipped with a wind speed and direction sensor that communicates to the turbine's control system when sufficient winds are present for operation. Turbines feature variable-speed control and independent blade pitch to assure aerodynamic efficiency.

Collection Lines

At the base of each turbine, a step-up transformer will be installed to raise the voltage to the power collection line voltage of 34.5 kV. The power from these transformers will be run through an underground collection system consisting of various sized direct-buried cables that are generally located alongside the Project access roads. At the point where the access and public roads meet, the collection system will continue as underground lines. Eventually, all the collection system cables will terminate at an on-site collector substation, which raises the Project voltage to 230 kV and provides the necessary protection and control for interconnection to the transmission grid. The Project substation will be located in the southeast corner of Section 31, Township 130 North, Range 95 West. The Project substation will be connected to the MDU Hettinger 230kV Substation (**Figure 2, 3, and 9**).

All utility protection and metering equipment will meet Thunder Spirit and National Electric Safety Code (NESC) standards for parallel operations. The construction manager will ensure that proper interconnection protection is established.

Radial Transmission Line

The Project substation will be connected to the existing MDU Hettinger 230kV Substation via approximately 0.85 miles of 230 kV overhead radial line (**Figure 9a and 9b**). The transmission line poles will be supported using 11 double pole/H-frame 80 ft Class 1 wood poles.

4.1.4 Substation

At the Project substation, power will be transformed to 230 kV for transmission to the regional power grid. The Project substation will be an open switchrack 34.5 kV collector substation that will be constructed in the southeast corner of Section 31, Township 130 North, Range 95 West (**Figures 2 and 3**). The substation will be up to seven (7) acres in size and will include a low side bank breaker, station light, and power bay. It will include one (1) 34.5/230KV, 100/125/150 MVA, OF/FA/FA transformer and one (1) 230kV circuit breaker on the high side connected to a 230kV radial transmission line.

4.1.5 Operations and Maintenance Buildings

The O&M building will be approximately 8,000 ft^2 and will include office space for several contractors; bathroom and kitchen facilities; a break room; a storage area; a garage for vehicle, turbine, and equipment maintenance; and the SCADA equipment. A fenced, graveled area for parking and storage also will be provided. The O&M building will use a newly installed groundwater well to supply water for domestic use and will discharge to an on-site septic system.

4.2 Construction

Several activities must be completed prior to the proposed commercial production date. The majority of the activity relates to equipment ordering lead-time, as well as design and construction of the facility. Below is a preliminary schedule of activities necessary to develop the Project. Pre-construction, construction, and post-construction activities for the Project include:

- Ordering of all necessary components including towers, nacelles, blades, foundations, and transformers;
- Soil borings, testing and analysis for proper foundation design and materials;
- Final turbine micrositing;
- Complete survey to microsite locations of structures and roadways;
- Complete construction of access roads, to be used for construction and maintenance;
- Construction of underground feeder lines;
- Design and construction of the Project substation;
- Installation of tower foundations;
- Installation of underground and aboveground cables;
- Tower placement and wind turbine setting;
- Acceptance testing of facility; and
- Commencement of commercial production.

During the construction phase, several types of light, medium and heavy-duty construction vehicles will travel to and from the site, as well as private vehicles used by the construction personnel. Thunder Spirit estimates that there will be approximately 50 additional trips per day in the area during peak construction periods. That volume will occur during the peak time when the majority of the road, foundation and tower assembly are taking place. At the completion of each construction phase this equipment will be removed from the site or reduced in number.

4.2.1 Construction Management

An EPC contractor will be primarily responsible for the construction management of the Project. The EPC contractor will use the services of local contractors, where possible, to assist in Project construction. The EPC contractor, in coordination with local contractors, will undertake the following activities:

- Securing building, electrical, grading, road, and utility permits;
- Performing detailed civil, structural and electrical engineering;
- Scheduling execution of construction activities;
- Completing surveying and geotechnical investigations;
- Forecasting Project labor requirements and budgeting;

- Coordinating and managing the work of all Project subcontractors;
- Providing direct supervision for the installation of all Project components including roads, foundations, towers and turbines, communication and power collection lines, the O&M facility, Project substation and all related equipment.

Construction will consist of the following general tasks:

- Site development, including roads;
- Foundation excavation;
- Concrete foundation installation;
- Electrical and communications equipment installation;
- Tower assembly and machine erection; and
- System testing.

The construction team will be on site to handle material receipt, construction, quality control, testing and start-up.

Throughout the construction phase, ongoing coordination will occur between the Project development team and the construction teams. The on-site Project construction manager will help to coordinate all aspects of the Project, including ongoing communication with local officials, citizens groups and landowners. Even before the Project becomes fully operational, the O&M staff will be integrated into the construction phase of the Project. The construction manager and the O&M staff manager will work together continuously to ensure a smooth transition from construction through wind farm commissioning and, finally, operations.

4.2.2 Foundation Design

The wind turbines' freestanding tubular towers will be connected by anchor bolts to a concrete foundation. Geotechnical surveys, turbine tower load specifications and cost considerations will dictate final design parameters of the foundations.

The quantities described below are approximate and will be finalized after completion of geotechnical investigations and detailed design engineering. A typical spread foundation for the Siemens 2.3 MW turbine, 80 m hub height and 108 meter rotor diameter is 62 feet wide, and consists of 490 cubic yards of concrete and 50.5 tons of rebar. A Vestas turbine foundation is approximately 56 feet wide and consists of 365 cubic yards of concrete and 37 tons of rebar. Information is not available for the Acciona 3MW foundation but its size and design will be comparable to those of the Siemens and Vestas foundations. The final wind turbine foundation design will be prepared by a registered professional engineer licensed to practice in the State of North Dakota.

4.2.3 Civil Works

Completion of the Project will require various types of civil works and physical improvements to the land. These civil works may include the following:

- Improvement of existing public access roads to the Project Area;
- Construction of roads adjacent to the wind turbine strings (turbine access roads) to allow construction and continued servicing of the wind turbines;
- Clearing and grading for wind turbine tower foundation installations;
- Installation of underground cabling for connecting the individual wind turbines;
- Installation of an on-site feeder system for connecting wind turbine strings for delivery to the electrical collection/metering location;
- Installation of any site fencing and security; and
- Restoration and re-vegetation of disturbed land when construction activities are completed.

Any improvements to existing public access roads will consist of re-grading and filling of the surface to allow access in inclement weather. No asphalt or other paving is anticipated. Turbine access roads will be constructed along turbine strings or arrays. These roads will be sited in consultation with local landowners and completed in accordance with local building requirements where these roads intersect with public roads. They will be located to facilitate both construction (cranes) and continued operation and maintenance. Siting roads in areas with unstable soil will be avoided wherever possible. All roads will include appropriate drainage and culverts while still allowing for the crossing of farm equipment. The roads will be 16 to 36 feet wide and will be covered with road base designed to allow passage during inclement weather conditions. The roads will consist of graded dirt and will be covered with an aggregate surface. Once construction is completed, the roads will be regraded, filled, and dressed as needed.

4.2.4 Commissioning

The Project will be commissioned after completion of the construction phase. The Project will undergo detailed inspection and testing procedures prior to final turbine commissioning. Inspection and testing will occur for each component of the wind turbines, as well as the communication system, meteorological system, obstruction lighting, high voltage collection and feeder system, and the SCADA system.

4.3 Operation and Maintenance

After construction is complete, on-site personnel will operate and maintain all components of the Project, including the substation.

4.3.1 Wind Turbine Generators

Routine maintenance of the wind turbines will be necessary to maximize performance and detect potential malfunctions. O&M procedures will be established that define specific routine turbine maintenance and inspection activities in accordance with the turbine manufacturer's recommendations. Scheduled maintenance will be performed approximately every 12 months on each turbine. On average, each turbine will require 40 to 50 hours of scheduled mechanical and electrical maintenance per year. O&M personnel will perform routine maintenance, including periodically replacing lubricating fluids, checking parts for wear, generator alignments, visual

inspection, and recording operating parameters. All roads, pads, and trenched areas will be inspected regularly and maintained to minimize erosion. The O&M staff will perform most repairs with the assistance of contracted personnel, as needed.

Each turbine will be monitored continuously by a SCADA system that communicates major aspects of operation through communication lines to the O&M staff and a 7-day-per-week, 24-hour-per-day facility. Alarm systems will be triggered if operational characteristics fall outside set limits. Each turbine has an automatic braking system to stop the blades in the event of malfunction or excessive wind speed, including a battery back-up in case a turbine is disconnected from the grid. Any problems will be reported promptly to on-site O&M personnel for correction.

4.3.2 Electric Collection Line and Communication Cables

Periodic maintenance of underground (or overhead, if necessary) collection lines and communication cable will be required during the life of the Project. Maintenance activities will be conducted pursuant to prudent utility practices. Maintenance disturbance associated with all buried lines will typically be limited to an approximate 25- to 50-ft-wide construction corridor associated with each proposed linear disturbance. All electrical terminations will occur above ground in appropriate weather-tight electrical enclosures to facilitate ease of maintenance. Underground collection lines are relatively maintenance free, but maintenance will be performed as needed.

4.3.3 Transformers and Substations

Substations, large step-up transformers, and pad-mounted transformers will be maintained as part of normal O&M activities and will be accessed from the private site roads. In the event of transformer or other device failure, replacement of this equipment could be accomplished from the access roads.

4.3.4 Operations and Maintenance

Operations, maintenance and service for the Project will be structured so as to provide for timely and efficient operations.

4.4 Decommissioning and Restoration

Thunder Spirit will develop a Decommissioning Plan in accordance with NDCC 49-02-27 and NDAC 69-09-09. Additionally, Thunder Spirit has a contractual obligation to the landowners to remove the wind facilities, including foundations to a depth of forty-two (42) inches, when the wind easement expires. Thunder Spirit also reserves the right to explore alternatives regarding Project decommissioning at the end of the Project Certificate term. Retrofitting the turbines and power system with upgrades based on new technology may allow the wind farm to produce efficiently and successfully for many more years. Based on estimated costs of decommissioning and the salvage value of decommissioned equipment, the salvage value of the wind farm is expected to exceed the cost of decommissioning.

5. ENVIRONMENTAL ANALYSIS

This section provides a description of the environmental conditions that exist within the Project Area. Consistent with the North Dakota Energy Conversion and Transmission Facility Siting Act, exclusion and avoidance criteria, as well as selection and policy criteria, were considered in the selection and design of the site. To support this siting process, maps of the Project Area were generated that indicate the presence or absence of many of the criteria highlighted in NDCC 69-06-08 (**Figure 5**).

The Project Area boundary encompasses an area of 26,867 acres (42 square miles). However, the land occupied by turbines and other wind farm infrastructure during operation will be approximately 0.7% percent of this area, depending on the number of turbines included in the Project design. It is anticipated that the area of direct land use during operation will be approximately 176 acres for the turbines, aggregate-surfaced access or service roads, and a substation and O&M building. Total land disturbance for the wind farm and associated facilities is expected to be up to approximately 641 acres, including temporary disturbance due to turbine installation, road construction and collection line trenching, tie- line construction, and the laydown/construction staging area. See **Table 6 in Section 1.5** and **Section 5.0** for a detailed description of the Project Area impacts. **Figures 2-3** show proposed turbine locations, which are subject to shifts during micrositing.

5.1 Description of Environmental Setting

The Project Area is located in approximately two (2) miles northeast of Hettinger, in Adams County in southwestern North Dakota, a primarily rural agricultural area.

5.2 Demographics

5.2.1 Description of Resources

The proposed Project is located north of U.S. Highway 12 and west of North Dakota State Highway 49, approximately two (2) miles northeast of Hettinger, North Dakota. There is no indication of any new residential construction within the Project Area. Adams County had a population of 2,343 persons in 2010, a 9.6 percent decrease from the 2000 population of 2,593 individuals. The county contains approximately 988 square miles of land, with a density of approximately 2.4 persons per square mile (U.S. Census Bureau 2013). Approximately half of the county population (1,226 persons in 2010) resides in the city of Hettinger, the county seat. The population density within the rural area of the county is therefore much lower than the county average. Approximately 96 percent of the population is composed of white persons who are not of Hispanic or Latino origin. Approximately 25 percent of the county population is 65 years or older, while only 5 percent of the population is under five (5) years of age (US Census Bureau 2013).

Agriculture continues to play a significant role in the county's land use and economy. In 2007, there were 426 farms in Adams County, comprising virtually all of the land area. The median size of the farms was 640 acres. According to the 2007 Census of Agriculture (USDA 2007), total market value of agricultural products produced in Adams County was $70,542,000, of which 55 percent was from crops and 45 percent from livestock sales. The primary livestock is cattle, followed by pigs and sheep, and the principal crops include wheat and corn.

5.2.2 Impacts

Developing the state's wind energy resource has created jobs in the construction, operation, and manufacturing sectors. In addition to small manufacturers, North Dakota has two major manufacturers for the wind energy industry. In 1998, LM Glasfiber, a leading blade manufacturer, opened a facility in Grand Forks. In 2006, DMI Industries, a major tower manufacturer, opened a facility in West Fargo. The wind energy manufacturing sector in North Dakota represented over one thousand jobs as of 2011, and could grow as installations in the state grow (AWEA 2012).

The proposed Project would have positive economic impacts for the local population, including lease and royalty payments for participating landowners, employment, and property and sales tax revenue. A case study evaluated the socioeconomic impacts of a wind energy facility constructed in 2007 and 2008 in Cavalier County, northeastern North Dakota (Leistritz and Coon 2009). The study authors felt that the project area was typical of Great Plains communities where many similar wind energy projects are being constructed, therefore, this information is relevant to a consideration of the Thunder Spirit Project.

The authors found that the 159-MW project resulted in a peak workforce of 269 workers during construction, 10 permanent jobs, direct construction expenditures of $56.4 million to entities in the Langdon area and elsewhere in North Dakota, and $1.4 million in annual, direct post-construction expenditures to local businesses and households. This annual expenditure includes payments to landowners totaling $413,000 the first year, annual local property taxes to the County and school district, and direct payments for wages and materials in Cavalier County and adjacent counties. Leistritz and Coon utilized an economic model to estimate secondary expenditures, the increased local economic activity made possible by the direct project expenditures. **Table 14** summarizes the direct and secondary economic impacts from the construction and operation of the project.

Table 14. Economic Impacts of the Wind Project in Cavalier County, ND

Impact	Construction (one-time) in millions of dollars	Operation (annual) in millions of dollars
Direct	$56.4	$1.4
Secondary (indirect and induced)	$169.3	$3.0
Total	**$225.7**	**$4.4**

During construction, temporary housing in Cavalier County was full, and local service businesses (hotels, restaurants, etc.) experienced a short-term increase. An increase in traffic on local roadways during shift changes was noticeable. There was little or no impact to public services, as the majority (55%) of construction jobs were filled locally, only five percent of the construction workers brought their families and most (80%) of the long-term jobs were filled locally. There were negligible added costs to the County, school district, or state, while all received increased revenue from the project. The increase in revenue for the school district and the County were largely due to property tax payments from the project, as well as to an increase in residential and commercial property values (Leistritz and Coon 2009).

On a per-megawatt basis, the project's annual economic impacts were $8,900 in local expenditures; this included $2,600 per year in landowner payments. In addition the project paid about $2,900 per megawatt per year in property taxes. Economic impacts of direct project construction expenditures were $354,716 per megawatt.

Project-specific impacts for Thunder Spirit will vary based on the local availability of materials, services, and labor. Direct expenditures in the Hettinger area and elsewhere in North Dakota are expected to be approximately $335,000 per MW during construction and an annual average of approximately $875,000 will be paid to landowners. In addition, the Project will pay an average of approximately $650,000 per year in property taxes for the life of the Project. These figures are planning-level estimates; however it is clear that the overall economic impact of the Project would be positive.

Up to 176 acres of the total Project Area will be permanently affected due to conversion to turbine sites, access roads, and a Project substation and O&M facility. Landowner compensation for this impact will be established under individual lease agreements. In general, agricultural areas surrounding each turbine can still be farmed. In addition, in an environment of uncertain and often declining agricultural prices and yields, the supplemental income provided to landowners from wind energy leases is expected to provide stability to farm incomes and thus will help assure the continued viability of farming in the Project Area. Project construction will not cause additional impacts to leading industries within the Project Area. There is no indication that any minority or low-income population is concentrated in any one area of the Project, or that the wind turbines will be placed in an area occupied primarily by any minority group.

To the extent that local contractors are used for portions of the construction, total wages and salaries paid to contractors and workers in Adams County will contribute to the total personal income of the region. Additional personal income will be generated for residents in the county as well as the state by circulation and recirculation of dollars paid out by the applicant as business expenditures and state and local taxes. Expenditures made for equipment, energy, fuel, operating supplies and other products and services will benefit businesses in the county and the state.

It is likely that general skilled labor is available either in the county or the state to serve the basic infrastructure and site development needs of the Project. Specialized labor will be required for certain components of wind farm development. It is likely that this labor will be imported from other areas of the state or from other states, as the relatively short duration of construction does not warrant special training of local or regional labor. Balancing the use of local contractors and imported specialized contractors will likely alleviate any labor relations issues.

No effects on permanent housing are anticipated. During construction, out-of-town laborers will likely use lodging facilities in Adams County and neighboring towns such as Dickinson. Operation and maintenance of the facility will require few laborers. Sufficient permanent housing is available within the county to accommodate these laborers.

Long-term beneficial impacts to the county's tax base as a result of the construction and operation of the wind farm will contribute to improving the local economy in this area of North Dakota. The development of wind energy in this region will be important in diversifying and strengthening the

economic base of southwest North Dakota. In addition, establishing the central region of North Dakota as an important producer of renewable energy, such as wind, may spur the development of wind-related businesses in the area and in turn contribute to the economic growth in the region.

5.2.3 Mitigative Measures

Socioeconomic impacts associated with the project will be primarily positive, with an influx of wages and expenditures made at local businesses during the Project construction and an increase in the county's tax base due to construction and operation of the wind turbines and associated infrastructure. In addition, the lease payments paid to landowners will offset potential financial losses associated with removing land from agricultural production.

5.3 Land Use

5.3.1 Description of Resources

The land in Adams County within the Project Area boundary [26,867 acres (42 square miles)] is primarily agricultural with scattered farmstead residences. The Project Area is not within any city limits or within an area of any known military installation. The Project Area does not include any federal, state, or tribal lands.

Current land use within the Project Area is rural agricultural, supporting both crops and livestock grazing. **Table 15** and **Figure 13** identify current land use in the Project Area based on 2006 USGS National Land Cover Dataset (NLCD).

Table 15. Land Cover within the Project Area

2006 NLCD Land Cover Classification	Acres	Percent of Project Area
Barren Land	5.3	0.02%
Cultivated Crops	9353.0	34.78%
Deciduous Forest	15.3	0.06%
Developed, Low Intensity	15.1	0.06%
Developed, Open Space	848.7	3.16%
Grassland/Herbaceous	8433.5	31.36%
Open Water	30.7	0.11%
Pasture/Hay	8051.2	29.94%
Shrub/Scrub	68.6	0.26%
Woody Wetlands	72.7	0.27%

Source: NLCD 2006.

Native prairie is an important land use type providing habitat for many species. In 2011, Western EcoSystems Technology Inc. (WEST) conducted desktop habitat mapping of the Project area using GAP Land Data for North Dakota. In 2013, Tetra Tech conducted an additional field reconnaissance to determine the location of any wetlands and to verify the condition of the grassland habitat features with respect to native prairie. This reconnaissance included additional information on the dominant plant species, which were then used to distinguish grassland habitats that are pasture and hayfields from actual native prairie habitats.

Utilizing the information collected during the field reconnaissance along with subsequent desktop analysis, native prairie within the WEFP was further defined. In order to determine potential native prairie habitat, the 2006 NLCD data was reclassified. Due to the size of the Project Area, this reclassification was performed only on lands within the WEFP. Native prairie and native prairie /hayfields accounted for 4,527 acres within the 14,881 acre WEFP. The remaining 10,354 acres are comprised of agriculture, developed lands, pasture/hayfields, roads, trees/shrubs, and wetlands.

There are no USFWS wetlands easements or other USFWS conservation easements within or near the Project Area, according to information provided by the USFWS on April 17, 2013 (Kvas 2013). The NRCS administers a number of conservation-based programs for private landowners. The Conservation Reserve Program (CRP) conserves soil and water resources and provides wildlife habitat by removing enrolled tracts from agricultural production, generally for a period of 10 years. These tracts cannot be hayed, tilled, seeded, or otherwise disturbed without the authorization of the NRCS. Thunder Spirit will work with individual landowners to help identify potential impacts to land enrolled in CRP within their properties, and impacts to these lands will be avoided to the extent practicable.

The Project Area also includes properties that participate in the Private Land Open To Sportsmen (PLOTS) program. The North Dakota Game and Fish Department (NDGFD) administers and regulates the PLOTS program to allow hunting access on private lands through lease agreements with landowners. PLOTS allow for walk-in hunting during the legal hunting season. Activities such as horseback riding, camping, baiting, driving ATVs or snowmobiles, dog training, and many others are not regulated by the PLOTS program agreement and are not allowed without landowner permission. There are several properties within the Project Area that participate in PLOTS (**Figure 10**).

5.3.2 Impacts

The development of the Project will not result in a significant change in land use. The development of the Project will not displace any residents or existing or planned industrial facilities. Wind turbines will be sited a minimum of 2,640 feet from non-participating occupied residences. **Figure 17** shows the distances of each receptor to the closest turbine. **Appendix D** shows a table with all receptors which are located within ½ mile of a turbine. The area will retain the rural sense and remote characteristics of the vicinity.

Farming practices will not be significantly altered. At other wind developments in the upper Midwest, landowners frequently plant crops and/or graze livestock to the edge of the access roads and turbine pads. The access roads will have a low profile to allow cross-travel by farm equipment. Thunder Spirit will work closely with landowners in locating access roads to minimize land use disruptions to the extent possible. Consideration will be taken in locating access roads to minimize impact on current or future row crop agriculture and environmentally sensitive areas. During the construction of the wind power facilities, additional areas may be temporarily disturbed for contractor staging areas and underground power lines. Thunder Spirit is also seeking to obtain an easement of up to 30 acres for laydown and contractor staging areas, which will be temporarily affected during the construction phase of the Project.

While the permanent site layout has not yet been determined, it is estimated that installation of up to 75 turbines, and the associated access roads and collection substation, will result in the conversion of

up to 176 acres of land. **Table 16** shows temporary and permanent land use impacts for the April 26, 2013 layout.

Table 16. Temporary and Permanent Land Use Impacts

2006 NLCD Land Cover Classification	Temporary Impacts (Acres)	Permanent Impacts (Acres)
Barren Land	2.0	0.4
Cultivated Crops*	185.5	46.6
Deciduous Forest**	0.8	0.3
Developed, Low Intensity	0.1	0.0
Developed, Open Space	23.3	9.3
Grassland/Herbaceous**	265.2	74.5
Pasture/Hay*	161.6	45.2
Shrub/Scrub**	0.5	0.0
Woody Wetlands	2.3	0.7

Source: NLCD 2006

* These categories were used in calculating impacts for agricultural discussion.

** These categories were used in calculating impacts for vegetation discussion.

With regard to native prairie habitat, it was determined that up to 247 acres will be temporarily impacted. Only 73 acres of native prairie would be permanently impacted by the Project.

The Project is not anticipated to affect use of the land for recreational hunting purposes. Thunder Spirit will work with landowners enrolled in the CRP or participating in PLOTS, and will not restrict access to the majority of the area available for hunting on properties participating in the PLOTS program.

At other wind farms, the public has expressed concerns over potential reduction in property values in and adjacent to proposed wind projects, primarily based on visual impacts. A study published in October 2002, *"Economic Impacts of Wind Power in Kittitas County, Final Report,"* conducted by Dr. Stephen Grover of ECONorthwest of Portland, OR, summarized survey results as follows:

> "Views of wind turbines will not negatively impact property values. Based on a nationwide survey conducted of tax assessors in other areas with wind power projects, we found no evidence supporting the claim that views of wind farms decrease property values" (Grover 2002, p.2).

In 2009, the Lawrence Berkeley National Laboratory completed a study on the impact of wind power projects on residential property values in the United States (Hoen et al. 2009). The study found that neither the view of wind facilities nor the distance of homes to those facilities is found to have any consistent, measurable, and statistically significant effect on sales prices. The study consisted of a hedonic analysis of transaction data from 10 study areas surrounding 24 wind facilities in 9 states that became operational through the end of 2005. The total study sample consisted of 7,459 sales transactions that were evaluated with various models and using data subsets based on distance to turbines, timing of sale in relation to timing of wind project announcement and

construction, and view of turbines from the site. Visibility of turbines, existing amenities, and other information was also collected during field visits to the residences over the course of the 3-year study period. The analysis found that home sales prices are very sensitive to the overall quality of the scenic vista from a property, but that a view of a wind energy facility did not demonstrably impact sales prices.

The results of the study indicate that while the possibility exists that individual homes have been or could be impacted, if these impacts do exist, they are either too small and/or too infrequent to result in widespread, statistically observable impacts. The study did not find evidence of impacts to prices of sales occurring after construction of the facility for homes within a mile of the nearest wind turbine, and found some evidence that sales occurring prior to construction are affected. Notably, the study was not able to obtain information on whether turbine easement payments or neighbor agreements were in place at any of the projects in the study sample. Such mitigative measures have become more common and create a socioeconomic benefit that is not factored into these earlier study results.

A study conducted by Appraisal Group One examined the effects on property values of three wind farms in two counties in Wisconsin. The study was composed of three parts: a literature study, an opinion survey of area realtors, and sales studies comparing residential lot sales near the wind farms and comparable lots outside the wind farms. Specifically for properties 1-5 acres in size within 1,000 to 2,640 feet from wind turbines, the negative impact on property values was between 24 and 29 percent (Appraisal Group One 2009).

More recently, another hedonic study completed in July 2011 found that wind farms reduced the value of nearby real estate in two Northern New York counties, but not in a third (Heintzelman and Tuttle 2011). The authors collected data from 11,331 residential and agricultural property transactions over nine (9) years from Clinton, Franklin and Lewis counties. They found that in some of the cases in New York, nearby wind facilities significantly reduced property values. Decreasing the distance to the nearest turbine to one (1) mile results in a decline in price of between 7.73% and 14.87%. According to the report, "Overall, the results of this study are mixed as regards the effect of wind turbines on property values."

The available literature also indicates that every case is unique, and therefore it is not possible to determine with certainty if this particular proposed Project would have positive, negative, or neutral impacts on property values. Properties with wind energy developments would be expected to increase in value, due to the guaranteed revenue stream from the turbine leases. Chuck DeFoe, Tax Equalization Director and County Assessor for Adams County, stated that there are currently no operating wind energy facilities in Adams County, so the County has not yet determined exactly how these facilities will be assessed. He said that from a tax appraisal perspective, the proximity or view of a wind turbine will have no effect on the appraised value of a nearby property. The assessment of the parcels with Project facilities on them may change slightly because they may be evaluated as industrial, rather than agricultural land (DeFoe pers. comm. 2013).

5.3.3 Mitigative Measures

Operation of the wind farm will not change the land use in the majority of the Project Area. The proposed land use will not involve any ongoing industrial use of non-renewable resources or emissions into the environment. Consequently, the need for mitigative measures for impacts to land use is minimal. Nevertheless, Thunder Spirit is working closely with landowners and seeking input from local, state, and federal agencies in locating wind turbines and access roads to minimize land use disruptions and impacts to environmentally sensitive areas to the extent possible.

Areas disturbed during construction will be graded to original contour and, if necessary, reseeded with appropriate vegetation. A management plan to prevent the spread of noxious weeds during construction and ongoing operations will also be developed.

5.4 Public Services

5.4.1 Description of Resources

Local Services

The Project is located in a lightly populated, rural area in southwestern North Dakota. There is an established transportation and utility network that provides access and necessary services to the small cities, homesteads, and farms existing near the Project. The closest town to the Project is Hettinger. Hettinger provides sanitary sewer, water, utility services, educational facilities, and recreational facilities and parks to its residents and visitors. Local services also include emergency services, ambulance service, hospitals, clinics, schools, a landfill, and law enforcement. Law enforcement responsibilities are shared between Hettinger and Adams County.

Electrical Service

Electrical service is provided to the region by Montana-Dakota Utilities Co. in the City of Hettinger and Slope Electric Cooperative, Inc. (Slope Electric) in rural areas. Thunder Spirit will purchase station service from both MDU (to satisfy power requirements at the turbines and substation) and from Slope Electric (for requirements at O&M offices).

Roads

County and township (section line) roads characterize the existing roadway infrastructure in and around the Project Area. The Project Area is accessed via North Dakota State Road 8 from the east, Cemetery Rod/2nd Street NE from Hettinger, and other local two-lane paved and gravel county roads.

Traffic

Existing traffic volumes on the area's major roadways are documented in **Table 17** and **Figure 11**. Determining the specific capacity of any highway is a complex process. However, general estimates are sufficiently accurate for planning purposes. For purposes of comparison, the functional capacity of a two-lane paved rural highway is approximately 5,000 vehicles per day, or Average Annual Daily Traffic (AADT).

Additional county and township roads run through the Project Area in addition to those listed in **Table 17**, but no vehicle count data are available for them. In general, the North Dakota Department of Transportation (NDDOT) indicated that roads with vehicle counts under 100

AADT are rarely counted. According to NDDOT, vehicle counts on routes with no count data are likely lower than those with count data.

Table 17. Existing Daily Traffic Levels

Roadway Segment	Existing Average Annual Daily Traffic (AADT)/Commercial Truck Traffic
US 12 west of Hettinger	1,300/275
US 12 east of Hettinger	1,300/200
ND-8 south of Hettinger	480/70
ND-8 north of US 12	420/55

Source: 2012 Traffic Volumes (NDDOT 2012).

Water Supply

The only municipal water supply near the Project Area is that provided by the City of Hettinger. Rural areas/townships outside of the Hettinger city limits have limited public infrastructure services. Homes typically utilize septic systems and water wells for their household needs. No agricultural irrigation is currently known to take place within the Project Area.

Communications

There are two AM radio stations in the vicinity of the Project area: KNDC 1490 based in Hettinger, ND and KBJM 1400 based in Lemmon, SD. There are three FM radio stations: two (2) of the stations are translator stations that operate at low power and have limited range. The one full-power station is licensed under call sign KNDH 102.3 and is located in Hettinger, ND. (See **Appendix A**, AM and FM Radio Report)

Two (2) cable operators were located in the area of the Project, Midcontinent Communications (PSID 010394) and Consolidated Cable Vision Inc. (PSED 0211454), both with offices located in Hettinger. The two cable headend locations are 35 miles west and over 50 miles north of the Project Area. One satellite earth station, also operated by Midcontinent Communications, is located near Lemmon, approximately 13 miles southeast of the Project Area. (See **Appendix A**, Cable and Satellite Report).

Thunder Spirit evaluated the registered frequencies for the following types of first responder entities: police, fire, emergency medical services, emergency management, hospitals, public works, transportation and other state, county, and municipal agencies. Industrial and business land mobile radio (LMR) systems and commercial E911 operators within the Project Area were also assessed. A total of 17 site-based land mobile licenses were identified in or near the Project Area, of these, two (2) land mobile sites were identified within the Project Area, and the remainder within approximately 10 miles. Ten regional area-wide licenses were identified; these are held by public entities including police departments, emergency service providers, and state and county governments. Finally, seven (7) area-wide licenses were identified in Adams County which provide E911 service to cellular handsets. (See **Appendix A**, Land Mobile and Emergency Services Report)

No microwave paths intersecting the Project area were identified. (See Appendix B, Microwave Study) There are nine (9) mobile phone carriers operating in Adams County, represented by 19 callsigns and Market IDs. (See **Appendix A**, Mobile Phone Carrier Report)

TV stations at a distance of 75 kilometers or less are the most likely to provide off-air coverage to the project area and neighboring communities. There are a total of two database records for stations within approximately 75 kilometers of the Project Area. (See **Appendix A**, Off-Air TV Analysis), KDSE and KXMA-TV, both are full-power digital stations located in Dickinson.

Four tower structures were identified in the vicinity of the Project area; all four (4) are located in the City of Hettinger. (See **Appendix A**, Tower Structures Report)

Thunder Spirit submitted an inquiry to the National Telecommunications and Information Administration (NTIA) in May 2013. The NTIA forwards the Project information to various federal agencies and provides them 45 days to respond with potential concerns regarding potential impacts to federal telecommunication systems and military airspace.

5.4.2 Impacts

The Project is expected to have a minimal effect on the existing services and infrastructure. The following is a brief description of the impacts that may occur to public services during construction and operation of the Project.

Local Services

No impact is expected to local services.

Electrical Service

Thunder Spirit does not expect an impact to local or regional electric service.

Roads

Construction of the Project will require approximately 27 miles of new aggregate-surfaced access roads. During operation of the Project, the access roads will be used by operation and maintenance crews while inspecting and servicing the wind turbines. The access roads will be between towers, offset as necessary to allow for adequate crane access. One road will be required for each string of turbines. Although a 64-foot easement will be used during construction, the permanent access roads will be between 16 and 36 feet wide and low profile to allow cross-travel by farm equipment.

Impacts to existing road infrastructure will mostly be positive. Where needed, existing local roads will be improved to allow heavy construction cranes and extra-long trucks used to transport turbine blades. These improvements will remain in place following the completion of construction. Roads will be returned to pre-construction condition (if requested).

Traffic

The maximum construction workforce is expected to generate approximately 50 additional vehicle trips per day. Using any combination of state and county highways and other township roads throughout the Project Area, the traffic impacts are considered minimal, and neither the capacity of any route nor the level-of-service to the traveling public will be affected.

Truck access to the Project site will likely be provided by US-12 or ND-8. Specific additional truck routes will be dictated by delivery location. Additional operating permits will be issued by the State for over-sized truck movements.

Water Supply

Construction and operation of the Project will not significantly impact the water supply. No abandonment of existing wells will be required for the Project. The Project will not require appropriation of surface water or permanent dewatering. Temporary dewatering of groundwater may be required during construction of turbine foundations. The O&M building will use a newly installed groundwater well to supply water for domestic use and will discharge to an on-site septic system.

Communications

Telephone and fiber optic cables within the Project Area will be located in the field by the respective utility companies prior to construction and will not be negatively affected during construction.

The extent of the interference created by wind turbines on AM and FM radio and television has been gradually diminished over the past decade due to advances in turbine manufacturing and transmitter/receiver antenna design. Potential problems with AM broadcast coverage are only anticipated when AM broadcast stations with directive antennas are within 3.2 kilometers of wind turbine towers and AM broadcast stations with non-directive antennas are within 0.8 kilometers. The closest station to the Project, KNDC, is non-directive and located 3.7 kilometers from the boundary of the Project area; therefore, no impact to the coverage of AM stations should result due to the presence of the proposed turbines. The coverage of FM stations, when the stations are at distances greater than 4.0 kilometers from wind turbines, is not subject to degradation. The closest operational FM station to the proposed Project, K220FG, is a translator station located 2.5 kilometers from the boundary of the Project area. The height of the FM translator antenna above ground is 38 meters. If the planned wind turbines have a hub height of 100 meters and a blade diameter of 92 meters the blades will have a minimum height above ground level of 54 meters. This means that the wind turbine blades will be 16 meters above the FM translator's antenna and will not affect the coverage of the station. If the planned wind turbines have a hub height of 80 meters and a blade diameter of 92 meters the blades will have a minimum height above ground level of 34 meters. This would potentially obstruct the FM translator's antenna which is at 38 meters height, if the turbines are located less than 4 kilometers from the antenna.

Wind turbines may affect cable headend facilities that are receiving wireless off-air television and satellite signals. In addition, wind turbines may attenuate the signal transmitted and received in satellite uplinks and receive earth stations. However, since all of the cable and satellite sites identified near the Thunder Spirit Wind project are well outside the area of interest, no impact to their services is expected.

Communications systems for first responders, industrial/business land mobile sites, area-wide public safety, and commercial E-911 communications are typically unaffected by the presence of wind turbines and no significant harmful effect to these services in the Thunder Spirit Wind project area is anticipated. A conservative approach to avoiding impacts to land mobile fixed base stations would dictate not locating any turbines within 77.5 meters of land mobile fixed-base stations. This distance

is based on FCC interference emissions from electrical devices in the land mobile frequency bands. As long as the turbines are located more than 77.5 meters from the land mobile stations, they will meet the setback distance criteria for FCC interference emissions in the land mobile bands. As currently designed, the turbines are located beyond the recommended setback distances. The closest land mobile site is currently approximately 700 meters north of Turbine 76. Thunder Spirit will work with the two land mobile base station owners in the Project Area as needed. The telephone carrier bands are typically unaffected by the presence of wind turbines and no significant harmful effects are anticipates.

In the unlikely event that a land mobile licensee or mobile phone carrier believes their coverage has been compromised by the presence of the wind energy facility, they have many options to improve their signal coverage to the area through optimization of a nearby base station or even adding a repeater site. Utility towers, meteorological towers, or even the turbine towers within the Project area can serve as the platform for a land mobile base station or mobile phone repeater site.

Wind turbines can interfere with microwave paths by physically blocking the line-of-sight between two microwave transmitters. Because no microwave paths were identified that intersect the Project area, there are no potential obstructions.

The two full-power digital TV stations may have their reception disrupted in and around the Thunder Spirit Wind project area, primarily in locations on the opposite side of the Project Area, relative to the station antennas. Communities and homes directly to the south and east of the Project may have degraded reception of stations KDSE and KXMA-TV, which broadcast from northwest of the project area, after the wind turbines are installed. However, based on the low number of full-power TV channels available in the immediate vicinity of the Project Area, it is unlikely that off-air television stations are the primary mode of television service for the local communities. TV cable service, where available, and direct broadcast satellite service (DBS) are more likely the dominant modes of service delivery. Cable service and direct broadcast satellite service (DBS) should be unaffected by the presence of the wind turbine facility and may be offered to those residents who can show that their off-air TV reception has been disrupted by the presence of the wind turbines after they are installed.

No impacts are anticipated to the four towers identified, all of which are outside the Project Area.

5.4.3 Mitigative Measures

Construction and operation of the Project will be in accordance with all associated local, state, and federal permits and laws, as well as industry construction and operation standards. Because impacts to existing public services are expected to be minor during both Project construction and operation, extensive mitigative measures will not be required.

Local Services

With the addition of substation and transmission capacity, no impact to local services is anticipated, and no mitigation will be required.

Electrical Service

Thunder Spirit will work with MDU to prevent impacts to the transmission system. The Project layout meets the County setback requirement of 200 feet from existing transmission lines. No additional mitigation will be required.

Roads

Thunder Spirit is working closely with the landowners to locate access roads in order to minimize land use disruptions to the extent possible. The preliminary layout of the turbines and access roads is shown in **Figures 2-3**. With these measures in place, no additional mitigation will be required.

Traffic

The capacity of any route and level-of-service to the traveling public will not be affected and as such, no mitigation will be necessary.

Water Supply

If temporary dewatering of groundwater is required during construction activities, discharge of dewatering fluid will be conducted under the requirements of the National Pollutant Discharge Elimination System (NPDES) permit and Storm Water Pollution Prevention Plan (SWPPP).

No wells should need to be abandoned, however, in the event that wells are abandoned, they will be sealed as required by North Dakota law.

Communications

An underground utilities locator company will be contacted prior to construction to locate and avoid underground facilities. To the extent Project facilities cross or otherwise affect existing communications systems, Thunder Spirit will enter into agreements with service providers as necessary to avoid interference with their facilities. Additionally, in the event that the Project is reported to cause interference, Thunder Spirit will respond to the complaint and take necessary measures.

5.5 Human Health and Safety

5.5.1 Description of Resources

Air Traffic

There is one public airport in the vicinity of the Project Area. Nautical miles are the standard measure for aviation; one nautical mile is equal to 1.15 statute miles. The Hettinger Municipal Airport (FAA ID KHEI) is located northwest of the city of Hettinger and is 3.93 nautical miles (4.53mi) away from the closest turbine (Turbine A31). It is open to the public and as of 2011, averaged 93 aircraft operations per week. There is one asphalt runway and one turf runway. The airport does have published instrument procedures (AirNav 013a).

The Hagen Private Airport (FAA ID 14 ND) is the only FAA-listed privately owned airport in the area; permission is required prior to landing (AirNav 2013b). It is located approximately 12 nautical mile west of the Project Area, northeast of Reeder, ND. It has one turf runway and no published instrument procedures. Published maps show six additional non-FAA-listed private airstrips located

between 2.8 and 5.3 nautical miles of the Project Area; no information is available on the actual use of these airstrips.

Electromagnetic Fields

The term electromagnetic fields (EMF) refers to electric and magnetic fields that are present around any electrical device. Electric fields arise from voltage, or electrical charges, and magnetic fields arise from current, or the flow of electricity that travels along transmission lines, electrical collection lines, substation transformers, house wiring, and electrical appliances. The intensity of the electric field is related to the voltage of the line and the intensity of the magnetic field is related to the current flow through the conductors (wire). EMF can occur indoors and outdoors.

Electric and magnetic fields created by the Project would primarily be created by the 0.85 mile 230 kV transmission line connecting the Project to the MDU Hettinger Substation. Electric fields related to power lines are generally considered to have little to no health risk. The health risk of magnetic fields is the subject of ongoing research, however, the nearest occupied residence is approximately 1,560 ft to the west of this transmission line, and magnetic fields are not expected to pose a threat to human health at this distance.

Shadow flicker

A wind turbine's moving blades can cast a moving shadow on locations within a certain distance of a turbine. These moving shadows are called shadow flicker, and can be a temporary phenomenon experienced by people at nearby residences or public gathering places. The impact area depends on the time of year and day (which determines the sun's azimuth and altitude angles) and the wind turbine's physical characteristics (height, rotor diameter, blade width, and orientation of the rotor blades). Shadow flicker generally occurs during low angle sunlight conditions, typical during sunrise and sunset.

Hazardous Materials / Hazardous Waste

The site is located in a relatively rural area of North Dakota. Hazardous wastes from large industrial or commercial activities are not likely. Potential hazards may exist in rural areas from old gasoline facilities, landfill sites, and private activities. An assessment of the Project Area will be conducted in the fall of 2013 to identify any recognized environmental conditions that may exist.

Potentially hazardous materials associated with the Project include fluids found in association with turbines and substation/transformer equipment. There will be three types of fluids used in the operation of the wind turbines, all of which are petroleum products. These fluids are necessary for the operation of each turbine and include gear box oil, hydraulic fluid, and gear grease. The transformers contain mineral oil.

Security

The Project Area is located in an area that has a low population density. Construction and operation of the Project will have minimal impacts on the security and safety of the local communities.

5.5.2 Impacts

Air Traffic

The installation of wind turbines creates a potential for air traffic collision. However, the wind turbines and meteorological towers will have lighting and markings that comply with Federal Aviation Administration (FAA) requirements. In addition, the FAA's review will include the evaluation of any potential interference with air traffic and requirements for lighting and marking of the turbines and meteorological towers. Thunder Spirit will submit Notices of Proposed Construction or Alteration to the FAA for the Project turbines in June 2013. FAA's response will be submitted once received.

Electromagnetic Fields

While the general consensus is that electric fields associated with power transmission lines pose no risk to humans, the question of whether exposure to magnetic fields can cause biological responses or health effects continues to be the subject of research and debate. Based on available research on electromagnetic fields, and the distance between any turbines or collector lines and houses, the Project will have no impact to public health and safety due to either electric or magnetic fields (National Institute of Environmental Health Sciences EMF-RAPID Program Staff, 1999).

Shadow flicker

Considering all turbine scenarios, only 2 of the 26 receptors modeled had expected shadow flicker impacts of more than 30 hours per year. The maximum predicted shadow flicker impact at a receptor is 76 hours 58 minutes per year (Receptor 28), which is approximately 1.7 percent of the potential available daylight hours. This receptor belongs to a participating landowner and according to the landowner, the structure is not occupied full-time. Rather, they allow a hired hand to stay in this structure. The other receptor had predicted shadow flicker impacts of 34 hours 40 minutes per year (Receptor 67). This structure belongs to a participating landowner and, according to the landowner, the structure is an abandoned farmstead that has not been occupied for over 30 years and has neither electric nor water. (See **Appendix A**, Shadow Flicker Report.)

The analysis of potential shadow flicker impacts from the Project on nearby receptors shows that shadow flicker impacts within the area of study are expected to be minor and well within acceptable ranges for avoiding nuisance and/or health hazards. The two receptors that exceed the target of 30 hours per year under the most conservative conditions are participating landowners, with land under lease to Thunder Spirit. The analysis assumes that the receptors all have a direct in-line view of the incoming shadow flicker sunlight and does not account for trees or other obstructions which may block sunlight. In reality, the windows of many houses will not face the sun directly for the key shadow flicker impact times. Adding to the analysis' conservatism is that potential shadow flicker impacts for wind turbines up to one mile (5,280 feet) away from a receptor were determined, and Thunder Spirit will only construct 150 MW (i.e. not all 85 turbines modeled will be constructed). For these reasons, shadow flicker impacts are expected to be considerably less than estimated in this conservative analysis, and shadow flicker is not expected to be a significant environmental impact. Mitigation measures such as strategic vegetative screening and/or installation of curtains and blinds on the windows facing the turbine casting the shadows are effective and economically viable options that Thunder Spirit could consider on an individual basis with landowners, if necessary.

Hazardous Materials / Hazardous Waste

An assessment will be conducted and results will be used to minimize risk associated with potential recognized environmental conditions that may pose a threat to human health and safety. Significant findings are not anticipated due to the known historic uses of the property. Thunder Spirit does not anticipate generating any hazardous wastes.

Security

Project construction and operation will have minimal impacts to the security and safety of the local communities.

5.5.3 Mitigative Measures

Air Traffic

Thunder Spirit will submit a request to FAA to determine whether the Project layout and lighting will impact navigable airspace or communications technology used in aviation operations. The Determination of No Hazard to Air Navigation will be forwarded when received. Wind turbines and meteorological towers will have lighting and markings according to FAA requirements that minimize any potential for air traffic impacts.

Electromagnetic Fields

Thunder Spirit will follow prudent avoidance methods to EMF exposure, such as encouraging conservation and distributed generation, and will continue to monitor EMF research. Thunder Spirit has considered the local setbacks from transmission lines. In addition, Thunder Spirit will locate the transmission line at a sufficient distance from occupied structures that no adverse health effects are expected.

Shadow flicker

The primary mitigation measure used for wind turbines is setback distance. Thunder Spirit is committed to a minimum 2,640-foot setback distance from all non-participating existing occupied residential structures. Because no significant impacts are anticipated, no additional mitigation is proposed at this time.

Hazardous Materials/Hazardous Waste

Since no significant findings are anticipated, no mitigation is proposed at this time. All petroleum fluids will be contained within the wind turbines and electrical equipment. Any petroleum wastes generated will be handled and disposed of in accordance with local, state and federal regulations.

Security

The following security measures will be taken to reduce the chance of physical and property damage, as well as personal injury, at the site:

- The towers will be placed at least 200 feet from road right-of-way and 2,640 feet from non-participating occupied homes. These distances are considered to be safe based on developer experience, and are consistent with the required local setbacks.

- Security measures will be taken during the construction and operation of the Project, including temporary and permanent safety fencing, warning signs, and locks on equipment and wind power facilities.
- Turbines will sit on solid steel-enclosed tubular towers in which all electrical equipment will be located, except for the pad-mounted transformer. Access to the tower is only through a solid steel door that will be locked when not in use.
- Where necessary or requested by landowners, Thunder Spirit will construct gates or fences to control access to private property, such as those around the collection substation.
- Thunder Spirit will provide educational materials to landowners within the site boundaries and upon, request, to interested persons about the Project.

5.6 Noise

5.6.1 Description of Resources

The Project Area is rural and agricultural, and the local acoustic environment is defined primarily by distant transportation noises, aircraft flyover, farming equipment and local traffic. In addition to such anthropogenic noise sources, the windy conditions of this site define a somewhat elevated ambient sound level, which increases with wind speed. Windy conditions can generate noise caused by the rustling of grass and tree leaves. Generally, the ambient acoustic environment in the Project Area is expected to remain relatively low, based on the anticipated low rate of residential, agricultural or industrial development.

5.6.2 Impacts

At the county level, the Adams County Zoning Ordinance states that sustained noise of over 80 dB during the day and 70 dB at night is not allowed. At the state level, the North Dakota Administrative Code (Article 69-06-08, Section 3) requires that the potential for adverse impacts at noise sensitive receptors be assessed during the site selection process. There are no numerical decibel limits or explicit definitions of the locations of compliance given either by the North Dakota PSC or any other agency at the state level. There are no federal noise requirements specific to the Project; however, the USEPA has issued relevant guidance. Thunder Spirit will employ appropriate environmental noise criteria such as the guidelines provided by the USEPA and the generally accepted average noise impact threshold level for wind turbines of less than 48.6 dBA at any residence, day or night (USEPA, 1974).

Wind turbine generators produce noise through a number of different mechanisms roughly grouped into mechanical and aerodynamic sources. Modern wind turbines include design features that minimize mechanical sound sources. The interaction of air and the turbine blades produces aerodynamic noise through a variety of processes as air passed over and past the blades. Wind turbines generally radiate more noise as wind speed increases. However, at elevated wind speeds the wind tends to generate significant background noise by moving trees and grasses, which can create a masking effect and may aid in reducing the audibility of wind turbine sound.

Special conditions can occur which are difficult to predict, such as high wind shear events where there is little masking wind noise at surface level but at hub-height there is sufficient wind for energy generation. In addition, residents in homes which are poorly insulated or highly exposed in the environment with limited nearby vegetation may be subject to a higher perceptibility.

The project layout has been designed so that any of the three turbine models can be sited within the 85 locations. Since the layout has not been finalized, the acoustic modeling analysis considered all 85 turbines. Since this is more than will be constructed for any of the three scenarios, this analysis reflects a 'worst-case' estimate.

The modeling results indicate that received sound levels under maximum rotation and maximum rotation during anomalous events may potentially exceed the USEPA 48.6 dBA criterion at a few noise sensitive receptor locations for all turbine models. The Acciona turbine exhibited the greatest potential impacts, yielding the highest received sound levels at noise sensitive receptors and one (1) potential exceedance at cut-in wind speed, two (2) potential exceedances at maximum rotation and three (3) potential exceedances at maximum rotation under anomalous meteorological conditions. However, two (2) of these exceedances occurred at residences both identified as abandoned (Receptor 67 which belongs to a participating landowner and Receptor 183, which is not participating but according to the landowner who farms the land, the structure has not been occupied for over 50 years and has neither water nor electricity). The third (Receptor 28) is a participating landowner and the structure is not occupied full time. In conclusion, the acoustic modeling analysis, demonstrates the Project has been adequately designed inclusive of a number of conservative assumptions to generate sound levels below EPA guidelines at all occupied non-participant receptors. Noise levels due to the operation of the proposed wind farm have been predicted at nearby properties and, at all of these properties considered noise sensitive based on present day use, the predicted noise levels are 48.6 dBA or below, under all considered wind speeds. See **Appendix A**, Acoustic Memo.

Project construction may cause short-term but unavoidable noise impacts. The sound levels resulting from construction activities vary significantly depending on the type and age of equipment, the specific equipment manufacturer and model, the operations being performed, and the overall condition of the equipment and exhaust system mufflers. Sounds generated by construction activities are typically exempt from state and local noise oversight provided that they occur within weekday, daytime periods as may be specified under local zoning or legal codes. All reasonable efforts will be made to minimize the impact of noise resulting from construction activities.

Traffic noise is categorized into two categories: (1) the noise that will occur during the initial temporary traffic movements related to turbine delivery, haulage of components and remaining construction; and (2) noise from ongoing maintenance and operation, which is expected to be minor. Construction activity will generate traffic having potential noise effects, such as trucks traveling to and from the site on public roads. At the early stage of the construction phase, equipment and materials will be delivered to the site, such as hydraulic excavators and associated spreading and compacting equipment needed to form access roads and foundation platforms for each turbine. Once the access roads are constructed, equipment for lifting the towers and turbine components will arrive.

5.6.3 Mitigative Measures

The primary mitigative measure used for wind turbines is setback distance. To meet county zoning setbacks, Thunder Spirit is committed to a minimum 2,640-foot setback distance from all non-participating occupied residential structures.

If a complaint is registered and sound is measured above the 48.6 dBA level on more than a rare occasion, Thunder Spirit will provide improved insulation, landscaping, or other appropriate candidate mitigative measures. It should be noted that the acoustic model conservatively predicts outdoor sound levels and assumes no shielding or attenuation by trees or other vegetation.

5.7 Cultural, Archaeological, and Historic Architectural Impacts

5.7.1 Description of Resources

Tetra Tech provided the necessary information for the State Historical Society of North Dakota (SHSND) review by performing a Class I Literature Review, a Class II Historic Architecture Survey, and a Class III Cultural Resources Inventory. The Class I Literature Review included identifying archaeological sites and surveys, and structures, bridges, and cemeteries within one (1) mile of the Project layout. The Class II Historic Architecture Survey examined potential impacts to historic architecture within one (1) mile of the nearest turbine. The Class III Cultural Resources Inventory included a pedestrian survey of the Area of Potential Effects (APE) developed from the aforementioned layout. The APE included the proposed turbine locations, the proposed access roads, the proposed electrical collection system, the proposed overhead transmission line, and the proposed substation, proposed O&M facility, and laydown areas.

Class I Literature Review

The literature review was conducted on May 3, 2013. The review identified archaeological sites and surveys, and structures, bridges, and cemeteries within 1 mile of the Project layout dated April 26, 2013.

The Class I Literature Review revealed that three investigations have intersected portions of the APE and one survey has been conducted within 1 mile (**Table 18**). These surveys mainly include long, narrow corridors for pipeline and fiber optic projects; however, one project (Buechler 2010) included 88 acres in the vicinity of Turbines 12, 13, Alternate 7 and within the proposed laydown area.

Table 18. Previous investigations conducted within 1 mi of the APE.

Report Title	Manuscript #	Location
Results of Class I, Class II, and Class III Cultural Resource Investigations for the Southwest Pipeline Project: The Bucyrus and Three Pocket Service Areas, Adams, Bowman, Hettinger, Slope, and Stark Counties, North Dakota	007137	Within 1 mi of the APE
Hettinger to Mott Fiber Optic Line: An Intensive Inventory in Adams and Hettinger Counties, North Dakota	008581	Intersects APE
Hettinger Exchange: A Class II and III Cultural Resource Inventory in Adams and Hettinger Counties	11259	Intersects APE
A Cultural Resources Inventory Survey of the Ericson Gravel Pit in Adams County, North Dakota	11754	Intersects APE

During previous surveys, six (6) archaeological sites and four (4) site leads were documented within one (1) mile of the APE. The six (6) archaeological sites include four (4) prehistoric artifact scatters, one prehistoric stone circle, and one (1) historic artifact scatter and features associated with a former

farmstead. The site leads include two (2) prehistoric artifact scatters, one (1) historic post office, and a former Leonardite Mine.

Of these previously documented resources, only two (2) intersect the APE. Site 32ADx041 is the historic Schnebly Post Office (artifact scatter, depression, and foundation) which is located in the northeast ¼ of Section 7, Township 130 North, Range 95 West. The exact location of this site is not known at this time and cultural materials associated with the post office were not identified during the pedestrian survey associated with this project. Site 32ADx042 is a prehistoric artifact scatter located in the center of Section 2, Township 130 North, Range 95 West. The exact location of this site is not known and cultural materials associated with the artifact scatter were not identified during the pedestrian survey associated with this project.

No previously documented structures, bridges, and cemeteries were present within one (1) mile of the APE.

Class II Historic Architecture Survey

Thunder Spirit undertook an examination of historic architecture in order to assess the effect of the proposed Project on above ground resources. In consultation with the SHSND, an APE for this survey was established as the zone within one (1) mile of the nearest turbine. The SHSND ultimately identified 23 properties (for the April 26, 2013 layout) for which documentation and assessment of eligibility to the National Register of Historic Places (NRHD) was requested.

A literature review of the APE identified no previously documented architectural properties within the APE. Fieldwork, undertaken on April 7-9 and May 14, 2013, photographically documented all 23 properties within the APE for which the SHSND sought further information. The buildings were photographed with digital cameras meeting the requirements of the National Park Service. In addition, photo locations were geographically located using a hotshoe geotagger during the April survey, when the bulk of the work was accomplished, and using USGS maps and aerial photos during the work in May.

Class III Pedestrian Survey

A Class III Pedestrian Survey of the APE based on the April 26, 2013 Project layout was conducted. This included surveying the locations for:

- 85 locations for wind turbine generators;
- approximately 26.8 miles of access roads;
- approximately 35.3 miles of the electrical collection system;
- approximately 0.64 miles of the overhead transmission line;
- a 20-acre substation; and
- a 20-acre temporary laydown area.

To provide some additional layout areas and allow for some flexibility in construction, a 250-ft radius for each of the proposed turbine locations; a 250-ft corridor for service roads, a 100-ft corridor for collection line routes, and a 250-ft corridor for the overhead transmission line were included in the survey.

The Class III pedestrian survey was conducted from May 4-14, 2013. During the pedestrian survey of the APE, twenty (20) archaeological sites were documented including 7 prehistoric stone feature sites, three (3) quarry/lithic workshop sites, four (4) lithic scatters, three (3) historic dumps, two (2) stone pile sites of indeterminate cultural affiliation, and 1 former Euro-American clay pit; five (5) site leads consisting of chipped stone isolated finds; and one (1) Euro-American stone pile site. Due to the sensitive nature of these sites, specific site details are not included in this Application. The full report will be submitted to SHSND for concurrence and will be submitted to the PSC upon receipt.

5.7.2 Impacts

Analysis and assessments of the subject properties was undertaken by a qualified Architectural Historian. Of the 23 properties identified by the SHSND from maps and aerial photographs, two (2) turned out to contain no buildings 50 years old or older, while two (2) others were without any buildings at all at the time of survey. Review of the 19 remaining properties leads to the recommendation that these properties are not eligible for inclusion in the NRHP. With respect to potential effects of the proposed Project on architectural properties in the study area a determination of No Historic Properties Affected. The full report will be submitted to SHSND for concurrence and will be submitted to the PSC upon receipt.

Based on the layout, there are two (2) previously documented site leads and 26 newly documented cultural resources within the current APE. The Class III Pedestrian Survey did not identify any archaeological materials associated with the two previously documented site leads. Based on the absence of archaeological associated with site leads, avoidance is not recommended.

At this time, the newly documented Native American stone feature sites, quarry/lithic workshop sites, and lithic scatters and stone piles of indeterminate cultural affiliation have not been evaluated for their eligibility for inclusion to the National Register of Historic Places (NRHP); however, these sites may contain intact archaeological features and may also hold traditional religious and cultural importance to regional Native American tribes and therefore may meet the criteria for inclusion in the NRHP (36 CFR 800.16[I][1]). These sites should be avoided during construction.

The newly identified Euro-American dump sites and clay pit has not been evaluated for their potential eligibility for inclusion to the NRHP; however, these sites may contain intact archaeological features. These sites should be avoided during construction.

No avoidance is recommended for the small agricultural dump; this site appears to be relatively modern and does not meet the criteria to be eligible to the NRHP. No avoidance is recommended for, the Euro-American stone pile sites located adjacent to a cultivated field.

The five (5) site leads consisted of non-diagnostic artifacts located in upland settings (i.e., non-depositional settings) with very little soil accumulation and will likely not be eligible for inclusion to the NRHP. Avoidance is not recommended for the site leads.

5.7.3 Mitigative Measures

It is recommended that these 20 archaeological sites and an associated avoidance buffer be avoided during construction and snow fencing be placed around the avoidance buffer to reduce the potential that they will be inadvertently disturbed.

If areas beyond the currently surveyed APE for direct effects are to be utilized during construction, a Class III cultural resource survey should conducted to determine the presence of cultural resources within these areas. An unanticipated discoveries plan to accommodate any archaeological materials that may be exposed during project construction has also been developed for this Project. This document contains sensitive information and will not be available for public distribution.

If archaeological resources are encountered during Project construction and/or operation, work in the area will stop and further consultation will be conducted. Thunder Spirit will work with the SHSND to document the resource and mitigate impacts in a timely manner. If human remains are inadvertently disturbed or exposed during construction, all work within the vicinity of the discovery should be halted and the local law enforcement agency shall be notified immediately. The local law enforcement agency shall, as soon as practicable, report the receipt of such notification to SHSND and the North Dakota State Department of Health and Consolidated Laboratories (NDSDHCL).

The Native American Graves Protection and Repatriation Act of 1990 allow tribes to protect American Indian graves and to repatriate human remains. The proponent must comply with this act if a burial site is encountered during construction, as the aforementioned act applies to all developments regardless of the funding source. Any burial site identified, including tribal or pioneer, must be referred to the North Dakota Intertribal Reinterment Committee and the SHSND.

Although there are no reservations or Bureau of Indian Affairs trust lands in Adams County, the following Tribal Historic Preservation Officers (THPO) or Tribal Cultural Preservation Officers (TCPO) may be contacted if archaeological resources or other properties of Tribal interest are identified prior to or during construction:

Waste Win Young, THPO
Officer/Program Director
Standing Rock Sioux Tribe
Phone: 701.854.8645

Darrell Smith
Cultural Resources Representative
Spirit Lake Nation
P.O.Box 475
Fort Totten, N.D. 58335

Pete Coffey, Chief Compliance Officer
Mandan, Hidatsa, and Arikara Nation (Three Affiliated Tribes)
pcoffey@mhanation.com

5.8 Recreational Resources

5.8.1 Description of Resources

Recreational opportunities in Adams County include hunting and wildlife observation. Review of state and federal databases indicates that no registered national wildlife refuges, state game refuges, nature preserves, county parks, or formal recreational areas are present within the Project Area. As discussed in **Section 5.3**, properties within the Project Area participate in the PLOTS program, which allows public access to hunting on private lands (**Figure 10**).

5.8.2 Impacts

In general, recreational impacts will be visual in nature and limited to individuals using public or private property in and near the Project Area for hunting, fishing, or nature observation.

5.8.3 Mitigative Measures

Since it is not anticipated that any significant recreational resources will be removed from service by implementation of the Project, no mitigative measures are proposed.

5.9 Effects on Land-Based Economies

5.9.1 Description of Resources

Agriculture/Farming

The majority of the Project Area is either cropland or grazing land (**Figure 13**). Crops observed during the field reconnaissance in April/May 2013 included spring wheat, corn, sunflowers, and canola. As discussed in **Section 5.2.1**, agriculture continues to play a significant role in the county's land use and economy. In 2007, there were 426 farms in Adams County, comprising virtually all of the land area. The median size of the farms was 640 acres. According to the 2007 Census of Agriculture (USDA 2007), total market value of agricultural products produced in Adams County was $70,542,000, of which 55 percent was from crops and 45 percent from livestock sales. The primary livestock is cattle, followed by pigs and sheep, and the principal crops include wheat and corn.

Woodlands

Economically important forestry resources are not found in the Project Area. Trees and shrubs in the Project Area are limited to mostly windbreaks around residential properties and between fields, and for landscaping.

5.9.2 Impacts

Agriculture/Farming

Wind energy development removes less total land from agricultural use than other forms of development. No impacts are anticipated to animal health and safety due to the construction or operation of the wind farm and associated facilities. Except for the physical locations of the turbines, access roads, and substation, all the land surrounding the Project facilities will be available for the continuation of existing farming practices.

Actual impacts to agricultural production will be determined once turbine and road locations are finalized. Exact impact acreages will not be known until turbine siting is finalized, but expected permanent impacts will be approximately 92 acres, including turbine foundations, access roads, and the Project substation. It is possible that some of this land is not used for agricultural purposes, thus the actual impacts to agricultural production cannot be determined until turbine and road locations are finalized.

The Project layout dated April 26, 2013 for turbines, roads, and collection includes up to 0.5 acres of Project infrastructure in soils classified as prime farmland and up to 73 acres in farmland soils of statewide importance, not including the collection lines, which will be buried and would be a temporary disturbance of soil. This would be a negligible impact to agricultural production in the

county. As noted earlier, wind lease payments will provide farmers with a supplemental source of income, helping assure that farmers can continue to operate financially viable farms, and thus helping to assure the continuation of farming in Adams County.

No turbines will be placed within 2,640 feet of non-participating occupied homes. Other impacts to homes are discussed throughout **Section 5.0**. Family farms will be affected due to the loss of land associated with the construction of the turbines and access roads. The extent of impacts will not be known until final turbine locations are determined in conjunction with the landowners.

Woodlands

No significant impacts are anticipated to woodlands.

5.9.3 Mitigative Measures

Agriculture/Farming

The wind turbines and access roads will be located so that prime farmland will be avoided as much as practicable. Only land for the turbines, substation, access roads, and O&M facility will be unavailable for cattle grazing and/or crop production. Thunder Spirit will work with landowners to minimize impacts to their land. Once the wind turbines are constructed, all land surrounding the turbines can still be farmed or grazed. All construction areas will be separated from grazing animals by temporary or permanent fencing.

Woodlands

If trees are removed as part of the Project, they will be replaced per PSC's Tree and Shrub Mitigation Specifications.

5.10 Soils

5.10.1 Description of Resources

The U.S. Department of Agriculture has mapped 40 soil map units within the Project Area (USDA 2013). These soils are primarily loams and silt and sandy loams derived from the underlying alluvium and sedimentary rock including shale, sandstone, and to a lesser extent mudstone. Seven soil types comprise approximately 54 percent of the Project Area (**Figure 15**) and include the "Beisigl-Flasher loamy fine sands (6 to 20 percent slopes)", "Daglum-Rhoades loams (0 to 6 percent slopes)", "Shambo loam (0 to 2 percent slopes)", "Cabba-Amor-Savage complex (6 to 70 percent slopes)", "Vebar-Parshall fine sandy loams (0 to 6 percent slopes)", "Belfield-Savage-Daglum silt loams (0 to 2 percent slopes)", and "Belfield-Savage-Daglum silt loams (2 to 6 percent slopes)". All of these individual soil types compose 5 percent or more of the Project Area.

Soils, including those classified as prime farmlands, can also be an indicator of important agricultural lands. Prime farmland is the land that has the best combination of physical and chemical characteristics for producing food, feed, forage, fiber and oilseed crops. The National Resource Conservation Service (NRCS) has two classifications for prime farmland. The first is where all areas of the soil series are classified prime farmland. The second is where only the drained areas of the soil series are prime farmland. The NRCS also identifies farmland of statewide and local importance, which is land that is important for the production of food, feed, fiber, forage and oilseed crops. Generally, additional farmlands of statewide or local importance include those that are nearly prime

and that produce high yields of crops in an economic manner when treated and managed according to acceptable farming methods. Some may produce a yield as high as prime farmland if conditions are favorable. **Table 19** lists the soils within the Project Area, including those considered prime farmland and soils of statewide or local importance. **Figure 14** shows the prime farmland soil distribution in the Project Area.

Table 19 provides a summary of the soil map units and farmland classifications within the Project Area, including their acreages and percentages of the Project Area.

Table 19. Soil Map Units Within the Project Area

Map Unit Symbol	Map Unit Name	Area (acres)	Percentage of Project Area	Farmland Classification
10B	Beisigl-Lihen loamy fine sands, 0 to 6 percent slopes	606.0	2.15	Not prime farmland
10D	Beisigl-Flasher loamy fine sands, 6 to 20 percent slopes	2,608.7	9.24	Not prime farmland
12B	Daglum-Rhoades loams, 0 to 6 percent slopes	1,405.7	4.98	Not prime farmland
14B	Parshall fine sandy loam, 0 to 6 percent slopes	924.0	3.27	Farmland of statewide importance
15	Arnegard loam, 0 to 2 percent slopes	377.6	1.34	All areas are prime farmland
16	Shambo loam, 0 to 2 percent slopes	1,453.3	5.15	Farmland of statewide importance
16B	Shambo loam, 2 to 6 percent slopes	98.1	0.35	Farmland of statewide importance
17B	Sen silt loam, 3 to 6 percent slopes	777.0	2.75	Farmland of statewide importance
17C	Chama-Cabba silt loams, 6 to 9 percent slopes	461.5	1.64	Farmland of statewide importance
17D	Chama-Cabba silt loams, 9 to 15 percent slopes	300.5	1.06	Not prime farmland
18B	Amor-Shambo loams, 3 to 6 percent slopes	682.6	2.42	Farmland of statewide importance
18C	Amor-Cabba loams, 6 to 9 percent slopes	476.1	1.69	Not prime farmland
18D	Amor-Cabba loams, 9 to 15 percent slopes	190.9	0.68	Not prime farmland
19F	Cabba-Chama silt loams, 15 to 70 percent slopes	146.2	0.52	Not prime farmland
2	Heil silt loam, 0 to 1 percent slopes	108.5	0.38	Not prime farmland
20F	Flasher-Beisigl-Parshall complex, 3 to 70 percent slopes	921.3	3.26	Not prime farmland
21B	Ruso fine sandy loam, 0 to 6 percent slopes	257.2	0.91	Not prime farmland
22	Bowdle loam, 0 to 2 percent slopes	817.6	2.90	Farmland of statewide importance
22B	Bowdle loam, 2 to 6 percent slopes	270.3	0.96	Farmland of statewide importance
23F	Flasher-Beisigl-Rock outcrop complex, 6 to 70 percent slopes	224.7	0.80	Not prime farmland
25B	Lihen loamy fine sand, 0 to 6 percent slopes	13.0	0.05	Not prime farmland
26	Regan silt loam, 0 to 2 percent slopes	56.8	0.20	Not prime farmland
27E	Sinnigam-Janesburg loams, 0 to 25 percent slopes	1,081.7	3.83	Not prime farmland
28	Harriet loam, 0 to 2 percent slopes	851.6	3.02	Not prime farmland
3	Dimmick silty clay, 0 to 1 percent slopes	14.8	0.05	Not prime farmland
30	Straw loam, channeled, 0 to 2 percent slopes	319.7	1.13	Not prime farmland
31B	Watrous loam, 0 to 6 percent slopes	120.7	0.43	Farmland of statewide importance
33B	Savage clay loam, 2 to 6 percent slopes	757.0	2.68	Farmland of statewide importance
35F	Cabba-Amor-Savage complex, 6 to 70 percent slopes	1,932.0	6.85	Not prime farmland
4	Grail clay loam, 0 to 2 percent slopes	278.6	0.99	All areas are prime farmland
51	Parshall fine sandy loam, saline, 0 to 2 percent slopes	77.0	0.27	Not prime farmland
5C	Wayden silty clay, 3 to 9 percent slopes	31.7	0.11	Not prime farmland
61	Arnegard loam, saline, 0 to 2 percent slopes	35.9	0.13	Not prime farmland
6B	Vebar-Parshall fine sandy loams, 0 to 6 percent slopes	1,958.7	6.94	Farmland of statewide importance
7C	Vebar-Flasher fine sandy loams, 3 to 9 percent slopes	1,041.7	3.69	Not prime farmland
8	Belfield-Savage-Daglum silt loams, 0 to 2 percent slopes	3,585.1	12.70	Farmland of statewide importance
81	Belfield-Savage-Daglum silt loams, saline, 0 to 2 percent slopes	358.2	1.27	Not prime farmland
8B	Belfield-Savage-Daglum silt loams, 2 to 6 percent slopes	2,349.8	8.33	Farmland of statewide importance
9B	Regent silty clay loam, 3 to 6 percent slopes	247.1	0.88	Farmland of statewide importance
W	Water	4.5	0.02	Not prime farmland

Source: USDA 2013.

Approximately 54 percent of the soils within the Project Area are prime farmland or farmland of statewide importance. Twenty-seven percent of the Project Area is covered by soils classified as partially hydric soils (i.e., soils containing hydric inclusions). Soils in the Project Area (with the exception of areas mapped as "Water", which are unrated) have a wide range, from very low to very high, of susceptibility to erosion by water (i.e. K-factors from 0.0 to 14.17). More than half of the soils also have low to moderate susceptibility to wind erosion (i.e., USDA Wind Erosion Groups 6 or greater) (USDA 2013).

5.10.2 Impacts

The impact to soils within the Project Area will be limited to areas removed from agricultural production by occupancy of Project components, including turbines, roads, collection lines, and a Project substation and O&M building. Estimated impacts include up to 176 acres of permanent disturbance due to turbine placement, access road construction, and a Project substation and O&M building.

5.10.3 Mitigative Measures

Wind and water erosion are potential hazards for the soils found in the Project Area. To minimize erosion during and after construction, best management practices (BMPs) for erosion and sediment control will be utilized. Construction sites will maintain sediment control practices in accordance with the required Stormwater Pollution Prevention Plan (SWPPP). Since towers will not be located on significant slopes, only non-structural practices should be required. These practices include temporary seeding, permanent seeding, mulching, filter strips, erosion blankets, and sod stabilization. If cuts are made during construction, top soil will be segregated and reapplied after final contours have been graded.

5.11 Geologic and Groundwater Resources

5.11.1 Description of Resources

Southwest North Dakota, including Adams County and the Project Area, lies within the unglaciated Missouri Plateau (or Missouri Slope Upland) section of the Great Plains physiographic province which rises gradually westward toward the Rocky Mountains. This area is southwest of the limit of glaciation in North Dakota; however, drainage changes caused by glaciation have affected this region. This landscape has formed over an exceptionally long period of time, unlike the much more recent topography of the glaciated portion of the state (NDGS 2013a).

The broad valleys, hills, and buttes of the Missouri Plateau are largely the result of erosion of flat-lying beds of sandstone, siltstone, claystone, and lignite that belong primarily to the Paleocene-age Fort Union Group. These sediments were deposited by ancient rivers flowing away from the rising Rocky Mountains between about 65 to 55 million years ago. These deposits are approximately 12,000 feet thick. Around 10 to 5 million years ago, streams began eroding the sediments that had so long ago been deposited.

Surficial geology in the Project Area includes the Bullion Creek, Slope, and Ludlow Formations (USGS 2013a) (see **Figure 15**). The Slope Formation consists of gray-brown silt, sand, clay, sandstone, and lignite; and can reach a thickness of 300 feet. The Bullion Creek Formation consists of yellow-brown silt, sand, clay, sandstone, and lignite; and can reach thicknesses of up to 600 feet.

The Ludlow Formation consists of carbonaceous brown claystone, olive-gray siltstone, yellowish-gray fine-grained sandstone, limestone, and lignite (USGS 1978). The thickness of the Ludlow Formation can reach up to 300 feet.

No oil and gas production occurs in the Project Area based on a database inquiry of the North Dakota Department of Mineral Resources Oil and Gas Division well search database (DMR 2013). Although uranium resources are found in some areas of southwestern North Dakota, no uranium deposits are present in the Project Area according to North Dakota Geological Survey (NDGS) mapping of uranium deposits (NDGS 2013b). Sand and gravel resources in Adams County are generally small and poorly sorted; and are thus, not an important mineral resource in the area (NDGS 1979). The closest sand and gravel resource to the Project area is approximately 2.5 miles to the southeast - the "Smith Ullman Pit" (USGS 2013b).

Lignite (coal) beds are present in the Ludlow Formation in Adams County. Most of the coal production was produced by underground or slope mines and peaked in the early 1920s. Strip mining also took place in Adams County beginning in 1932. Most area mines were closed by 1950 due to a decline in the use of lignite. Based on lignite reserves maps available from the North Dakota Geological Survey (NDGS 2013c), there are no economically viable coal deposits in the Project Area. According to the PSC Abandoned Mine Lands Division, there is one known abandoned underground coal mine in the Project Area, located in the northeast quarter of Section 25, T130N, R96W (**Figure 5**).

No earthquakes of intensity V or above (Modified Mercalli Scale) have occurred within North Dakota during historical times. Earthquakes centered in Iowa, Minnesota, Montana, and Nebraska, and a few Canadian shocks have been felt in the State. The first instrumentally located earthquake in the history of North Dakota occurred on July 8, 1968. Its intensity did not exceed IV, however. Southeastern North Dakota experienced tremors on July 9, 1975, from a magnitude 4.8 earthquake located near Morris, Minnesota (USGS 2013c).

According to USGS seismic hazard maps, the Project Area is located in an area with very low seismic risk (USGS 2008a). The peak horizontal ground acceleration with a 2 percent in 50 year probability of exceedance ranges from 0.06 to 0.08 g (the acceleration due to Earth's gravity, equivalent to g-force) (USGS 2008b). Related geologic hazards, such as soil liquefaction, are therefore, also unlikely.

Adams County is located in the recharge area at the western edge of a large regional groundwater flow system that extends, in part, to the Missouri River. Groundwater resources in Adams County are available from the Fox Hills, Hell Creek, Ludlow, Cannonball, and Tongue River Formations (USGS 1978). The primary aquifer system is in the Fox Hills Formation and the basal portion of the Hell Creek Formation. This aquifer system ranges in thickness from 340 to 520 feet and is as much as 940 feet below land surface in Adams County. The aquifer consists of fine to medium grained sandstone interbedded with siltstone and claystone. The overlying upper Hell Creek and lower Ludlow, middle Ludlow, Cannonball, and upper Ludlow and Tongue River aquifer systems are more limited in terms of yield and are primarily used for domestic livestock.

The public water supply of Hettinger is sourced from wells with depths from 1,050 to 1,314 feet; the wells have yields between 50 and 168 gallons per minute (gpm) (USGS 1978). Water levels in these wells, which tap the Fox Hills and basal Hell Creek aquifer system, range from 331 to 670 feet in depth. Pumpage has resulted in the regional drawdown of water levels over the years.

Review of driller logs available from the North Dakota State Water Commission database indicates that 21 wells have been drilled within the Project Area, all of which are domestic and/or stock wells (NDSWC 2013). Well logs indicate that static water levels in the Project Area range from 25 to 200 feet below ground surface (bgs), although one shallow well log indicated a water level of 9 feet bgs. Reported yields ranged from 5 to 15 gallons per minute. Completion records and logs indicate the wells primary tap the sand, clay, silt, sandy clay, sandstone, and sandy shale/sandy claystone aquifer zones of the uppermost geologic formations including the Ludlow Formation.

5.11.2 Impacts

Impacts of the Project to available mineral resources are anticipated to be minimal. No sand, gravel, uranium, or coal resources are known to be actively or historically mined in the Project Area, and no economic deposits of mineral resources are known to be present in the Project Area. No geologic hazards were identified in the Project Area.

Impacts to groundwater resources in the Project Area are anticipated to be minimal. Major withdrawals of groundwater will not be necessary due to the limited water supply needs of the Project. Except for the newly installed groundwater well to supply water for domestic use at the O&M facility, no new wells will be drilled. Based on the small amount of increased impervious surface area that would be created by Project components relative to the separation of these components and the size of the entire Project Area, the Project will have minimal impacts to regional groundwater recharge. Based on the generally deep water levels recorded in well logs in the area, Project construction activities such as excavation and construction of foundations are unlikely to affect groundwater quality or flow patterns. If impacts were to occur, they would likely be minor and highly localized, and unlikely to adversely affect local water supply wells. In addition, each turbine will be located a minimum distance of 2,640 feet away from existing non-participating residential structures, thereby minimizing the risk of impacts to private wells in the area, which are assumed to be located in proximity to the structures they serve.

Development of the turbine foundations may require subsurface blasting, which could potentially fracture bedrock and affect groundwater flow in the immediate vicinity of the disturbance. In the event that subsurface blasting is required, a blasting plan would be developed and implemented to keep the impacts localized and fracture the least amount of bedrock necessary for construction. Potential disturbances due to blasting would be localized and temporary, with groundwater likely to resume its natural course of flow down gradient of the foundation. Although it is not anticipated, if dewatering of excavations is necessary, water would be discharged to the surrounding surface, allowing it to infiltrate back into the ground to minimize potential impacts.

5.11.3 Mitigative Measures

Geotechnical surveys will be conducted to evaluate the subsurface conditions at the location of each turbine and other significant Project structures (i.e., substation, O&M building). Project components will then be microsited, as necessary, to avoid unsuitable areas.

Wind turbine locations will not impact the use of existing water wells because the turbines will not be sited within 2,640 feet of non-participating occupied structures. In the event that subsurface blasting is required, a blasting plan would be developed and implemented to keep the impacts localized and fracture the least amount of bedrock necessary for construction. It may be necessary to pump out any accumulated groundwater in the excavation during construction. All dewatering of the excavation would be discharged to the surrounding surface, thereby allowing it to infiltrate back into the ground to minimize potential impacts.

5.12 Surface Water and Floodplain Resources

As of the writing of this application, the Final Wetland Delineation Report was not complete. Once complete, this report will be submitted to the NDPSC. Below is a summary of the contents of the report including preliminary findings.

5.12.1 Description of Resources

Surface water and floodplain resources were evaluated using a combination of desktop analysis and field delineation (**Table 20**). The desktop analysis was conducted for surface water and floodplain resources within the Project Area. Desktop data sources included U.S. Geological Survey topographic maps, FEMA Flood Insurance Rate Maps (FIRM), the National Hydrography (NHD) dataset (USGS 2013), and United States Fish and Wildlife Service (USFWS 2013) National Wetlands Inventory (NWI) data.

The Federal Emergency Management Agency (FEMA) website was queried for flood insurance rate mapping data (FIRM 1987). The Project Area is located in FEMA Map Panel ID # 380333IND0 (1987). The Project is located entirely within FEMA Zone D. This is defined as: "Areas with possible but undetermined flood hazards. No flood hazard analysis has been conducted. Flood insurance rates are commensurate with the uncertainty of the flood risk."

The Project area lies within the Cedar Creek watershed (HUC 10130303). The NHD dataset documents 33 intermittent stream segments in the Project area and two intermittent ponds. The only named stream on USGS and NHD mapping within the Project Area is Duck Creek. Duck Creek is intermittent, as evidenced not only by USGS mapping, but also from field observations made in April/May 2013. NWI mapping shows parts of Duck Creek as palustrine emergent wetland with temporary flooding (i.e., temporarily holding water during some portion of the growing season), while other segments of the stream within the Project area are mapped as palustrine, aquatic bed, semipermanently flooded. The aquatic bed segments would indicate that those areas have floating or submerged wetland plants dominating the feature in that location. The water regime of semipermanently flooded indicates that particular portion of stream is either inundated all growing season, or the water table is at or very near the ground surface for most of the growing season. Duck Creek flows east approximately 20 stream miles from the Project area eventually joining Cedar Creek, which is a perennial stream. Cedar Creek flows on to the east, joins the Cannonball River,

and ultimately, the Cannonball River flows in the Missouri River, which at that locations forms Lake Oahe. The Missouri River is a traditional navigable water.

The field delineation for surface water features was conducted April 29 through May 2, 2013. This work was limited to those features that were intersected either directly or within predetermined buffer distances (i.e., 200 feet from turbine locations, 250 feet either side of access road centerlines, and 100 feet either side of the collection line centerlines) from planned Project infrastructure. A Trimble GeoExplorer XH with submeter accuracy was utilized to delineate surface water features. Both sides of streams were generally mapped using the ordinary high water mark (OHWM) as the outer bounds of the stream feature. The U.S. Army Corps of Engineers (USACE) defines the term "ordinary high water mark" at 33 CFR 328.3(e) as "… that line on the shore established by the fluctuations of water and indicated by physical characteristics such as a clear, natural line impressed on the bank, shelving, changes in the character of soil, destruction of terrestrial vegetation, the presence of litter and debris, or other appropriate means that consider the characteristics of the surrounding areas." Swales and other drainage features that lacked an OHWM or defined beds and banks were not considered waters of the United States (WoUS) and were not delineated. The only named stream in the Project area (Duck Creek) was not observed to have any flow during field delineation work, nor did any other stream have flowing water. There was standing water in many drainage locations, generally with ponding in deeper segments of the stream channel.

5.12.2 Impacts

Only the USACE can make a final determination on the jurisdiction of a wetland at a site. Therefore, jurisdictional determinations provided in this report are preliminary and are based on interpretation of the regulations and application of the above guidance following desk top review of relevant information and field inspection. Construction of the wind turbines, transformer pads, collection lines, access roads, O&M building and the substation will disturb land within the Project Area. All transformer pads and the O&M and substation will be built on uplands to avoid ephemeral and intermittent streams located in the Project area. Turbines, collection lines and access roads to the turbines will be carefully sited so as to avoid impacts to the greatest extent practicable. In the event that some impacts from collector lines or access roads cannot be avoided, the impacts will be minimized and mitigated for. In those instances where electrical collection lines must cross ephemeral or intermittent drainages, the lines will either be placed using horizontal directional drilling (HDD) yielding no impact to the drainages, or they will be placed using open trenching methods, resulting in temporary impacts to WoUS.

Table 20 lists the WoUS that were delineated during April/May 2013 field work. Three potentially jurisdictional waters were identified within the Project Area in locations either intersected directly by planned Project infrastructure or they are in within conservative buffers for planned Project infrastructure. Buffer distances utilized include 200 feet for turbine locations, 250 feet either side of the centerline for access roads, and 100 feet either side of the centerline for collection lines.

Table 20. Delineated Waters of the United States* Identified During Wetland Delineation

Feature ID	Flow Regime	Preliminary Jurisdictional Determination
TS-WoUS-1	**Intermittent**	Potentially jurisdictional
TS-WoUS-2	**Intermittent**	Potentially jurisdictional
TS-WoUS-3	**Intermittent**	Potentially jurisdictional

*Delineated wetlands are also considered WoUS, but they are listed separately in Table 21.

5.12.3 Mitigative Measures

If WoUS cannot be fully avoided during the construction phase of the Project, then impacts should be minimized to the greatest extent practicable. Horizontal directional drilling could be used to install the electrical collection lines that cross delineated WoUS features on the Project site. Careful placement of culverts would lessen impacts to WoUS from access road construction. Impacts from construction of turbine pads should be carefully controlled to avoid any delineated WoUS. This can be accomplished with pre-construction marking of OHWM for WoUS and fencing to keep construction out of the feature. Informal consultation with the Bismarck Regulatory Office of the USACE is advisable.

Electrical collection lines and access roads constructed adjacent to intermittent streams and drainageways will be designed in such a manner that runoff from the upper portions of the watershed can flow unrestricted to the lower portion of the watershed. An application (Notice of Intent) to obtain coverage under the NPDES general permit for storm water discharges associated with construction activity will be submitted to the North Dakota Department of Health (DOH) prior to construction of the project. If open trenching for collection lines is selected, then the impacted drainage will be returned to the original contour following the trenching, and the upland and embankment areas will be reseeded with native vegetation noted for the area during field reconnaissance.

A stormwater runoff permit would be obtained prior to construction. Compliance with this permit and the associated SWPPP would ensure that surface water is not adversely affected by runoff from disturbances and construction areas.

5.13 Wetlands

As of the writing of this application, the Final Wetland Delineation Report was not complete. Once complete, this report will be submitted to the NDPSC. Below is a summary of the contents of the report including preliminary findings.

5.13.1 Description of Resources

Wetlands and riparian areas are important resources because they provide habitat utilized by both resident and migratory wildlife. Wetlands also provide a number of important ecosystem functions including providing terrestrial and aquatic wildlife habitat, food chain support, attenuation of flood flows, recharge and discharge of groundwater resources, stabilization of streambanks and shorelines, retention of sediments, retention and transformation of nutrients and contaminants, and recreation.

Wetlands were evaluated using a combination of desktop analysis and routine wetland delineation. Desktop analysis of wetland resources for the Thunder Spirit Project was conducted in March 2012, followed by routine onsite wetland delineation in April 2012. The desktop analysis included evaluation of the Project area using NWI mapping, National Agriculture Imagery Program (NAIP) aerial imagery interpretation, and topographic maps. A total of 129 wetland polygons were documented in the Project area using the NWI dataset (USFWS 2013d). Most of these features appear to be related to intermittent streams or drainageways. There is a smaller percentage of the 129 wetland polygons that are palustrine emergent wetland or palustrine unconsolidated bottom wetlands.

Wetland delineation was conducted from April 29 – May 2, 2013. Delineation methodology followed the U.S. Army Corps of Engineers (USACE) *Wetland Delineation Manual* (1987) and the *Regional Supplement to the Corps of Engineers Wetland Delineation Manual: Great Plains Region (Version 2.0)* [2010]. Wetland indicator status for vegetation was determined using the *Great Plains 2012 Final Regional Wetland Plant List* (Lichvar 2012). **Table 21** lists the wetlands that were delineated during April/May 2013 field work. Five potentially jurisdictional wetlands were identified within the Project Area in locations either intersected by planned Project infrastructure or are near to planned Project infrastructure (**Figure 16**).

5.13.2 Impacts

A stormwater runoff permit would be obtained prior to construction. Compliance with this permit and the associated SWPPP would ensure that surface water is not adversely affected by runoff from disturbances and construction areas.

Five potentially jurisdictional wetlands were delineated within the Project Area in locations either intersected directly by planned Project infrastructure or within conservative buffers (200 feet for turbines, 250 feet for access roads, and 100 feet for collection lines) for planned Project infrastructure. None of the delineated wetlands appears likely to have permanent disturbance from planned Project infrastructure; however, four of the wetlands would have temporary impacts from the current siting (**Tables 21**).

As currently designed, there would be temporary impacts to four wetlands from construction of the electrical collection line system. These temporary impacts would be cumulatively less than the 0.5-acre threshold for use of Nationwide Permit #12. However, field observations at each of the four wetland sites clearly documented that use of horizontal directional drilling could avoid all impacts. It is therefore recommended that the horizontal directional drilling approach be utilized for construction of the collection lines at these delineated wetland sites.

Table 21. Potentially Jurisdictional Features Identified During Wetland Delineation

Feature ID	Cowardin Classification	Preliminary Jurisdictional Determination a/	Potential Intersect w/Project Feature	
			Permanent	Temporary b/ (Collection Lines) Acres
TS-WET-1	**PEMA** (Palustrine, emergent, temporarily flooded)	Potentially jurisdictional	0.00	0.23 (Collection Lines)
TS-WET-2	**PEMA (**Palustrine, emergent, temporarily flooded)	Potentially jurisdictional	0.00	0.056 (Collection Lines)
TS-WET-3	**PEMCh (**Palustrine, emergent, seasonally flooded, diked/impounded)	Uncertain	0.00	0.069 (Access Road)
TS-WET-4	**PEMC** (Palustrine, emergent, seasonally flooded)	Uncertain	0.00	0.041 (Collection Lines)
TS-WET-5	**PEMCh (**Palustrine, Emergent, Semipermanently flooded, diked/impounded)	Uncertain	0.00	None
Potential Project impacts for uncertain or non-jurisdictional hydrologic features			0.00	0.11
Potential Project impacts for potentially jurisdictional or jurisdictional hydrologic features			0.00	0.29
Potential total Project impacts			0.00	0.40

Notes:
a/ Jurisdictional status of features were based on nexus determination completed during the field evaluation, but would require final decision of significant nexus from USACE.
b/ Temporary impacts assumed to be 3.75 acres for turbines (approximately, 250-foot radius), 100 feet for access roads, and 50 feet for collection lines. Of these temporary impacts, 0.75 acres (approximately, 100-foot radius) will be permanent for turbines, and 36 feet will be permanent for access roads.
d/ Impact calculations are rounded to two significant digits.
e/ Impacts were not calculated for drainage swales as these features are not generally considered USACE jurisdictional and impacts to these features do not require notification to the USACE.

5.13.3 Mitigative Measures

Horizontal directional drilling could be used to install the electrical collection lines that cross delineated wetland features on the Project site. If wetlands cannot be fully avoided during the construction phase of the Project, then impacts should be minimized to the greatest extent practicable and the Bismarck Regulatory Office of the USACE should be informally consulted.

5.14 Vegetation

5.14.1 Description of Resources

Using 2006 NLCD data, it was found that approximately 0.06 % of the Project Area was comprised as deciduous forest, 31.4% was comprised of grassland/herbaceous, and 0.3% was comprised of shrub/scrub (**Table 15**). As discussed in **Section 5.3.1**, to supplement the NLCD data, further land use analysis of the Project Area within the WEFP was performed to better assess native prairie habitat.

During the Project field reconnaissance, most of the grasslands in the Project Area observed were planted with smooth brome and intermediate wheatgrass. The hills within the Project area are the locations with remnant native shortgrass prairie patches, dominated very clearly by blue grama (*Bouteloua gracilis*), threadleaf sedge (*Carex filifolia*), and fringed sagebrush (*Artemisia frigida*). More mesic prairie sites have some green needlegrass (*Nassella viridula*), needle-and-thread grass (*Hesperostipa comata*), little bluestem (*Schizachyrium scoparium*), and various species of bluegrass (Poa sp.). Shrublands and forested areas are almost non-existent; trees and shrubs are limited to shelterbelts or for landscaping around residences.

5.14.2 Impacts

As **Table 16** in **Section 5.3** above indicates, deciduous forest, grassland/herbaceous, and shrub/scrub land cover types were considered vegetation for calculating impacts within the Project Area. Up to 267 acres of vegetated lands will be temporarily impacted while only up to 75 acres will be permanently impacted by the Project.

With regard to native prairie habitat, it was determined that up to 247 acres will be temporarily impacted. Only 73 acres of native prairie would be permanently impacted by the Project. Based on the layout dated April 26, 2013, 36 of the 85 potential turbine locations surveyed will be located in native prairie and native prairie/hayfields (note that only 50-75 of these will actually be constructed depending on which turbine model is selected).

Access road construction will result in the greatest effects to native vegetation, resulting in permanent loss of portions of these habitats where they occur along selected routes. Installation of the proposed buried collector system will result in some temporary effects to native and non-native grasslands. Where disturbance is significant, effects will be mitigated by reseeding the trenched areas with native grasses following completion of construction activities.

5.14.3 Mitigative Measures

Thunder Spirit will work to avoid and to minimize impacts to existing trees and shrubs. Trees and shrubs anticipated to be cleared will be inventoried for replacement. Tree replacement will be on a 2 to 1 basis with 2-year-old saplings; shrub replacement will be on a 2 to 1 basis with stem cuttings. Trees and shrubs will be replaced by the same species or similar species, according to the PSC Tree and Shrub Mitigation Specifications.

5.15 Wildlife

5.15.1 Description of Resources

Based on issues identified at wind generation sites throughout the U.S., those species of greatest concern are federally and/or state-protected species, avian species, and bats that may occur in the Project Area.

Avian Species

Avian Point Count Surveys

Avian point count surveys were conducted at 20 locations within the Project Area from June 2007 to October 2007 (Derby et al. 2008). An additional year of avian point count surveys were

conducted at 25 point locations within the Project Area from April 2011 to March 2012 (Derby et al. 2013). Surveys were conducted in accordance with industry-standard due diligence avian survey protocol. In 2007, surveys were conducted biweekly, at approximately 14-day intervals, during the summer season (June 5 – August 10) and weekly, at approximately 7 day intervals, during the fall season (August 24 – October 29). The 2011-2012 surveys were conducted biweekly, at approximately 14-day intervals, during spring (March 15 – May 31) and fall (September 1 – November 15) seasons and reduced to once per month, at approximately 28 day intervals, during the summer (June 1 – August 31) and winter seasons (November 16 – March 14).

In the 2007 avian surveys, 57 avian species were observed during the avian point count surveys, including six (6) species observed only incidentally to point count surveys (Derby et al. 2008). Four species dominated the observations, European starling, horned lark, ring-necked pheasant and western meadowlark, which accounted for 61.5 percent of all observations (Derby et al. 2008). Nine species of raptors were observed, including golden eagles (two individuals). Golden eagle observations occurred during the fall surveys and the individuals were observed flying within the anticipated rotor-swept area (RSA; Derby et al. 2008). Fourteen sensitive species listed as North Dakota Species of Conservation Priority (including the golden eagle) were observed. No other threatened or endangered (T&E) species were observed during these surveys.

In the 2011-2012 avian surveys, 73 avian species were observed during the avian point count surveys, including five (5) species observed only incidentally to point count surveys (Derby et al. 2013). Two species, sandhill crane and horned lark, accounted for 53.5 percent of all observations with 7.1 percent of the horned larks and 95.6 percent of all sandhill cranes recorded flying within the anticipated RSA (Derby et al. 2013). These cranes were all observed among four (4) flocks on a single day in April 2012. Eight species of raptors were observed, including golden and bald eagles (six individuals and one (1) individual, respectively). Golden eagles were observed in all survey seasons in 2011-2012 with four observations recorded flying within the anticipated RSA (Derby et al. 2013). The bald eagle was observed perched during the winter survey. Twenty-one (21) sensitive species, listed as North Dakota Species of Conservation Priority, (including the eagles) were observed including the federal candidate species Sprague's pipit (Derby et al. 2013). One Sprague's pipit was observed during the spring point count survey while two other individuals were observed during the late spring as incidental observations. No other threatened or endangered (T&E) species were observed during these surveys.

Sharp-tailed Grouse Lek Surveys

One season (spring 2011) of sharp-tailed grouse leks surveys was conducted (Derby and Thorn 2013). Three aerial transect surveys were conducted over a single nine-day period in late April-early May 2011. Surveys followed protocol consistent with prairie-chicken aerial leks surveys as described by Martin and Knopf (1981). The leks observed were defined as either confirmed (1 lek; observed courtship behavior during more than one surveys), probable (3 leks; observed courtship behavior during one surveys) and possible (1 lek; little to no courtship behavior but individuals observed in same general location during more than one survey; (Derby and Thorn 2013).

Five (5) grouse leks were identified, including one confirmed lek, three probable leks, and one possible lek (Derby and Thorn 2013). The confirmed lek was located within the Project area in planted grassland habitat. Two of the three probable leks were located in native prairie habitat outside of the Project area while the third was within the Project area in alfalfa hay cropland (Derby

and Thorn 2013). The one possible lek was located in an unknown grassland habitat type inside the Project area (Derby and Thorn 2013). The two leks outside the Project area were within the 1.6 kilometer (km; 1 mile) survey buffer (Derby and Thorn 2013).

Raptor Nest Surveys

Aerial and ground raptor nest surveys were conducted in spring 2011 (Derby and Thorn 2013). Aerial nest surveys were conducted within the Project area and 16.1 km (10-mile) buffer from a fixed-wing aircraft and, focused on potential nest structures for eagles. Ground-based raptor nest surveys were conducted concurrent to avian point count surveys.

Two active raptor nests were identified within the Project area, including one nest occupied by great-horned owls and one nest occupied by Swainson's hawks approximately 1.2 km (0.75 miles) east of the Project (Derby and Thorn 2013). Although no eagle nests were identified during the aerial surveys, WEST requested a database review of known eagle nest locations within 10 miles of the Project area from USFWS in 2011. One known golden eagle nest approximately 5 miles west of the Project boundary was identified by the USFWS, but was not observed during the 2011 season.

2013 Eagle Nest Survey

Thunder Spirit and WEST undertook a dedicated eagle nest survey in May 2013 using a helicopter within the Project area and a surrounding 10-mile buffer area. Detection levels can be higher using this type of aircraft compared to a fixed-wing. During this survey, a single golden eagle nest was found adjacent to the project area and a minimum 2 mile buffer has been instituted while ongoing behavioral observations are conducted to evaluate potential eagle use of the Project Area.

Bats

According to the USGS Northern Prairie Wildlife Research Center (2006), there are nine bat species that can be found in North Dakota, including the little brown bat (Myotis lucifugus), silver-haired bat (Lasionycteris noctivagans), big brown bat (Eptesicus fuscus), eastern red bat (Lasiurus borealis), hoary bat (Lasiurus cinereus), western long-eared myotis (M. evotis), western small-footed myotis (M. ciliolabrum), Keen's myotis (M. keenii), and long-legged myotis (M. volans).

Passive Acoustic Bat Monitoring Surveys

Two years of passive acoustic monitoring surveys were conducted in the Project area. The first year of surveys were conducted from 23 July to 15 October, 2007 with two ground-level AnaBat II (TitleyTM Scientific, Australia) ultrasonic bat call detectors placed in the southwestern and northwestern portions of the Project area (Derby et al. 2008). A second year of passive acoustic monitoring surveys was conducted within the Project area from 25 May to 20 October, 2011 using AnaBat SD1 ultrasonic bat call detectors (Derby and Sichmeller 2013). Incoming echolocation calls are digitally processed and stored by the detector. The integrated zero crossings analysis interface module (ZCAIM) produces a file that, when viewed in appropriate software (i.e., Analook ®; 2008, C. Corben), displays digital sonograms of the echolocation calls that show change in frequency over time (Derby and Sichmeller 2013). Frequency versus time displays was used to separate bat calls from other types of ultrasonic noise (e.g. wind, insects, etc.) and to identify the call frequency classification and species (when possible) of bat that generated the calls (Derby and Sichmeller 2013). One pair of detectors was placed at a pre-existing meteorological tower in the southwest corner of the Project area with one unit placed near the approximate turbine rotor-swept area and

another at ground-level. Two additional ground-level detectors were placed in suitable bat foraging habitat in short-grass habitats near agricultural fields in the south-central and northwest sections of the Project area.

In 2007, detectors collected 126 bat passes, defined as a sequence of echolocation calls produced by an individual bat as indicated by at least two calls (pulses) with no pause between calls of more than one second (Derby et al. 2009). Overall bat activity was 1.13 bat passes per detector night, and the bat activity between detectors was relatively similar (1.0 bat passes per detector night at the northwestern detector, and 1.13 bat passes per detector night at the southwestern detector; Derby et al. 2009). Of the bat passes not identifiable to species, calls were mainly low frequency, likely belonging to such species as silver-haired bat, big brown bat, Townsend's bat and hoary bat. Bat passes identifiable to species included the hoary and eastern red bat (Derby et al. 2009). Neither species is designated as a North Dakota Species of Conservation Priority, although both have been identified as fatalities at wind energy projects in North America.

In 2011, bat detectors were operational for approximately 82 percent of the survey period, and detected 406 bat passes (Derby and Sichmeller 2013). Overall bat activity was 0.78 bat passes per detector night, and the majority of calls were recorded at the ground-level detectors (364 bat passes; Derby and Sichmeller 2013). Of bat passes not identifiable to species, calls were mainly high-frequency bats identified as Myotis species and eastern red bat (Derby and Sichmeller 2013). Bat passes identifiable to species included the hoary and eastern red bat (Derby and Sichmeller 2013).

5.15.2 Impacts

In general, most wildlife species do not use disturbed agricultural land, heavily grazed land, or maintained pastures and hayfields as their primary habitat. As a result, there will be minimal impacts to most species. Most non-raptors had relatively low risk of collision due to the majority of individuals flying below the likely RSA (Derby et al. 2013). It is unlikely that non-raptor populations will be adversely affected by direct mortality from the operation of the wind energy facility given the robustness of their overall populations and overall low impacts to any one species (Derby et al. 2013).

Annual raptor use in the Project area (0.68 raptors/plot/20-min survey) was compared to annual raptor use at other wind energy facilities (Derby et al. 2013). The mean annual raptor use at these other wind energy facilities ranged from 0.06 raptors/20-min survey to 2.34 raptors/20-min survey. Based on the results from these facilities, a ranking of mean annual raptor use was developed as: low (0 – 0.5 raptors/plot/20-min survey); low to moderate (0.5 – 1.0); moderate (1.0 – 2.0); high (2.0 – 3.0); and very high (over 3.0; Derby et al. 2013). Using this ranking, mean raptor use in the Project area is considered to be low to moderate with the most abundant raptors at the project being northern harrier, red-tailed hawk, and Swainson's hawk.

Waterbirds (composed only of sandhill cranes) were the bird type with the highest collision risk exposure index of any bird type or species (Derby et al. 2013). All of the sandhill cranes observed during fixed-point surveys (1,125 individuals among 4 flocks observed in a single day) were flying and 95.6 percent of those individuals were within the RSA at some point (Derby et al. 2013). There is some potential for this species to collide with wind turbines at the Project; however, this species is

rarely reported as a fatality from wind energy facilities in the US, even though the sandhill crane is a relatively common species (Derby et al. 2013).

The presence of wind turbines may alter the landscape so that wildlife use patterns are affected, displacing wildlife away from the Project facilities and suitable habitat (Derby et al. 2013). In addition to direct effects through collision mortality, wind energy development results in indirect effects such as direct loss of habitat where infrastructure is placed and indirect loss of habitat through behavioral avoidance and perhaps habitat fragmentation. Prairie grouse have been identified as a group that exhibits such avoidance behavior. Ninety-eight sharp-tailed grouse observations were recorded during the study in 2011 (Derby et al. 2013). In 2011, five (5) leks were observed in or near the Project area during spring lek surveys (Derby and Thorn 2013). Much debate has occurred recently regarding the potential impacts of wind energy facilities on prairie grouse. Under a set of voluntary guidelines, the USFWS has taken a precautionary approach and recommends wind turbines be setback from known prairie grouse lek locations (USFWS 2003a). The USFWS argues that because prairie grouse evolved in habitats with little vertical structure, placement of tall man-made structures (e.g., wind turbines) in occupied prairie grouse habitat may result in a decrease in habitat suitability (USFWS 2004). While the potential exists for wind turbines to displace prairie grouse from occupied habitat, studies examining the extent of this potential impact are currently lacking (Derby et al. 2013). While there is no requirement for a buffer setback for wind energy, Thunder Spirit has imposed a 0.5 mile setback from known grouse leks (this is a buffer based on recommendations for petroleum development).

Potential impacts to sensitive species are discussed in more detail in **Section 5.16.2** below.

5.15.3 Mitigative Measures

Thunder Spirit has conducted environmental studies of the Project Area to aid in the initial placement of turbines, roads, and associated facilities to avoid or minimize impacts to wildlife and habitat. Thunder Spirit is currently developing a Bird and Bat Conservation Strategy (BBCS) that outlines the species of concern for the Project, how investigations were done to identify use of the area and results of those studies, what actions were done and will be done to avoid, minimize, and mitigate potential impacts, and what measures will be taken during the operation of the Project. This plan will include specific sections on golden eagles, Sprague's pipit, and sharp-tailed grouse but will also include other species of concern. In addition, the following measures will be used, to the extent practicable, by Thunder Spirit to help avoid potential impacts to wildlife in the Project Area during selection of the turbine locations and subsequent development and operation:

- Thunder Spirit will bury all collection lines and has reduced the overhead radial transmission line to 0.85 miles to reduce the likelihood of avian collisions;
- Siting access roads and turbines away from wetlands, waterbodies, and native prairies to the greatest extent practicable;
- Other than an approximately 0.85 mi overhead radial transmission line from the Project substation to the MDU Hettinger 230kV Substation, no overhead power lines will be used;
- A minimum 2 mile buffer around the eagle nest was instituted while ongoing behavioral observations are being conducted to evaluate eagle use of the Project Area.
- Thunder Spirit imposed a 0.5 mile setback around the five (5) known grouse leks in the design of the layout.

- Minimizing the use of lights on turbines when practicable in accordance with state, federal, and local requirements;
- Restricting construction and/or operation activities due to active raptor nests; mapping and flagging raptor nests found during construction; placing turbines as far away from raptor nests as project and engineering constraints permit and avoid removal of trees;
- Minimizing impacts to native vegetation and wetlands during design and construction of turbines and associated infrastructure;
- Reseeding or planting disturbed areas with native material;
- Enhancing existing degraded habitat, where practicable, through the removal and replacement of invasive species with plants native to the site;
- Developing a management plan to prevent the spread of noxious weeds throughout the Project Area or adjacent areas during construction and ongoing operations;
- Thunder Spirit has committed to a minimum of one year of post-construction mortality avian and bat monitoring; and
- Implementing a wildlife reporting protocol once turbine construction is completed. The protocol will include measures for field technicians to report and document avian mortalities during routine maintenance operations.

5.16 Rare and Unique Natural Resources

5.16.1 Description of Resources

The Endangered Species Act (ESA), as administered by the USFWS, mandates protection of species federally listed as threatened or endangered and their associated habitats. The ESA makes it unlawful to "take" a listed species. Take is defined as "to harass, harm, pursue, hunt, shoot, wound, kill, trap, capture or collect or attempt to engage in any such conduct." Significant modification or degradation of listed species' habitats is considered "harm" under ESA regulations. Projects that have such potential will require consultation with USFWS and may require special permitting or mitigative measures to avoid or reduce impacts to these species. Candidate species receive no statutory protection from the USFWS; however, they do receive full protection once listed.

The Bald and Golden Eagle Protection Act (BGEPA) prohibits the take of any bald eagle or golden eagle, alive or dead, including any part, nest, or egg. "Take" is defined as "pursue, shoot, shoot at, poison, wound, kill, capture, trap, collect, molest or disturb". "Disturb" means to agitate or bother an eagle to a degree that causes, or is likely to cause 1) injury to an eagle; 2) a decrease in its productivity, by substantially interfering with normal breeding, feeding, or sheltering behavior; or 3) nest abandonment, by substantially interfering with normal breeding, feeding, or sheltering behavior. Historically permits were not available under the BGEPA for incidental takes from otherwise lawful activities. However, USFWS promulgated regulations in 2009 that provided for a permitting framework for incidental take associated with otherwise lawful activities, including wind energy, under the existing BGEPA (50 Code of Federal Regulations § 22.26). The Final Eagle Conservation Plan (ECP) Guidance – Version 2, that outlines the recommended steps for permit applicants, was released by USFWS in April 2013 (USFWS 2013a).

Under the Migratory Bird Treaty Act (MBTA) it is unlawful to pursue, hunt, take, capture or kill; attempt to take, capture, or kill; possess, offer to or sell, barter, purchase, deliver or cause to be shipped, exported, imported, transported, carried or received any native migratory bird, part, nest,

egg or product. The USFWS has established a permitting scheme for a variety of intentional activities, such as hunting and scientific research, but has not done so for the incidental take of migratory birds associated with otherwise lawful activities. As a result, assuming that the collision of a migratory bird with a wind turbine would constitute an incidental take under the MTBA by the wind turbine owner and/or operator, there is no permitting framework that allows protection from liability. However, the USFWS typically exercises enforcement discretion to not pursue enforcement action under the MBTA if good faith efforts have been made to minimize impacts.

The USFWS's Environmental Conservation Online System website lists four species that have the potential to occur in the vicinity of the Project: the endangered whooping crane (*Grus Americana*), black-footed ferret (*Mustela nigripes*), and gray wolf (*Canis lupus*), and the candidate Sprague's pipit (*Anthus spragueii*; USFWS 2013b).

Whooping Crane

The whooping crane was considered endangered in the United States in 1970 and the endangered listing was 'grandfathered' into the ESA in 1973. One self-sustaining wild population of whooping cranes currently exists in the world. Members of this population breed primarily within the boundaries of Wood Buffalo National Park in Canada and migrate through the central United States in route to the wintering grounds at Aransas National Wildlife Refuge along the Gulf Coast of Texas. This flock is referred to as the Aransas-Wood Buffalo National Park Population. Due to intensive management, this population has increased from 15 birds in 1941 to 266 as of August 2012 (WCCA 2012).

Whooping cranes undertake a 5,000-mile annual round-trip migration from the breeding area in Canada to the wintering area in Texas. Individuals depart the breeding ground in Canada and travel south through Alberta, North Dakota, South Dakota, Nebraska, Kansas, Oklahoma, and reach the wintering ground on the Texas coast. The migration route is well defined and 94 percent of all observations occur within a 200-mile wide migration corridor during spring and fall migration (CWS and USFWS 2007). The Project Area is located approximately 11-miles west of the defined migration corridor. There are no historical sighting within the Project area and 11 historical sightings that occur within 35-miles of the Project area from 1961 to 2009. One of the historical sightings, in 1994, occurred within 10 miles of the Project area (Derby et al. 2008 and 2013). No whooping cranes were observed during 2007 or the 2011 avian surveys (Derby et al. 2008 and 2013).

Black-footed ferret

The black-footed ferret, a member of the weasel family, was listed as endangered in 1967 pursuant to early endangered species legislation in the United States and was also "grandfathered" into the ESA. The USFWS estimate that the average minimum number of breeding adult ferrets in the wild is approximately 364 animals (USFWS 2013c). Approximately 280 additional animals are managed in captive breeding facilities. As of 2013, the down-listing criteria is approximately 40 percent complete with regard to establishing 10 successful populations and approximately 18 percent complete with regard to the goal of 1,500 breeding adults at successful sites (USFWS 2013c). Four reintroduction sites—Aubrey Valley, Arizona; Cheyenne River Reservation, South Dakota; Conata Basin, South Dakota; and Shirley Basin, Wyoming—are considered self-sustaining as of 2013. The nearest of these reintroduction sites is Cheyenne River Reservation (4,267 square miles) in South Dakota (USFWS

2013c). The exact location of the reintroduction sites within the Cheyenne River Reservation was not given in the recovery plan.

The black-footed ferret depends on prairie dogs for food and on their burrows for shelter. The historical range of the ferret coincided with the ranges of the black-tailed prairie dog (*Cynomys ludovicianus*) which rage overlaps the Project area, Gunnison's prairie dog (*C. gunnisoni*), and white-tailed prairie dog (*C. leucurus*; USFWS 2013c). The ferret's close association with prairie dogs was an important factor in the ferret's decline. From the late 1800s to approximately the 1960s, prairie dog occupied habitat and prairie dog numbers were dramatically reduced by the effects of both temporal and permanent habitat loss caused by conversion of native prairie grasslands to cropland, intentional poisoning, and disease (sylvatic plague; USFWS 2013c). No black-footed ferrets or prairie dog colonies were observed in the Project area during any surveys.

Gray wolf

The gray wolf was listed as an endangered species in 1978 (USFWS 1978). In 2003, the USFWS downgraded the two northern subpopulations (Northern Rocky Mountain and Western Great Lakes distinct population segments) to threatened (USFWS 2003b). The Western Great Lakes (includes Minnesota, Wisconsin, and Michigan; the eastern half of North Dakota and South Dakota; the northern half of Iowa; the northern portions of Illinois and Indiana; and the northwestern portion of Ohio) and the Northern Rocky Mountain (Montana, Wyoming, Idaho, eastern Washington, eastern Oregon, and north central Utah) distinct population segments were delisted due to recovery on January 27, 2012 and February 27, 2008 respectively (USFWS 2013e). The gray wolf is still listed as endangered in western North Dakota west of the Missouri River to Lake Sakakawea then along Highway 83 to the Canadian border. Once a common keystone predator capable of utilizing a wide range of habitats throughout North Dakota, the last confirmed sighting in the state was 1991 although there have been more recent but unconfirmed reports of sightings in the Turtle Mountains in the north-central portion of the state.

Sprague's pipit

The Sprague's pipit is closely tied with native prairie habitat and breeds in the north-central United States in Minnesota, Montana, North Dakota and South Dakota as well as south-central Canada (Jones 2010). The USFWS reviewed the conservation status of Sprague's pipit to determine whether the species warrants protection under the Endangered Species Act. The status review found that listing Sprague's pipit as threatened or endangered is warranted, but that listing the species at this time is precluded by the need to complete other listing actions of a higher priority (Jones 2010). Currently the Sprague's pipit remains a candidate species for listing under the ESA and is still protected under the MBTA. Conversion of native prairie to agriculture and overgrazing in much of this species' range continue to cause declines on breeding and wintering grounds (Jones 2010). No Sprague's pipits were observed during the 2007 surveys; one individual was observed during avian point count surveys and two other individuals were observed as an incidental observation during the 2011 surveys.

Eagles

Wind energy development can affect eagles in a variety of ways. First, eagles can be killed by colliding with structures such as wind turbines. Second, disturbance from preconstruction, construction, or operation and maintenance activities might disturb eagles at concentration sites or and result in loss of productivity at nearby nests. Third, serious disturbance or mortality effects could result in the permanent or long term loss of a nesting territory (USFWS 2013a). Additionally, disturbances near important eagle use areas or migration concentration sites might stress eagles so much that they suffer reproductive failure or mortality elsewhere, to a degree that could amount to prohibited take (USFWS 2013a). All of these impacts, unless properly permitted, are violations of BGEPA.

State-listed Species

Although state-listed species in North Dakota receive no regulatory protection, the NDGFD has identified 100 species of conservation priority, or those in greatest need of conservation in the state (NDGFD 2008). They are categorized into three levels according to the need to conserve them:

- Level I - Species in greatest need of conservation.
- Level II - Species in need of conservation, but have had support from other wildlife programs.
- Level III - Species in moderate need of conservation, but are believed to be on the edge of their range in North Dakota.

Fourteen sensitive bird species were observed during point count surveys and/or as an incidental observation during the 2007 surveys (**Table 22**). Northern harrier (39 individuals), Swainson's hawk (20 individuals), and sharp-tailed grouse (18 individuals) were the most commonly observed sensitive species.

Twenty-one sensitive bird species were observed during point count surveys and/or as an incidental observation during the 2011 surveys (**Table 22**). The Swainson's hawk (150 individuals) was the most commonly observed sensitive species, followed by the northern harrier (142 individuals), and northern pintail (141 individuals).

Native Prairie Habitats

Native prairies serve as a vital ecological resource by improving water quality, providing erosion control, and supporting a diverse population of plants and animals. However, due to the native prairies' fertile soils and predominantly flat topography, large portions of the native prairie have been converted to agricultural lands. This wide spread loss of native prairie makes this an ecosystem of conservation concern and one of the most endangered ecosystems in North America (Samson et al. 2004).

Native prairies are important habitat used by prairie grouse (e.g., sharp-tailed grouse, greater prairie chicken) for lekking, nesting, brood rearing, and wintering. Grouse lek habitat is classified as open, short grass vegetation with minimal amounts of agriculture. Development in grouse lekking habitat could result in direct habitat loss, habitat loss through avoidance, predator facilitation, and construction-related disturbance. Most prairie grouse are considered gamebirds and are often managed locally by state fish and game agencies for hunting purposes.

Table 22. List of North Dakota species of conservation concern observed during the 2007 and 2011 surveys.

Species	Scientific Name	ND Status	Total Observed Individuals	
			2007 Surveys	2011 Surveys
American bittern	*Botaurus lentiginosus*	I	0	1
willet	*Catoptrophorus semipalmatus*	I	0	2
upland sandpiper	*Bartramia longicauda*	I	3	4
marbled godwit	*Limosa fedoa*	I	2	6
Swainson's hawk	*Buteo swainsoni*	I	20	150
ferruginous hawk	*Buteo regalis*	I	1	2
Sprague's pipit	*Anthus spragueii*	I	0	3
grasshopper sparrow	*Ammodramus savannarum*	I	8	15
Baird's sparrow	*Ammodramus bairdii*	I	1	0
lark bunting	*Calamospiza melanocorys*	I	2	88
chestnut-collared longspur	*Calcarius ornatus*	I	0	15
northern pintail	*Anas acuta*	II	0	141
redhead	*Aythya americana*	II	0	50
sharp-tailed grouse	*Tympanuchus phasianellus*	II	18	98
northern harrier	*Circus cyaneus*	II	39	142
prairie falcon	*Falco mexicanus*	II	3	0
bald eagle	*Haliaeetus leucocephalus*	II	0	1
golden eagle	*Aquila chrysaetos*	II	2	6
burrowing owl	*Athene cunicularia*	II	0	2
short-eared owl	*Asio flammeus*	II	1	5
loggerhead shrike	*Lanius ludovicianus*	II	2	14
red-headed woodpecker	*Melanerpes erythrocephalus*	II	0	3
bobolink	*Dolichonyx oryzivorus*	II	0	28
peregrine falcon	*Falco peregrinus*	III	1	0

Source: Derby et al. 2009, Derby et al. 2013.

5.16.2 Impacts

Whooping crane

The primary threats of wind energy development to whooping cranes are mortality due to collision with transmission lines, associated structures and loss of habitat due to avoidance. The Project presents a low risk to whooping cranes. The Project area is located outside the known migratory corridor. There are no historical records of whooping cranes occurring within the Project area, 11 historical sightings that occur within 35-miles of the Project area from 1961 to 2009, and one historical sighting within 10 miles of the Project area.[1] The Project area lacks suitable wetland habitat (103.4 acres or 0.39 percent of the Project area) that would make ideal roosting habitat for whooping cranes during the spring and fall migration. No whooping cranes were observed during any of the avian surveys.

Thunder Spirit has incorporated measures into the Project to minimize potential impacts to whooping cranes, including siting access roads and turbines away from wetlands and other waterbodies to the greatest extent practicable, and limiting new overhead powerlines to less than one mile from the Project substation to the MDU Hettinger 230kV Substation.

[1] The whooping crane observations should be used for general inference regarding use of an area and cannot be used for micrositing features away from whooping crane sightings because some of the observations may lack precise locations. Additionally, the absence of a sighting in a specific area should not be construed as a whooping crane having never occurred in that area.

Black-footed ferret

The Project is unlikely to affect black-footed ferret as there have not been any prairie dog colonies found in the Project area and it is unlikely that black-footed ferrets are present.

Gray wolf

The Project is unlikely to affect current gray wolf habitat, and there has not been a confirmed wolf sighting in North Dakota since 1991.

Sprague's pipit

The Project is unlikely to affect Sprague's pipit as the species was not detected breeding within the Project area. The Project may impact migratory individuals during the spring and fall migration due to risk of collision with the turbines. However, any impacts are expected to me minimal as the species was not detected during the 2007 surveys and three individuals were detected during the 2011 surveys indicating a low use of the Project area by Sprague's pipit.

Eagles

Preliminary site screening and pre construction surveys of the Project have indicated that little ideal nesting habitat for bald eagles (i.e. large trees) and golden eagle (steep cliffs) exists in the Project Area or nearby. Relatively little eagle use of the Project Area was documented within the Project Area (six (6) observations of golden eagles and one (1) of a bald eagle during 12 months of 2011-2012 surveys) and the Project lacks features such as large waterbodies or high concentration of prey items (fish and rodents such as prairie dog colonies) that would attract eagles.

Additional information obtained from the USFWS indicates that one historic golden eagle nest is located within 10 miles of the Project area. The nest was active in 2004 and 2006. Two golden eagles were observed during the 2007 surveys and six observations were noted in the 2011 surveys. Observations occurred in all seasons and were possibly the same birds. It is not known if the birds observed during the avian surveys are the same birds that were nesting within 10 miles of the Project area. Based on the low use and low amount of habitat for golden eagles, the Project may affect but is unlikely to impact golden eagles.

No bald eagles were observed during the June-October 2007 avian surveys. One bald eagle was detected during the yearlong 2011-2012 avian surveys and no bald eagle nests were found during that year's raptor nest survey. During the 2013 raptor nest surveys a single bald eagle nest was found approximately 10 mile from southwestern boundary of the Project Area. A minimum 2 mile buffer was instituted while ongoing behavioral observations are being conducted to evaluate eagle use of Project Area. Based on the low use of the area by bald eagles and the low amount of habitat, the Project is unlikely to affect bald eagles.

Additional mitigation and monitoring are outlined in **Section 5.15.3** and **5.16.3**.

State listed species

In general, the Project has a low risk of collision for most species of birds. For the 2011 surveys the flying raptors were observed within the rotor swept height (RSH) 50.6% of the time. Thirteen percent of flying northern harriers (Type II) were observed within the RSH. Swainson's hawks (Type

I) were observed within the RSH at any time during 97.4 percent of observations followed by the red-tailed hawk (90.3%), mallard (56.8%), and northern harrier (21.7%).

Ninety-eight sharp-tailed grouse (Type II) observations were recorded during the study. In 2011, five leks were observed in or near the Project area during spring lek surveys (Derby and Thorn 2013). Much debate has occurred recently regarding the potential impacts of wind energy facilities on prairie grouse are discussed in **Section 5.15.2**.

Native Prairie Habitats

As discussed, in **Section 5.3.2**, it was determined that up to 247 acres of native prairie will be temporarily impacted. Only 73 acres of native prairie would be permanently impacted by the Project.

Also, as discussed in **Section 5.14**, 36 of the 85 potential turbine locations surveyed will be located in native prairie and native prairie/hayfields (note that only 50-75 of these will actually be constructed depending on which turbine model is selected).

5.16.3 Mitigative Measures

Thunder Spirit will avoid the resources identified to the extent practicable. Avoidance/minimization practices are discussed in **Sections 5.15.3**. In addition to the ongoing nest monitoring for eagles and eagle surveys, Thunder Spirit has committed to a minimum of one year of post-construction mortality monitoring for birds and bats.

5.17 Summary of Impacts

Table 23 summarizes the resources that will be affected as a result of the Project and the appropriate mitigation.

Table 23. Summary of Impacts and Mitigation

Resource	Impact	Mitigation
Demographics	Primarily positive due to increased expenditures during construction and the long term benefits of lease payments and an increased tax base of the county due to property taxes.	N/A
Land Use	Approximately 176 acres of land will be affected by turbines, associated access roads, and O&M facility, and the substation during operation. Temporary impacts during construction for turbine installation, road construction, cable trenching, and laydown and contractor staging are estimated at 641 acres.	Thunder Spirit will work with landowners to minimize impacts of the Project to agricultural resources.
Public Services	No impacts are anticipated.	Thunder Spirit will utilize station service from the local electrical utility and will abide by the utility's recommendations to prevent impacts to the transmission system.
Human Health and Safety	No impacts are anticipated.	Turbines will be lighted to comply with FAA requirements. A variety of security measures will be implemented to reduce the chance of physical and property damage.
Noise	No impacts are anticipated to noise-sensitive resources (occupied residences).	Thunder Spirit has located turbines so the maximum level of 48.6 dBA is not exceeded at occupied residences. Thunder Spirit will also comply with the Adams County ordinance: Sustained noise of over 80 dB during the day and 70 dB at night is not allowed.
Visual	Visual impacts will occur. The impacts are based on a subjective human response, and there are existing wind energy facilities in the Project vicinity.	Thunder Spirit will work with landowners to site turbines. They will not be located in environmentally sensitive areas. Existing infrastructure will be used where possible. Cut and fill areas will be minimized and mitigated as appropriate.
Cultural, Archaeological, and Historic Architecture	No impacts to previously identified cultural resources are anticipated.	Thunder Spirit has conducted Class I, II, and III inventories for the proposed Project. Turbines and other Project facilities will be microsited to avoid impacts to newly documented archaeological sites that are potentially eligible to the NHRP. The sites that were identified during Project surveys will be evaluated for significance in consultation with SHPO and avoided as necessary.
Recreational Resources	No impacts are anticipated.	Since no significant recreational resources will be removed from service due to the Project, no mitigative measures are proposed.
Land Based Economies	The agricultural economy would have up to 92 acres of land permanently affected. In addition, approximately 347 acres would be impacted temporarily due to construction activities.	These impacts represent a minor portion of the land area within the Project Area that is available for agricultural production. As a result, no adverse effects are expected. Thunder Spirit will work with landowners to minimize impact to their agricultural lands.

Resource	Impact	Mitigation
Soils	Approximately 176 acres of land will be permanently affected. Temporary impacts include 641 acres for turbine installation, road construction, cable trenching, O&M facility construction, and laydown and contractor staging. Also, Thunder Spirit will work with the landowners to alleviate the compaction of any soils which occurs during construction,	BMPs for erosion and sediment control will be utilized to minimize wind and water erosion at the site. Only land needed for the facility will be permanently affected. Temporarily disturbed areas will be restored.
Geologic and Groundwater Resources	No impacts to geologic or groundwater resources are anticipated.	Geotechnical surveys will be conducted to evaluate the subsurface conditions at the location of each turbine and other significant Project structures
Surface Water and Floodplain Resources	Access roads and turbines will be located and constructed in such a manner that impacts to surface waters will be avoided to the greatest extent practicable.	Thunder Spirit will implement BMPs to minimize erosion and sedimentation at the site.
Wetlands	As currently designed, there would be no permanent impacts are anticipated. Temporary impacts will be avoided to the greatest extent practicable.	Horizontal directional drilling will be used where necessary to avoid impacts to wetlands from collection line trenching during construction.
Vegetation	Up to 267 acres of vegetated lands (out of 641 temporarily disturbed acres) will be temporarily impacted while only up to 75 acres (out of 176 permanently disturbed acres) will be permanently impacted by the Project. Up to 247 acres of native prairie will be temporarily impacted (out of a total disturbed area of 641 acres). Only 73 acres of native prairie would be permanently impacted by the Project. Based on the layout dated April 26, 2013, 36 of the 85 potential turbine locations surveyed will be located in native prairie and native prairie/hayfields (note that only 50-75 of these will actually be constructed depending on which turbine model is selected).	Thunder Spirit will avoid existing trees and shrubs as practicable and will use BMPs during construction and operation to minimize impacts. If trees are removed as part of the Project, they will be replaced per PSC's Tree and Shrub Mitigation Specifications. Native prairie has been avoided to the extent practicable. Temporarily disturbed areas will be reseeded per USFWS and NRCS recommendations. Native prairie will be avoided to the extent practicable and will be reseeded using native prairie mix.
Wildlife	Potential avian and bat collisions may occur, but are anticipated to be relatively few. Two active raptor nests were identified within the Project area Also, five sharp-tailed grouse leks were observed during lek surveys.	In addition to developing the BBCS, a variety of mitigative measures will be implemented, as discussed in **Section 5.15.3**. In addition to the BMPs described throughout this Application, Thunder Spirit will conduct one-year of post-construction mortality monitoring as described in **Section 5.15.3**.
Rare and Unique Natural Resources	An active golden eagle nest was discovered adjacent to the Project Area in May 2013. Intensive behavioral observations are currently being conducted to determine the degree to which, if any, the eagles use the Project Area. Native Prairie is discussed above.	While patterns of eagle use are being investigated, a minimum buffer of 2 miles has been implemented between the known nest and the closest turbine location. Further mitigation measures will be established, including ongoing nest monitoring and one year post-construction mortality monitoring, once more is known about potential eagle use of the Project Area. Additional mitigative measures will be implemented, as discussed in **Section 5.15.3**.

6. PUBLIC AND AGENCY COORDINATION

Per Section 69-06-01-05 of the PSC's administrative rules, Thunder Spirit and its representatives have contacted key local, state and federal agencies to inform them of the Project and for assistance in identifying concerns or issues within the Project Area. Agency correspondence and responses received as of May 31, 2013 are included in Appendix B. **Section 8.12** provides a summary of responses received from agencies.

Principal stakeholders in the Project are landowners that have entered or will be entering into agreements with Thunder Spirit to provide wind rights for the Project. Thunder Spirit will continue to meet with County officials as the Project moves forward and Thunder Spirit seeks any necessary local permits (e.g. building permit).

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7. POTENTIAL PERMITS/APPROVALS

The federal and state permits or approvals that have been identified as potentially required for the construction and operation of the Project are shown in **Table 24**. Permits dependent on the final site layout will be applied for after receiving PSC approval, but prior to construction.

Table 24. Potential Permits and Approvals Required for Construction and Operation of the Proposed Facility

Agency	Type of Approval	Status*	Need
Federal Approvals			
U.S. Army Corps of Engineers	Nationwide Permit	3	Wetland delineation was completed May 2013. (See **Section 5.13**)
Federal Aviation Administration	Determination of No Hazard to Air Navigation	1	Notice and approval are required for structures over 200 feet in height. FAA approval of lighting and marking of turbines is required.
State of North Dakota			
Public Service Commission	Certificate of Site Compatibility	1	Required for construction of generation facility over 0.5 MW in size.
North Dakota State Historic Preservation Office	Concurrence on results of Cultural Resources Inventory	1	Class I, Class II, and Class III surveys were completed May 2013; report will be submitted to SHPO for review. (See **Section 5.7**)
North Dakota Department of Health	NPDES Permit: General Construction Storm Water	2	Required for disturbance of over 1 acre of land. Must prepare a Storm Water Pollution Prevention Plan (SWPPP).
North Dakota Highway Patrol	Overheight/Overweight Permit	2	Permit required for hauling construction equipment and materials on State Highways.
North Dakota Department of Transportation	Road Approach/Access Permit	3	Permit required for construction of access roads from State Highways.
	Utility Permit/Risk Management Documents	3	Permit required for utility crossings on State Highway ROW.
Local Permits			
Adams County	Wind Energy Facility Siting Permit	1	Underway
	Building Permits	1	Adams County has determined that a single building permit will be issued for the entire proposed facility.

* Status Explanation:
1 Applied and/or Decision Pending
2 Will Apply Once Certificate is Received
3 Final Layout will Determine Whether Permit/Approval is Needed

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8. FACTORS CONSIDERED BY PSC

The North Dakota Energy Conversion and Transmission Facility Siting Act lists 11 factors to guide the Commission in the evaluation and designation of the site of the facility.

8.1 Public Health and Welfare, Natural Resources, and the Environment

The preceding sections discuss the research and investigations relating to the effects of the proposed facility on public health and welfare, natural resources, and the environment. These effects and the proposed mitigation to minimize these effects are summarized in **Section 5.17**.

8.2 Technologies to Minimize Adverse Environmental Effects

Thunder Spirit will utilize the most current technologies that minimize impacts to the environment. Current wind turbine technologies, including the equipment and siting tools, optimize the wind and land resources.

8.3 Potential for Beneficial Uses of Waste Energy

This factor is not applicable to this Project. No waste energy is created using wind energy.

8.4 Unavoidable Adverse Environmental Effects

Unavoidable adverse environmental effects may include the visual impacts associated with the Project, as well as those impacts related to the placement of Project facilities and the use of the land within the site. The visual character of the site will be changed due to the construction of the Project. In order to construct the facility, access roads and turbine pads are necessary for the operation and maintenance of the facility. The preliminary turbine, access road, collection line, O&M facility and substation layout is expected to impact approximately 176 acres of land during operation. Approximately 641 acres of land will be temporarily affected due to turbine and road construction, collection line trenching, O&M facility construction, and laydown/contractor staging areas.

8.5 Alternatives to the Proposed Site

Thunder Spirit consulted with various agencies and has conducted a variety of studies in the development process. An optimal area was selected which will balance the needs of the Project along with the need to avoid and/or minimize environmental impacts. In this iterative process, new information acquired was used to modify the Project footprint as necessary, including but not limited to:

- Construction feasibility
- Landowner preference specifically with respect to agricultural disturbance
- Local setbacks
- FAA interference
- The location of eagle nests
- The location of sharp-tailed grouse leks
- Cultural sites that were potentially eligible for the NRHP

Thunder Spirit believes that the proposed Project is the most viable alternative. Thunder Spirit is committed to being flexible on the preliminary site layout and will work closely with landowners and to examine all reasonable alternatives to the preliminary site layout.

8.6 Irreversible and Irretrievable Commitment of Natural Resources

Irreversible and irretrievable resource commitments are related to the use of nonrenewable resources and the effects that the use of these resources have on future generations. Irreversible effects primarily result from use or destruction of a specific resource that cannot be replaced within a reasonable timeframe. Irretrievable resource commitments involve the loss in value of an affected resource that cannot be restored as a result of the action. There are few commitments of resources associated with this Project that are irreversible and irretrievable, but these include those resources primarily related to construction. Construction of the Project will necessitate a one-time expenditure of funds, which is not retrievable.

Labor and natural resources will be used in the fabrication and preparation of construction materials. These materials are usually not retrievable. Construction resources that will be used include aggregate resources, concrete, steel, and hydrocarbon fuel. Each steel turbine requires the construction of a concrete base approximately 50 to 60 feet across and seven (7) to eight (8) feet thick. Access roads will require aggregate resources for their construction and maintenance. During construction, vehicles will be traveling to and from the site, utilizing hydrocarbon fuels. These resources are not in short supply, and their use will not have an adverse effect on the availability of these resources. In addition, the anticipated economic benefits of the Project will balance the irretrievable commitment of resources resulting from the construction of the Project (see **Section 8.7**).

8.7 Direct and Indirect Economic Impacts

Economic impacts include impacts associated with the temporary disturbance of up to 641 acres of land due to turbine installation, road construction and collection line trenching, O&M facility, and the laydown/construction staging area. Permanent impacts will be lower, at approximately 176 acres. In general, agricultural areas surrounding each turbine can still be grazed or farmed, and landowner compensation will be established by individual lease agreements

The remaining direct and indirect economic impacts are primarily positive. Wind energy development removes less total land from agricultural use than other forms of development. The rural economy and energy production in the county and state is diversified. To the extent that local contractors are used for portions of the construction, total wages and salaries paid to contractors and workers in Adams County will contribute to the total personal income of the region. Additional personal income will be generated for residents in the county and the state by circulation and recirculation of dollars paid out by Thunder Spirit as business expenditures and state and local taxes. Expenditures made for equipment, energy, fuel, operating supplies, and other products and services benefit businesses in the county and the state.

Long-term beneficial impacts to the county's tax base as a result of the construction and operation of the wind farm will contribute to improving the local economy in this area of North Dakota. The development of wind energy in this region will be important in diversifying and strengthening the

economic base of southwestern North Dakota. Additional revenues are expected from property and income taxes.

Continuing to establish the central region of North Dakota as an important producer of alternative energy sources may spur the development of wind-related businesses in the area, in turn contributing to economic growth in the region.

8.8 Existing Development Plans of the State, Local, Government and Private Entities at or in the Vicinity of the Site

No conflicts are anticipated with existing state and local government and private entities' development plans.

8.9 Effect of Site on Cultural Resources

Tetra Tech conducted a Class III Pedestrian Survey for archeological resources. Based on the April 26, 2013 Project layout, 20 archaeological sites, 5 site leads, and 1 Euro-American stone pile site are located within the current APE. The cultural resources inventory report will be submitted to the North Dakota State Historic Preservation Officer (SHPO) for comment once it is complete.

Thunder Spirit is committed to minimize impacts to these resources and will avoid these resources and any additional resources identified throughout the life of the Project. If avoidance is not possible, Thunder Spirit will work with the North Dakota SHPO to mitigate potential impacts.

Refer to **Section 5.7** for the results from the cultural surveys conducted.

8.10 Effect of Site on Biological Resources

Thunder Spirit will implement measures to avoid and minimize effects to biological resources at the proposed site. The impact of the Project on wildlife is expected to be minimal. There is potential for avian and bat collisions with facility turbines or meteorological towers. The site will be designed to minimize those impacts. Detailed discussion of potential impacts and proposed mitigative measures on biological resources is provided in **Section 5.14** (Vegetation), **Section 5.15** (Wildlife), and **Section 5.16** (Rare and Unique Natural Resources).

8.11 Cumulative Effects

Wind energy development is anticipated to have a positive cumulative impact on air quality, and minimal impacts to geology, soils, water, noise, safety and health issues, and cultural resources. Socioeconomic impacts are anticipated to be positive, as the rural economy and energy production is diversified. The principal resources of concern for cumulative impacts are anticipated to be land use and vegetation, wildlife, and visual resources. With the increase in land being used for wind energy generation activities, grazing and farming will decrease slightly. The cumulative impacts will be a concern for the rural communities that have historically made their living from agricultural activities. The additional income from wind development on their land, however, may make it more feasible for farmers to keep most of their land in agricultural uses rather than being developed for residential, commercial, or industrial uses. Wind energy development removes less total land from agricultural use than other forms of development.

With regard to the cumulative impacts to wildlife, there is a concern that even if no wetlands and other sensitive habitat are directly affected by wind energy projects, the wetlands surrounding the projects will no longer be used by wildlife. Thunder Spirit has committed to zero permanent impacts to wetlands and, other than a short overhead radial transmission line, no new transmission line construction.

8.12 Agency Comments

Agencies were contacted in April 2013 to comment on the Project in support of the application to the PSC (**Appendix B**). Of the agencies listed in Section 69-06-01-05 of the PSC's administrative rules, query letters were sent to agencies that have traditionally responded to requests for comment on wind energy projects. The responses received as of May 31, 2013 are summarized below.

8.12.1 North Dakota Aeronautics Commission

A query letter was sent to the North Dakota Aeronautics Commission on April 23, 2013. A response has not been received as of the writing of this application.

8.12.2 North Dakota Department of Agriculture

A query letter was sent to the North Dakota Department of Agriculture on April 23, 2013. The Department response dated May 1, 2013 indicated that they have no concerns or issues within the boundaries of the tracts that were listed in the letter.

8.12.3 North Dakota Department of Health

A query letter was sent to the North Dakota Department of Health on April 23, 2013. The Department response dated May 3, 2013 indicated that environmental impacts from the proposed construction are expected to be minor and can be controlled by recommended construction methods.

8.12.4 North Dakota Game and Fish Department

A query letter was sent to the North Dakota Game and Fish Department on May 17, 2013. A response has not been received as of the writing of this application.

8.12.5 North Dakota Geological Survey

A query letter was sent to the North Dakota Geological Survey on April 23, 2013. A response was received on May 14, 2013. The letter details the surface geology found in the project area and states that no permits from their department will be required for this Project.

8.12.6 North Dakota Department of Transportation

A query letter was sent to the North Dakota Department of Transportation on April 23, 2013. A response has not been received as of the writing of this application.

8.12.7 State Historical Society of North Dakota

A query letter was sent to the North Dakota Historical Society of North Dakota, which acts as the State Historic Preservation Office (SHPO) for North Dakota, on March 28, 2013. The SHPO provided a response in a letter dated April 29, 2013. SHPO recommended that Class I, II, and III surveys be conducted for the Project and that, as a federal undertaking, consultation include tribal

nations, ND Indian Affairs, and managers or owners of properties maintained for recreational or scenic value, including the NDDOT regarding any Scenic Byways. As part of the Class III inventory, SHPO requested that NDCRS site updates be submitted on all sites resurveyed.

8.12.8 North Dakota Indian Affairs Commission

A query letter was sent to the North Dakota Indian Affairs Commission on April 23, 2013. A response has not been received as of the writing of this application.

8.12.9 North Dakota State Land Department

A query letter was sent to the North Dakota State Land Department on April 23, 2013. A response has not been received as of the writing of this application.

8.12.10 North Dakota Parks and Recreation Department

A query letter was sent to the North Dakota Parks and Recreation Department on April 23, 2013. On May 10, 2013 a response was received. The letter states that the Project does not affect state park lands or Land and Water Conservation Fund recreation projects. There are no documented occurrences for any plant or animal species of concern or other significant ecological community in their database. They recommend proper evaluation of the Project including pre- and post-construction avian and bat monitoring studies. Also, the Department recommends that the Project be accomplished with minimal impacts and that all efforts be made to ensure that critical habitats not be disturbed in the Project Area. Impacted areas should be revegetated with species native to the Project Area.

8.12.11 Adams County Soil Conservation District

A query letter was sent to the Adams County Soil Conservation District on April 23, 2013. A response has not been received as of the writing of this application.

8.12.12 North Dakota State Water Commission

A query letter was sent to the North Dakota State Water Commission on April 23, 2013. On May 16, 2013, a response was received. The letter summarizes the following:

- There are no floodplains identified and/or mapped where this proposed project is to take place.
- The area is identified by the National Flood Insurance Program (NFIP). The NFIP map used to make this determination is: Adams County, Date 1/2/1987.
- A drain permit may be needed if wetlands are filled. It is the responsibility of the project sponsor to ensure that local, state, and federal agencies are contacted for any required approvals, permits, and easements.
- All waste material associated with the project must be disposed of properly and not placed in identified floodway areas.
- No sole-source aquifers have been designated in North Dakota.

There are no other concerns associated with this project that affect the State Water Commission or State Engineer regulatory responsibilities.

8.12.13 U.S. Fish and Wildlife Service

While not required by Section 69-06-01-05 of the PSC's administrative rules, a query letter was sent to the USFWS on May 17, 2013. A response to that letter has not been received as of the writing of this application. A copy of this permit application will be submitted to the USFWS.

8.12.14 U.S. Army Corps of Engineers

While not required by Section 69-06-01-05 of the PSC's administrative rules, a query letter was sent to the USACE on April 23, 2013. A response has not been received as of the writing of this application.

8.12.15 Other Agencies

Other agencies that provided comments during the public scoping period included the USDA Natural Resources Conservation Service (NRCS) and the USEPA. The NRCS expressed their responsibility under the Farmland Protection Policy Act and recommended that impacts to wetlands be avoided. The USEPA recommended that impacts several environmental resources be addressed in the NEPA process and that the appropriate agencies be consulted.

Thunder Spirit also submitted an inquiry to the NTIA in May 2013. The NTIA forwards the Project information to various federal agencies and provides them 45 days to respond with potential concerns regarding potential impacts to federal telecommunication systems and military airspace. A response has not been received as of the writing of this application.

9. QUALIFICATIONS OF CONTRIBUTORS

Name Project Role	Education and Professional Experience
INGO STUCKMANN, PH.D. CEO and Director Wind Works Power Corp.	Dr. Stuckmann received his Ph.D. in Natural Sciences from the University of Heidelberg and conducted post-doctoral research at Harvard University. In 2002, he joined Energy Farming International in Germany. He has worked on 1,500 MW of projects that are developed (900 turbines installed), representing $3 billion investment value, in Germany, Spain, and the United States. In 2008, he co-founded Zero Emission People LLC. Since 2009 served as CEO and Director of Wind Works Power Corp.
LARRY GREENE CDO and President Wind Works Power Corp.	Mr. Greene received a MS from University of California, Davis and MBA from UCLA Anderson School. He has 23 years of international energy experience in Canada, United States, Thailand and Indonesia, with the last 10 years in renewable energy. From 2001 to 2005, he served as the Vice President of Development for Global Renewable Energy Partners (a Vestas Company). From 2005 to 2011, he served as the Vice President of Development and Director of Public Policy for Acciona Energy. He has developed 511 MW of wind and solar energy projects in the United States, with 178 MW of wind in Canada now under construction or in operation. Since 2010, he has served as the President of the California Wind Energy Association (CalWEA). In 2011, Mr. Greene joined Wind Works Power Corp. to head the project development function and expand utility-scale development activities in the Americas.
ERICH BACHMEYER JD, VP of Development Global Winds Harvest, Inc.	Mr. Bachmeyer received a JD from the George Washington University National Law Center. In 2000, he joined Global Winds Harvest, focusing on land rights agreements, interconnection procedures/agreements, and corporate agreements. He is experienced with the entire greenfield development process of wind power projects across the United States.
DAN ALBANO, PH.D VP of Environmental Affairs Global Winds Harvest, Inc.	Dr. Albano received his doctoral degree in avian ecology from University of Massachusetts – Amherst. He worked for several years as Senior Scientist for private environmental consulting firm. In 2001, he joined Global Winds Harvest as Director of Permitting and Environmental Affairs. Dr. Albano has longstanding experience with environmental due diligence and site suitability, contracting and reviewing environmental impact studies, and working closely with regulators at local, state, and federal levels to permit complex projects under tight timelines Lead permitting experience at over 30 wind projects in the U.S. (NY, PA, ME, LA, IL, KS, SD, ND, MN, CO, NV, OR, and CA) and Ontario, Canada.
TRACEY DUBUQUE, P.E. Project Manager Tetra Tech, Inc.	Ms. Dubuque has over 15 years of experience in the environmental consulting business. She has experience preparing and securing environmental permits for energy-related facilities, coordinating and managing biological and cultural field surveys, and contributing to National and State Environmental Policy Act (NEPA) documentation. Ms. Dubuque manages siting studies, prepares environmental permits, and conducts consultation with local, state and federal stakeholders for wind energy. Bachelor's degree in Civil Engineering, Merrimack College.

Name Project Role	Education and Professional Experience
EMILY MANN Deputy Project Manager Tetra Tech, Inc.	Ms. Mann has over three years' experience as an environmental planner and siting specialist, with over seven years' experience as a GIS Analyst working in environmental consulting. Ms. Mann has supported utilities and other energy clients with the siting and permitting of energy facilities in over 12 states. Responsibilities have included siting and environmental issues analyses, impact and critical issues assessment along with technical support of National Environmental Policy Act (NEPA) documents and analyses and state level energy permits. BA, Geography (Specialization in Human Geography), Boston University, 2005
WILLIAM SCALES GIS Analyst Tetra Tech, Inc.	Six years as a GIS analyst, with a wide range of experience including database design and management; GIS Data conversion, development, migration, and integration; GIS/GPS deployment; Expertise in GIS projects involving marine and oceanographic data, utility systems, energy planning/siting, asset management, infrastructure, and constraint/impact analysis. BS (Bachelor of Science), English (Minor: Biology), Lehigh University, 1999
ANNE-MARIE GRIGER, AICP Environmental Planner Tetra Tech, Inc.	Ms. Griger has ten years of experience in environmental planning and permitting, including public involvement, NEPA compliance, and large-scale infrastructure projects including wind energy generating facilities, solar energy facilities, highways, and landfills. She has prepared the PSC permit application and other environmental documents for five other wind energy projects in North Dakota.
ADAM HOLVEN Archaeologist Tetra Tech	Mr. Holven led the Class I and Class III Cultural Resources Inventory for the Project. He has extensive archaeological field experience, including large-scale multi-square mile cultural resource surveys for wind farms in North Dakota, South Dakota, and Minnesota.
STEVE YARBROUGH Wetlands Biologist Tetra Tech	Mr. Yarbrough, a certified professional ecologist with the Ecological Society of America and a director on the board of the Colorado Native Plant Society, has 26 years of experience as a biologist and environmental scientist in the environmental consulting field, including managing Environmental Impact Statement/Environmental Assessment (EIS/EA) projects under the National Environmental Policy Act (NEPA). His background in wetland science includes conducting jurisdictional wetland delineations, wetland permitting, consulting with the U.S. Army Corps of Engineers (USACE), preparing wetland mitigation monitoring plans, and writing wetland restoration conceptual plans. MA (Master of Arts), Biology, University of Colorado, Denver, 2000 BA (Bachelor of Arts), Environmental Studies, University of Kansas, 1983
CLAYTON DERBY Wildlife Biologist/Senior Manager WEST	Clayton Derby is senior manager and wildlife biologist for WEST. Since graduating in 1995, Clayton has worked for WEST as a wildlife biologist. His work has covered numerous subject matters; include raptors, migratory birds, wetlands, fisheries, water quality, big game, and vegetation. Clayton has been the Project Manager for several large natural gas pipeline development projects in the western U.S., and wind energy development projects throughout the west and Midwest. BA (Bachelor of Arts), Biology, Moorhead State University, Moorhead, Minnesota 1992 MS (Masters of Science), Zoology and Physiology, University of Wyoming, Laramie, Wyoming 1995.
JIM KOWALSKY Ecologist Tetra Tech, Inc.	Mr. Kowalsky prepared much of the biological sections for the wildlife, rare and unique natural resources initially studied by the various wildlife surveys. He has over 20 years of field biology experience dealing with avian ecology studies with a strong emphasis on the recovery and management of endangered species and five years of direct experience dealing with impacts caused by wind energy facilities in the Midwest. Bachelor's degree in Environmental Studies from the University of Maine at Machias.

Name Project Role	Education and Professional Experience
TED GUERTIN Shadow Flicker Tetra Tech, Inc.	Over 22 years' experience environmental licensing, dispersion modeling, air toxic assessments, air permitting (including PSD), and air quality compliance monitoring, and wind power related environmental assessments and wind resource assessments. He has conducted wind power related assessments using the WindPro software including shadow flicker, zone of visual impact (ZVI), wind farm photo simulations, and initial wind resource evaluation. MS (Master of Science), Atmospheric Science, University of New York at Albany BS (Bachelor of Science), Atmospheric Science, University of New York at Albany
ERIK KALAPINSKI Sound Analysis Tetra Tech, Inc.	Mr. Kalapinski has 20 years' experience in acoustic engineering, consulting and project management. Currently serving as the Noise Group Discipline Lead overseeing technical work. Experience includes over 15 years of industry experience conducting noise evaluations of wind energy facilities for the purpose of permitting. Mr. Kalapinski has the ability to address noise concerns in a clear concise manner through testing, analyses, reporting, public presentation, and expert witness testimony for which he has served before numerous Federal, state and local planning agencies, energy facility siting boards, and in courts of law. BS, Civil and Environmental Engineering, University of Massachusetts

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11. DEFINITIONS

AADT	Average Annual Daily Traffic
ANSI	American National Standards Institute
APE	Area of Potential Effects
Asynchronous Generator	A cage-wound generator, also called an induction generator, used to generate alternating current
bgs	Below ground surface
BBCS	Bird and Bat Conservation Strategy
BMPs	Best Management Practices; prevents soil erosion and sedimentation
Capacity	The capability of a system, circuit, or device for storing electronic charge
Certificate	Certificate of Site Compatibility
Class I Cultural Resources Inventory	Existing data inventory – a large-scale review and compilation of known cultural resource data
Class II/III Cultural Resources Inventory	Field inventory to identify cultural resources that could be affected by project facilities within the Project Area
Aggregate Surface	Road cover used for proposed access roads
Commission or PSC	North Dakota Public Service Commission
CRP	Conservation Reserve Program
DA	Department of the Army
dBA	A-weighted decibel
Distribution	Relatively low-voltage lines that deliver electricity to the retail customer's home or business
DOE	US Department of Energy
Electromechanical	Of, relating to, or being a mechanical process or device actuated or controlled electrically; especially being a transducer for converting electrical energy to mechanical energy
EMF	Electromagnetic Field
EPC	Engineering, procurement, and construction
EPCRA	Emergency Planning and Community Right-to-Know Act
ESA	Endangered Species Act or Environmental Site Assessment
FAA	Federal Aviation Administration
FEMA	Federal Emergency Management Agency
FIRM	Flood Insurance Rate Maps
FPPA	Farmland Protection Policy Act
Ft	Foot/Feet
GE	General Electric
Gearbox	An assembly of parts including the speed-changing gears and the propeller shaft by which the power is transmitted from an automobile engine to a live axle; the speed-changing gears in such an assembly
Generator	A machine by which mechanical energy is changed into electrical energy
Geotechnical	A science that deals with the application of geology to engineering
Hub	The central part of a circular object (as a wheel or propeller)
Interconnection	To be or become mutually connected

kV	kilovolt
kW	kilowatt
MW	megawatt
M	meter
m/s	meter per second
MAPP	Mid-Continent Area Power Pool
MBTA	Migratory Bird Treaty Act
Micrositing	The process in which the wind resources, potential environmentally sensitive areas, soil conditions, and other site factors, as identified by local, state and federal agencies, are evaluated to locate wind turbines and associated facilities.
mph	miles per hour
Nacelle	A streamlined enclosure (as for an engine), which houses the gearbox, generator, brake, cooling system and other electrical and mechanical systems
NAIP	National Agriculture Imagery Program
NDDOH	North Dakota Department of Health
NDDOT	North Dakota Department of Transportation
NESC	National Electric Safety Code
NDAC	North Dakota Administrative Code
NDCC	North Dakota Century Code
NDGFD	North Dakota Game and Fish Department
NDPRD	North Dakota Parks and Recreation Department
NDSDHCL	North Dakota State Department of Health and Consolidated Laboratories
NFIP	National Hydrology dataset
NHD	National Flood Insurance Program
NHID	Natural Heritage Inventory Database
NPDES	National Pollutant Discharge Elimination System
NRCS	National Resource Conservation Service
NRHP	National Register of Historic Places
NWI	National Wetlands Inventory
NTIA	National Telecommunications and Information Administration
NWP	Nationwide Permit
O&M	Operations and maintenance
OHWM	Ordinary high water mark
Pitch	The action or a manner of pitching; especially an up-and-down movement
PPA	Power Purchase Agreement
Project, the	Thunder Spirit Wind Energy Project
PSC or Commission	North Dakota Public Service Commission
PTC	Production Tax Credit
REC	Recognized Environmental Condition
Resistance	The opposition offered by a body or substance to the passage through it of a steady electric current
Rotor	The rotor consists of three blades mounted to a rotor hub
RSH	Rotor Swept Height

RD	Rotor Diameter: Diameter of the rotor from the tip of a single blade to the tip of the opposite blade
ROW	Right-of-Way
rpm	Revolutions per minute
RSA	Rotor swept area
SCADA	Supervisory Control and Data Acquisitions (communications technology)
SHPO	North Dakota State Historic Preservation Office
SHSND	State Historical Society of North Dakota
Step-up Transformer	A transformer that increases voltage
Substation	A subsidiary station in which electric current is transformed
SWPPP	Storm Water Pollution Prevention Plan
TCPO	Tribal Cultural Preservation Officers
THPO	Tribal Historic Preservation Officers
Torque	A force that produces or tends to produce rotation or torsion; also a measure of the effectiveness of such a force that consists of the product of the force and the perpendicular distance from the line of action of the force to the axis of rotation : a turning or twisting force
Transformer	An electrical device by which alternating current of one voltage is changed to another voltage
Transmission	An assembly of parts including the speed-changing gears and the propeller shaft by which the power is transmitted from an automobile engine to a live axle; the speed-changing gears in such an assembly
USACE	US Army Corps of Engineers
USEPA	US Environmental Protection Agency
USFWS	US Fish and Wildlife Service
UT	Unincorporated Township
WCCA	Whooping Crane Conservation Association
WEST	Western EcoSystems Technology Inc.
WoUS	Waters of the United States
WMD	Wetland Management District
WPA	Waterfowl Protection Area
Yaw	To deviate erratically from a course (as when struck by a heavy sea); especially to move from side to side: to turn by angular motion about the vertical axis

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FIGURES

Figure 1

Project Location

Thunder Spirit Wind Energy Project
Thunder Spirit Wind, LLC
Adams County, North Dakota

May 2013

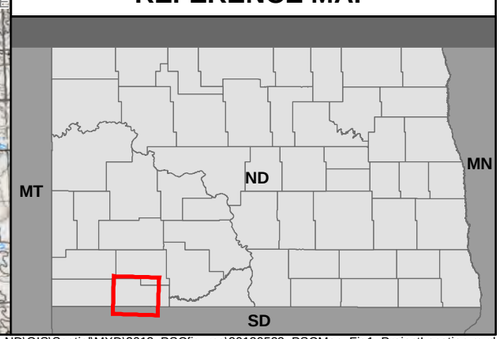
Legend

- Project Area (4/26)
- WEFP (4/26)
- Primary Limited Access or Interstate
- Primary US and State Highway
- Secondary State and County
- Local -Rural
- Railroad
- Populated Place
- County Boundary
- Township Boundary
- Waterbody

N
W E
S

0 1 2 4 6 Miles

REFERENCE MAP



Path: P:\Global Winds Harvest\Thunder Spirit - ND\GIS\Spatial\MXD\2013_PSCfigures\20130523_PSCMap_Fig1_ProjectLocation.mxd

Figure 2

Project Area (Aerial)

Thunder Spirit Wind Energy Project
Thunder Spirit Wind, LLC
Adams County, North Dakota

May 2013

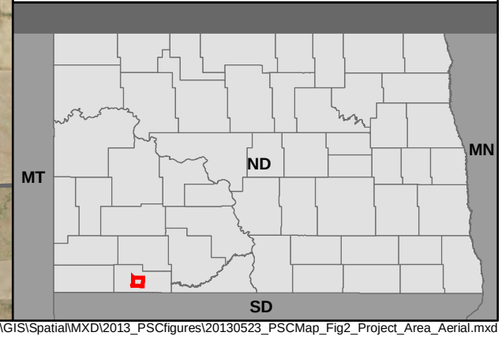
Legend

- Met Tower Location
- Approximate POI
- Proposed Turbine Location (4/26/2013)
- Proposed Collector Substation (4/8/2013)
- Overhead Line (4/8/2013)
- Collection Line (4/26/2013)
- Access Road (4/26/2013)
- Construction Laydown Area (10 Acres)
- Collection Substation, O&M Facility, and Additional Laydown Area
- Project Area (4/26)
- Township Boundary

N
W E
S

0 0.75 1.5 Miles

REFERENCE MAP



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Figure 3

Project Area (Topographical)

Thunder Spirit Wind Energy Project
Thunder Spirit Wind, LLC
Adams County, North Dakota

May 2013

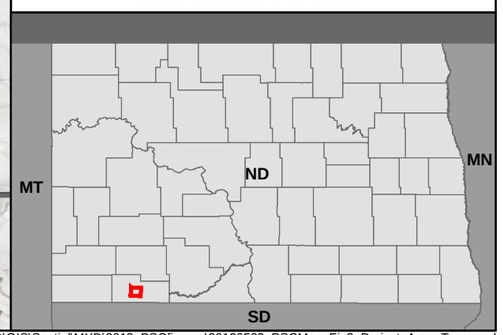
Legend

- Met Tower Location
- Approximate POI
- Proposed Turbine Location (4/26/2013)
- Proposed Collector Substation (4/8/2013)
- Overhead Line (4/8/2013)
- Collection Line (4/26/2013)
- Access Road (4/26/2013)
- Construction Laydown Area (10 Acres)
- Collection Substation, O&M Facility, and Additional Laydown Area
- Project Area (4/26)
- Township Boundary
- Road

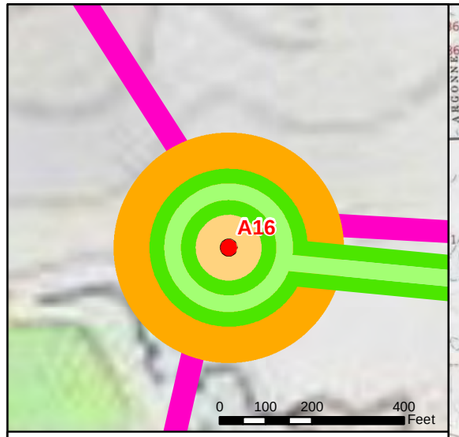
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0 0.75 1.5 Miles

REFERENCE MAP



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"Typical" Impact Buffer Inset*

*This is the worst case scenario (i.e. largest impact area) for the impact assumptions and is not necessarily what will be impacted in the field. Refer to notes in Table 5 of the application.

Figure 4

Project Impact Assumptions

Thunder Spirit Wind Energy Project
Thunder Spirit Wind, LLC
Adams County, North Dakota

May 2013

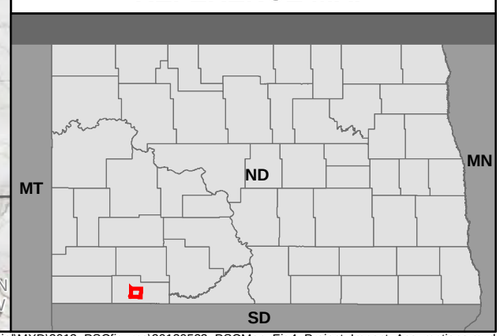
Legend

- Permanent Access Road Impact Buffer
- Temporary Access Road Impact Buffer
- Permanent Turbine Impact Buffer
- Temporary Turbine Impact Buffer
- Temporary Collection Line Impact Buffer
- Permanent Collector Substation and O&M Building Impact
- Temporary Collector Substation, O&M Building, and Laydown Area Impact
- Proposed Turbine Location (4/26/2013)
- Met Tower Location
- Approximate POI
- Proposed Collector Substation (4/8/2013)
- Overhead Line (4/8/2013)
- Collection Line (4/26/2013)
- Access Road (4/26/2013)
- Construction Laydown Area (10 Acres)
- Collection Substation, O&M Facility, and Additional Laydown Area
- Project Area (4/26)
- Township Boundary

0 0.5 1 Miles

N W E S

REFERENCE MAP



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Exclusion Areas

Prime Farmland

Avoidance Areas

Abandoned Mine

Lek Location

Buffer of Lek (0.5 mi)

NWI Wetland

Native Prairie

Native Prairie

Native Prairie/Hayfields

NOTE: FEMA Special Flood Hazard Areas (avoidance area) data not available in this area of North Dakota.
NOTE: Archeological sites (exclusion area) not depicted.

Figure 5

Exclusion and Avoidance Areas

Thunder Spirit Wind Energy Project
Thunder Spirit Wind, LLC
Adams County, North Dakota

May 2013

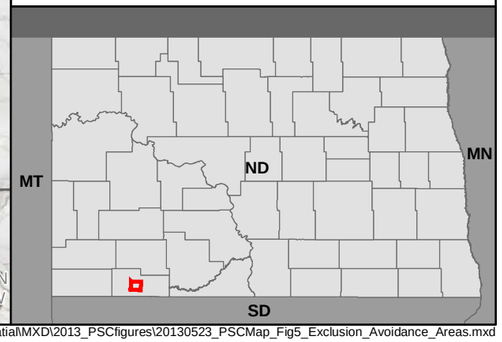
Legend

- Proposed Turbine Location (4/26/2013)
- Met Tower Location
- Approximate POI
- Proposed Collector Substation (4/8/2013)
- Overhead Line (4/8/2013)
- Collection Line (4/26/2013)
- Access Road (4/26/2013)
- Construction Laydown Area (10 Acres)
- Collection Substation, O&M Facility, and Additional Laydown Area
- Project Area (4/26)
- Township Boundary

0 0.5 1 Miles

N W E S

REFERENCE MAP



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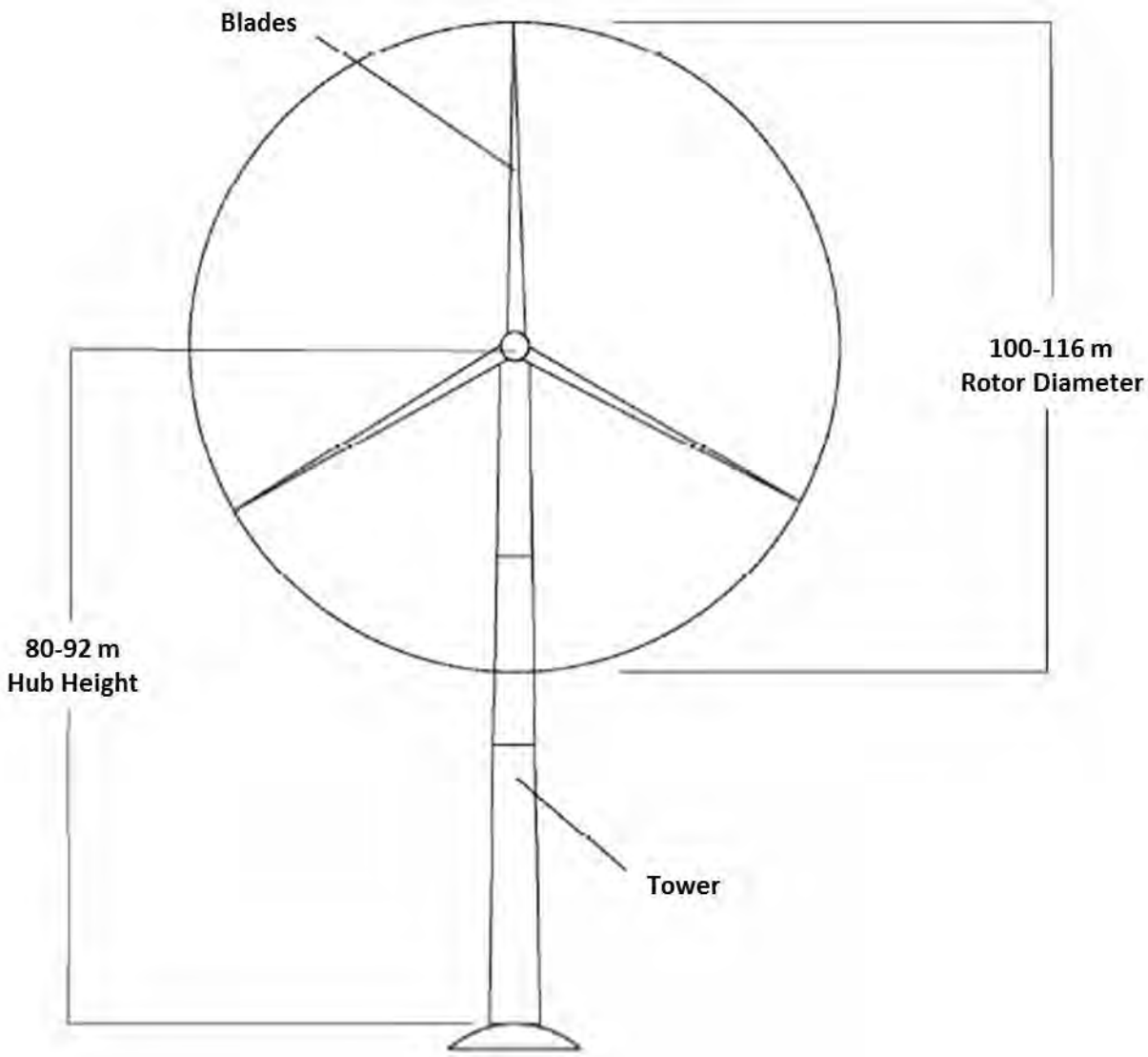
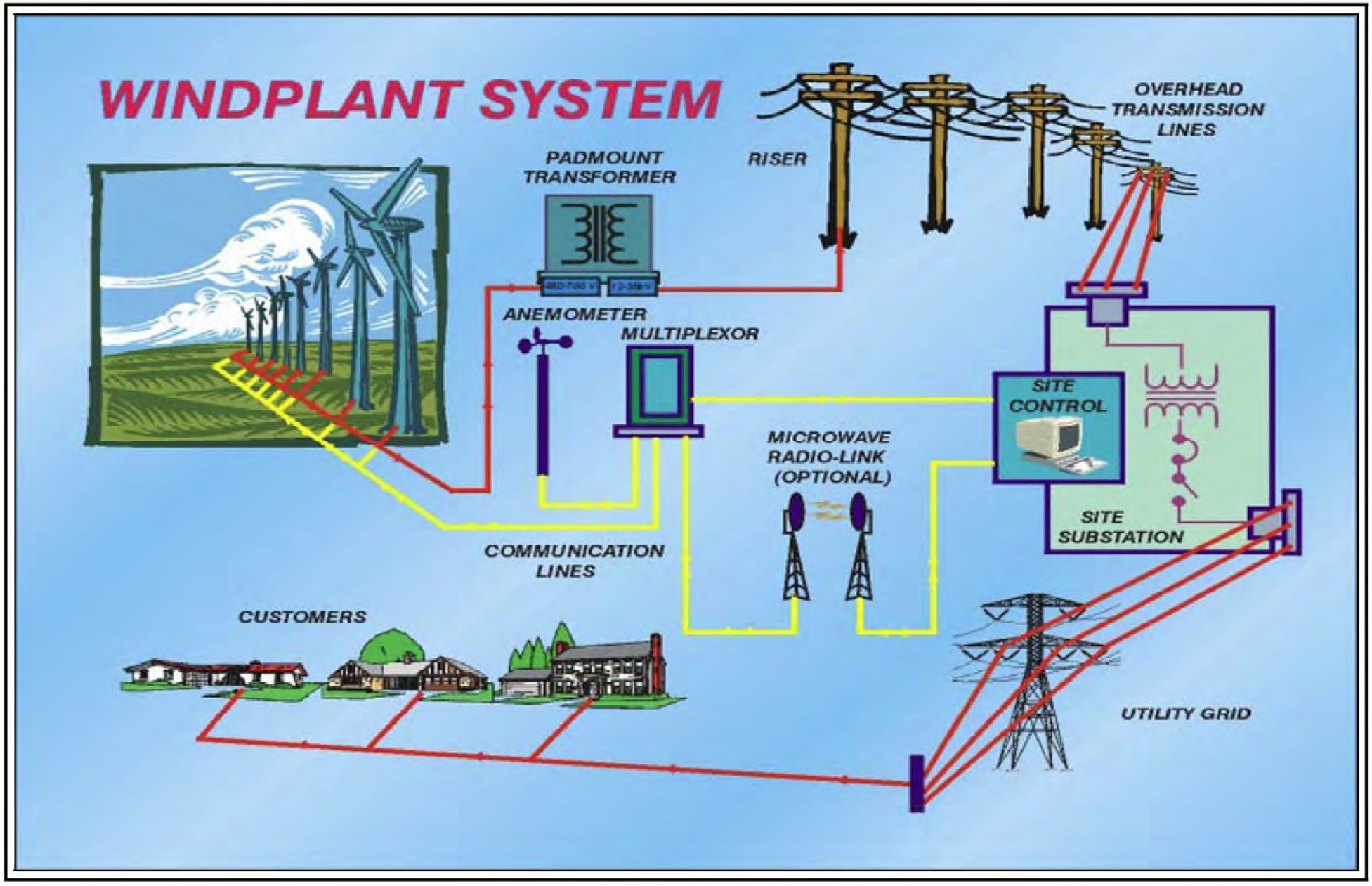


Figure 6
Wind Turbine Design Features

Thunder Spirit Wind Energy Project
Thunder Spirit Wind, LLC
Adams County, North Dakota

May 2013

TETRA TECH



TETRA TECH

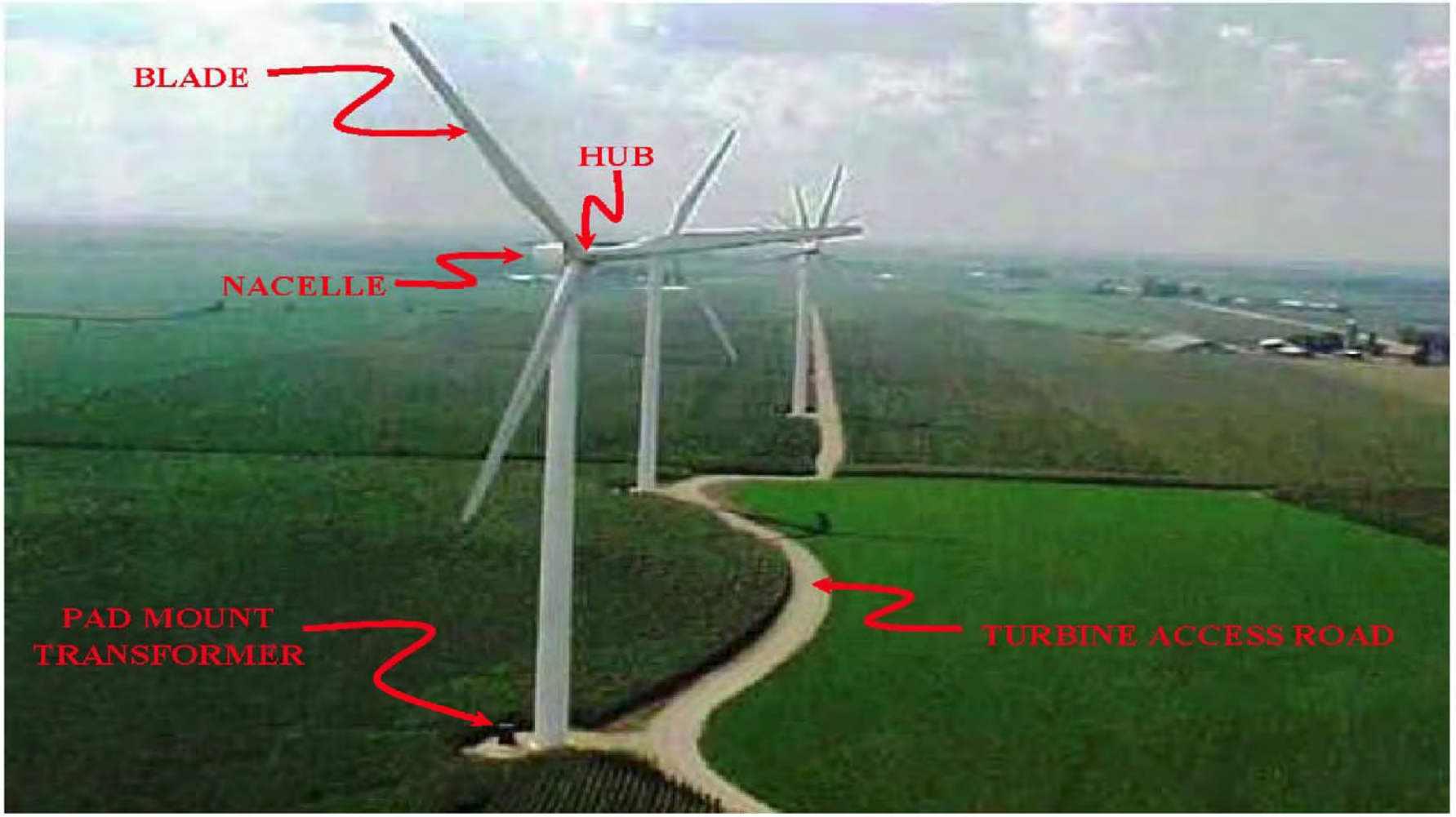
FIGURE 7

Path of Energy Diagram

Thunder Spirit Wind Energy Project

Adams County, North Dakota

May 2013



TETRA TECH

FIGURE 8

Typical Wind Energy Center Layout
Wilton IV Wind Energy Center
Burleigh County, North Dakota
November 2011

NOTES

NOTE 1.- Ower transformer connection group to be addressed with *MDU* and MidWest ISO.

NOTE 2.- Interrupting rating to be decided depending on short circuit strenght of the grid.

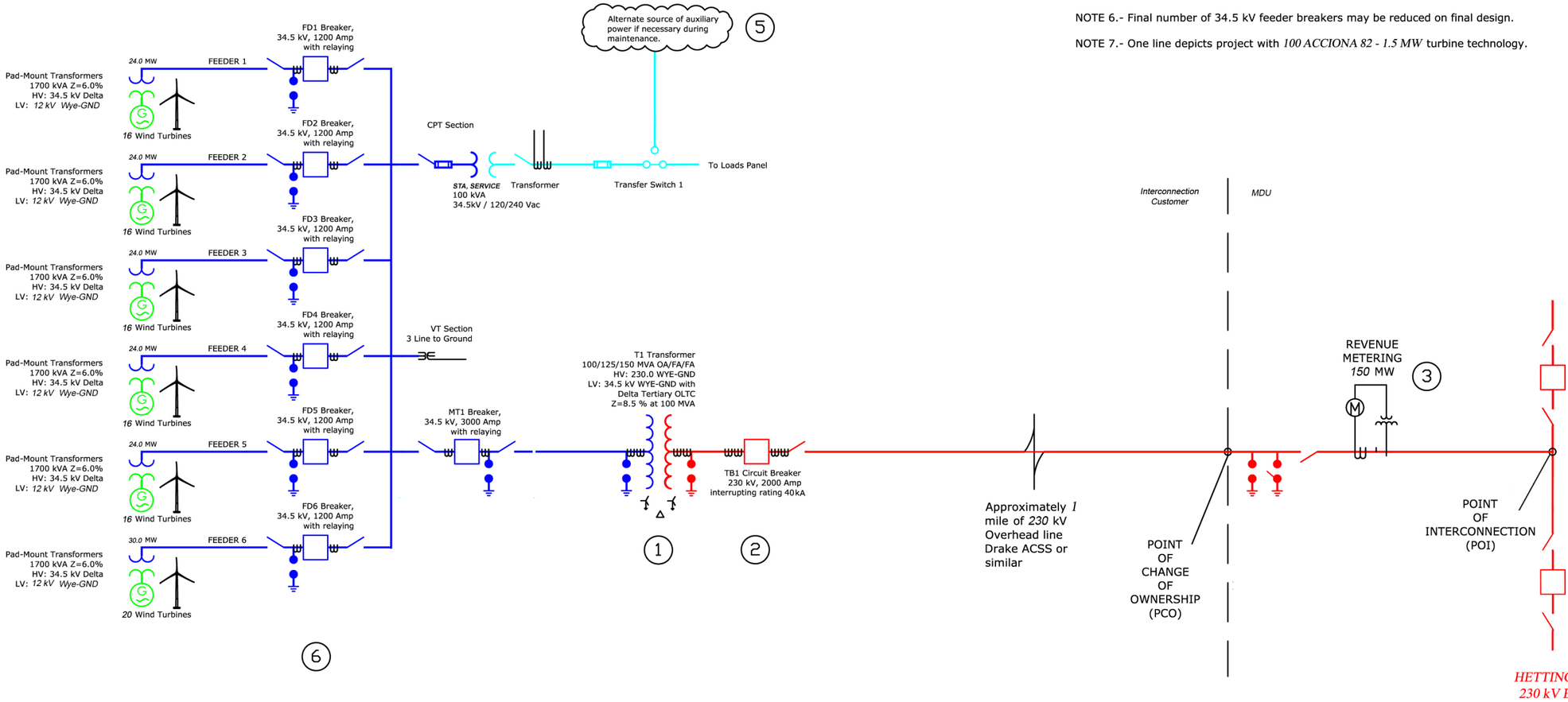
NOTE 3.- Current design is based on direct interconnection to *230 kV bus at MDU Hettinger substation.*

NOTE 4.-The utility meter will be included and one additional ION Meter owned by interconnection customer.

NOTE 5.- Alternate source of power to be defined.

NOTE 6.- Final number of 34.5 kV feeder breakers may be reduced on final design.

NOTE 7.- One line depicts project with *100 ACCIONA 82 - 1.5 MW* turbine technology.



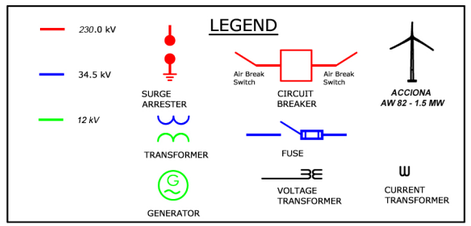


Figure 9a
Thunder Spirit One-Line Diagram
Substation Plan

Thunder Spirit Wind Energy Project
Thunder Spirit Wind, LLC
Adams County, North Dakota

May 2013

G752 Thunder Spirit Wind One Line Diagram
(Preliminary - Not for construction)

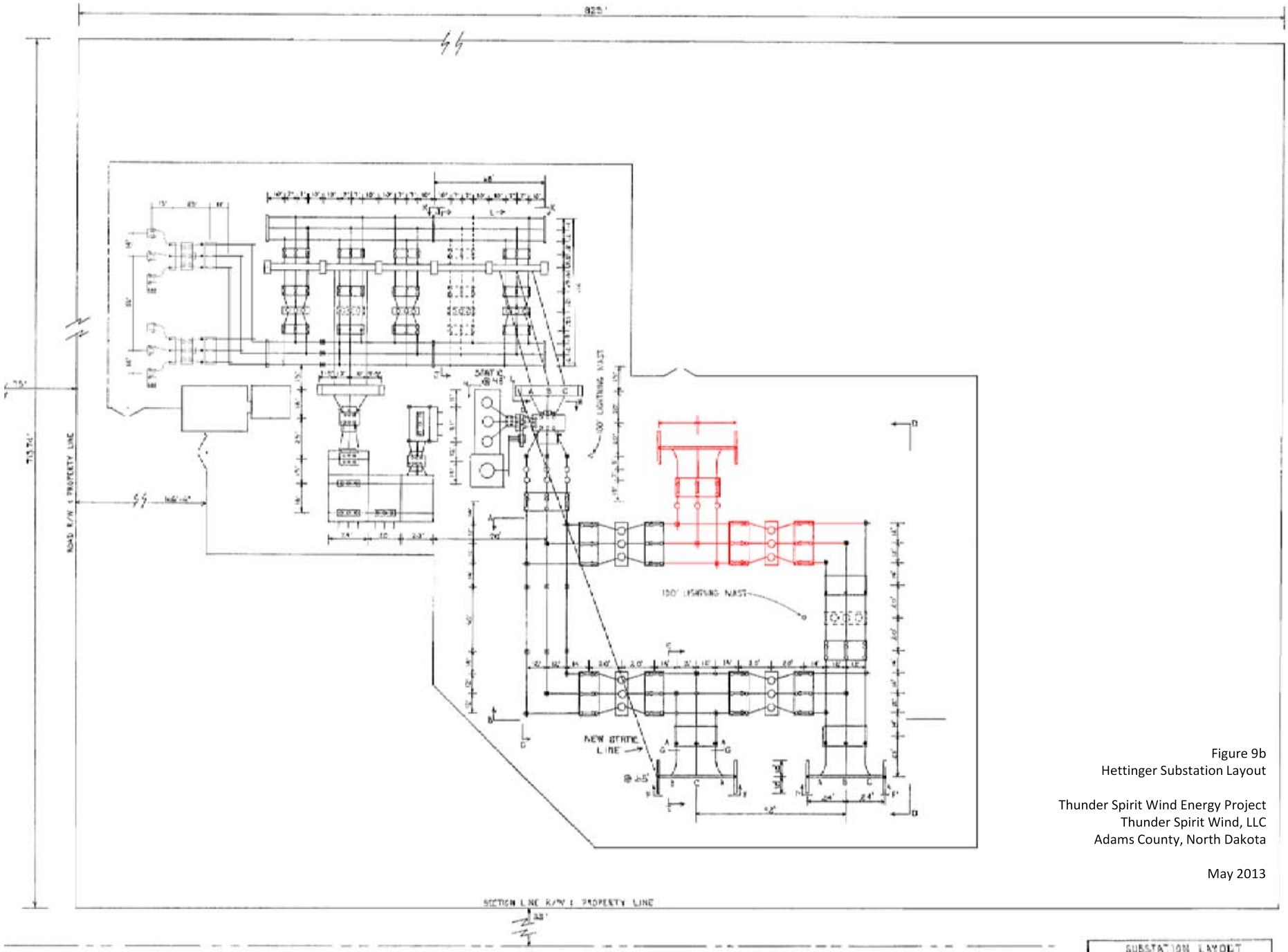


Figure 9b
Hettinger Substation Layout

Thunder Spirit Wind Energy Project
Thunder Spirit Wind, LLC
Adams County, North Dakota

May 2013

Figure 10

Public Lands and Easements

Thunder Spirit Wind Energy Project
Thunder Spirit Wind, LLC
Adams County, North Dakota

May 2013

Legend

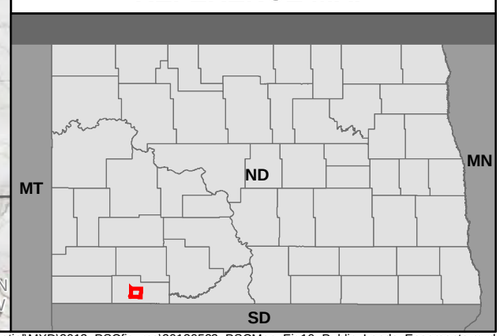
- Proposed Turbine Location (4/26/2013)
- Met Tower Location
- Approximate POI
- Proposed Collector Substation (4/8/2013)
- Overhead Line (4/8/2013)
- Collection Line (4/26/2013)
- Access Road (4/26/2013)
- Construction Laydown Area (10 Acres)
- Collection Substation, O&M Facility, and Additional Laydown Area
- Project Area
- ND PLOTS Data*
- Township Boundary

*Public Lands Open to Sportsmen data provided by North Dakota Game and Fish Department. Current as of Spring 2013.

0 0.5 1 Miles

N W E S

REFERENCE MAP



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Figure 11

Average Daily Traffic Map

Thunder Spirit Wind Energy Project
Thunder Spirit Wind, LLC
Adams County, North Dakota

May 2013

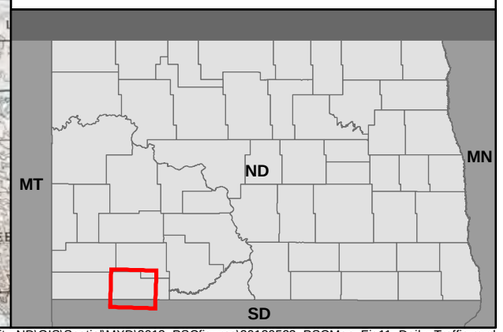
Legend

- Project Area (4/26)
- Airport
- Primary Limited Access or Interstate
- Primary US and State Highway
- Secondary State and County
- Local -Rural
- Railroad
- Populated Place
- County Boundary
- Township Boundary
- 999 Average Annual Daily Traffic
- 99 Commercial Truck Traffic

N
W E
S

0 1 2 4 6 Miles

REFERENCE MAP



Path: P:\Global Winds Harvest\Thunder Spirit - ND\GIS\Spatial\MXD\2013_PSCfigures\20130523_PSCMap_Fig11_Daily_Traffic.mxd





Figure 12
Photos of Typical Landscape

Thunder Spirit Wind Energy Project
Thunder Spirit Wind, LLC
Adams County, North Dakota

May 2013

Figure 13

Land Cover Map

Thunder Spirit Wind Energy Project
Thunder Spirit Wind, LLC
Adams County, North Dakota

May 2013

Legend

- Proposed Turbine Location (4/26/2013)
- Met Tower Location
- Approximate POI
- Proposed Collector Substation (4/8/2013)
- Overhead Line (4/8/2013)
- Collection Line (4/26/2013)
- Access Road (4/26/2013)
- Construction Laydown Area (10 Acres)
- Collection Substation, O&M Facility, and Additional Laydown Area
- Project Area
- Township Boundary

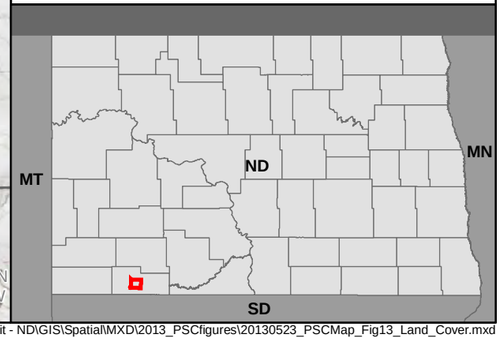
NLCD 2006 Land Cover Type

- Barren Land
- Developed, Low Intensity
- Developed, Open Space
- Cultivated Crops
- Grassland/Herbaceous
- Pasture/Hay
- Shrub/Scrub
- Deciduous Forest
- Woody Wetlands
- Open Water

N
W E
S

0 0.5 1 Miles

REFERENCE MAP



Path: P:\Global Winds Harvest\Thunder Spirit - ND\GIS\Spatial\MXD\2013_PSCfigures\20130523_PSCMap_Fig13_Land_Cover.mxd

Figure 14

Prime Farmland
Soil Distribution Map

Thunder Spirit Wind Energy Project
Thunder Spirit Wind, LLC
Adams County, North Dakota

May 2013

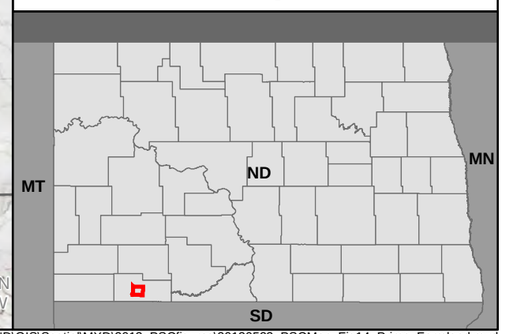
Legend

- Proposed Turbine Location (4/26/2013)
- Met Tower Location
- Approximate POI
- Proposed Collector Substation (4/8/2013)
- Overhead Line (4/8/2013)
- Collection Line (4/26/2013)
- Access Road (4/26/2013)
- Construction Laydown Area (10 Acres)
- Collection Substation, O&M Facility, and Additional Laydown Area
- Project Area (4/26)
- Prime farmland
- Farmland of statewide importance
- Township Boundary

N
W E
S

0 0.5 1 Miles

REFERENCE MAP



Path: P:\Global Winds Harvest\Thunder Spirit - ND\GIS\Spatial\MXD\2013_PSCfigures\20130523_PSCMap_Fig14_Prime_Farmland.mxd

Figure 15

State Soils Association Map

Thunder Spirit Wind Energy Project
Thunder Spirit Wind, LLC
Adams County, North Dakota

May 2013

Legend

- Proposed Turbine Location (4/26/2013)
- Met Tower Location
- Approximate POI
- Proposed Collector Substation (4/8/2013)
- Overhead Line (4/8/2013)
- Collection Line (4/26/2013)
- Access Road (4/26/2013)
- Construction Laydown Area (10 Acres)
- Collection Substation, O&M Facility, and Additional Laydown Area
- Project Area (4/26)
- Township Boundary

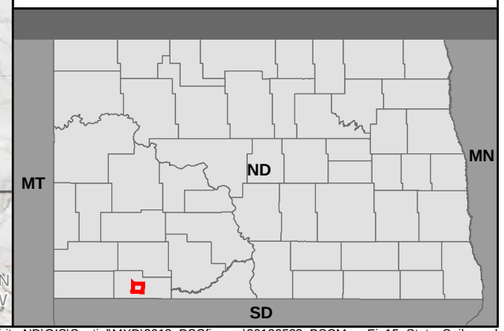
Soil Unit Symbols

10B	17C	21B	3	61
10D	17D	22	30	6B
12B	18B	22B	31B	7C
14B	18C	23F	33B	8
15	18D	25B	35F	81
16	19F	26	4	8B
16B	2	27E	51	9B
17B	20F	28	5C	W

0 0.5 1 Miles

N W E S

REFERENCE MAP



Path: P:\Global Winds Harvest\Thunder Spirit - ND\GIS\Spatial\MXD\2013_PSCfigures\20130523_PSCMap_Fig15_State_Soils.mxd

Figure 16

National Wetlands Inventory and Surface Waters Map

Thunder Spirit Wind Energy Project
Thunder Spirit Wind, LLC
Adams County, North Dakota

May 2013

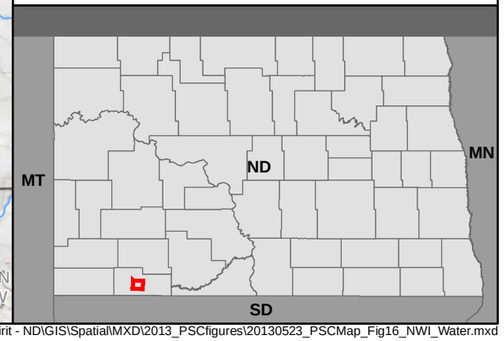
Legend

- Proposed Turbine Location (4/26/2013)
- Met Tower Location
- Approximate POI
- Proposed Collector Substation (4/8/2013)
- Overhead Line (4/8/2013)
- Collection Line (4/26/2013)
- Access Road (4/26/2013)
- Construction Laydown Area (10 Acres)
- Collection Substation, O&M Facility, and Additional Laydown Area
- Project Area (4/26)
- River/Stream
- Open Water
- NWI Wetland
- Township Boundary

0 0.5 1 Miles

N W E S

REFERENCE MAP



Path: P:\Global Winds Harvest\Thunder Spirit - ND\GIS\Spatial\MXD\2013_PSCfigures\20130523_PSCMap_Fig16_NWI_Water.mxd

Figure 17

Residential Receptor Distances
to Closest Wind Turbine

Thunder Spirit Wind Energy Project
Thunder Spirit Wind, LLC
Adams County, North Dakota

May 2013

Legend

- Proposed Turbine Location (4/26/2013)

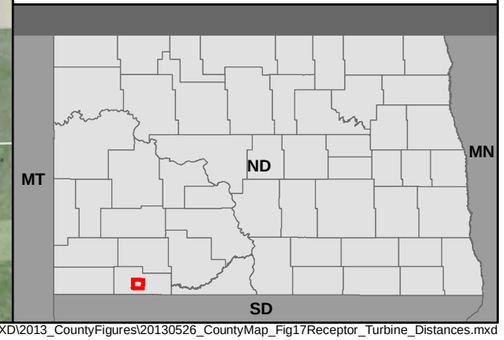
Receptor

- Signed Easement (Occupied)
- Signed Easement (Unoccupied)
- Not Signed (Occupied)
- Not Signed (Unoccupied)
- Distance Dimension (Residence to nearest turbine)
- Collector Substation Construction Footprint (20 Acres)
- Project Area
- Road

N
W E
S

0 0.5 1 Miles

REFERENCE MAP



Path: P:\Global Winds Harvest\Thunder Spirit - ND\GIS\Spatial\MXD\2013_CountyFigures\20130526_CountyMap_Fig17Receptor_Turbine_Distances.mxd

Figure 18

Project Layout with
Adams County Zoning Setbacks

Thunder Spirit Wind Energy Project
Thunder Spirit Wind, LLC
Adams County, North Dakota

May 2013

Legend

- Met Tower Location
- Approximate POI
- Proposed Turbine Location (4/26/2013)
- Proposed Collector Substation (4/8/2013)
- Overhead Line (4/8/2013)
- Collection Line (4/26/2013)
- Access Road (4/26/2013)
- Construction Laydown Area (10 Acres)
- Collection Substation, O&M Facility, and Additional Laydown Area
- Existing Road
- Existing Transmission Line
- Parcel Boundary
- PLSS Township
- PLSS Section Boundary
- Occupied Residence
- Occupied Residence Buffer (0.5 miles)
- Project Area
- NWI Wetland
- Setbacks (See Table 12 in PSC Application)

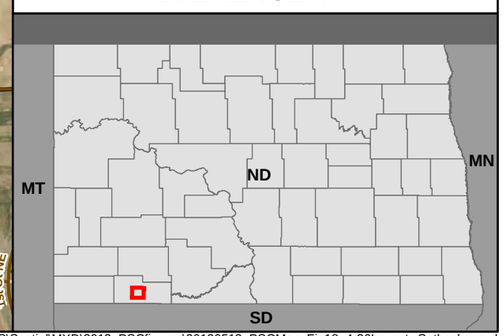
Land Status (5-13-13)

- Signed Easement
- Not Signed

N W E S

0 1 2 Miles

REFERENCE MAP



Path: P:\Global Winds Harvest\Thunder Spirit - ND\GIS\Spatial\MXD\2013_PSCfigures\20130513_PSCMap_Fig18_4-26LayoutwSetbacks.mxd

Appendix A
Studies and Assessments

DRAFT

Baseline Wildlife Studies for the Two Creeks Wind Resource Area Adams County, North Dakota

Final Report
June 2007 – October 2007

Prepared for:

Two Creeks Wind, LLC
197 North Street Rd
Argyle, NY 12809

Prepared by:

Clayton Derby, Ann Dahl, and Karen Seginak
Western **E**co**S**ystems **T**echnology**,** Inc.
4007 State Street, Suite 109
Bismarck, North Dakota



June 30, 2008

EXECUTIVE SUMMARY

Two Creeks Wind LLC has proposed a wind-energy facility in Adams County, North Dakota, near the town of Hettinger. Two Creeks Wind LLC contracted with Western EcoSystems Technology, Inc. to conduct surveys and monitor wildlife resources in the Two Creeks Wind Resource Area to estimate the impacts of wind-energy facility construction and operations on wildlife.

The principal objectives of this wildlife monitoring study were to: 1) estimate the seasonal, spatial, and temporal use of the study area by birds, particularly raptors; 2) estimate the seasonal and spatial use of the study area by bats; 3) identify any federal and state threatened, endangered, proposed, candidate, or sensitive-status wildlife and their potential habitats that may be affected by the proposed wind-energy facility; 4) describe incidental wildlife observations; 5) estimate any potential impacts to birds and bats that could result from construction and operation of the proposed wind-energy facility; and 6) identify potential project modifications and/or mitigation measures that could reduce negative impacts.

The objective of the fixed-point bird use surveys was to estimate the seasonal, spatial, and temporal use of the Two Creeks Wind Resource Area by birds, particularly raptors, defined here as kites, accipiters, buteos, harriers, eagles, falcons, owls and vultures. Surveys were conducted at 20 points located within the study area approximately once every two weeks during the summer season (June 5 to August 10, 2007), resulting in 95 twenty-minute fixed-point surveys during the summer season. Surveys were also conducted weekly during the fall season (August 24 to October 29, 2007), resulting in 120 twenty-minute fixed-point surveys during the fall season. Fifty-one bird species were observed in the 215 twenty-minute fixed-point surveys that were conducted, with a mean number of species observed per survey of 2.31. A total of 1,517 individual bird observations within 544 separate groups were recorded during the fixed-point surveys, and cumulatively, four species (7.8% of all species) comprised approximately 61.5% of the observations: European starling, horned lark, ring-necked pheasant, and western meadowlark (*Sturnella neglecta*; 13.6%). All other species comprised less than seven percent of the observations individually. A total of 65 individual raptors were observed within the study area, comprising eight species.

To standardize the data for comparison between points, seasons, and with other wind-energy facilities, bird use, frequency of occurrence, and species composition were calculated from observations within an approximate half mile (800 meters) of the point. Bird use by species was calculated as the mean number of birds per 20-minute survey. Upland gamebirds were the most abundant large bird type observed in the summer (0.61 birds/20-minute survey), followed by raptors (0.35) and waterfowl (0.19). Upland gamebirds were also the most abundant large bird type observed in the fall (1.32 birds/20-minute survey), followed by raptors (0.26). Overall, passerines were the most abundant bird type observed in the summer (4.69 birds/plot/20-minute survey) and in the fall (5.35).

During the study, 290 groups totaling 1,082 individuals were observed flying during fixed-point bird use surveys. For all species combined, 93.0% of all flying birds observed were below the likely zone of risk, 6.7% were within the zone of risk, and 0.3% were observed flying above the

zone of risk for typical turbines that could be used in the Two Creeks Wind Resource Area. Bird types most often observed flying within the zone of risk for potential collision with turbine blades were waterfowl (87.5%) and raptors (41.3%). For species with at least 15 separate observations of flying birds, those most often observed within the zone of risk were northern harrier (26.9%), eastern kingbird (15.8%), and horned lark (4.7%). Based on the use (measure of abundance) of the site by each species and the flight characteristics observed for that species, lapland longspur had the highest probability of turbine exposure. The raptor species with relatively high exposure indices were northern harrier, red-tailed hawk, and Swainson's hawk, which were ranked fifth, sixth, and seventh of all species.

For all bird species combined, use was highest at point one (29.00 birds/20-minute survey), followed by points 13 and 14 (13.64 and 13.70, respectively). Use was relatively uniform among the other points. No obvious flyways or concentration areas were observed. No strong association with topographic features within the study area was noted for raptors or other large birds. Although some differences in bird use were detected among survey points, the differences are not large enough to suggest that any portions of the Two Creeks Wind Resource Area should be avoided when siting turbines.

The objective of the acoustic bat surveys was to estimate the seasonal and spatial use of the study area by bats. Two AnaBat® II echolocation detectors were used to monitor bat use at the study from July 23 through October 15, 2007, resulting in a total of 112 detector nights. A total of 126 bat calls were recorded during the 112 bat detector nights. Calls were approximately evenly split between calls less than 35 kHz in frequency (e.g., big brown bat, hoary bat) and calls more than 35 kHz (e.g., *Myotis* bat species). The mean number of bat calls recorded per night per detector was similar between the two locations.

No species protected under the federal Endangered Species Act were recorded during the surveys at the Two Creeks Wind Resource Area. One-hundred-three individuals in 80 groups comprising 14 bird species observed during the fixed-point bird use surveys or as incidental wildlife observations were sensitive species listed by the North Dakota Game and Fish Department or the US Fish and Wildlife Service.

Incidental species bird observed at the Two Creeks Wind Resource Area consisted mostly of sandhill cranes, sharp-tailed grouse, ring-necked pheasant, northern harrier, and Swainson's hawk. Eighteen bird species total were observed, with a total of 100 individuals in 39 groups. Large mammals observed at the Two Creeks Wind Resource Area included pronghorn antelope, white-tailed deer, and mule deer. Other mammals included eastern cottontail rabbit and coyote.

Based on fixed-point bird use data collected for the Two Creeks Wind Resource Area, mean raptor use during the summer was 0.35 birds/plot/20-minute survey and mean use was 0.26 during the fall. These values from the Two Creeks Wind Resource were compared separately to raptor use at other wind-energy facilities that implemented similar protocols to the present study. Similar studies were conducted at 34 other wind-energy facilities in the summer and 32 in the fall. Mean raptor use at Two Creeks Wind Resource would be considered low in summer and fall in comparison to these wind-energy facilities. The Two Creeks Wind Resource area ranked eleventh lowest for mean raptor use in the summer and ranked sixth lowest in the fall. A

regression analysis of raptor use and raptor collision mortality for 11 new-generation wind-energy facilities where similar methods were used to obtain raptor use estimates showed a significant (R^2 = 81.4%) correlation between raptor use and raptor collision mortality. Using this regression to predict raptor collision mortality at Two Creeks Wind Resource Area yields an estimated fatality rate of 0.02/MW/year, or two raptors per year for a 100-MW wind-energy facility.

The mean number of bat passes per detector per night was compared to existing data at other wind-energy facilities where both bat activity and mortality levels were measured. The level of bat activity documented at the Two Creeks Wind Resource Area was much lower than the eastern wind-energy facilities, all of which had fairly high levels of bat mortality, and was slightly lower than the recorded activity levels at the western and Midwestern locations, both of which had relatively low levels of bat mortality. The data collected in the study area do not indicate that substantial numbers of bats migrate through the Two Creeks Wind Resource Area. Some bat mortality will likely occur in the study area; however, the available data indicate it would be lower than that experienced in the east and potentially to levels found at the western and Midwestern locations.

The data collected during this study suggests that the Two Creeks Wind Resource Area is not within a major migratory pathway. Construction and operation of the wind-energy facility may displace some types of grassland nesting birds. However because much of the Two Creeks Wind Resource Area will be sited in previously altered habitats (i.e., tilled agriculture), it is unlikely that displacement of birds would result in any population impacts.

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INTRODUCTION

Two Creeks Wind LLC has proposed a wind-energy facility in Adams County, North Dakota, near the town of Hettinger. Two Creeks Wind LLC contracted with Western EcoSystems Technology, Inc. (WEST) to conduct surveys and monitor wildlife resources in the Two Creeks Wind Resource Area (TCWRA) to estimate the impacts of wind-energy facility construction and operations on wildlife.

The principal objectives of this wildlife monitoring study were to: 1) estimate the seasonal, spatial, and temporal use of the study area by birds, particularly raptors; 2) estimate the seasonal and spatial use of the study area by bats; 3) identify any federal and state threatened, endangered, proposed, candidate, or sensitive-status wildlife and their potential habitats that may be affected by the proposed wind-energy facility; 4) describe incidental wildlife observations; 5) estimate any potential impacts to birds and bats that could result from construction and operation of the proposed wind-energy facility; and 6) identify potential project modifications and/or mitigation measures that could reduce negative impacts.

This report provides results of the baseline surveys at TCWRA conducted from June 5, 2007, through October 29, 2007. Baseline surveys conducted at TCWRA in 2007 included fixed-point bird use surveys, bat acoustic surveys, and incidental wildlife observations. In addition to site-specific data, this report presents existing information and results of studies conducted at other wind-energy facilities. The ability to estimate potential bird and bat mortality at the proposed TCWRA is greatly enhanced by operational monitoring data collected at existing wind-energy facilities. For several wind-energy facilities, standardized data on fixed-point surveys and acoustic bat surveys were collected in association with standardized post-construction (operational) monitoring, allowing comparisons of bird/bat use with bird/bat mortality.

STUDY AREA

The proposed TCWRA is located three miles (4.8 kilometers; km) northeast of Hettinger, North Dakota (Figure 1). The elevation of the project area ranges from approximately 2,559 to 2,963 feet (ft; 780-903 meters [m]) above sea level (Figure 2).

Land in the project area is privately owned. Cropland, planted grasslands, and prairie are predominant in the area (Strong et al. 2005); the latter two habitat types are used for cattle grazing and haying. Small grain agriculture, such as wheat, are common crops in the TCWRA and surrounding area. There are a few scattered wetlands with scattered patches of deciduous trees and shrubs around some of the wetlands. Planted tree rows and shelter belts lie in cultivated fields and near residences. Duck Creek crosses the northeast portion of the TCWRA and its tributaries drain most of the area (Figure 2).

METHODS

The study at TCWRA consisted of the following research components: 1) fixed-point bird use surveys; 2) acoustic bat surveys; and 3) incidental wildlife observations.

Fixed-point Bird Use Surveys

The objective of the fixed-point bird use surveys was to estimate the seasonal, spatial, and temporal use of the study area by birds, particularly raptors, defined here as kites, accipiters, buteos, harriers, eagles, falcons, owls, and vultures. Fixed-point surveys (variable circular plots) were conducted using methods described by Reynolds et al. (1980). The points were selected to survey representative habitats and topography of the study area as defined in spring 2007, while also providing relatively even coverage with minimal overlap of points. All birds seen during fixed-point surveys were recorded. Raptors and other large birds, species of concern, and species not previously seen in the study area that were observed between fixed-point surveys were recorded; coordinates derived from GPS also were noted for species of concern.

Bird Use Survey Plots
Twenty points were selected to achieve optimal coverage of the study area and habitats within the study area (Figure 3). Each survey plot was an approximate half-mile (800-m) radius circle centered on a point and each point was surveyed for 20 minutes (min). All species of birds observed during fixed-point surveys were recorded, and all large birds observed perched within or flying over the plot were recorded and mapped. Small birds (e.g., sparrows) within 328 ft (100 m) of the point were recorded, but not mapped. Observations of birds beyond the plot were recorded, but were not included in the statistical analyses. A unique observation number was assigned to each observation.

The date, start, and end time of the survey period, and weather information such as temperature, wind speed, wind direction, and cloud cover were recorded for each survey. Species or best possible identification, number of individuals, sex and age class (if possible), distance from plot center when first observed, closest distance, altitude above ground, activity (behavior), and habitat(s) were recorded for each observation. The behavior of each bird observed, and the vegetation type in which or over which the bird occurred, were recorded based on the point of first observation. Approximate flight height and flight direction at first observation were recorded to the nearest 15 ft (five-m) interval. Other information recorded about the observation included whether or not the observation was auditory only.

Locations of raptors, other large birds, and species of concern seen during fixed-point bird use surveys were recorded on field maps by observation number. Any comments or unusual observations were recorded in the comments section of the data sheet.

Observation Schedule
Sampling intensity was designed to document bird use and behavior by habitat and season within the study area. Surveys were conducted approximately every other week during the summer season (June 5, 2007 through August 10, 2007) and weekly during the fall season (August 24, 2007 through October 29, 2007). Surveys were conducted during daylight hours and survey

periods varied to approximately cover all daylight hours during a season. To the extent practical, each point was surveyed about the same number of times; however, the schedule varied in response to adverse weather conditions (e.g., rain), which may have caused delays and/or missed surveys.

Acoustic Bat Surveys

The objective of the acoustic bat surveys was to estimate the seasonal and spatial use of the TCWRA by bats. Bats were surveyed at the TCWRA using AnaBat® II (AnaBat) ultrasonic detectors coupled with Zero Crossing Analysis Interface Modules (ZCAIM; Titley Electronics Pty Ltd., New South Wales, Australia). Bat detectors are widely used to index and compare bat habitat use. The use of bat detectors for calculating an index for bat impacts has been used at several wind-energy facilities, and is a primary and economically feasible bat risk assessment tool (Kunz et al. 2007a). Detectors were placed at two fixed locations (Figure 4) from July 23, 2007 to October 15, 2007.

AnaBat detectors record bat echolocation calls with a broadband microphone. Incoming echolocation calls were digitally processed by the detector and passed to the ZCAIM for further processing and data storage. Each series of echolocation calls was saved to a file on a high-capacity CompactFlash ™ card and these files were then transferred to a computer for analysis. Computer software was used to view digital "sonograms" of the echolocation calls showing change in frequency over time. During analysis, these frequency versus time displays were used to separate bat calls from other types of ultrasonic noise (e.g. wind, rain, insects, etc.) and to assign calls to a high- or low-frequency group (see statistical section). To help minimize interference from extraneous ultrasonic noise, a sensitivity level of six was used. Each detector was placed inside a water-tight plastic container through which a hole was cut in the side for the microphone. The microphone was encased in PVC tubing with drain holes that curved vertically outside the container to minimize potential rainwater damage. AnaBat units were raised approximately one foot above the ground to minimize echo interference and lift the unit above vegetation. Both units were programmed to turn on each night an approximate half-hour before sunset and turn off an approximate half-hour after sunrise.

Sensitive Species

The objective of the sensitive species surveys is to determine the presence or absence and spatial distribution of state- or federal-listed bird species, bird species of conservation concern or other species of interest observed within the study area during other surveys at the TCWRA. Based on information from the North Dakota Game and Fish Department (NDGFD) and the US Fish and Wildlife Service (USFWS), several state-listed bird species could occur in the project area based on habitat.

The fixed-point bird use surveys and incidental observations (see below) will provide some information on the presence/absence of these species; however, areas not covered with the standardized survey plots may include species not observed during other surveys.

Incidental Wildlife Observations

The objective of the incidental wildlife observations was to provide use and occurrence information about wildlife outside the standardized survey areas that might be affected by the proposed wind-energy facility. Incidental wildlife observations were made while observers were within the study area conducting the various surveys. All sightings of raptors, raptor nests, unusual or unique birds, sensitive species, mammals, reptiles, and amphibians were recorded. These observations were recorded in a similar fashion to those recorded during the standardized surveys. The observation number, date, time, species, number of individuals, sex/age class, distance from observer, activity, height above ground (for bird species), habitat, and, in addition, the location of sensitive species was recorded.

Statistical Analysis

Quality Assurance and Quality Control
Quality assurance and quality control (QA/QC) measures were implemented at all stages of the study, including in the field, during data entry and analysis, and report writing. Following field surveys, observers were responsible for inspecting their data forms for completeness, accuracy, and legibility. A sample of records from an electronic database was compared to the raw data forms and any errors detected were corrected. Irregular codes or data suspected as questionable were discussed with the observer and/or project manager. Errors, omissions, or problems identified in later stages of analysis were traced back to the raw data forms, and appropriate changes in all steps were made.

Data Compilation and Storage
A Microsoft® ACCESS database was developed to store, organize, and retrieve survey data. Data were keyed into the electronic database using a pre-defined format to facilitate subsequent QA/QC and data analysis. All data forms, field notebooks, and electronic data files were retained for reference.

Fixed-point Bird Use Surveys
Bird Diversity and Species Richness
A list of all bird species observed during all surveys types was generated for the TCWRA. The total number of unique species and the mean number of species observed per survey (i.e., number of species/plot/20-min survey) were calculated to illustrate and compare differences between seasons for fixed-point bird use surveys.

Bird Use, Composition, and Frequency of Occurrence
Species lists, with the number of observations and the number of groups, were generated by season, including all observations of birds detected regardless of their distance from the observer. For the standardized fixed-point bird use estimates, only observations of birds detected within the plot were used. Estimates of bird use (i.e., number of birds/plot/20-min survey) were used to compare differences between bird types, seasons, and other wind-energy facilities.

The frequency of occurrence by species was calculated as the percent of surveys in which a particular species was observed. Frequency of occurrence provided relative estimates of the bird

diversity of the study area. For example, a particular species might have high use estimates for the study area based on just a few observations of large flocks; however, the frequency of occurrence would indicate that it only occurred during a few of the surveys, therefore making it less likely to be affected by the wind-energy facility.

Bird Flight Height and Behavior

To calculate potential risk to bird species, the first flight height recorded was used to estimate the percentages of birds flying within the likely "zone of risk" (ZOR) for potential collision with typical turbines. Because the type of turbines that will be used at the TCWRA is currently unknown, the likely ZOR was defined as a flight height of between 82 to 410 feet (25 to 125 m) above ground level (AGL), which is the blade height of typical turbines that could be used at the TCWRA.

Bird Exposure Index

A relative index to collision exposure (R) was calculated for bird species observed during the fixed-point bird use surveys using the following formula:

$$R = A*P_f*P_t$$

Where A equals mean relative use for species *i* (observations within a half mile (800 m) of observer) averaged across all surveys, P_f equals proportion of all observations of species *i* where activity was recorded as flying (an index to the approximate percentage of time species *i* spends flying during the daylight period), and P_t equals proportion of all initial flight height observations of species *i* within the likely ZOR for collision with turbine blades. This index does not account for differences in behavior other than flight heights and percent of birds observed flying.

Spatial Use

The objective of mapping observed bird locations was to look for areas of concentrated use by raptors and other large birds within the study area. Data were analyzed by comparing use among points. This information could be used to aid in turbine layout design or adjustments of individual turbines by micro-siting.

Acoustic Bat Surveys

The units of activity were number of bat passes (Hayes 1997). A pass was defined as a continuous series of two or more call notes produced by an individual bat with no pauses between call notes of less than one second (White and Gehrt 2001; Gannon et al. 2003). In this report, the terms bat pass and bat call are used interchangeably. The number of bat passes was determined by downloading the data files to a computer and tallying the number of echolocation passes recorded. Total number of passes was corrected by dividing by the number of detector nights. Bat calls were classified as either high-frequency calls (≥ 35 kHz) that are generally given by small bats (e.g. *Myotis* spp.) or low-frequency (< 35 kHz) that are generally given by larger bats (e.g. silver-haired bat [*Lasionycteris noctivagans*], big brown bat [*Eptesicus fuscus*], Townsend's big-eared bat [*Corynorhinus townsendii*], hoary bat [*Lasiurus cinereus*]). Data determined to be noise (produced by a source other than a bat) or call notes that did not meet the pre-specified criteria to be termed a pass were removed from the analysis. To establish which

species may have produced the high- and low-frequency calls recorded, a list of species expected to occur in the study area was compiled from range maps (Harvey et al. 1999; BCI website).

The total number of bat passes per detector night was used as an index for bat use in the TCWRA. Bat pass data represented levels of bat activity rather than the numbers of individuals present because individuals could not be differentiated by their calls. To predict potential for bat mortality (i.e. low, moderate, high), the mean number of bat passes per detector night was compared to existing data from wind-energy facilities where both bat activity and mortality levels have been measured.

RESULTS

Surveys at the TCWRA occurred from June 5 through October 29, 2007. Excluding bats, 62 animal species were identified: 57 birds and five mammals. Results of these surveys and the specific numbers of unique species observed per survey type are discussed in the sections below.

Fixed-point Bird Use Surveys

Fixed-point bird use surveys were conducted approximately every other week during the summer season (June 5 to August 10, 2007), resulting in 95 twenty-minute fixed-point surveys, and weekly during the fall season (August 24 to October 29, 2007), resulting in 120 twenty-minute fixed-point surveys at the TCWRA during the fall. A total of 215 twenty-minute fixed-point surveys were conducted (Table 1).

Bird Diversity and Species Richness

Fifty-one unique species were observed over the course of all fixed-point bird use surveys, with a mean number of species observed per survey of 2.31 (Table 1). A total of 1,517 individual bird observations within 544 separate groups were recorded during the fixed-point surveys (Table 2). Cumulatively, four species (7.8% of all species) comprised approximately 61.5% of the observations: European starling (*Sturnus vulgaris*; 19.1%), horned lark (*Eremophilia alpestris*; 15.0%), ring-necked pheasant (*Phasianus colchicus*; 13.9), and western meadowlark (13.6%). All other species comprised less than seven percent of the observations individually. A total of 65 individual raptors were observed within the study area, comprising eight species (Table 2).

Bird Use, Composition, and Frequency of Occurrence by Season

Mean bird use, percent composition, and frequency of occurrence for all species and bird types are shown in Table 3. The highest overall bird use occurred in the fall (7.33 birds/plot/20-min survey), compared to summer (6.71). The higher use in the fall was in part due to larger numbers upland gamebirds and passerines than were observed during the summer surveys.

Waterfowl

Waterfowl were the fifth most abundant bird type in the summer (0.19 birds/plot/20-min survey) and were not observed during the fall surveys. Waterfowl made up 2.8% of the overall bird use in the summer and 0% in the fall. Waterfowl were observed during 4.3% of summer surveys and composed 2.8% of the total birds observed in the summer. Most observations of waterfowl were

of mallard (*Anas platyrhynchos*), which comprised 94.7 % of the total use for this bird type in the summer (Table 3).

Shorebirds

Shorebirds were the sixth most abundant bird type in the summer (0.08 birds/plot/20-min survey), but were not observed in the fall. Shorebirds made up 1.2% of the overall bird use and were observed during 8.3% of surveys during the summer (Table 3).

Raptors

Raptors were the fourth most abundant bird type in the summer (0.35 birds/plot/20-min survey) and in the fall also (0.26). Raptors comprised 5.2% of the overall bird use in the summer and 3.5% in the fall. Raptors were observed for a similar proportion of the surveys during the summer (25.7%) compared to the fall (20.0%). Most observations of raptors during the summer were of northern harrier (*Circus cyaneus*), which comprised 60.0% of the total use for this bird type in the summer. During the fall, most observations of raptors were comprised of red-tailed hawk (*Buteo jamaicensis*) and northern harrier, which each comprised 30.8% of the total raptor use in the fall (Table 3).

Upland gamebirds

Upland gamebirds were the third most abundant bird type in the summer (0.61 birds/plot/20-min survey) and had the second highest abundance in the fall (1.32). Upland gamebirds made up 9.1% of the overall bird use in the summer and 18.0% in the fall. Upland gamebirds were also observed for a similar proportion of the surveys during summer (32.3%) compared to the fall (25.8%). Most observations of upland gamebirds were of ring-necked pheasant, which composed 95.1% of the total use for this bird type in the summer and 99.2% in the fall (Table 3).

Doves/pigeons

Doves/pigeons were the second most abundant bird type in the summer (0.75 birds/plot/20-min survey) and had the third highest abundance in the fall (0.38). Doves/pigeons comprised 11.2% of the overall bird use in the summer and 5.2% in the fall. Doves/pigeons were observed during 30.3% of fixed-point bird use surveys in the summer compared to in the fall (8.3%). Most observations of doves/pigeons were of mourning dove (*Zenaida macroura*), which comprised more than 60% of the total use for this bird type in both seasons (Table 3).

Passerines

Passerines were the most abundant type in the summer (4.69 birds/plot/20-min survey) as well as in the fall (5.35). Passerines made up 69.9% of the overall bird use in the summer and 73.0% in the fall. Passerines were observed more often in the summer (82%) compared to in the fall (51.7%). Most observations during the summer were of western meadowlark, which comprised over 20% of the total use for this bird type, while European starling comprised nearly 45% of the total use for this bird type during the fall (Table 3).

Other Birds

Other birds were the least abundant bird type in the summer and fall (0.04 and 0.02 birds/plot/20-min survey, respectively). Other birds comprised less than one percent the overall bird use and were observed in less than five percent of the surveys in both seasons (Table 3).

Bird Flight Height and Behavior

Flight height characteristics were estimated for both individual bird species and bird types (Tables 4 and 5). Percentages of observations below, within, and above the likely ZOR of 82 to 410 feet (25 to 125 m) AGL were reported. During the study, 290 groups totaling 1,082 individuals were observed flying during fixed-point bird use surveys. Five species had at least 15 groups observed flying, but none of these species were observed flying within the likely ZOR for at least 50% of the observations (Table 4). For these species with at least 15 separate observations of flying birds, those most often observed within the zone of risk were northern harrier (26.9%), eastern kingbird (*Tyrannus tyrannus*; 15.8%), and horned lark (4.7%). Eight species were always observed flying within the ZOR, but only based upon a small number of groups (one to two observations).

Overall, 6.7% of the bird types observed flying were recorded within the ZOR, 93.0% were below the ZOR, and 0.3% were flying above the ZOR (Table 5). More than half (52.2%) of flying raptor observations were of individuals below the ZOR, 41.3% were within the ZOR, and there were 6.5% of the observations of flying raptors above the ZOR. Raptor subtypes that were observed within the ZOR more often than the overall raptor type were eagles (100.0%), other raptors (100%), and buteos (78.6%). All falcons (100.0%) and most northern harriers (84.6%) were observed flying below the ZOR, while all vultures (100.0%) were observed above the ZOR. Waterfowl (87.5%) and other birds (100.0%) had a higher percentage of birds within the ZOR than raptors, but only based upon a small number of groups (one to four observations). All shorebirds and upland gamebirds, as well as most passerines (95.3%) and doves/pigeons (93.7%) were observed flying below the ZOR (Table 5).

Bird Exposure Index

A relative exposure index (bird use multiplied by proportion of flying observations within the ZOR) was calculated for each species (Table 4). This index is only based on initial flight height observations and relative abundance, and does not account for other possible collision risk factors such as foraging or courtship behavior. No species had exposure indices higher than 1.00. Lapland longspur (*Calcarius lapponicus*) had the highest exposure index of 0.07, followed by horned lark (0.05), and cliff swallow (*Petrochelidon pyrrhonota*; 0.04). Raptors with the highest exposure index (0.02) were northern harrier, red-tailed hawk, and Swainson's hawk (*Buteo swainsoni*).

Spatial Use

Mean use (birds/20-min survey) was plotted by point for all birds combined and all of the major bird types (Figures 5a-h). For all bird species combined, use was highest at point one (29.00 birds/20-min survey). Bird use for the other points ranged from 2.55 to 13.70 birds/20-min survey. The high mean use estimate for point one was due to many observations of passerines (27.55 birds/20-min survey) at that point (Figure 5g). Waterfowl were only observed at four points and the mean use ranged from 0.09 birds/ 20-min survey at point 19 to 0.73 at point 15. Shorebirds were observed at six points and use was consistent among points, ranging from 0.09 to 0.18 birds/20-min survey. Raptors were observed at all but one of the points (point five), and use was very consistent among the remaining points, ranging from 0.09 to 0.82 birds/20-min. survey. Upland gamebirds were observed at all but four points, with the highest use at point five

(4.55 birds/20-min survey) and lowest at point 12 (0.10), and ranged from 0.27 to 3.82 birds/20-min survey at the remaining points. Doves/pigeons were observed at all but seven points with the highest use at points fourteen (2.40) and three (2.27), and the lowest use at points five, seven, 10, and 11 at 0.18 birds/20-min survey. Dove/pigeon use ranged from 0.30 to 1.64 birds/20-min survey at the remaining points. Passerine use was highest at point one (27.55 birds/20-min survey), lowest at point six (1.36), and ranged from 1.73 to 8.60 at the other points. Other birds were only observed at points three, four, 13, 15, and 19, and use ranged from 0.09 to 0.18 birds/20-min survey.

Acoustic Bat Surveys

Eleven species of bat are known or suspected to occur in Adams County, North Dakota (Table 6), some of which are considered sensitive species by the NDGFD (Tables 6 and 7).

A total of 126 bat calls were recorded during 112 bat detector nights (Table 8). Fifty-eight of the calls were more than 35 kHz in frequency (e.g., little brown bat [*Myotis lucifugus*], northern long-eared bat [*Myotis septentrionalis*], eastern red bat [*Lasiurus borealis*]), while the remaining 68 were less than 35 kHz (e.g., big brown bat [*Eptesicus fuscus*], silver-haired bat [*Lasionycteris noctivagans*], hoary bat [*Lasiurus cinereus*]) (Table 8). Noise was recorded on many nights throughout the sample period, which may have interfered with detection of bats. Further AnaBats failed sporadically during the sampling period. The north unit failed to capture data to any great degree during the last two weeks of the study and the south unit failed to record data during a two and a half week period, from August 6-23.

Spatial Variation
Bat activity was similar between the ground AnaBat units in the north end (1.0 passes per detector-night) and south (1.13 passes per detector-night). More low-frequency calls than high-frequency calls were detected at the south location. This was reversed at the north location with more high-frequency calls being detected

Temporal Variation
The earliest call detected occurred on July 23 and the latest was detected on September 29. Calls were fairly regular, between 1 and 7 per night with most nights having 2-4 calls from July 23 and September 6. After early September the calls drop off dramatically. This time period would correspond to the summer breeding and fall bat migration periods.

Species Composition
Species identification for specific passes was possible for two species, the hoary bat and eastern red bat, on limited occasions. A total of seven hoary bat calls (10.3% of low-frequency calls) and one eastern red bat call (1.7% of high-frequency calls) were identified. All other bat calls detected could not be identified to species.

Sensitive Species

The NDGFD and the USFWS list 104 animals as state- or federal-listed threatened and endangered, or sensitive status species for North Dakota (Table 7). Fourteen species, comprised

of one-hundred-three individuals in 80 groups listed by the NDGFD and/or the USFWS were observed during the fixed-point bird use surveys or as incidental wildlife observations (described below).

No species protected under the federal Endangered Species Act (ESA 1973) were recorded during the surveys at the TCWRA. One species, the golden eagle (*Aquila chrysaetos*), while not protected under the Endangered Species Act, is federally protected by the Bald and Golden Protection Act (BGEPA 1940). The golden eagle is also considered a Level-II Species of Conservation Priority by the NDGFD, or a species in need of conservation, but one that has support from other conservation programs. Two golden eagles were observed during fixed-point bird use surveys (Table 8).

The sharp-tailed grouse (*Tympanuchus phasianellus*) is listed as a Level II species by the NDGFD and the USFWS has raised concerns about impacts on leking prairie grouse species (USFWS 2004). One sharp-tailed grouse was observed during fixed-point bird use surveys (Table 8) and 17 were observed as incidentally (Table 8 and see below).

Other species observed during the fixed-point bird use surveys and/or as incidental wildlife observations were all listed as by the NDGFD as Level-I (in greatest need of conservation), Level-II, or Level-III (in moderate need of conservation, but that are on the edge of their range in North Dakota). Most observations were of northern harrier (Level-II; 30 observations), Swainson's hawk (Level-I; *Buteo swainsoni*; 20), and grasshopper sparrow (Level-I; *Ammodramus savannarum*; eight). Prairie falcon (Level-II; *Falco mexicanus*) and upland sandpiper (Level-I; *Bartramia longicauda*) each had three observations, while there were two observations each of lark bunting (Level-I; *Calamospiza melanocorys*), loggerhead shrike (Level-I; *Lanius ludovicianus*), and marbled godwit (Level I; *Limosa fedoa*). One species, ferruginous hawk (Level-I; *Buteo regalis*), was seen as a single observation as an incidental species (Table 8 and see below), while single observations of Baird's sparrow (Level-I; *Ammodramus bairdii*), peregrine falcon (Level-III; *F. peregrinus*), and short-eared owl (Level-II; *Asio flammeus*) occurred during the fixed-point surveys at the TCWRA (Table 8).

Incidental Wildlife Observations

Bird Observations

Observations of state or federally listed species, raptors, and other species of interest observed while in-transit between surveys points were recorded (Table 10). The most abundant bird species recorded were sandhill cranes (*Grus canadensis*; 33 observations), sharp-tailed grouse (17), ring-necked pheasant (14), northern harrier (nine), and Swainson's hawk (also nine). Eighteen species were observed, with a total of 100 individuals in 39 groups.

Mammal Observations

Mammal species were observed throughout the study area. Large mammals observed included 36 pronghorn antelope (*Antilocapra americana*), 13 white-tailed deer (*Odocoileus virginianus*), and three mule deer (*O. hemionus*). Other mammals included five eastern cottontail rabbit (*Silvlagus floridanus*), and one coyote (*Canis latrans*; Table 10).

DISCUSSION AND IMPACT ASSESSMENT

Bird Impacts

Direct Effects

The most probable impact to birds from wind projects is direct mortality or injury due to collisions with turbines or guy wires of meteorological towers (met towers). Collisions may occur with resident birds foraging and flying within the project area or with migrant birds seasonally moving through the project area. Project construction could affect birds through loss of habitat, potential fatalities from construction equipment, and disturbance/displacement effects from construction activities. Impacts from the decommissioning of the facility are anticipated to be similar to construction in terms of noise, disturbance, and equipment. Potential mortality from construction equipment is expected to be very low. Equipment used in wind facility construction generally moves at slow rates or is stationary for long periods (e.g., cranes). The risk of direct mortality to birds from construction is most likely potential destruction of a nest for ground- and shrub-nesting species during initial site clearing.

Substantial data on bird mortality at wind facilities are available from studies in California and throughout the west and Midwest. Of 841 bird fatalities reported from California studies (>70% from the Altamont Pass wind-energy facility, California), 39% were diurnal raptors, 19% were passerines (excluding house sparrow [*Passer domesticus*] and European starling), and 12% were owls. Non-protected birds including house sparrow, European starling, and rock pigeon [*Columba livia*] comprised 15% of the fatalities. Other bird types generally made up less than 10% of the fatalities (Erickson et al. 2002). During 12 fatality monitoring studies conducted at wind-energy facilities outside of California, diurnal raptor fatalities comprised only two percent of the wind-energy facility-related fatalities and raptor mortality averaged 0.03 raptors/turbine/year. Passerines (excluding house sparrows and European starlings) were the most common collision victims, comprising 82% of the 225 fatalities documented. These facilities that were studied outside California have more modern turbines than the older California facilities.

For all bird species combined, estimates of the number of bird fatalities per turbine per year from individual studies ranged from zero at the Searsburg, Vermont (Kerlinger 1997), and Algona, Iowa (Demastes and Trainer, 2000), wind-energy facilities, to 7.7 at the Buffalo Mountain, Tennessee, facility (Nicholson 2003). Using mortality data from the last 10 years from wind-enrgy facilities throughout the entire United States, the average number of bird collision fatalities is 3.1 birds per megawatt per year or 2.3 per turbine per year (NWCC 2004).

Raptor Use and Exposure Risk

Mean raptor use at the TCWRA was compared with other wind-energy facilities that implemented similar protocols and had data for summer and fall raptor use. Mean raptor use at the TCWRA for the summer and fall (0.35 and 0.26 birds/20-min survey, respectively) were compared separately to raptor use at other wind-energy facilities; similar studies were conducted at 34 other wind-energy facilities in the summer, and 32 in the fall. Summer mean raptor use at other wind-energy facilities ranged from 0.06 to 2.38 birds/20-min survey, and ranged from 0.08

to 3.38 for fall surveys (Figures 6 and 7). Mean raptor use at the TCWRA was eleventh lowest compared to the other sites in the summer at 0.35 raptors/20-min survey (Figure 6; Table 3), and sixth lowest at compared to other sites in the fall at 0.26 raptors/20-min survey (Figure 7; Table 3). Based on the results from these projects a ranking of seasonal raptor mean use was developed as: low (0 – 0.5/survey); low to moderate (0.5 – 1.0/survey); moderate (1.0 – 2.0/survey); high (2.0 – 3.0); and very high (> 3.0). Under this ranking, mean raptor use at TCWRA would be considered low in the summer and fall.

Although high numbers of raptor fatalities have been documented at some wind-energy facilities (e.g. Altamont Pass), a review of studies at wind-energy facilities across the United States reported that only 3.2% of casualties were raptors (Erickson et al. 2001b). Indeed, although raptors occur in most areas with the potential for wind-energy development, individual species appear to differ from one another in their susceptibility to collision (NRC 2007). Results from the Altamont Pass wind-energy facility in California suggest that mortality for some species is not necessarily related to abundance (Orloff and Flannery 1992). American kestrels, red-tailed hawks, and golden eagles (were killed more often, and turkey vultures were killed less often than predicted based on abundance. A recent report from the Buffalo Gap wind-energy facility in Texas, however, suggests that turkey vulture (*Cathartes aura*) may show a higher susceptiblity to collision at larger wind turbines than for smaller turbines than previously believed (Tierney 2007). In addition, reports from the High Winds wind-energy facility in California document high American kestrel (*Falco sparverius*) mortality. Relative use by this species at High Winds is six times that at the Altamont Pass facility (Kerlinger et al. 2005). It is likely that many factors, in addition to abundance, are important in predicting raptor mortality.

Exposure indices analysis may also provide insight into what species might be the most likely turbine casualties; however, the index only considers relative probability of exposure based on abundance, proportion of daily activity spent flying, and proportion of flight height of each species within the ZOR for turbines likely to be used at the wind-energy facility. This analysis is based on observations of birds during the daylight period and does not take into consideration flight behavior (e.g. during foraging or courtship) or abundance of nocturnal migrants. It also does not take into consideration habitat selection, the ability to detect and avoid turbines, and other factors that may vary among species and influence likelihood for turbine collision. For these reasons, the actual risk for some species may be lower or higher than indicated by these data.

A regression analysis of raptor use and mortality for 11 new-generation wind-energy facilities, where similar methods were used to estimate raptor use and mortality, found that there was a significant correlation between use and mortality ($R^2 = 81.4\%$; Figure 8). Using this regression to predict raptor collision mortality at the TCWRA, based on an adjusted mean raptor use of 0.28 birds/20-min. survey, yields an estimated fatality rate of 0.02 raptors/MW/year, or two raptor fatalities per year for a 100-MW wind-energy facility. A 90% prediction interval around this estimate is zero to 0.18 raptors/MW/year

Raptor fatalities at wind-energy facilities near the proposed TCWRA location have been relatively low, between zero at a site in Wisconsin (Howe et al. 2002) and 0.04 raptors/MW/year at Buffalo Ridge, Minnesota (Johnson et al. 2000a; Table 11). The predicted raptor mortality

based on use at the TCWRA is very similar to these values (estimate of zero raptors/MW/year with 90% confidence interval of 0-0.16). Based on the relative abundance of northern harrier in the summer and fall (Table 2), and a similar or higher exposure index than other raptor species, there is higher potential for northern harrier fatalities compared to other species.

Non-raptor Use and Exposure Risk

Exposure indices of non-raptors indicated that the Lapland longspur, horned lark, cliff swallow, and mallard are most likely to be exposed to potential collision from wind turbines at the TCWRA. Most non-raptors had relatively low exposure indices due to the majority of individuals flying below the likely ZOR. Due to the low exposure risks at TCWRA, it is unlikely that non-raptor populations will be adversely affected by direct mortality from the operation of the wind-energy facility.

Indirect Effects

The presence of wind turbines may alter the landscape so that wildlife use patterns are affected, displacing wildlife away from the project facilities and suitable habitat. Some studies from wind-energy facilities in Europe consider displacement effects to have a greater impact on birds than collision mortality (Gill et al. 1996, Strickland 2004). The greatest concern with displacement impacts are for wind-energy facilities placed in grassland or other native habitats (Leddy et al. 1999, Mabey and Paul 2007), and disturbance appears to impact feeding, resting, and migrating birds rather than breeding birds (Crockford 1992). Studies on habitat displacement caused by wind-energy facilities have concentrated on grassland passerines, waterfowl, and raptors (NRC 2007). This issue may warrant further investigation if the project significantly impacts native grassland areas.

Raptor Nesting Disturbance

In addition to possible direct effects on raptors within the study area (discussed above), indirect effects caused by disturbance-type impacts, such as construction activity near an active nest or primary foraging area, also have a potential impact on raptor species. Birds displaced from wind-energy facilities might move to areas with fewer disturbances, but lower quality, with an overall effect of reducing breeding success. Most studies on raptor displacement at wind-energy facilities, however, indicate effects to be negligible (Howell and Noone 1992; Johnson et al. 2000a; Whitfield and Madders 2006). Notable exceptions to this include a study in Scotland that described territorial golden eagles avoiding the entire wind-energy facility area except when intercepting non-territorial birds (Walker et al. 2005). A study at the Buffalo Ridge wind-energy facility in Minnesota found evidence of harriers avoiding turbines on both a small scale (< 100 m from turbines) and larger scale in the year following construction (Johnson et al. 2000a) as well as lower raptor nest densities near turbines compared to densities in similar habitat away from turbines (Usgaard et al. 1997).

Information concerning the effect of nesting displacement on specific species is limited; however, a Swainson's hawk was reported to have nested within 0.25 mile (0.8 km) of the turbine string at a wind-energy facility in Oregon, suggesting little disturbance to this species (Johnson et al. 2003b). In addition, at the Foote Creek Rim wind-energy facility in southern Wyoming, one pair of red-tailed hawks nested within 0.3 mile of the turbine strings, and seven

red-tailed hawk, one great horned owl, and one golden eagle nests located within one mile (1.6 km) of the wind-energy facility successfully fledged young (Johnson et al. 2000b). The golden eagle pair successfully nested a half-mile (800 m) from the wind-energy facility for three different years after it became operational. Studies at the Stateline wind-energy facility in Oregon and Washington have not shown any measurable short-term effects to nesting raptors (Erickson et al. 2004). These observations suggest that there will be limited displacement of nesting raptor species at TCWRA, although the creation of a buffer surrounding known nests when siting turbines will further reduce any impact.

Displacement of Non-Raptor Bird Species

Studies concerning displacement of non-raptor species have concentrated on grassland songbirds and waterfowl/waterbirds (Winkelman 1990; Larsen and Madsen 2000; Mabey and Paul 2007). Wind-energy facility construction appears to cause small scale local displacement of grassland songbirds and is likely due to the birds avoiding turbine noise and maintenance activities. Construction also reduces habitat effectiveness because of the presence of access roads and large gravel pads surrounding turbines (Leddy 1996; Johnson et al. 2000b). Leddy et al. (1999) surveyed bird densities in Conservation Reserve Program (CRP) grasslands at the Buffalo Ridge wind-energy facility in Minnesota and found mean densities of 10 grassland bird species. Densities were four times higher at areas located 591 ft (180 m) from turbines than they were at grasslands nearer turbines. The observed species included the western meadowlark, red-winged blackbird (*Agelaius phoeniceus*), and savannah sparrow (*Passerculus sandwichensis*), all of which have been observed within the TCWRA. Johnson et al. (2000b) at the same wind resource area found reduced use of habitat in seven of 22 grassland-breeding birds following construction. Results from the Stateline wind-energy facility, Oregon and Washington (Erickson et al. 2004), and the Combine Hills project, Oregon (Young et al. 2005), suggest a relatively small impact of the wind-energy facilities on grassland nesting passerines. Transect surveys conducted prior to and after construction of the wind-energy facilities found that grassland songbird use was significantly reduced within approximately 164 ft (50 m) of turbine strings; areas further away from turbine strings did not have reduced bird use. Displacement of grassland songbirds may be reduced by siting turbines away from grassland or natural habitats. Turbines sited within agricultural land, similar to the surrounding area, should minimize displacement to lessen any population impacts.

Displacement effects of wind-energy facilities on waterfowl and wading birds appear to be mixed. Studies from the Netherlands and Denmark suggest that densities of these types of species near turbines were lower compared to densities in similar habitats away from turbines (Winkelman 1990; Pedersen and Poulsen 1991). However, a study from a facility in England, found no effect of wind turbines on populations of cormorant (*Phalacrcorax xarbo*), purple sandpipers (*Calidris maritima*), eiders (*Somateria mollissima*), or gulls, although the cormorants were temporarily displaced during construction (Lawrence et al. 2007). At the Buffalo Ridge wind-energy facility, Minnesota, the abundance of several bird types, including shorebirds and waterfowl, were found to be significantly lower at survey plots with turbines than at plots without turbines (Johnson et al 2000b). The report concluded that the area of reduced use was limited primarily to those areas within 328 ft (100 m) of the turbines. Disturbance tends to be greatest for migrating birds while feeding and resting (Crockford 1992; NRC 2007). The

majority of waterfowl/waterbirds using the TCWRA was four groups of mallards comprising a total of 15 individuals. The presence of similar habitat surrounding TCWRA means that any displacement of this species is unlikely to impact the population.

Bat Impacts

Direct Effects

Bat casualties have been reported from most wind-energy facilities where post-construction fatality data are available. Reported estimates of bat mortality at wind-energy facilities have ranged from 0.01 – 47.5 per turbine per year (0.9 – 43.2 bats/MW/year) in the United States, with an average of 3.4 per turbine or 4.6 per MW (NWCC 2004). Most of the bat casualties at wind-energy facilities to date are of a non-hibernating foliage (tree) dwelling migratory species that conduct long-distance migrations between summer breeding and wintering areas, specifically: hoary bat, eastern red bat, and silver-haired bat (Johnson 2005). Arnett et al. (2005) reported from 25 to 38 bat fatalities per turbine during a six-week study period at wind-energy facilities in West Virginia and Pennsylvania. Most of the species killed were eastern red bat, hoary bat, and eastern pipistrelle (Kerns et al. 2005). The West Virginia and Pennsylvania wind-energy facilities are located on prominent forested ridges in the Appalachian Mountains. A large number of hoary bats and silver-haired bats (532) were also found at a southern Alberta, Canada wind-energy facility in 2005 and 2006 (Baerwald 2006). Unlike eastern US wind-energy facilities with high bat mortality, the Alberta facility is in open grasslands and cropfields, although it is adjacent to foothills along the Rocky Mountains (Rowland 2006). The causes of the relatively high number of migratory bat deaths at wind-energy facilities are not well understood (Johnson 2005). Kerns et al. (2005) hypothesized that bats may have been attracted to turbines by ultrasound emissions, ephemeral increases in food sources, or bats may have investigated turbines for roosting sites or to glean insects from turbine blades. Researchers also theorized that clearings made in the forest for turbines and roads may have created attractive foraging areas for bats (Kerns et al. 2005).

Potential Impacts

Assessing the potential impacts of wind energy development to bats at the TCWRA is complicated by our current lack of understanding of why bats collide with wind turbines (Kunz et al 2007b), combined with the inherent difficulties of monitoring elusive, night-flying animals (O'Shea et al. 2003). To date, monitoring studies of wind energy projects suggest that: a) migratory tree-roosting species (eastern red, hoary, and silver-haired bats) comprise almost 75% of reported bats killed (Johnson 2005, Kunz et al. 2007b); b) the majority of collisions occur during the post-breeding or fall migration season (roughly August and September; Gruver 2002; Johnson et al. 2003a); and c) the highest reported fatalities occur at wind facilities located along forested ridge tops in the eastern US (Kunz et al. 2007b), although recent studies in agricultural regions of Iowa and Alberta, Canada, report relatively high fatalities as well (Jain 2005; Baerwald 2006).

Post-construction fatality data collected at wind-energy facilities appear to be the best available predictor of mortality levels and species composition for proposed wind-energy facilities. Some studies of wind-energy facilities have recorded both AnaBat detections per night and bat

mortality (Table 12). The number of bat calls per night as determined from bat detectors shows a rough correlation with bat mortality, but may be misleading because effort, timing of sampling, species recorded, and detector settings (equipment and locations) varies among studies (Kunz et al. 2007b). Thus, our best available estimate of mortality levels at a proposed wind-energy facility involves evaluation of our on-site acoustic bat data in terms of activity levels, seasonal variation, species composition, and topographic features of the project area.

Activity

Bat activity within the TCWRA (mean = 1.13 bat passes per detector-night) was comparable to that observed at facilities in Minnesota and Wyoming, where bat collision mortality was low, and it was much lower than activity recorded at sites in West Virginia and Tennessee, where bat mortality rates were high (Table 13). Thus, based on the presumed relationship between pre-construction bat activity and post-construction fatalities, and assuming that this relationship extends to the Midwest, we expect bat mortality rates at the TCWRA to be similar to the 2.2 bat fatalities/turbine/year reported at the Buffalo Ridge, Minnesota, wind-energy facility, but much lower than the 20.8 fatalities/turbine/year reported at the Buffalo Mountain, Tennessee, facility.

Species Composition

Acoustic bat surveys were unable to determine most bat species detected durin the study (only a limited number of calls were identified to hoary bat or eastern red bat), but they were able to distinguish high-frequency from low-frequency species. In the TCWRA, 46.0% of all bat passes were high-frequency and 54% were low-frequency calls, suggesting only slightly higher relative abundance of species such as hoary bats, silver haired bats, and big brown bats.

Topographic Features

The proposed wind-energy facility is not located near any large, known bat colonies or other features that are likely to attract large numbers of bats. As well, the TCWRA does not contain topographic features that may funnel migrating bats, and is lacking large tracts of forest cover, unlike high-mortality sites in the eastern US. However, the relatively large numbers of bat fatalities recently reported in northern Iowa (Jain 2005) and southwestern Alberta (Baerwald 2006) indicate that an open landscape is no guarantee of low mortality. There were relatively even numbers of calls per detector night at each location, suggesting that there is not a topographic or other landscape feature increasing bat use in one area of another. Based on species composition and timing, we expect the majority of bat mortalities to be individuals migrating through the area.

Sensitive Species Use and Exposure Risk

No species protected under the federal Endangered Species Act (ESA 1973) were recorded during the surveys at the TCWRA. One species, the golden eagle (*Aquila chrysaetos*), while no longer protected under the Endangered Species Act, is still federally protected . The golden eagle is also considered a Level-II speices by the NDGFD. Altogether, seven NDGFD Level-I species,

six Level-II species, and one Level-III specie were observed during surveys at the TCWRA (Table 8).

The sharp-tailed grouse is one of those listed as a Level II species by the NDGFD. Because sharp-tailed grouse evolved on prairie landscapes with few trees or vertical structures, wildlife researchers have postulated that sharp-tailed grouse may avoid tall vertical structures, such as wind turbines and powerlines (USFWS 2004). However, few researchers have documented the level of avoidance by prairie grouse of wind turbines or other structures. Robel (2002) describes unpublished data that indicate that lesser prairie chickens (*Tympanuchus pallidicinctus*) avoided powerlines, human dwellings, and a large powerplant by distances ranging from a quarter mile to almost one mile (0.4 to 1.6 km). No published studies are available that have examined sharp-tailed grouse response to disturbance at various distances. Eighteen sharp-tailed grouse were observed during the surveys, indicating that sharp-tailed grouse do utilize the TCWRA.

Because surveys were limited to public roads and accessible private roads, the potential exists for other undocumented sensitive species to occur within the TCWRA.

CONCLUSION AND RECOMMENDATIONS

Based on data collected during this study, raptor and all bird use of TCWRA is generally lower than most wind resource areas evaluated throughout the western and Midwestern US using similar methods. Additionally, the bat use data indicated a relatively low amount of bat activity in the study area. Based on the results of the studies to date, bird and bat mortality at the TCWRA would likely be similar or lower than that documented at other wind farms located in the western and Midwestern United States where bird and bat collision mortality has been relatively low.

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Table 1. Summary of bird use, species richness, and sample size by season and overall during the fixed-point bird use surveys in the TCWRA, June 5 through October 29, 2007.

Season	# of Visits	Mean Use	# Species /Survey	# Species	# Surveys Conducted
Summer	5	6.71	3.56	44	95
Fall	6	7.33	1.26	23	120
Overall	**11**	**7.05**	**2.31**	**51**	**215**

Table 2. Total number of groups and individuals for each bird type and species by season and overall during the fixed-point bird use surveys in the TCWRA[a], June 5 through October 29, 2007.

		Summer		Fall		Total	
Species/Type	**Scientific Name**	**# grps**	**# obs**	**# grps**	**# obs**	**# grps**	**# obs**
Waterfowl		**5**	**16**	**0**	**0**	**5**	**16**
Canada goose	*Branta canadensis*	1	1	0	0	1	1
mallard	*Anas platyrhynchos*	4	15	0	0	4	15
Shorebirds		**7**	**7**	**0**	**0**	**7**	**7**
killdeer	*Charadrius vociferus*	3	3	0	0	3	3
marbled godwit	*Limosa fedoa*	1	1	0	0	1	1
upland sandpiper	*Bartramia longicauda*	3	3	0	0	3	3
Raptors		**31**	**34**	**29**	**31**	**60**	**65**
Buteos		*9*	*9*	*13*	*14*	*22*	*23*
red-tailed hawk	*Buteo jamaicensis*	1	1	9	9	10	10
rough-legged hawk	*Buteo lagopus*	0	0	1	1	1	1
Swainson's hawk	*Buteo swainsoni*	7	7	3	4	10	11
unidentified buteo		1	1	0	0	1	1
Northern Harrier		*18*	*21*	*8*	*9*	*26*	*30*
northern harrier	*Circus cyaneus*	18	21	8	9	26	30
Eagles		*0*	*0*	*2*	*2*	*2*	*2*
golden eagle	*Aquila chrysaetos*	0	0	2	2	2	2
Falcons		*2*	*2*	*1*	*1*	*3*	*3*
peregrine falcon	*Falco peregrinus*	0	0	1	1	1	1
prairie falcon	*Falco mexicanus*	2	2	0	0	2	2
Owls		*1*	*1*	*0*	*0*	*1*	*1*
short-eared owl	*Asio flammeus*	1	1	0	0	1	1
Other Raptors		*0*	*0*	*5*	*5*	*5*	*5*
unidentified hawk		0	0	4	4	4	4
unidentified raptor		0	0	1	1	1	1
Vultures		*1*	*1*	*0*	*0*	*1*	*1*
turkey vulture	*Cathartes aura*	1	1	0	0	1	1

Table 2. Total number of groups and individuals for each bird type and species by season and overall during the fixed-point bird use surveys in the TCWRA[a], June 5 through October 29, 2007.

		Summer		Fall		Total	
Species/Type	**Scientific Name**	**# grps**	**# obs**	**# grps**	**# obs**	**# grps**	**# obs**
Upland Gamebirds		**32**	**57**	**38**	**158**	**70**	**215**
gray partridge	*Perdix perdix*	2	3	0	0	2	3
ring-necked pheasant	*Phasianus colchicus*	30	54	37	157	67	211
sharp-tailed grouse	*Tympanuchus phasianellus*	0	0	1	1	1	1
Doves/Pigeons		**42**	**73**	**12**	**46**	**54**	**119**
mourning dove	*Zenaida macroura*	41	71	10	31	51	102
rock pigeon	*Columba livia*	1	2	2	15	3	17
Passerines		**252**	**447**	**90**	**642**	**342**	**1,089**
American crow	*Corvus brachyrhynchos*	4	5	2	2	6	7
American goldfinch	*Carduelis tristis*	3	6	1	1	4	7
American robin	*Turdus migratorius*	5	7	1	4	6	11
Baird's sparrow	*Ammodramus bairdii*	1	1	0	0	1	1
barn swallow	*Hirundo rustica*	12	20	1	4	13	24
black-capped chickadee	*Poecile atricapillus*	0	0	1	1	1	1
bobolink	*Dolichonyx oryzivorus*	16	28	0	0	16	28
Brewer's blackbird	*Euphagus cyanocephalus*	5	19	0	0	5	19
brown thrasher	*Toxostoma rufum*	1	1	0	0	1	1
brown-headed cowbird	*Molothrus ater*	15	47	0	0	15	47
cliff swallow	*Petrochelidon pyrrhonota*	4	25	0	0	4	25
common grackle	*Quiscalus quiscula*	3	10	0	0	3	10
eastern kingbird	*Tyrannus tyrannus*	24	31	0	0	24	31
European starling	*Sturnus vulgaris*	1	1	2	288	3	289
grasshopper sparrow	*Ammodramus savannarum*	7	8	0	0	7	8
horned lark	*Eremophila alpestris*	11	30	28	197	39	227
Lapland longspur	*Calcarius lapponicus*	0	0	1	15	1	15
lark bunting	*Calamospiza melanocorys*	2	2	0	0	2	2
loggerhead shrike	*Lanius ludovicianus*	1	1	0	0	1	1
northern rough-winged swallow	*Stelgidopteryx serripennis*	2	14	0	0	2	14
red-winged blackbird	*Agelaius phoeniceus*	17	26	0	0	17	26

Table 2. Total number of groups and individuals for each bird type and species by season and overall during the fixed-point bird use surveys in the TCWRA[a], June 5 through October 29, 2007.

		Summer		Fall		Total	
Species/Type	**Scientific Name**	**# grps**	**# obs**	**# grps**	**# obs**	**# grps**	**# obs**
savannah sparrow	*Passerculus sandwichensis*	25	28	2	3	27	31
song sparrow	*Melospiza melodia*	1	1	0	0	1	1
tree swallow	*Tachycineta bicolor*	1	2	0	0	1	2
unidentified sparrow		4	6	5	6	9	12
vesper sparrow	*Pooecetes gramineus*	3	3	1	5	4	8
warbling vireo	*Vireo gilvus*	1	1	0	0	1	1
western kingbird	*Tyrannus verticalis*	20	33	0	0	20	33
western meadowlark	*Sturnella neglecta*	62	90	45	116	107	206
yellow-rumped warbler	*Dendroica coronata*	1	1	0	0	1	1
Other Birds		**4**	**4**	**2**	**2**	**6**	**6**
common nighthawk	*Chordeiles minor*	1	1	0	0	1	1
downy woodpecker	*Picoides pubescens*	0	0	1	1	1	1
northern flicker	*Colaptes auratus*	3	3	1	1	4	4
Total		**373**	**638**	**171**	**879**	**544**	**1,517**

[a] All individuals observed, including those outside the half-mile (800 m) plot.

Table 3. Mean bird use (number/plot/20-min survey), percent of total composition (%), and frequency of occurrence (%) for each bird type and species by season during the fixed-point bird use surveys at the TCWRA, June 5 through October 29, 2007.

	Use		% Composition		% Frequency	
Species/Type	**Summer**	**Fall**	**Summer**	**Fall**	**Summer**	**Fall**
Waterfowl	**0.19**	**0**	**2.8**	**0**	**4.3**	**0**
Canada goose	0.01	0	0.1	0	1.0	0
mallard	0.18	0	2.6	0	4.3	0
Shorebirds	**0.08**	**0**	**1.2**	**0**	**8.3**	**0**
Killdeer	0.03	0	0.5	0	3.3	0
marbled godwit	0.01	0	0.1	0	1.0	0
upland sandpiper	0.04	0	0.6	0	4.0	0
Raptors	**0.35**	**0.26**	**5.2**	**3.5**	**25.7**	**20.0**
Buteos	*0.09*	*0.12*	*1.4*	*1.6*	*9.3*	*9.2*
red-tailed hawk	0.01	0.08	0.2	1.0	1.3	6.7
rough-legged hawk	0	0.01	0	0.1	0	0.8
Swainson's hawk	0.07	0.03	1.0	0.5	7.0	2.5
unidentified buteo	0.01	0	0.1	0	1.0	0
Northern Harrier	*0.21*	*0.08*	*3.1*	*1.0*	*15.0*	*6.7*
northern harrier	0.21	0.08	3.1	1.0	15.0	6.7
Eagles	*0*	*0.02*	*0*	*0.2*	*0*	*1.7*
golden eagle	0	0.02	0	0.2	0	1.7
Falcons	*0.02*	*0.01*	*0.3*	*0.1*	*2.0*	*0.8*
peregrine falcon	0	0.01	0	0.1	0	0.8
prairie falcon	0.02	0	0.3	0	2.0	0
Owls	*0.01*	*0*	*0.2*	*0*	*1.3*	*0*
short-eared owl	0.01	0	0.2	0	1.3	0
Other Raptors	*0*	*0.04*	*0*	*0.6*	*0*	*4.2*
unidentified hawk	0	0.03	0	0.5	0	3.3
unidentified raptor	0	0.01	0	0.1	0	0.8
Vultures	*0.01*	*0*	*0.1*	*0*	*1.0*	*0*
turkey vulture	0.01	0	0.1	0	1.0	0

Table 3. Mean bird use (number/plot/20-min survey), percent of total composition (%), and frequency of occurrence (%) for each bird type and species by season during the fixed-point bird use surveys at the TCWRA, June 5 through October 29, 2007.

	Use		% Composition		% Frequency	
Species/Type	**Summer**	**Fall**	**Summer**	**Fall**	**Summer**	**Fall**
Upland Gamebirds	**0.61**	**1.32**	**9.1**	**18.0**	**32.3**	**25.8**
gray partridge	0.04	0	0.5	0	2.3	0
ring-necked pheasant	0.58	1.31	8.6	17.9	30.0	25.8
sharp-tailed grouse	0	0.01	0	0.1	0	0.8
Doves/Pigeons	**0.75**	**0.38**	**11.2**	**5.2**	**30.3**	**8.3**
mourning dove	0.73	0.26	10.9	3.5	29.3	7.5
rock pigeon	0.02	0.13	0.3	1.7	1.0	1.7
Passerines	**4.69**	**5.35**	**69.9**	**73.0**	**82.0**	**51.7**
American crow	0.06	0.02	0.8	0.2	4.7	1.7
American goldfinch	0.06	0.01	0.9	0.1	3.0	0.8
American robin	0.08	0.03	1.1	0.5	5.3	0.8
Baird's sparrow	0.01	0	0.1	0	1.0	0
barn swallow	0.21	0.03	3.2	0.5	13.0	0.8
black-capped chickadee	0	0.01	0	0.1	0	0.8
Bobolink	0.30	0	4.5	0	15.3	0
Brewer's blackbird	0.20	0	2.9	0	4.3	0
brown thrasher	0.01	0	0.1	0	1.0	0
brown-headed cowbird	0.47	0	7.0	0	15.0	0
cliff swallow	0.25	0	3.7	0	3.0	0
common grackle	0.13	0	1.9	0	3.7	0
eastern kingbird	0.33	0	5.0	0	24.3	0
European starling	0.01	2.40	0.1	32.8	1.0	0.8
grasshopper sparrow	0.09	0	1.3	0	7.7	0
horned lark	0.30	1.64	4.5	22.4	11.3	21.7
Lapland longspur	0	0.13	0	1.7	0	0.8
lark bunting	0.02	0	0.3	0	2.0	0
loggerhead shrike	0.01	0	0.1	0	1.0	0
northern rough-winged swallow	0.14	0	2.1	0	2.0	0

Table 3. Mean bird use (number/plot/20-min survey), percent of total composition (%), and frequency of occurrence (%) for each bird type and species by season during the fixed-point bird use surveys at the TCWRA, June 5 through October 29, 2007.

	Use		% Composition		% Frequency	
Species/Type	**Summer**	**Fall**	**Summer**	**Fall**	**Summer**	**Fall**
red-winged blackbird	0.28	0	4.1	0	17.0	0
savannah sparrow	0.30	0.03	4.5	0.3	25.0	1.7
song sparrow	0.01	0	0.1	0	1.0	0
tree swallow	0.02	0	0.3	0	1.0	0
unidentified sparrow	0.06	0.05	0.9	0.7	4.0	3.3
vesper sparrow	0.04	0.04	0.5	0.6	3.7	0.8
warbling vireo	0.01	0	0.1	0	1.0	0
western kingbird	0.33	0	4.9	0	18.0	0
western meadowlark	0.96	0.97	14.3	13.2	57.0	30.8
yellow-rumped warbler	0.01	0	0.1	0	1.0	0
Other Birds	**0.04**	**0.02**	**0.6**	**0.2**	**4.0**	**1.7**
common nighthawk	0.01	0	0.1	0	1.0	0
downy woodpecker	0	0.01	0	0.1	0	0.8
northern flicker	0.03	0.01	0.4	0.1	3.0	0.8
Overall	**6.71**	**7.33**	**100.0**	**100.0**		

Table 4. Relative exposure index and flight characteristics by species during the fixed-point bird use surveys at the TCWRA, June 5 through October 29, 2007.

Species	# Groups Flying	Overall Mean Use	% Flying	% Flying Initially in ZOR[a]	Exposure Index	% Within ZOR† at any time
Lapland longspur	1	0.07	100.0	100.0	0.07	100.0
horned lark	33	1.03	93.4	4.7	0.05	4.7
cliff swallow	4	0.11	100.0	32.0	0.04	32.0
mallard	3	0.08	46.7	85.7	0.03	85.7
northern harrier	23	0.14	86.7	15.4	0.02	26.9
red-tailed hawk	6	0.05	60.0	83.3	0.02	100.0
Swainson's hawk	6	0.05	63.6	71.4	0.02	71.4
mourning dove	32	0.47	60.8	3.2	0.01	3.2
rock pigeon	3	0.08	100.0	17.6	0.01	17.6
unidentified sparrow	7	0.05	91.7	18.2	0.01	18.2
unidentified hawk	2	0.02	50.0	100.0	0.01	100.0
golden eagle	2	0.01	100.0	100.0	0.01	100.0
tree swallow	1	0.01	100.0	100.0	0.01	100.0
brown-headed cowbird	11	0.21	78.7	2.7	<0.01	2.7
eastern kingbird	15	0.15	61.3	5.3	<0.01	15.8
northern rough-winged swallow	1	0.06	7.1	100.0	<0.01	100.0
American crow	3	0.03	57.1	25.0	<0.01	25.0
Canada goose	1	<0.01	100.0	100.0	<0.01	100.0
common nighthawk	1	<0.01	100.0	100.0	<0.01	100.0
rough-legged hawk	1	<0.01	100.0	100.0	<0.01	100.0
European starling	3	1.31	100.0	0	0	0
bobolink	15	0.14	89.3	0	0	0
barn swallow	12	0.12	83.3	0	0	0
Brewer's blackbird	5	0.09	100.0	0	0	0
common grackle	3	0.06	100.0	0	0	0

Table 4. Relative exposure index and flight characteristics by species during the fixed-point bird use surveys at the TCWRA, June 5 through October 29, 2007.

Species	# Groups Flying	Overall Mean Use	% Flying	% Flying Initially in ZOR[a]	Exposure Index	% Within ZOR† at any time
American robin	4	0.05	81.8	0	0	0
grasshopper sparrow	1	0.04	25.0	0	0	0
American goldfinch	2	0.03	57.1	0	0	0

†ZOR, the likely "zone of risk" for collision with turbine blades, or 82-410 ft (25-125 m) AGL.

Table 5. Flight height characteristics by bird type during the fixed-point bird use surveys in the TCWRA June 5 through October 29, 2007.

Type	# Obs Flying	# Groups Flying	Mean Flight Height	% Obs Flying	% within Flight Height Categories		
					0-82 ft	82-410 ft†	> 410 ft
Waterfowl	8	4	40.00	50.0	12.5	87.5	0
Shorebirds	3	3	6.33	42.9	100.0	0	0
Raptors	46	42	60.10	70.8	52.2	41.3	6.5
Buteos	*14*	*13*	*117.31*	*60.9*	*7.1*	*78.6*	*14.3*
Northern Harrier	*26*	*23*	*10.61*	*86.7*	*84.6*	*15.4*	*0*
Eagles	*2*	*2*	*75.00*	*100.0*	*0*	*100.0*	*0*
Falcons	*1*	*1*	*5.00*	*33.3*	*100.0*	*0*	*0*
Owls	*0*	*0*	*0*	*0*	*0*	*0*	*0*
Other Raptors	*2*	*2*	*100.00*	*40.0*	*0*	*100.0*	*0*
Vultures	*1*	*1*	*400.00*	*100.0*	*0*	*0*	*100.0*
Upland Gamebirds	79	15	1.80	36.7	100.0	0	0
Doves/Pigeons	79	35	9.40	66.4	93.7	6.3	0
Passerines	866	190	6.43	79.5	95.3	4.7	0
Other Birds	1	1	100.00	16.7	0	100.0	0
Overall	**1082**	**290**	**15.11**	**71.3**	**93.0**	**6.7**	**0.3**

†ZOR, the likely "zone of risk" for collision with turbine blades, or 82-410 ft (25-125 m) AGL.

Table 6. Bat species determined from range-maps (Harvey et al. 1999; BCI website) as likely to occur within the TCWRA, sorted by call frequency.

High-frequency (≥ 35 kHz)		Low frequency (< 35 kHz)	
Eastern Red Bat*	*Lasiurus borealis*	Big Brown Bat	*Eptesicus fuscus*
Northern Long-eared Bat‡	*Myotis septentrionalis*	Silver-haired Bat*	*Lasionycteris noctivagans*
Little Brown Bat‡	*Myotis lucifugus*	Hoary Bat*	*Lasiurus cinereus*
Western Small-footed Bat**‡	*Myotis ciliolabrum*	Townsend's Big-eared Bat**	*Corynorhinus townsendii*
Western Long-eared Bat**	*Myotis evotis*	Fringed Bat**	*Myotis thysanodes*
Long-legged Bat**	*Myotis volans*		

*long-distance migrant; **on the edge or just outside species range, ‡species listed as sensitive by the NDGFD.

Table 7. North Dakota state and federal special/sensitive status species listed by the USFWS or the NDGFD.

Common Name	Scientific Name	USFWS	NDGFD
Birds			
American avocet	*Recurvirostra americana*		II
American bittern	*Botaurus lentiginosus*		I
American white pelican	*Pelecanus erythrorhynchos*		I
Baird's sparrow	*Ammodramus bairdii*		I
bald eagle	*Haliaeetus leucocephalus*	EA	II
black tern	*Chlidonias niger*		I
black-billed cuckoo	*Coccyzus erythropthalmus*		I
bobolink	*Dolichonyx oryzivorus*		II
brewer's sparrow	*Spizella breweri*		III
burrowing owl	*Athene cunicularia*		II
canvasback	*Aythya valisineria*		II
chestnut-collared longspur	*Calcarius ornatus*		I
dickcissel	*Spiza americana*		II
Eskimo curlew	*Numenius borealis*	E	
ferruginous hawk	*Buteo regalis*		I
Franklin's gull	*Larus pipixcan*		I
golden eagle	*Aquila chrysaetos*	EA	II
grasshopper sparrow	*Ammodramus savannarum*		I
greater prairie chicken	*Tympanuchus cupido*	SoC*	II
greater sage-grouse	*Centrocercus urophasianus*	C*	II
horned grebe	*Podiceps auritus*		I
lark bunting	*Calamospiza melanocorys*		I
Le Conte's sparrow	*Ammodramus leconteii*		II
least tern	*Sterna antillarum*	E	E/II
loggerhead shrike	*Lanius ludovicianus*		II
long-billed curlew	*Numenius americanus*		I
marbled godwit	*Limosa fedoa*		I
McCown's longspur	*Calcarius mccownii*		III
nelson's sharp-tailed sparrow	*Ammodramus nelsonii*		I
northern harrier	*Circus cyaneus*		II
northern pintail	*Anas acuta*		II
peregrine falcon	*Falco peregrinus*		III
piping plover	*Charadrius melodus*		T/II
prairie falcon	*Falco mexicanus*		II
redhead	*Aythya americana*		II
red-headed woodpecker	*Melanerpes erythrocephalus*		II
sedge wren	*Cistothorus platensis*		II
sharp-tailed grouse	*Tympanuchus phasianellus*	SoC*	II

Table 7. North Dakota state and federal special/sensitive status species listed by the USFWS or the NDGFD.

Common Name	Scientific Name	USFWS	NDGFD
short-eared owl	*Asio flammeus*		II
Sprague's pipit	*Anthus spragueii*		I
Swainson's hawk	*Buteo swainsoni*		I
upland sandpiper	*Bartramia longicauda*		I
whooping crane	*Grus americana*	E	E/III
willet	*Catoptrophorus semipalmatus*		I
Wilson's phalarope	*Phalaropus tricolor*		I
yellow rail	*Coturnicops noveboracensis*		I
Bats			
long-eared myotis	*Myotis evotis*		III
long-legged myotis	*Myotis volans*		III
western small-footed myotis	*Myotis ciliolabrum*		III
Other Mammals			
arctic shrew	*Sorex arcticus*		III
black-footed ferret	*Mustela nigripes*		II
black-tailed prairie dog	*Cynomys ludovicianus*		I
eastern spotted skunk	*Spilogale putoris*		III
gray wolf	*Canis lupis*		III
hispid pocket mouse	*Chaetodipus hispidus*		III
plains pocket mouse	*Perognathus flavescens*		III
pygmy shrew	*Sorex hoyi*		II
Richardson's ground squirrel	*Spermophilus richardsonii*		II
river otter	*Lutra canadensis*		II
sagebrush vole	*Lemmiscus curtatus*		III
swift fox	*Vulpes velox*		II
Amphibians			
Canadian toad	*Bufo hemiophrys*		I
plains spadefoot	*Spea bombifrons*		I
Reptiles			
common snapping turtle	*Chelydra serpentina*		II
false map turtle	*Graptemys pseudogeographica*		III
northern prairie skink	*Eumeces septentrionalis*		III
northern redbelly snake	*Storeria occipitomaculata*		II
northern sagebrush lizard	*Sceloporus graciosus*		III
short-horned lizard	*Phrynosoma douglassi*		II
smooth green snake	*Liochlorophis vernalis*		I
smooth softshell turtle	*Apalone mutica*		III
western hognose snake	*Heterodon nasicus*		I
Fish			
blacknose shiner	*Notropis heterolepis*		III

Table 7. North Dakota state and federal special/sensitive status species listed by the USFWS or the NDGFD.

Common Name	Scientific Name	USFWS	NDGFD
blue sucker	*Cycleptus elongatus*		I
central stoneroller	*Campostoma anomalum*		III
chestnut lamprey	*Ichthyomyzon castaneus*		III
finescale dace	*Phoxinus neogaeus*		III
flathead catfish	*Pylodictis olivaris*		III
flathead chub	*Platygobio gracilis*		II
hornyhead chub	*Nocomis biguttatus*		III
logperch	*Percina caprodes*		III
northern redbelly dace	*Phoxinus eos*		II
paddlefish	*Polyodon spathula*		II
pallid sturgeon	*Scaphirhynchus albus*		II
pearl dace	*Margariscus margarita*		I
pugnose shiner	*Notropis anogenus*		III
river darter	*Percina shumardi*		III
rosyface shiner	*Notropis rubellus*		III
sicklefin chub	*Macrhybopsis meeki*		I
silver chub	*Macrhybopsis storeriana*		II
silver lamprey	*Ichthyomyzon unicuspis*		III
sturgeon chub	*Macrhybopsis gelida*		I
trout-perch	*Percopsis omiscomaycus*		II
yellow bullhead	*Ameiurus natalis*		III
Mollusks			
black sandshell	*Ligumia recta*		II
creek heelsplitter	*Lasmigona compressa*		II
mapleleaf	*Quadrula quadrula*		II
pink heelsplitter	*Potamilus alatus*		II
pink papershell	*Potamilus ohiensis*		III
threeridge	*Amblema plicata*		II
Wabash pigtoe	*Fusconaia flava*		II
black sandshell	*Ligumia recta*		II
Insects			
Dakota skipper	*Hesperia dacotae*	C	
American burying beetle	*Nicrophorus americanus*	E	

USFWS: C-Candidate; E-Endangered; EA-Bald and Golden Eagle Protection Act; SoC-Species of Concern; T-Threatened

NDGFD: E-Endangered; T-Threatened; Levels are for species of State Conservation Concern: Level-I - Species in greatest need of conservation; Level-II - Species in need of conservation, but that have had support from other wildlife programs; Level-III - Species in moderate need of conservation, but that are on the edge of their range in North Dakota

Data from ND Outdoors (2004) and the USFWS Online (2008). Additionally, prairie grouse species considered a SoC by the USFWS (2004).

Table 8. Summary of sensitive species observed at the TCWRA during fixed-point bird use surveys (FP) and as incidental wildlife observations (Inc), June 5 – October 29, 2007.

		USFWS	NDGFD	FP		Inc		Total	
Common Name	**Scientific Name**	**Status**	**Status**	**Grps**	**Obs**	**Grps**	**Obs**	**Grps**	**Obs**
northern harrier	*Circus cyaneus*		II	26	30	9	9	35	39
Swainson's hawk	*Buteo swainsoni*		I	10	11	7	9	17	20
sharp-tailed grouse	*Tympanuchus phasianellus*	SoC*	II	1	1	2	17	3	18
grasshopper sparrow	*Ammodramus savannarum*		I	7	8	0	0	7	8
prairie falcon	*Falco mexicanus*		II	2	2	1	1	3	3
upland sandpiper	*Bartramia longicauda*		I	3	3	0	0	3	3
golden eagle	*Aquila chrysaetos*	EA	II	2	2	0	0	2	2
lark bunting	*Calamospiza melanocorys*		I	2	2	0	0	2	2
loggerhead shrike	*Lanius ludovicianus*		II	1	1	1	1	2	2
marbled godwit	*Limosa fedoa*		I	1	1	1	1	2	2
Baird's sparrow	*Ammodramus bairdii*		I	1	1	0	0	1	1
ferruginous hawk	*Buteo regalis*		I	0	0	1	1	1	1
peregrine falcon	*Falco peregrinus*		III	1	1	0	0	1	1
short-eared owl	*Asio flammeus*		II	1	1	0	0	1	1
Overall				**58**	**64**	**22**	**39**	**80**	**103**

USFWS: C-Candidate; E-Endangered; EA-Bald and Golden Eagle Protection Act; SoC-Species of Concern; T-Threatened

NDGFD: E-Endangered; T-Threatened; Levels are for species of State Conservation Concern: Level-I - Species in greatest need of conservation; Level-II - Species in need of conservation, but that have had support from other wildlife programs; Level-III - Species in moderate need of conservation, but that are on the edge of their range in North Dakota.

Data from ND Outdoors (2004) and the USFWS Online (2008). Additionally, prairie grouse species considered a SoC by the USFWS (2004).

Table 9. Summary of AnaBat results of the acoustic bat surveys conducted at the TCWRA, May 23 – September 22, 2007.

AnaBat Location	# of HF Bat Passes	# of LF Bat Passes	Total Bat Passes	Detector-Nights	Bat Passes/ Det-Night
2024 (south)	25	42	67	53	1.26
2037 (north)	33	26	59	59	1.00
Total	58	68	126	112	1.13

Table 10. Incidental wildlife observed while conducting all surveys at the TCWRA.

Species	Scientific Name	# grps	#obs
Birds			
sandhill crane	*Grus canadensis*	1	33
sharp-tailed grouse	*Tympanuchus phasianellus*	2	17
ring-necked pheasant	*Phasianus colchicus*	4	14
northern harrier	*Circus cyaneus*	9	9
Swainson's hawk	*Buteo swainsoni*	7	9
red-tailed hawk	*Buteo jamaicensis*	3	3
mallard	*Anas platyrhynchos*	1	2
vesper sparrow	*Pooecetes gramineus*	1	2
broad-winged hawk	*Buteo platypterus*	1	1
ferruginous hawk	*Buteo regalis*	1	1
great-horned owl	*Bubo virginianus*	1	1
loggerhead shrike	*Lanius ludovicianus*	1	1
marbled godwit	*Limosa fedoa*	1	1
merlin	*Falco columbarius*	1	1
northern flicker	*Colaptes auratus*	1	1
prairie falcon	*Falco mexicanus*	1	1
savannah sparrow	*Passerculus sandwichensis*	1	1
unidentified hawk		1	1
white-throated sparrow	*Zonotrichia albicollis*	1	1
Bird Subtotal		**39**	**100**
Mammals			
pronghorn antelope	*Antilocapra americana*	8	36
white-tailed deer	*Odocoileus virginianus*	7	13
eastern cottontail	*Silvilagus floridanus*	2	5
mule deer	*Odocoileus hemionus*	3	3
coyote	*Canis latrans*	1	1
Mammal Subtotal		**21**	**58**

Table 11. All bird and raptor fatality estimates for several wind-energy facilities in the US.

Facility Name	# of Turbines	# of MW	Bird Fatalities /Turbine	Bird Fatalities /MW	Raptor Fatalities /Turbine	Raptor Fatalities /MW
Altamont, CA[1]	5,400	518	0.90	8.1	0.14	1.50
Montezuma Hills, CA[2]	600	60	NA	NA	0.05	0.48
San Gorgonio, CA[3]	2,900	300	2.31	9.23	0.01	0.04
Stateline, OR/WA[4]	454	300	1.93	2.56	0.05	0.08
Vansycle, OR[5]	38	25	0.63	0.96	0	0
Klondike, OR[6]	16	24	1.42	0.95	0	0
Nine Canyon, WA[7]	37	48	3.59	2.76	0.07	0.05
Foote Creek Rim, WY Phase I and II[8, 9]	72	43	1.50	2.50	0.03	0.05
Foote Creek Rim, WY Phase III[9]	33	25	1.49	1.99	0.04	0.06
Wisconsin (MG&E and PSC) [10]	31	20	1.30	1.97	0	0
Buffalo Ridge, MN, Phase I[11]	73	22	0.98	3.27	0.01	0.04
Buffalo Ridge, MN, Phase II[11]	143	107	2.27	3.03	0	0
Buffalo Ridge, MN, Phase III[11]	139	104	4.45	5.93	0	0
Buffalo Mountain, TN[12]	3	2	7.70	11.55	0	0
Mountaineer, WV[13]	44	68	4.04	3.00	NA	NA
Top of Iowa, IA[14]	89	80	0.65	0.72	.01	.01

[1]Smallwood and Thelander 2004; [2]Howell et al. 1991; [3]McCrary et al. 1986; [4]WEST, Inc. and Northwest Wildlife Consultants, Inc. 2004; [5]Erickson et al. 2000c; [6]Johnson et al. 2003b; [7]WEST, Inc. and Northwest Wildlife Consultants, Inc. 2003; [8]Young et al. 2003c; [9]Young et al. 2003c; [10]Howe et al. 2002; [11]Johnson et al. 2000b; [12]Nicholson 2001; [13]Kerns and Kerlinger 2004; [14]Koford et al. 2005.

Table 12. Bat mortality estimates at US wind-energy facilities.

Location and Number of Turbines	Turbine Size	Year	Number of Bat Fatalities Found	Annual Bat Fatalities per Turbine	Annual Bat Fatalities per MW
Buffalo Ridge, MN Phase 1 73 turbines[1,2,3]	330 kw 53 m high	1994-1998	20	0.1	0.3
Buffalo Ridge, MN Phase 2&3 281 turbines[3,4,5]	750 kw 74 m high	1998-2002	400	2.0	2.7
Kewaunee County, WI 31 turbines[6]	660 kw 89 m high	1999-2001	72	4.3	6.5
Foote Creek Rim, WY 105 turbines[7,8,9,10]	660 kw 61 m high	1999-2002	135	1.3	2.0
Buffalo Mountain, TN 3 turbines[11, 12]	660 kw 89 m high	2001-2003	119	19.7	29.8
Mountaineer, WV 44 turbines[13]	1.5 MW 102 m high	2003	475	40.9	27.3
Stateline, OR/WA border 399 turbines[14]	660 kw 74 m high	1999-2003	150	1.1	1.7
Klondike, OR[15] 16 turbines	1.5 MW 100 m high	2002	6	1.2	0.8
Vansycle, OR[16] 38 turbines	660 kw 74 m high	1999	28	0.7	1.1
Nine Canyon, WA[17] 37 turbines	1.3 MW 91 m high	2003	27	3.2	2.5

[1]Osborn et al. 1996; [2]Johnson et al. 2000a; [3]Johnson et al. 2003a; [4]Johnson et al. 2003c; [5]Krenz and McMillan 2000; [6]Howe et al. 2002; [7]Johnson et al. 2000b; [8]Young et al. 2002; [9]Young et al. 2003c; [10]Gruver 2002; [11]Nicholson 2001; [12]Nicholoson 2003; [13]Kerns and Kerlinger 2004; [14]Erickson et al. 2004; [15]Johnson et al. 2003b; [16]Erickson et al. 2000a; [17]Erickson et al. 2003c.

Table 13. Wind-energy facilities in the US with both pre-construction AnaBat sampling data and post-construction mortality data for bat species (adapted from Kunz et al. 2007b).

Wind-Energy Facility	Activity (#/detector night)	Mortality (bats/turbine/year)	Reference
Two Creeks, ND	1.13	–	This study
Foote Creek Rim, WY	2.2	1.3	Gruver 2002
Buffalo Ridge, MN	2.1	2.2	Johnson et al. 2004
Buffalo Mountain, TN	23.7	20.8	Fiedler 2004
Top of Iowa, IA	34.9	10.2	Koford et al. 2005
Mountaineer, WV	38.3	38.0	Arnett et al. 2005

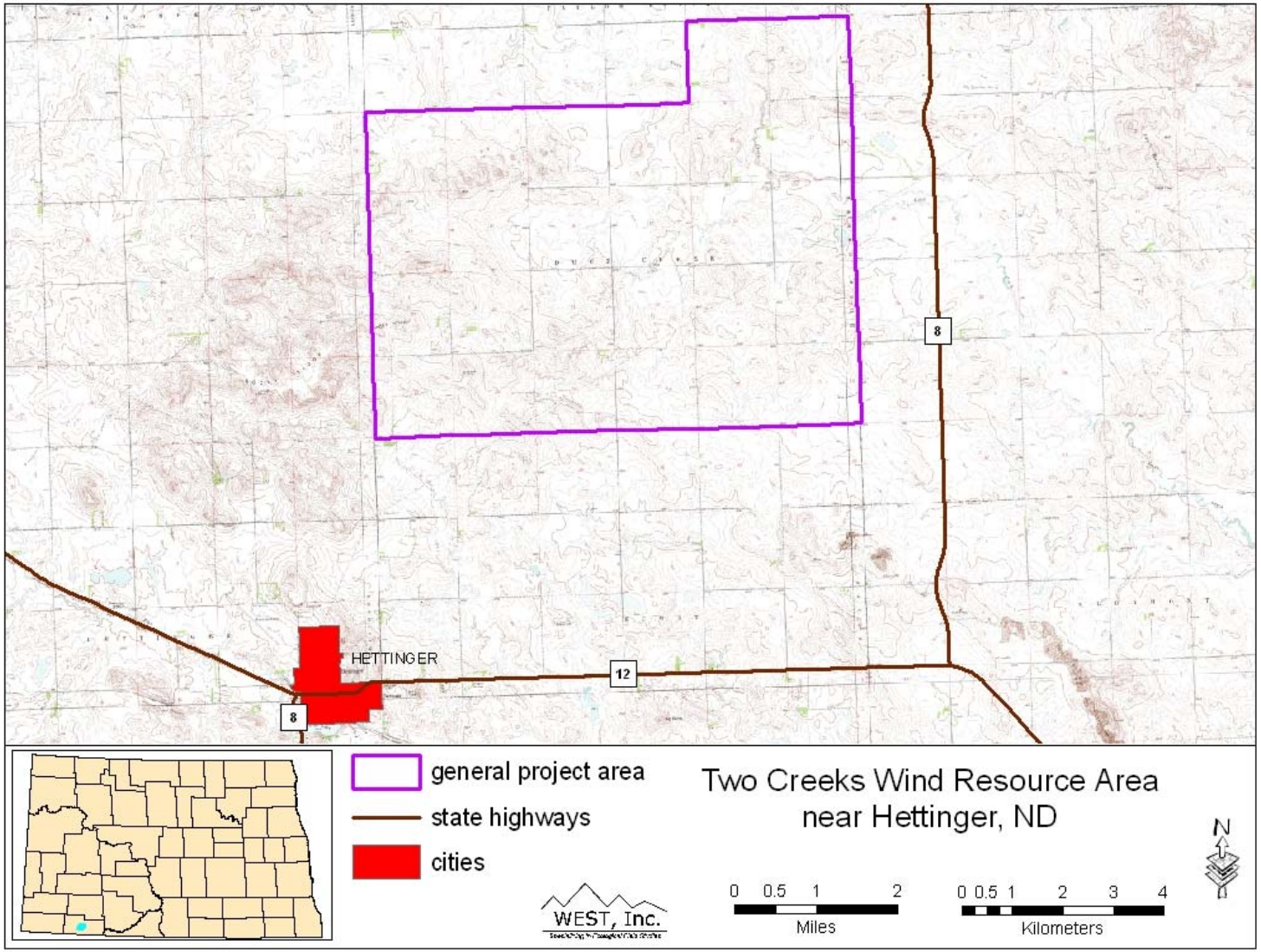


Figure 1. Location of the TCWRA.

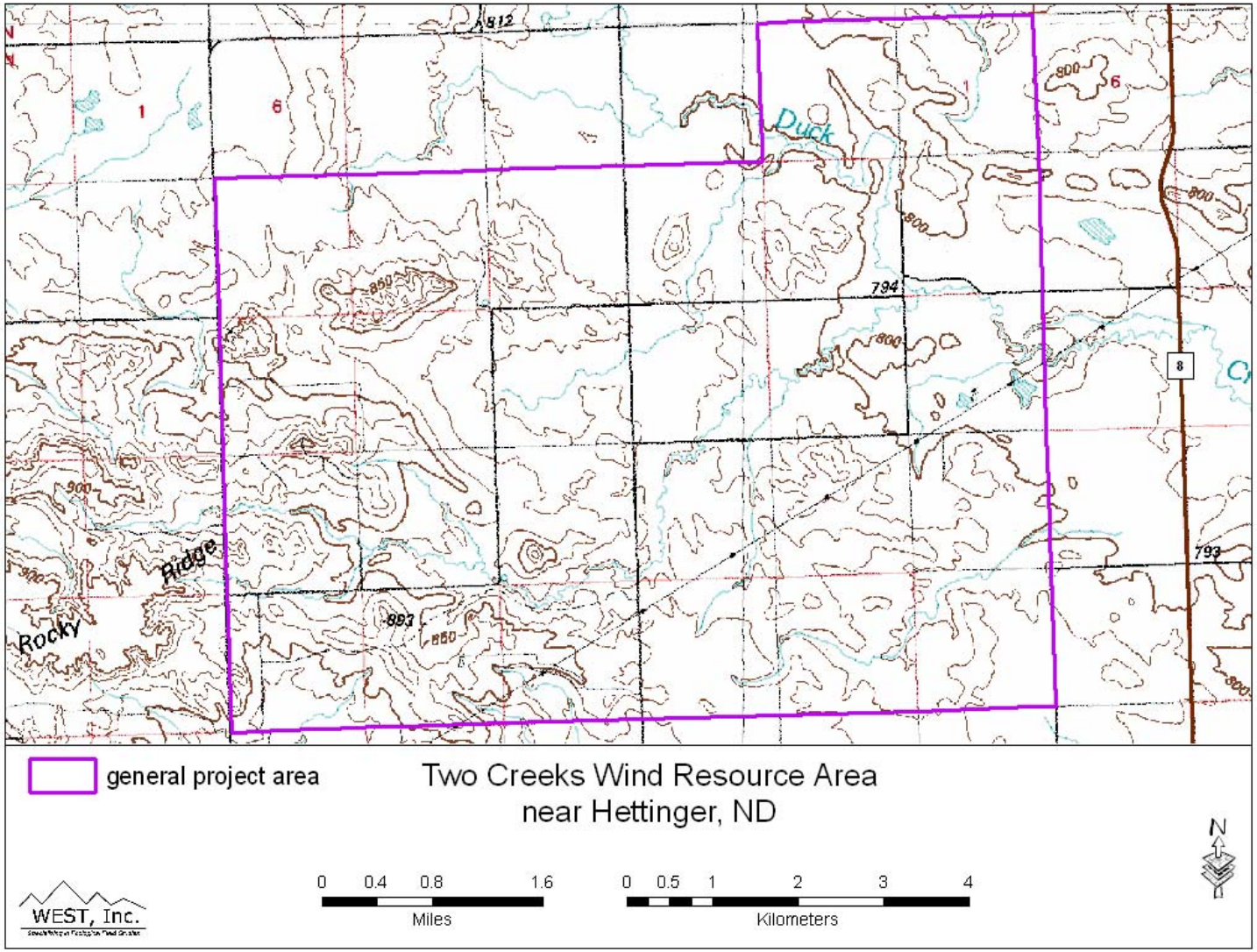


Figure 2. Overview of the TCWRA.

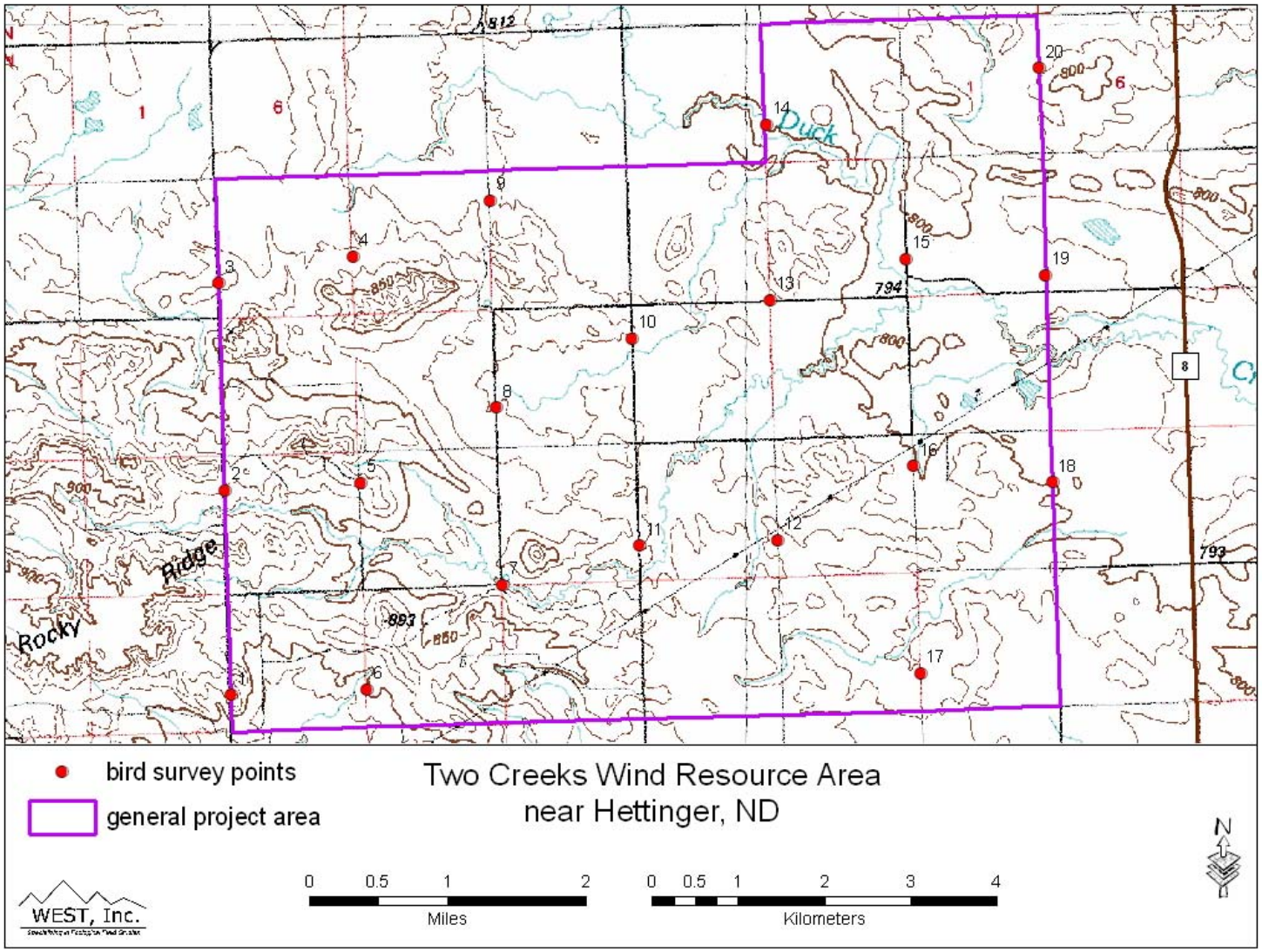


Figure 3. Fixed-point bird use survey points at the TCWRA.

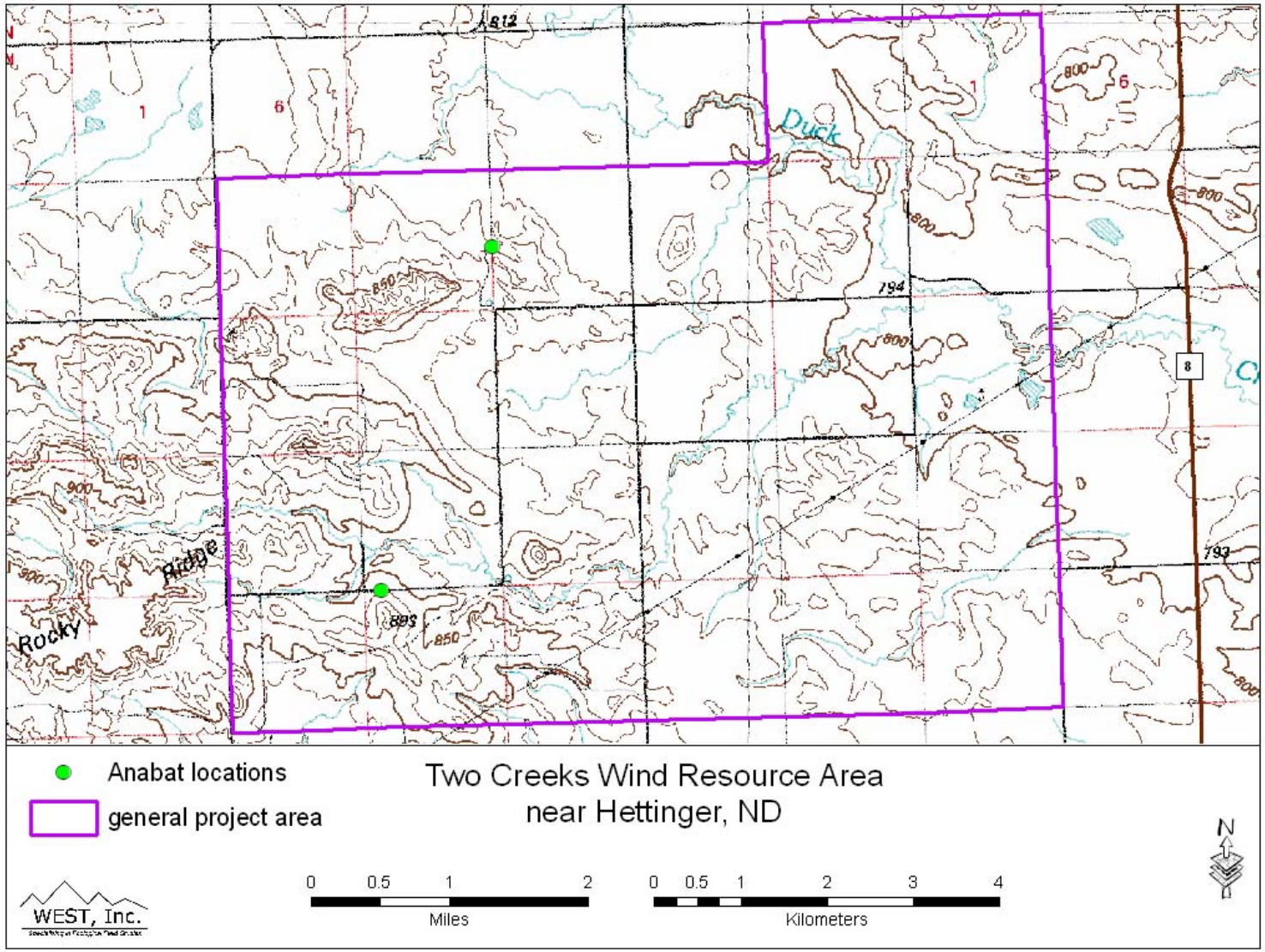


Figure 4. AnaBat sampling locations at the TCWRA.

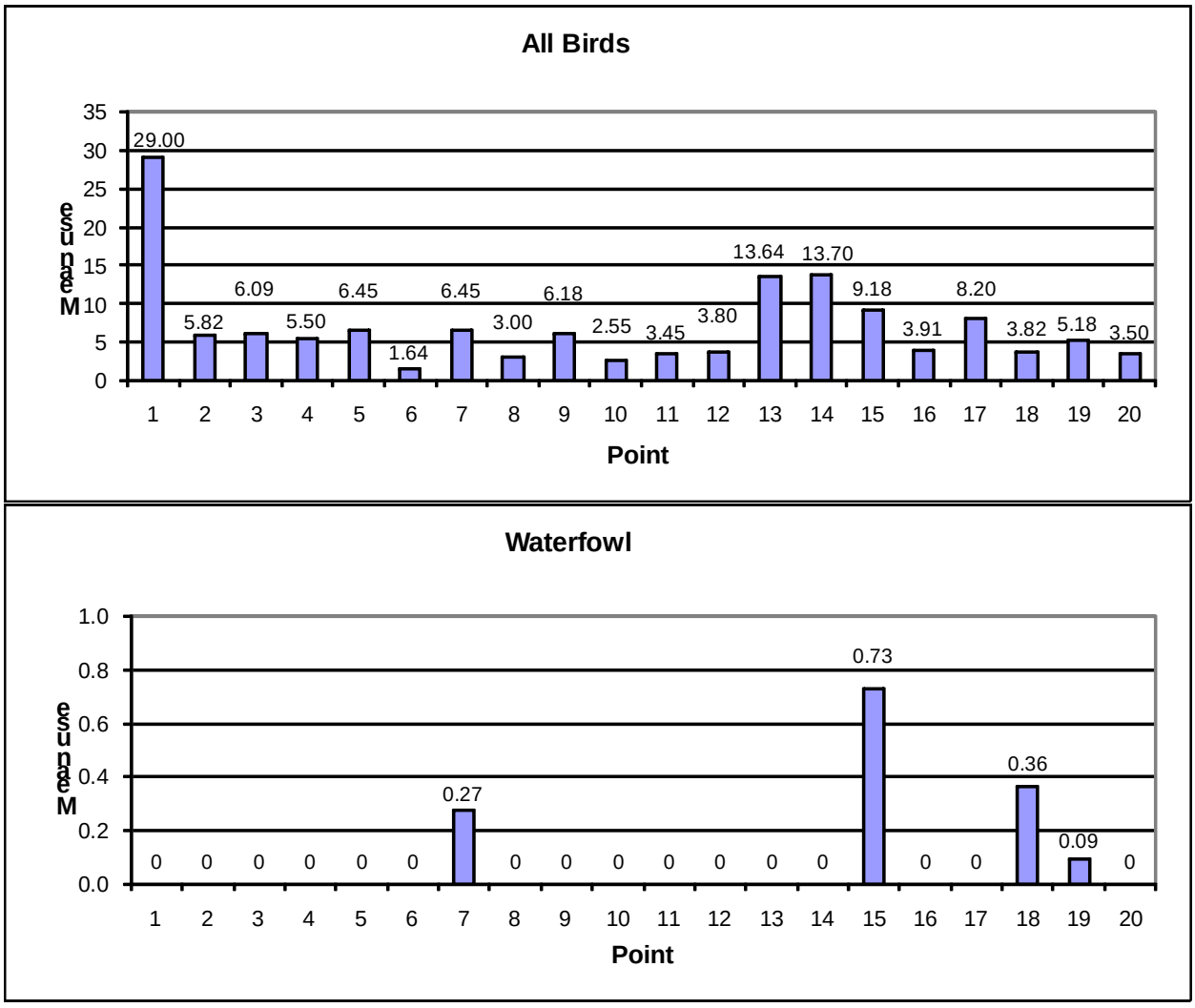


Figure 5a-b. Mean use (birds/20-min survey) at each fixed-point bird use survey point for all birds and waterfowl at the TCWRA.

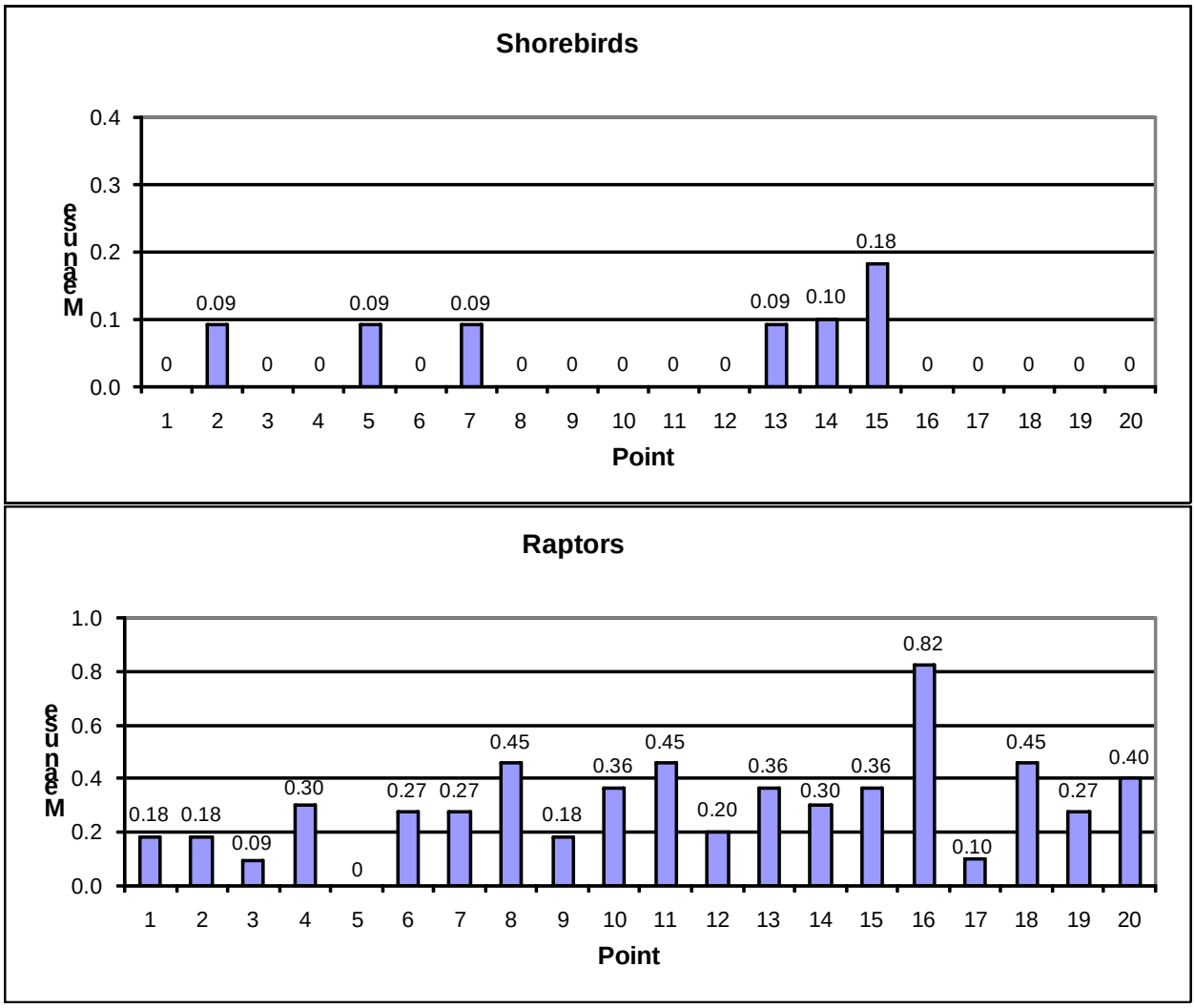


Figure 5 c-d. Mean use (birds/20-min survey) at each fixed-point bird use survey point for shorebirds and raptors at the TCWRA.

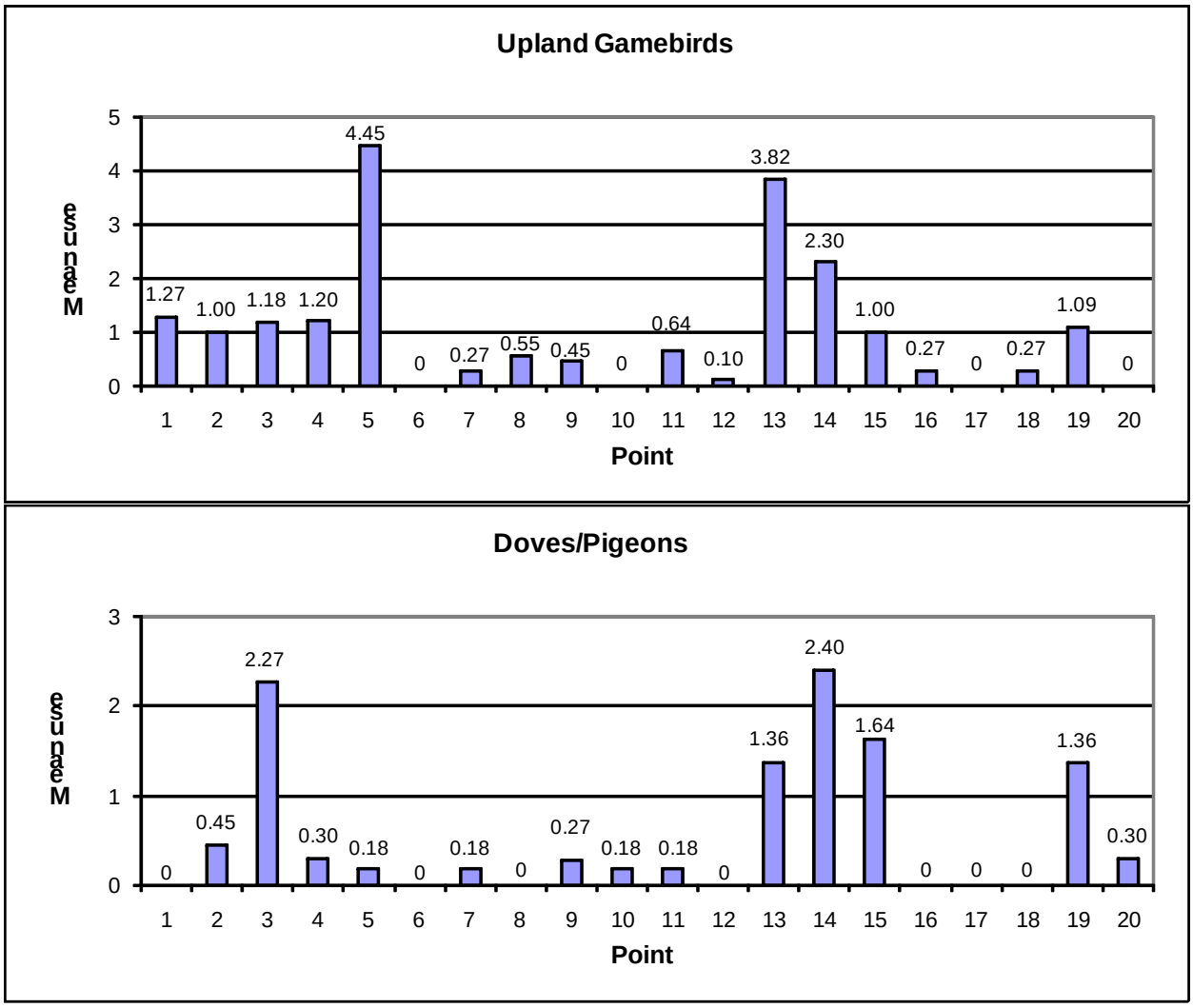


Figure 5 e-f. Mean use (birds/20-min survey) at each fixed-point bird use survey point for upland gamebirds and dove/pigeons at the TCWRA.

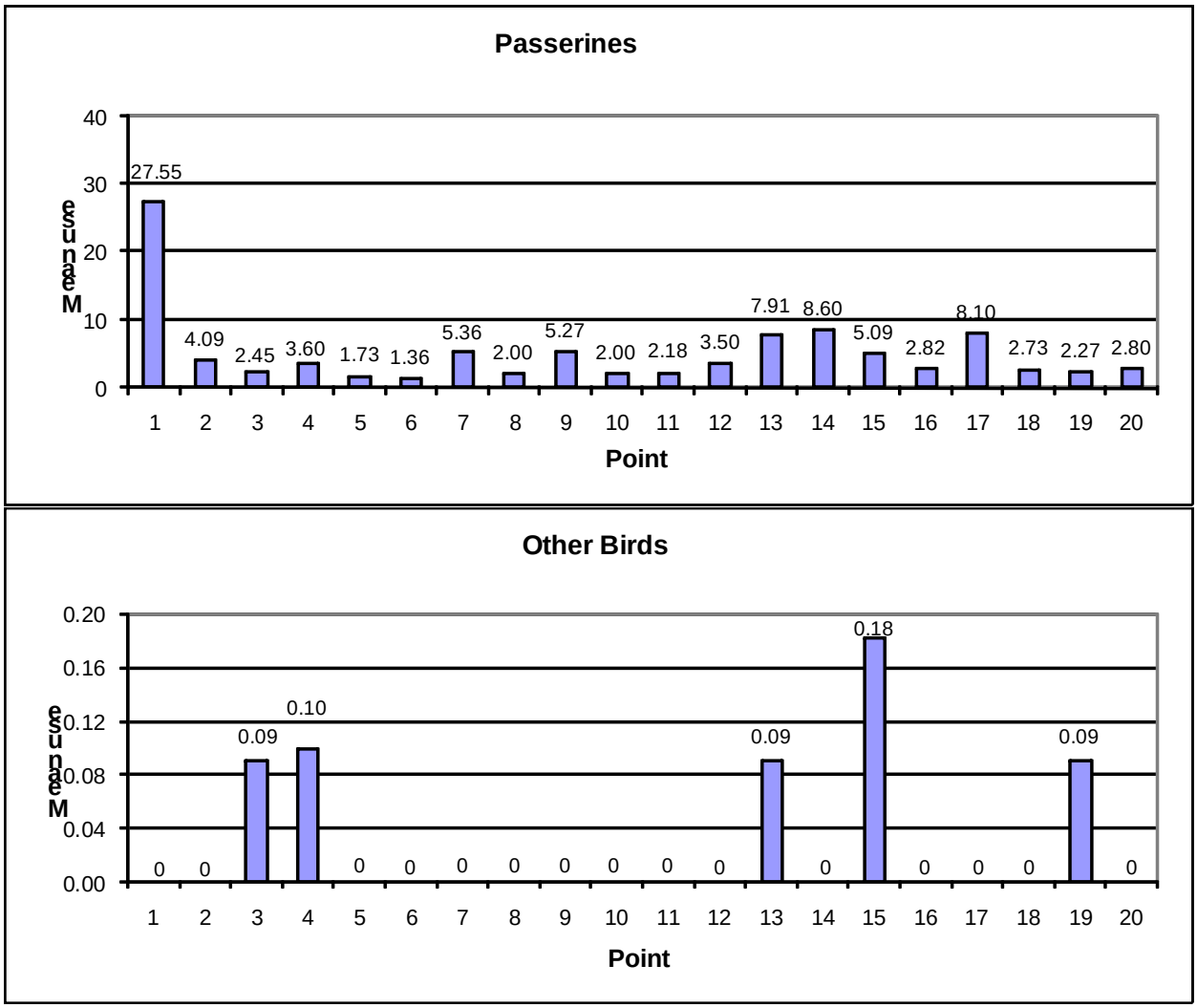


Figure 5 g-h. Mean use (birds/20-min survey) at each fixed-point bird use survey point for passerines and other birds at the TCWRA.

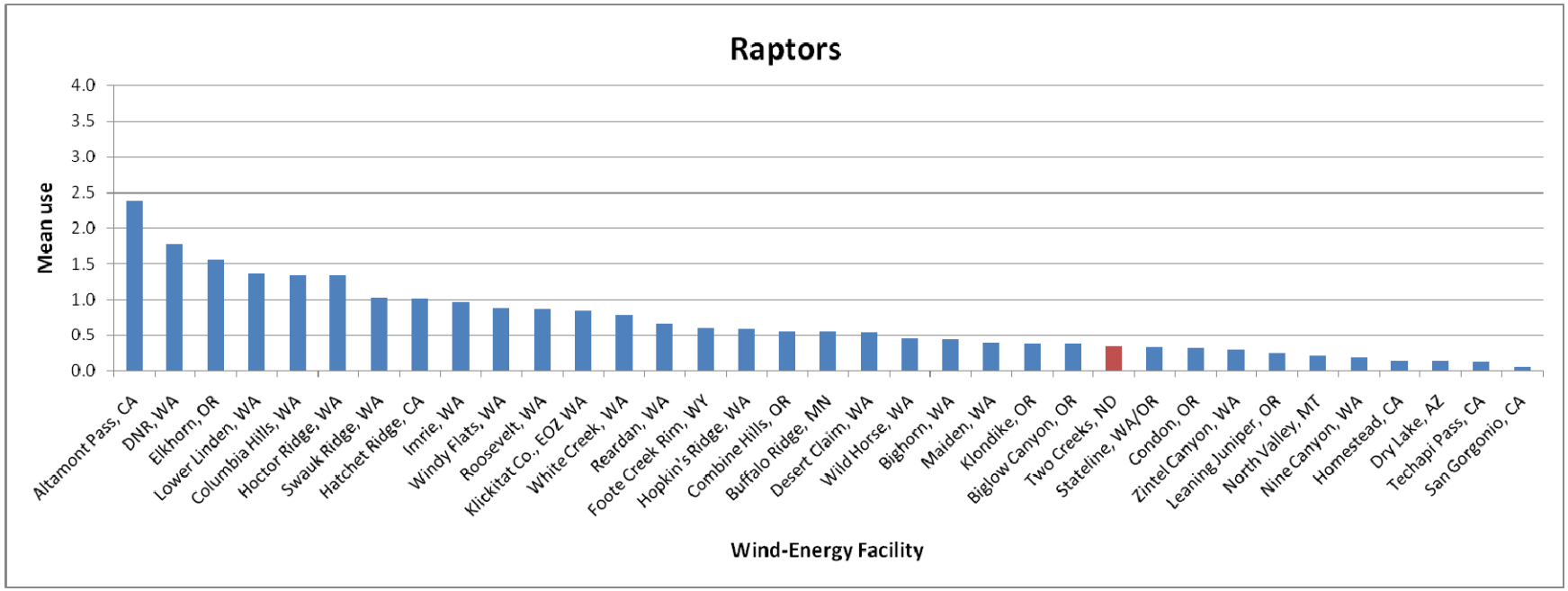


Figure 6. Comparison of raptor use in the summer between the TCWRA and other US wind-energy facilities.

Data from the following sources:

Location	Source
Two Creeks, ND	This study.
Altamont Pass, CA	Erickson et al. 2002
DNR, WA	Johnson et al. 2006
Elkhorn, OR	WEST 2005a
Lower Linden, WA	Johnson 2007b
Columbia Hills, WA	Erickson et al. 2002
Hoctor Ridge, WA	Johnson et al. 2006b
Swauk Ridge, WA	Erickson et al. 2003a
Hatchet Ridge, CA	Young et al. 2007b
Imrie, WA	Johnson et al. 2006c

Location	Source
Windy Flats, WA	Johnson et al. 2007
Roosevelt, WA	NWC and WEST 2004
Klickitat Co., EOZ WA	WEST and NWC 2003a
White Creek, WA	NWC and WEST 2005a
Reardon, WA	WEST 2005b
Foote Creek Rim, WY	Erickson et al. 2002
Hopkin's Ridge, WA	Young et al. 2003a
Combine Hills, OR	Young et al. 2003d
Buffalo Ridge, MN	Erickson et al. 2002
Desert Claim, WA	Young et al. 2003b

Location	Source
Wild Horse, WA	Erickson et al. 2003b
Bighorn, WA	Johnson et al. 2004a
Invenergy_Vantage	WEST 2007 b
Maiden, WA	Erickson et al. 2002
Klondike, OR	Johnson et al. 2002
Biglow Canyon, OR	WEST 2007
Biglow Reference	WEST 2007
Stateline, WA/OR	Erickson et al. 2002
Condon, OR	Erickson et al. 2002
Zintel Canyon, WA	Erickson et al. 2002

Location	Source
Leaning Juniper, OR	NWC and WEST 2005b
North Valley, MT	
Nine Canyon, WA	Erickson et al. 2001a
Homestead, CA	WEST et al. 2007
Dry Lake, AZ	Young et al. 2007c
Tehachapi Pass, CA	Erickson et al. 2002
San Gorgonio, CA	Erickson et al. 2002

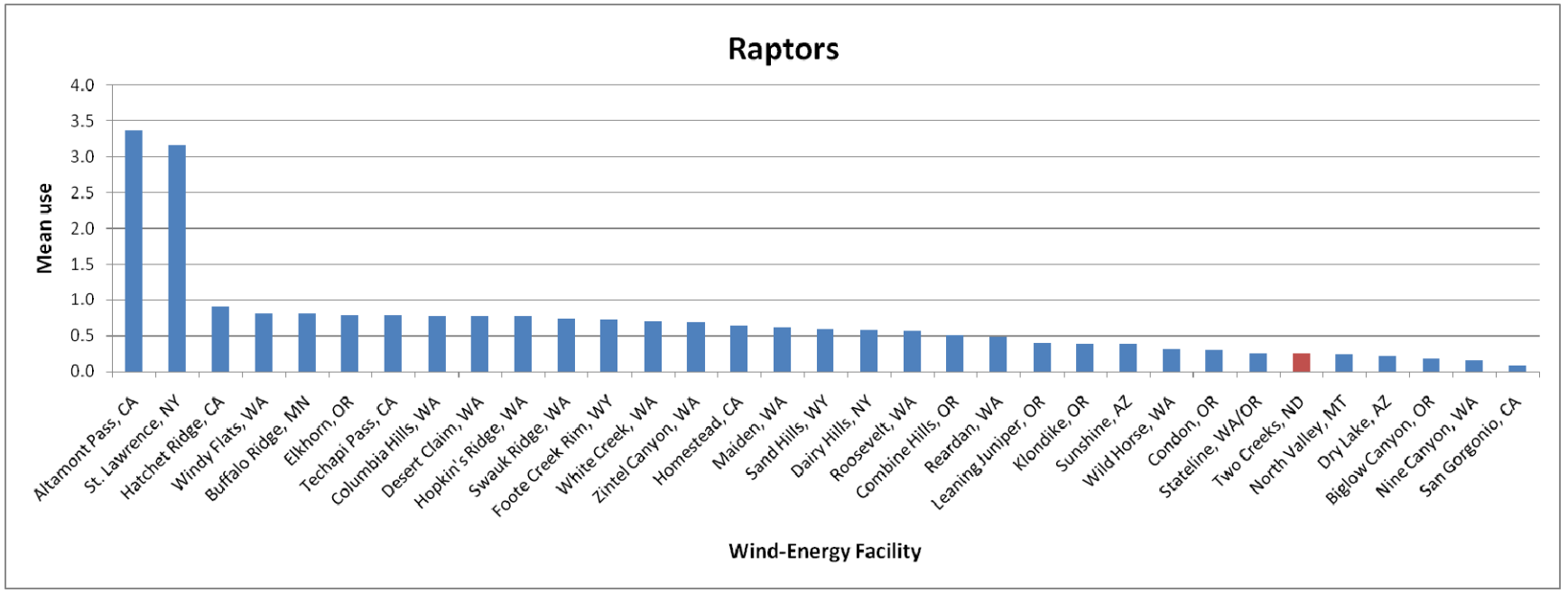


Figure 7. Comparison of raptor use in the fall between the TCWRA and other US wind-energy facilities.

Data from the following sources:

Location	Source	Location	Source	Location	Source	Location	Source
Two Creeks, ND	This study						
Altamont Pass, CA	Erickson et al. 2002	Desert Claim, WA		Sand Hills, WY		Wild Horse, WA	
St. Lawrence, NY		Hopkin's Ridge, CA		Dairy Hills, NY		Condon, OR	Erickson et al. 2002
Hatchet Ridge, CA		Swauk Ridge, WA		Roosevelt, WA		Stateline, WA/OR	Erickson et al. 2002
Windy Flats, WA		Foote Creek Rim, WY	Erickson et al. 2002	Combine Hills, OR		North Valley, MT	
Buffalo Ridge, MN	Erickson et al. 2002	White Creek, WA		Reardon, WA		Dry Lake, AZ	
Elkhorn, OR		Zintel Canyon, WA	Erickson et al. 2002	Leaning Juniper, OR		Biglow Canyon, OR	
Tehachapi Pass, CA	Erickson et al. 2002	Homestead, CA		Klondike, OR		Nine Canyon, WA	
Columbia Hills, WA	Erickson et al. 2002	Maiden, WA	Erickson et al. 2002	Sunshine, AZ		San Gorgonio, CA	Erickson et al. 2002

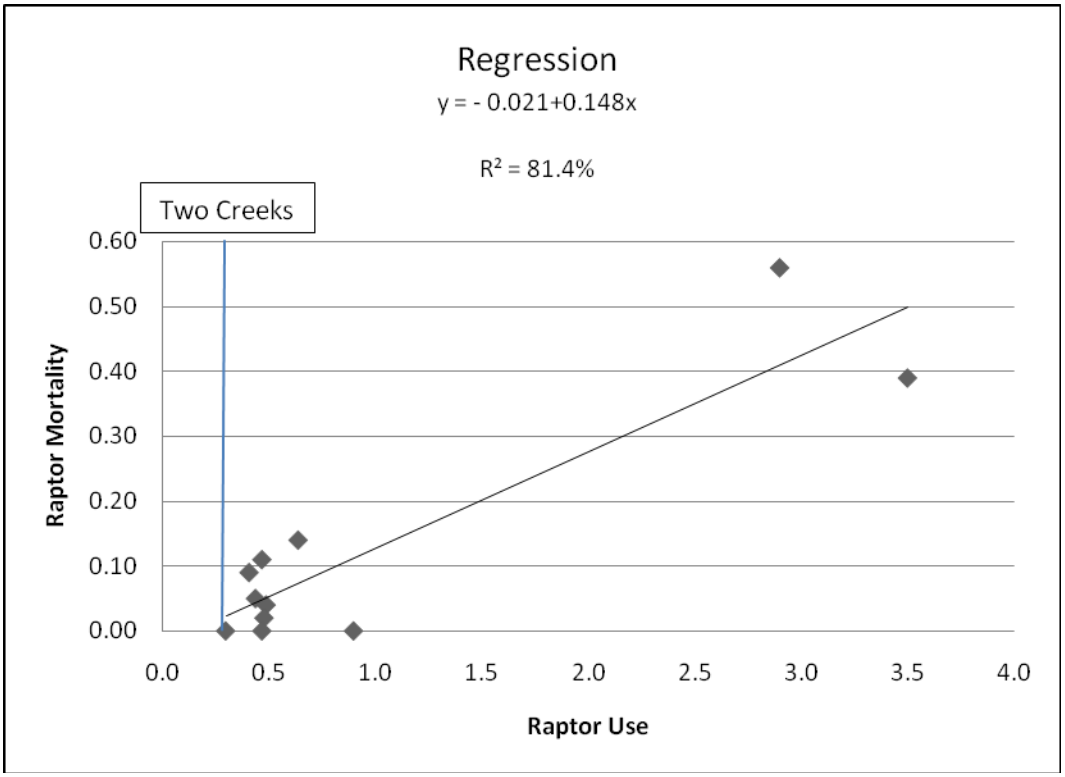


Figure 8. Regression analysis comparing raptor use estimations versus estimated raptor mortality.

Data from the following sources:

Raptor Use	Raptor Mortality	Wind-Energy Facility	Study
0.3	0	Vansycle, OR	Erickson et al. 2000b
0.41	0.09	Stateline WA/OR	Erickson et al. 2002
0.44	0.05	Nine Canyon Phase I and II, WA	Erickson et al. 2002
0.47	0	Klondike, OR	Johnson et al. 2003b
0.47	0.11	Klondike II, OR	NWC and WEST 2007
0.48	0.02	Buffalo Ridge, MN	Erickson et al. 2002
0.49	0.04	Foote Creek Rim, WY	Erickson et al. 2002
0.64	0.14	Hopkin's Ridge	Young et al. 2007a
0.9	0	Combine Hills, OR	Young et al. 2005
2.9	0.56	Diablo Winds, CA	WEST 2006a
3.5	0.39	High Winds, CA	Kerlinger et al. 2005a

THUNDER SPIRIT - 150MW

N

1:40,000

T130N - R95W

NORH DAKOTA

Bismarck

Duck Creek

lek 1

lek 2

lek 4

lek 5

1 2 3 04 alt 5 6 7 8 9 10 alt 12 alt 13 alt 15 alt 17alt 18 alt 19 alt 20 21 22 alt 23 24 25 26 27 28 30 31 32 alt 33 34 35 36 38 alt 39 alt 40 alt 41 alt 42 alt 43 alt 44 45 46 47 48 alt 49 50 51 52 alt 53 54 55 56 57 58 59 60 alt 61 62 alt 63 64 alt 65 alt 66 67 68 69 70 alt 73 74 alt 75 alt A1 A2 A3 A4 A6 A7 A8

POI

Adams Co.

- Proposed Turbine Location
- Roads
- Lek Setback - 2640ft
- Anabat location
- 60m Met tower location
- Thunder Spirit Project Area

TS Habitat Mapping 2011

- Agriculture
- Developed
- Farm/Rural home
- Grassland
- Grassland, wetland
- Shrubs/Trees

0 0.5 1 2 3 Miles

Wildlife Baseline Studies for the Thunder Spirit Wind Resource Area Adams County, North Dakota

Final Report
April 2011 – March 2012

Prepared for:

Thunder Spirit Wind LLC

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February 12, 2013

NATURAL RESOURCES ◆ SCIENTIFIC SOLUTIONS

Draft Pre-Decisional Document - Privileged and Confidential - Not For Distribution

EXECUTIVE SUMMARY

Thunder Spirit Wind LLC has proposed development of the Thunder Spirit Wind Resource Area (TSWRA) near the town of Hettinger in Adams County, North Dakota. Thunder Spirit Wind LLC requested that Western EcoSystems Technology, Inc. develop and assist in implementing a standardized protocol for baseline wildlife studies. The principal objectives of the study were to: 1) provide site-specific bird resource and use data and 2) provide information that could be used in project planning and design of the facility to minimize impacts to birds. Results pertaining to bat surveys are included in a separate report. Baseline surveys were conducted from April 6, 2011, through March 13, 2012.

The objective of the fixed-point bird use surveys was to estimate the seasonal and spatial use of the project area by birds, particularly raptors. Four hundred 20-min fixed-point bird use surveys were conducted at 25 points within the TSWRA during the course of 18 visits.

A total of 3,386 individual bird observations within 715 separate groups were recorded during the fixed-point surveys. Regardless of bird size, two species accounted for 58.2% of the observations: sandhill cranes and horned larks. The most abundant large bird species observed was the sandhill crane (1,125 individuals). The most abundant small bird species was the horned lark with 844 individuals recorded. Two hundred ninety-six individual raptors in 228 groups were recorded within the TSWRA, representing eight species. The northern harrier was the raptor species observed most often (123 individuals), followed by the Swainson's hawk (99).

The highest overall large bird use occurred during spring (17.93 birds/plot/20-min survey); mean use in summer was 2.27, 1.43 in fall, and 1.78 in winter. Small bird use was highest during winter (5.99) followed by summer (4.49), fall (3.30), and spring (2.84). Raptor use was highest in fall (1.12 birds/plot/20-min survey) compared to spring (0.97), summer (0.74), and winter (0.18). Higher fall use was mostly due to Swainson's hawks, northern harriers, and red-tailed hawks.

Passerine use (excluding large corvids) was highest in winter (5.99 birds/plot/20-min survey) followed by summer (4.48), fall (3.30), and spring (2.81). Horned larks had the highest use of any passerine species in winter (4.53 birds/plot/20-min survey) and fall (2.40). In summer, lark buntings had the highest passerine use (0.95 birds/plot/20-min survey) while the western meadowlark had the highest use (0.60) in spring.

Flight height characteristics were observed during fixed-point surveys. Overall, 79.5% of large birds observed flying were initially observed within the rotor-swept-heights (RSH). Waterbirds had the highest percentage of flying birds within the RSH (95.6%) followed by buteos with 85.4% and waterfowl (73.7%; Table 3). Overall, raptors were observed within the RSH 50.6% of the time. A relative collision risk exposure index was calculated for each bird species. Sandhill cranes had a collision risk exposure index (3.02), higher than any other large bird species. The raptor with the highest collision risk exposure index was the Swainson's hawk (0.15). The

passerine species with the highest collision risk exposure index was the snow bunting with an index of 0.05.

Incidental wildlife observations were recorded while conducting fixed-point surveys, moving between fixed-point locations, and traveling in the TSWRA. Twenty-seven bird species were observed incidentally, totaling 910 birds within 146 groups. The most commonly observed bird was the Canada goose (404 individuals), followed by the northern pintail (100) and sharp-tailed grouse (88). Overall, seven species of raptors and four owl species were observed incidentally. Five bird species were only observed incidentally. Five mammal species were observed incidentally; the most commonly observed species were the pronghorn (87) and white-tailed deer (50).

No federally-listed threatened or endangered species were observed in the TSWRA. The Sprague's pipit, is a candidate species for listing under the Endangered Species Act; three individuals were observed during the study. Overall, twenty-one sensitive bird species were observed during the study. The Swainson's hawk (150 individuals) was the most commonly observed sensitive species, followed by the northern harrier (142), and northern pintail (141). One bald eagle and six golden eagles were observed; eagles are protected under the Bald and Golden Eagle Protection Act. Several species observed are North Dakota 100 Species of Conservation Priority.

Annual raptor use in the TSWRA (0.68 raptors/plot/20-min survey) was compared to annual raptor use at other wind energy facilities. Based on the results from these facilities, a ranking of mean annual raptor use was developed. Using this ranking, mean raptor use in the TSWRA is considered to be low to moderate. Compared to the other wind energy facilities, raptor use in the TSWRA ranked 14 of 44 projects reviewed.

Based on the relative abundance of Swainson's hawks throughout the year and a higher exposure index than other raptor species, there is higher potential for Swainson's hawks fatalities compared to other species. It is expected that risk to raptors would be slightly higher during fall.

STUDY PARTICIPANTS

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REPORT REFERENCE

Derby, C., A. Dahl, and S. Nomani. 2013. Wildlife Baseline Studies for the Thunder Spirit Wind Resource Area, Adams County, North Dakota. Final Report: April 2011 – March 2012. Prepared for Thunder Spirit Wind LLC, Argyle, New York. Prepared by Western EcoSystems Technology, Inc. (WEST), Bismarck, North Dakota.

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INTRODUCTION

Thunder Spirit Wind LLC (Thunder Spirit) has proposed development of the Thunder Spirit Wind Resource Area (TSWRA) in Adams County, North Dakota (Figure 1). Thunder Spirit requested that Western EcoSystems Technology, Inc. (WEST) develop and assist in implementing a standardized protocol for baseline wildlife studies in the TSWRA. Studies were conducted to estimate impacts of the proposed wind energy facility on wildlife and to assist with siting turbines to minimize impacts to wildlife resources.

The principal objectives of the study were to: 1) provide site-specific bird resource and use data that would be useful in evaluating potential impacts from the proposed facility and 2) provide information that could be used in project planning and design of the facility to minimize impacts to birds. Results from bat surveys are presented in a separate report.

Baseline surveys were conducted from April 6, 2011, through March 13, 2012, and consisted of fixed-point bird use surveys, acoustic bat surveys, raptor nest surveys, and sharp-tailed grouse lek surveys. This report includes a detailed discussion on the avian use survey aspects of the surveys, with bat studies (Derby and Sichmeller 2013) and raptor nest and lek surveys (Derby and Thorn 2013) discussed in separate reports. In addition to site-specific data, this report presents existing information and results of studies conducted at other wind energy facilities. Where possible, comparisons with regional and local studies were made.

STUDY AREA

The proposed TSWRA is in Adams County, North Dakota, approximately 3.6 kilometers (2.2 miles) northeast of Hettinger, North Dakota (Figure 1). The general boundary of the TSWRA encompasses about 9,310.2 hectares (ha; 23,006 acres [ac]). The area is a mixed landscape of grassland (about 53%) and agricultural areas (about 46%), including small areas of rural homes, shrubs and trees, and other developed areas. Elevation ranges from 779 to 902 feet (ft; 237.4 to 274.9 meters [m]) above sea level. There are about 210.4 ha (520 ac) of wetlands in 97 basins, excluding streams; about 96% of those wetlands are freshwater emergent wetlands (USFWS NWI 2011).

The number and size of wind turbines that will be installed within TSWRA area is currently unknown.

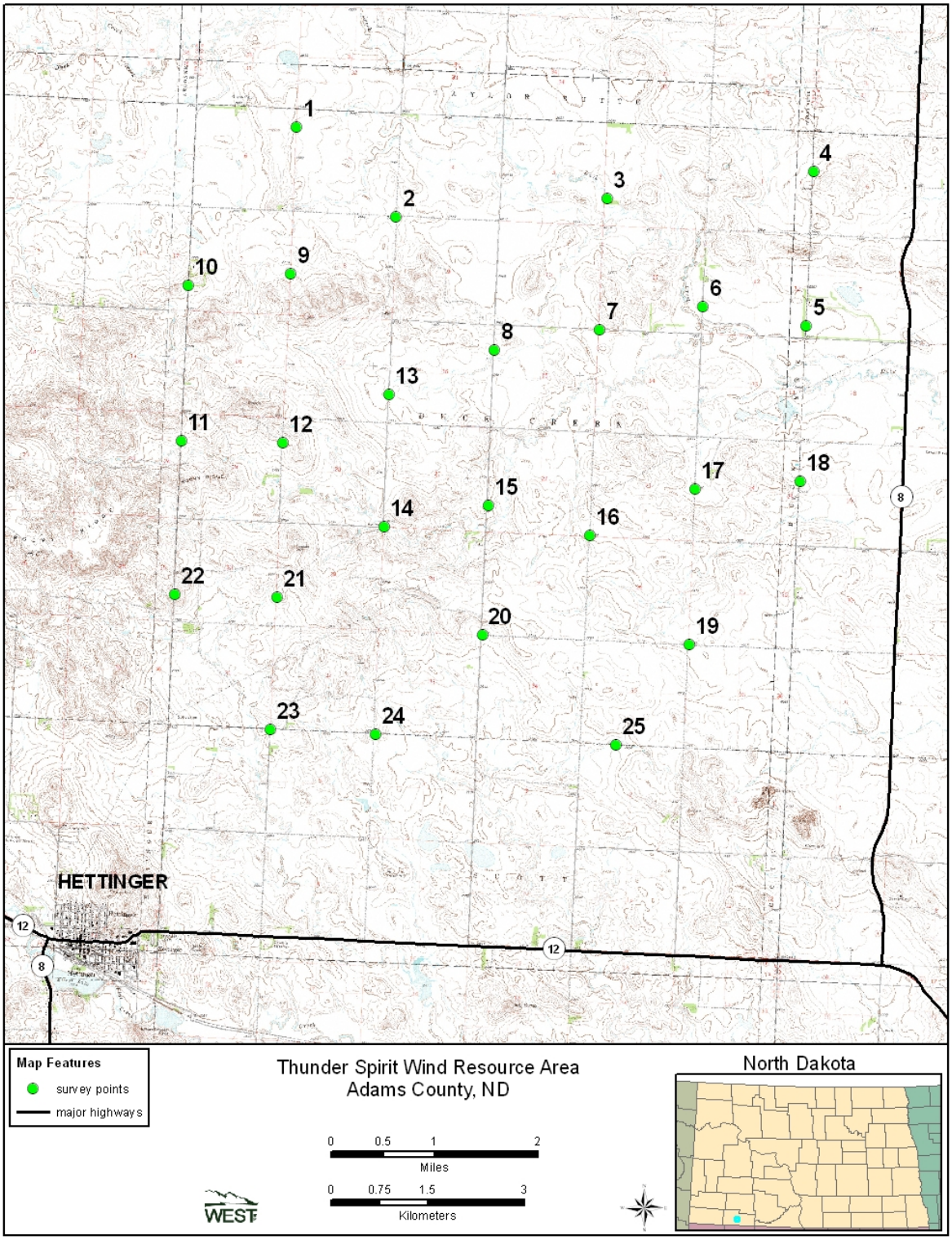


Figure 1. Location and fixed-point survey locations of the Thunder Spirit Wind Resource Area in Adams County, North Dakota.

METHODS

The baseline wildlife studies for avian species at TSWRA consisted of fixed-point bird use surveys. Incidental wildlife observations were recorded while conducting fixed-point bird use surveys.

Fixed-Point Bird Use Surveys

The objective of the fixed-point bird use surveys was to estimate the seasonal and spatial use of the project area by birds, particularly raptors (defined here as kites, accipiters, buteos, harriers, eagles, falcons, and ospreys [*Pandion haliaetus*]). Fixed-point surveys (variable circular plots) were conducted using methods described by Reynolds et al. (1980).

Bird Use Survey Plots

Twenty-five points were selected to encompass representative habitats and topography of the TSWRA, while also providing relatively even coverage of the area (Figure 1). Each survey plot was an 800-m (2,625-ft) radius circle centered on the point.

Bird Use Survey Methods

An attempt was made to record all birds observed during each 20-minute (min) fixed-point survey, regardless of distance from observer. Observations of large birds beyond the 800-m radius were recorded, but were not included in the statistical analyses; for small birds, observations beyond the 100-m (328-ft) radius were excluded from analysis. Large birds included waterbirds, waterfowl, shorebirds, raptors, owls, upland game birds, doves/pigeons, large corvids (e.g., ravens, magpies, and crows), and goatsuckers. Passerines (excluding large corvids) and woodpeckers were considered small birds.

The date, start and end time of the survey period, and weather information (e.g., temperature, wind speed, wind direction, and cloud cover) were recorded for each survey. Species or best possible identification, number of individuals, sex and age class (if possible), distance from plot center when first observed, closest distance, altitude above ground, activity (behavior), and habitat(s) were recorded for each observation. The behavior of each bird observed, and the vegetation type in which or over which the bird occurred, were recorded based on the point of first observation. Approximate flight height and distance from plot center at first observation were recorded to the nearest 5-m (16-ft) interval. Other information recorded about the observation included whether or not the observation was auditory only and the 10-min interval of the 20-min survey in which it was first observed. Locations of raptors, other large birds, and species of concern observed during fixed-point surveys were recorded on field maps.

Incidental wildlife observations were recorded while conducting fixed-point surveys, moving between fixed-point locations, and traveling in the TSWRA. All raptors, unusual or unique birds, and sensitive bird species were documented. All mammals, reptiles, and amphibians were also recorded. The observation number, date, time, species, number of individuals, sex/age class, distance from observer, activity, height above ground (for bird species), and habitat were recorded. The location of sensitive species was recorded.

Bird Use Observation Schedule

Each fixed-point bird use survey point was surveyed approximately every two weeks in fall (September 1 to November 15) and spring (March 15 to May 31) with even numbered points surveyed one week and odd numbered points the next week, and once per month during summer (June 1 to August 31) and winter (November 16 to March 14).

Surveys were carried out during daylight hours and survey periods varied to approximately include all daylight hours during a season. To the extent practical, each point was surveyed the same number of times. However, the schedule varied in response to adverse weather conditions (e.g., fog and/or rain) which caused delays and/or missed surveys.

Statistical Analysis

Fixed-Point Bird Use Surveys

Species lists, (with number of observations and groups) were generated by season and included all observations of birds detected, regardless of their distance from the observer (Appendix A).

Species Diversity and Species Richness

Bird diversity was illustrated by the total number of unique species observed. Species richness was calculated as the mean number of species observed per plot per survey (i.e., number of species/plot/20-min survey). Species richness by season was calculated by first averaging the total number of species observed within each plot during a visit, then averaging across plots within each visit, followed by averaging across visits within the season. Overall species richness was calculated as a weighted average of seasonal values by the number of days in each season.

Bird Use, Percent of Use, and Frequency of Occurrence

For the standardized fixed-point bird use estimates, only observations of large birds detected within the 800-m radius plot were used in the analysis. For small birds, only observations within a 100-m radius were used. The metric used to represent mean bird use was number of birds per plot per 20-minute survey. A visit is defined as the length of time it takes to survey all of the points one time. Mean use by season was calculated by first averaging the total number of birds observed within each plot during a visit, then averaging across plots within each visit, followed by averaging across visits within the season. Overall mean use was calculated as a weighted average of seasonal values by the number of days in each season. Estimates of mean bird use (i.e., number of birds/plot/20-min survey) were used to compare differences between bird types, seasons, survey points, and other wind energy facilities.

Percent of use was calculated as the proportion of large or small bird mean use that was attributable to a particular bird type or species. Frequency of occurrence was calculated as the percent of surveys in which a particular bird type or species was observed. When considered together, frequency of occurrence and percent composition provide relative measures of species use of the proposed wind energy facility. For example, a particular species might have

high use estimates based on just a few observations of large groups and the frequency of occurrence would indicate that the species only occurred during a few of the surveys. Therefore, even though the species exhibited high use, only a few, large groups accounted for that use, suggesting that the species might be less likely to be negatively affected by the construction and operation of the wind energy facility. Conversely, a species that has a relatively low percentage of use, but a relatively high frequency of occurrence would have longer-term exposure to the facility, increasing the likelihood that this species may be affected by the facility.

Bird Flight Height and Behavior

The flight height recorded during the initial observation was used to calculate mean flight height and the percentage of birds flying within the likely rotor-swept height (RSH) for collision with turbine blades of 25 – 150 m (82 to 492 ft) above ground level. This is the blade height range of turbines that could be used in the TSWRA. The percentage of individuals flying within the RSH at any time was calculated using the lowest and highest flight heights recorded.

Collision Risk Exposure Index

The exposure index is used as a relative measure of how often birds fly at heights similar to heights of turbine blades of modern wind turbines, thus putting them at risk for collision. A relative index of collision risk exposure (R) was calculated for bird species observed during the fixed-point bird use surveys using the following formula:

$$R = A*P_f*P_t$$

where A equals mean relative use for species *i* (large bird observations within 800 m of the observer or 100 m for small birds) averaged across all surveys, P_f equals the proportion of all observations of species *i* where activity was recorded as flying (an index to the approximate percentage of time species *i* spends flying during the daylight period), and P_t equals the proportion of all initial flight height observations of species *i* within the likely RSH.

Spatial Use

Data were analyzed by comparing use among plots to look for areas of concentrated use by raptors and other large birds within the TSWRA. This information can be useful in turbine layout design or for micro-siting turbine location.

RESULTS

Surveys were completed from April 6, 2011 through March 13, 2012. Seventy-three bird species and five mammal species were observed.

Fixed-Point Bird Use Surveys

Four hundred 20-min fixed-point bird use surveys were conducted within the TSWRA during the course of 18 visits (Table 1).

Table 1. Number of visits, surveys, unique species, and species richness (species/plot[a]/20-min survey) by season, observed during fixed-point bird use surveys at the Thunder Spirit Wind Resource Area from April 6, 2011, to March 13, 2012.

Season	Number of Visits	Number of Surveys	Number of Unique Species	Species Richness	
				Large Birds	Small Birds
Spring	4	79	51	1.68	1.73
Summer	4	90	47	1.29	2.52
Fall	5	120	21	0.80	0.58
Winter	5	111	16	0.38	0.34
Overall	**18**	**400**	**68**	**0.97**	**1.24**

[a] 800-meter radius for large birds and 100-meter radius for small birds

A total of 3,682 individual bird observations within 943 separate groups were recorded during the fixed-point surveys (Appendix A). Regardless of bird size, two species (2.9% of all unique species observed during fixed-point surveys) accounted for 53.5% of the observations: sandhill cranes (*Grus canadensis*) and horned larks (*Eremophila alpestris*). All other species accounted for less than 5% of the observations individually. The most abundant large bird species observed was the sandhill crane (1,125 individuals in 4 groups; Appendix A). The most abundant small bird species was the horned lark with 844 individuals recorded within 91 groups.

Two hundred ninety-six individual raptors in 228 groups were recorded within the TSWRA, representing eight species (Appendix A). The northern harrier (*Circus cyaneus*) was the raptor species observed most often (123 individuals in 109 groups), followed by the Swainson's hawk (*Buteo swainsoni*; 99 individuals in 47 groups).

Species Diversity and Species Richness

Sixty-eight unique species were observed during fixed-point bird use surveys (species diversity), with a mean of 0.97 species/800-m plot/20-min survey (species richness) for large birds and a mean of 1.24 species/100-m plot/20-min survey for small birds (Table 1). Species diversity was highest during spring (51 species) compared to summer (47), fall (21), and winter (16). Species richness for large birds was highest in spring (1.68 species/survey), followed by summer (1.29), fall (0.80), and winter (0.38). Small bird species richness was highest in summer (2.52 species/survey) followed by spring (1.73), fall (0.58), and winter (0.34; Table 1).

Bird Use, Percent of Use, and Frequency of Occurrence

Mean bird use, percent of use, and frequency of occurrence were calculated by season for all bird types and raptor subtypes (Table 2) and species (Appendix B-1 and B-2). The highest overall large bird use occurred during spring (17.93 birds/plot/20-min survey); mean use in summer was 2.27, 1.43 in fall, and 1.78 in winter (Table 2). Small bird use was highest during winter (5.99) followed by summer (4.49), fall (3.30), and spring (2.84).

Table 2. Mean bird use (number of birds/plot[a]/20-min survey), percent of total use (%), and frequency of occurrence (%) by bird type, raptor subtype, and season, observed during fixed-point bird use surveys at the Thunder Spirit Wind Resource Area April 6, 2011, to March 13, 2012.

	Bird Use				% of Use				% Frequency			
Bird Type / Subtype	**Spring**	**Summer**	**Fall**	**Winter**	**Spring**	**Summer**	**Fall**	**Winter**	**Spring**	**Summer**	**Fall**	**Winter**
Waterbirds	14.80	0	0	0	82.6	0	0	0	5.3	0	0	0
Waterfowl	1.24	0.39	0.05	0.96	6.9	17.3	3.5	53.6	35.6	18.5	0.8	3.5
Shorebirds	0.20	0.15	0	0	1.1	6.5	0	0	15.1	10.2	0	0
Gulls/Terns	0.18	0	0	0	1.0	0	0	0	1.3	0	0	0
Raptors	0.97	0.74	1.12	0.18	5.4	32.5	77.9	9.9	54.7	45.2	51.7	17.6
Buteos	*0.42*	*0.24*	*0.82*	*0.09*	*2.3*	*10.4*	*57.6*	*5.0*	*32.9*	*19.2*	*34.2*	*9.0*
Northern Harrier	*0.54*	*0.48*	*0.28*	*0.04*	*3.0*	*21.1*	*19.2*	*2.4*	*35.8*	*33.5*	*25.8*	*4.3*
Eagles	*0.01*	*0.01*	*<0.01*	*0.03*	*<0.1*	*0.4*	*0.6*	*1.5*	*1.3*	*1.0*	*0.8*	*2.6*
Falcons	*0*	*0*	*<0.01*	*0*	*0*	*0*	*0.6*	*0*	*0*	*0*	*0.8*	*0*
Other Raptors	*0*	*0.01*	*0*	*0.02*	*0*	*0.6*	*0*	*0.9*	*0*	*1.2*	*0*	*1.7*
Owls	0.01	0.02	0	<0.01	<0.1	1.1	0	0.5	1.2	1.2	0	0.8
Upland Game Birds	0	0.12	0.05	0.34	0	5.1	3.5	18.8	0	11.5	2.5	11.5
Doves/Pigeons	0.13	0.82	0.21	0.31	0.7	36.1	14.5	17.3	6.3	22.2	10.8	2.5
Large Corvids	0.39	0.03	0	0	2.2	1.4	0	0	5.1	3.2	0	0
Goatsuckers	0	0	<0.01	0	0	0	0.6	0	0	0	0.8	0
Large Birds Overall	**17.93**	**2.27**	**1.43**	**1.78**	**100**	**100**	**100**	**100**				
Passerines[b]	2.81	4.48	3.30	5.99	99.1	99.8	100	100	78.2	90.8	51.7	30.9
Woodpeckers	0.03	0.01	0	0	0.9	0.2	0	0	1.3	1.0	0	0
Small Birds Overall	**2.84**	**4.49**	**3.30**	**5.99**	**100**	**100**	**100**	**100**				

[a.] 800-meter radius for large birds and 100-meters for small birds.
[b] excluding large corvids

Waterbirds

Waterbirds, consisting only of sandhill cranes, were only observed in spring (14.80 birds/plot/20-min survey; Table 2; Appendix A). Sandhill cranes accounted for about 83% of large bird use in spring and but observed in only 5.3% of spring surveys (i.e., a few larger flocks).

Waterfowl

Waterfowl had highest use in spring (1.24 birds/plot/20-min survey; Table 2). Waterfowl accounted for about 53.6% of large bird use in winter, 17.3% of use in summer, and 6.9% of use in spring. Percent of use for waterfowl in fall was relatively small (3.5%). Waterfowl were observed more frequently in spring and summer surveys (Table 2) than in other seasons.

Shorebirds

Shorebird were observed only in spring and summer and bird use was similar in both seasons (0.20 birds/plot/20-min survey in spring 0.15 in summer; Table 2). Shorebirds accounted for 6.5% of overall large bird use in summer and 1.1% in spring. Shorebirds were observed during 15.1% of the surveys in spring and 10.2% of summer surveys (Table 2).

Gulls/Terns

The ring-billed gull (*Larus delawarensis*) was the only gull/tern observed during fixed-point surveys and they were only observed during spring (0.18 birds/plot/20-min survey; Table 2; Appendix A). The ring-billed gull accounted for 1.0% of overall large bird use in spring and was observed during 1.3% of the surveys in spring (Table 2).

Raptors

Raptor use was highest in fall (1.12 birds/plot/20-min survey) compared to spring (0.97), summer (0.74), and winter (0.18; Table 2). Higher fall use was mostly due to Swainson's hawks, northern harrier, and red-tailed hawk (*Buteo jamaicensis*; 0.55 birds/plot/20-min survey, 0.28, and 0.22, respectively; Appendix B-1). The raptor subtypes buteos and northern harrier exhibited highest use in fall whereas the raptor subtype eagles use was highest in winter (0.03). In fall, raptors accounted for about 77.9% of mean large bird use and in summer raptors accounted for 32.5% of use; in spring and winter, raptors accounted for less than 10% of mean use (Table 2). Raptors were observed during 54.7% of surveys in spring, 51.7% in fall, 45.2% in summer, and 17.6% in winter (Table 2).

Owls

Owl use was recorded during spring, summer, and winter; use was highest in summer (0.02 birds/plot/20-min survey), 0.01% in spring, and <0.01 in winter (Table 2). Owls accounted for 1.1% of overall large bird use during summer and <1% during spring and winter. Owls were observed during 1.2% of surveys in spring and summer and 0.8% of winter surveys (Table 2).

Upland Game Birds

Upland game birds had higher use during winter (0.34 birds/plot/20-min survey) than in summer (0.12) and fall (0.05; Table 2); upland game birds were not observed during spring. Upland game birds accounted for 18.8% of overall large bird use in winter, 5.1% of summer use, and

3.5% in fall. Upland game birds were observed during 11.5% of surveys in summer and winter and 2.5% in fall (Table 2).

Doves/Pigeons

Highest use by doves/pigeons was recorded during summer (0.82 birds/plot/20-min survey) compared to other seasons (Table 2). Doves/pigeons accounted for 36.1% of overall large bird use during summer, 17.3% during winter, 14.5% during fall, and less than 0.7% during spring. Doves/pigeons were observed in 22.2% of summer surveys compared to 11.0% or less in other seasons (Table 2).

Large Corvids

American crow (*Corvus brachyrhynchos*) was the only large corvid observed and it was only observed in spring and summer (Table 2; Appendix A). Use by this species was higher in spring (0.39 birds/plot/20-min survey) than in summer (0.03; Table 2; Appendix B-1). American crows accounted for 2.2% of overall large bird use in spring and 1.4% in summer. Crows were observed during 5.1% of spring surveys and 3.2% of summer surveys (Table 2).

Goatsuckers

The common nighthawk (*Chordeiles minor*) was the only goatsucker observed; one individual was observed during fall (Appendix A). Use by this species was <0.01 birds/plot/20-min survey, accounted for 0.6% of overall large bird use in fall, and was observed during 0.8% of fall surveys (Table 2).

Passerines

Passerine use (excluding large corvids) was highest in winter (5.99 birds/plot/20-min survey) followed by summer (4.48), fall (3.30), and spring (2.81; Table 2). Horned larks had the highest use of any passerine species in winter (4.53 birds/plot/20-min survey) and fall (2.40; Appendix B-2). In summer, lark buntings (*Calamospiza melanocorys*) had the highest passerine use (0.95 birds/plot/20-min survey) while the western meadowlark (*Sturnella neglecta*) had the highest use (0.60) in spring. Passerine use accounted for >99% of small bird use in all seasons (Table 2). Passerines were observed in 90.8% of summer surveys, 78.2% of spring surveys, 51.7% of fall surveys, and 30.9% of winter surveys.

Woodpeckers

Woodpeckers were only observed in spring and summer; use was higher in spring (0.03 birds/plot/20-min survey) than in summer (0.01; Table 2). Woodpeckers accounted for <1% of bird use in spring and summer. Woodpeckers were observed during 1.3% of surveys in spring and 1.0% of surveys in summer.

Bird Flight Height and Behavior

Flight height characteristics were summarized for both bird types (Table 3) and bird species (Appendices C-1 and C-2) observed during fixed-point surveys.

For large bird species, 306 single birds or groups totaling 1,747 individuals were observed flying within the 800-m plot (Table 3). Overall, 79.5% of large birds observed flying were recorded initially within the RSH, 17.6% were below the RSH, and 3.0% were observed flying above the RSH. Waterbirds had the highest percentage birds flying initially within the RSH (95.6%) followed by buteos with (85.4%), waterfowl (73.7%), and eagles (60%; Table 3). Overall, flying raptors were observed within the RSH 50.6% of the time. Thirteen percent of flying northern harriers were observed within the RSH. The only raptor subtype to fly above the RSH was buteo (1.6%). Flying waterbirds also flew above the RSH (4.4%).

A total of 1,357 passerines (excluding large corvids) and other small birds in 300 groups were recorded flying within 100 meters of the survey plots. The majority of flying passerines were observed below the RSH (94.6%), while 5.4% were recorded within the RSH; no passerines were observed flying above the RSH (Table 3).

Of all large bird species, four species had at least 20 groups observed flying (Appendix C-1). Of these four species, flying Swainson's hawks were observed within the RSH at any time during 97.4% of observations followed by the red-tailed hawk (90.3%), mallard (*Anas platyrhynchos*; 56.8%), and northern harrier (21.7%; Appendix C-1).

Of all passerine (excluding large corvids) and small bird species, four species had at least 20 groups observed flying (Appendix C-2). Of those species, the horned lark was recorded flying within the RSH (at any time) 7.1% of the time. The other three species, the western meadowlark, lark bunting, and red-winged blackbird (*Agelaius phoeniceus*), did not fly within the RSH.

Table 3. Flight height characteristics by bird type[a] and raptor subtype, observed during fixed-point bird use surveys at the Thunder Spirit Wind Resource Area from April 6, 2011 to March 13, 2012.

Bird Type/Subtype	Number of Groups Flying	Number Observed Flying	Flight Height (meters)	% Observed Flying	% within Flight Height Categories		
					0 - 25 meters	25 - 150 meters[b]	> 150 meters
Waterbirds	4	1,125	162.50	100	0	95.6	4.4
Waterfowl	50	194	25.70	78.2	26.3	73.7	0
Shorebirds	18	23	9.72	79.3	82.6	17.4	0
Gulls/Terns	1	14	20.00	100	100	0	0
Raptors	191	245	35.79	82.8	48.6	50.6	0.8
Buteos	*81*	*123*	*63.98*	*75.5*	*13.0*	*85.4*	*1.6*
Northern Harrier	*103*	*115*	*13.37*	*93.5*	*87.0*	*13.0*	*0*
Eagles	*5*	*5*	*35.00*	*83.3*	*40.0*	*60.0*	*0*
Falcons	*0*	*0*	*0*	*0*	*0*	*0*	*0*
Other Raptors	2	2	51.00	66.7	50.0	50	0
Owls	1	2	10.00	50.0	100	0	0
Upland Game Birds	10	22	1.50	40.7	100	0	0
Doves/Pigeons	27	92	11.19	61.7	70.7	29.3	0
Large Corvids	3	29	23.33	87.9	48.3	51.7	0
Goatsuckers	1	1	15.00	100	100	0	0
Large Birds Overall	**306**	**1,747**	**30.65**	**89.5**	**17.6**	**79.5**	**3.0**
Passerines[c]	299	1,356	4.66	81.2	94.6	5.4	0
Woodpeckers	1	1	10.00	33.3	100	0	0
Small Birds Overall	**300**	**1,357**	**4.68**	**81.2**	**94.6**	**5.4**	**0**

[a.] 800-meter radius for large birds and 100-meter for small birds.
[b.] The likely "rotor-swept height" for potential collision with a turbine blade, or 25 to 150 meters (82 to 492 feet) above ground level
[c] excluding large corvids

Collision Exposure Index

A relative collision risk exposure index was calculated for each bird species (Table 4 and Appendices C-1 and C-2). Sandhill cranes had a collision risk exposure index (3.02) higher than other large bird species. The raptor with the highest exposure index was the Swainson's hawk (0.15); all other raptor species had a collision risk exposure index of 0.04 or less (Table 4).

Based on observations within 100 m, the identified passerine species (excluding large corvids) with the highest collision risk exposure index was the snow bunting (*Plectrophenax nivalis*), with an index of 0.05, followed by the horned lark (0.02) and common grackle (<0.01; Table 4).

Table 4. Relative collision risk exposure index, mean bird use (number of birds/plot[c]/20-min survey), and flight characteristics for bird species[a] observed during fixed-point bird use surveys at the Thunder Spirit Wind Resource Area from April 6, 2011 to March 13, 2012.

Species	Number of Groups Flying	Overall Mean Use	% Flying	% Flying Within RSH[b] Based on Initial Observation	Exposure Index	% Within RSH at Any Time
Large Bird Species[c]						
sandhill crane	4	3.16	100	95.6	3.02	95.6
Canada goose	6	0.29	95.0	100	0.27	100
Swainson's hawk	37	0.2	77.8	94.8	0.15	97.4
rock pigeon	9	0.24	68.4	41.5	0.07	56.9
northern pintail	13	0.11	85.4	57.1	0.06	60.0
mallard	22	0.21	58.7	38.6	0.05	56.8
red-tailed hawk	29	0.09	70.5	64.5	0.04	90.3
American crow	3	0.09	87.9	51.7	0.04	51.7
northern harrier	103	0.31	93.5	13.0	0.04	21.7
rough-legged hawk	15	0.05	78.9	80.0	0.03	86.7
unidentified duck	2	0.02	100	100	0.02	100
golden eagle	5	0.01	100	60.0	<0.01	80.0
killdeer	14	0.06	85.7	11.1	<0.01	11.1
marbled godwit	2	0.01	60.0	66.7	<0.01	66.7
gadwall	3	0.01	80.0	25.0	<0.01	25.0
unidentified hawk	2	<0.01	66.7	50.0	<0.01	50.0
Small Bird Species[c]						
unidentified passerine	6	0.28	99.0	44.7	0.12	59.2
snow bunting	1	0.05	100	100	0.05	100
horned lark	70	2.11	95.7	0.8	0.02	7.1
common grackle	8	0.04	93.3	7.1	<0.01	7.1

[a] Only includes species with exposure indices greater than zero;
[b.] RSH: the likely "rotor-swept height" for potential collision with a turbine blade, or 25 to 150 meters (82 to 492 feet) above ground level;
[c.] 800-meter radius for large birds and 100-meter for small birds

Spatial Use

For all large bird species combined, use was highest at points 4 and 18 (32.4 birds/20-min survey and 30.6 respectively; Figure 2; Appendix D). Bird use at other points ranged from 7.39 to 0.50 birds/20-min survey. The relatively higher mean use estimates for points 4 and 18 was largely due to waterbird use.

Raptor use was highest at points 21 (2.77 birds/20-min survey) and 25 (2.08) and ranged from 0.06 to 1.47 birds/20-min survey at other points (Figure 2). The higher raptor use at these two points was mainly due to use by buteos; buteo use was highest at points 21 (2.46 birds/20-min survey) and 25 (1.77). Eagle use, recorded at five points, was highest at point 9 (0.20 birds/20-min survey). Northern harriers were observed at all points except 23 and use was highest at point 17 (1.00 birds/20-min survey).

Waterfowl use was highest at point 22 (3.53 birds/20-min survey) and ranged from zero to 1.50 at other points. Upland game bird use was highest at points 5 (0.72 birds/20-min survey) and 9 (0.60). Shorebird use was highest at point 14 (0.33 birds/20-min survey); use at other points ranged from zero to 0.28 birds/20-min survey (Appendix D).

Passerine (excluding large corvids) use, focused within 100 m, was highest at point 19 with 22.4 birds/20-min survey. The second highest use occurred at point 25 (11.3). Mean use at other points ranged from 0.71 to 7.57 birds/20-min survey (Figure 2).

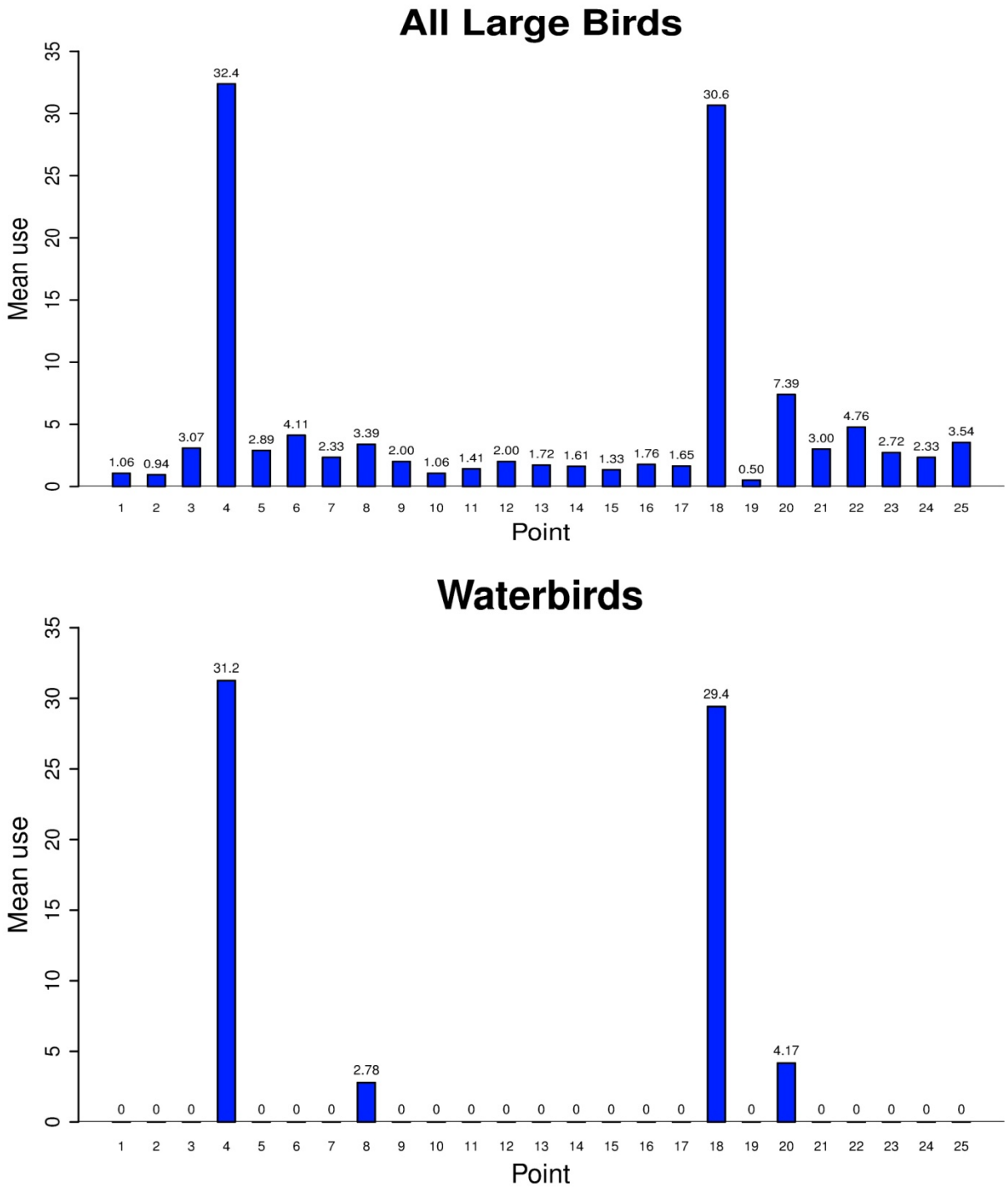


Figure 2. Mean use (number of birds/20-min survey) at each fixed-point survey point for all large birds, major bird types, and raptor subtypes at the Thunder Spirit Wind Resource Area from April 6, 2011 to March 13, 2012. Results are given for large birds within 800 meters of observer; passerine observations (excluding large corvids) were focused within 100 meters. Note variable scaling of y-axis.

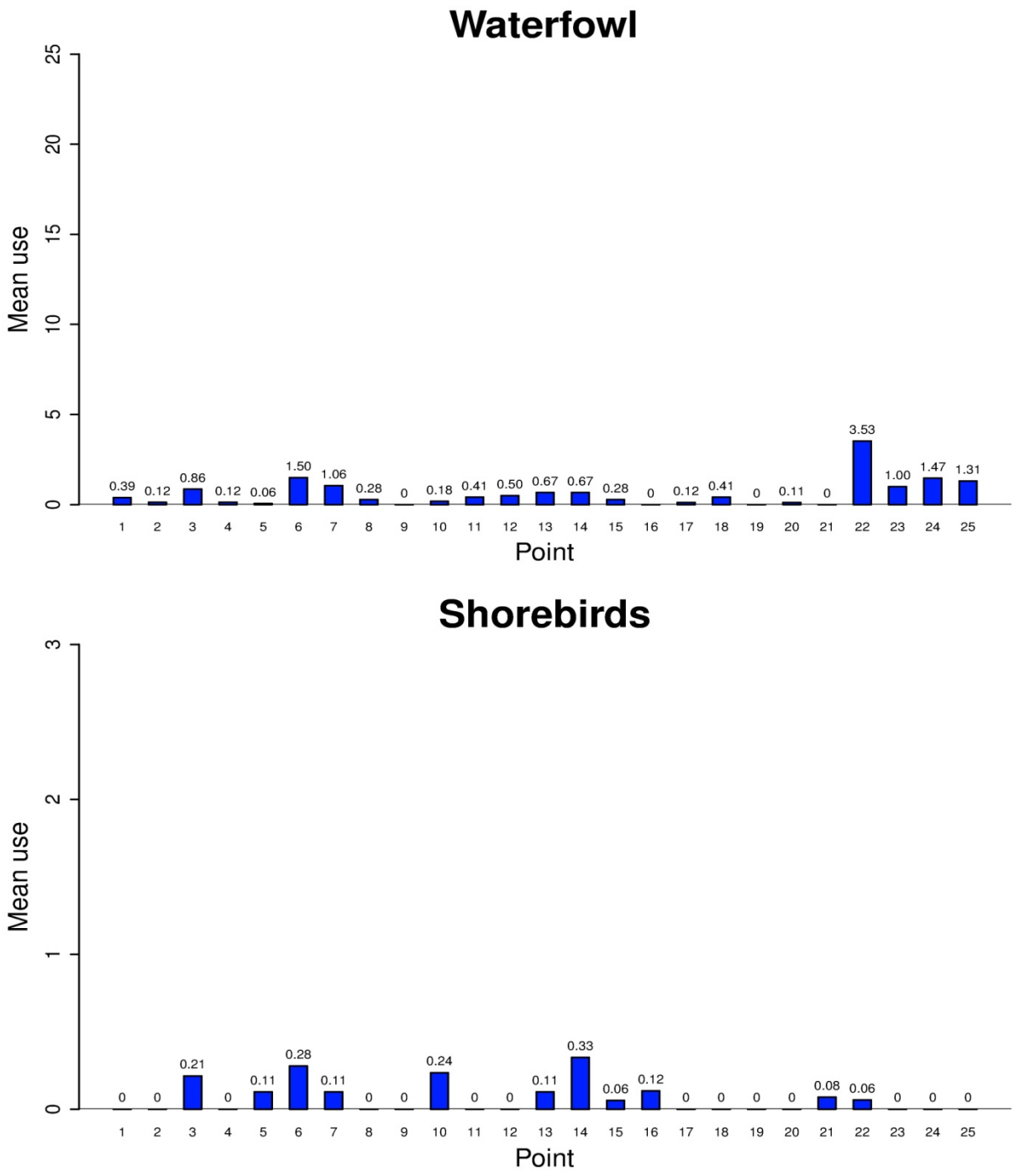


Figure 2 (continued). Mean use (number of birds/20-min survey) at each fixed-point survey point for all large birds, major bird types, and raptor subtypes at the Thunder Spirit Wind Resource Area from April 6, 2011 to March 13, 2012. Results are given for large birds within 800 meters of observer; passerine observations (excluding large corvids) were focused within 100 meters. Note variable scaling of y-axis.

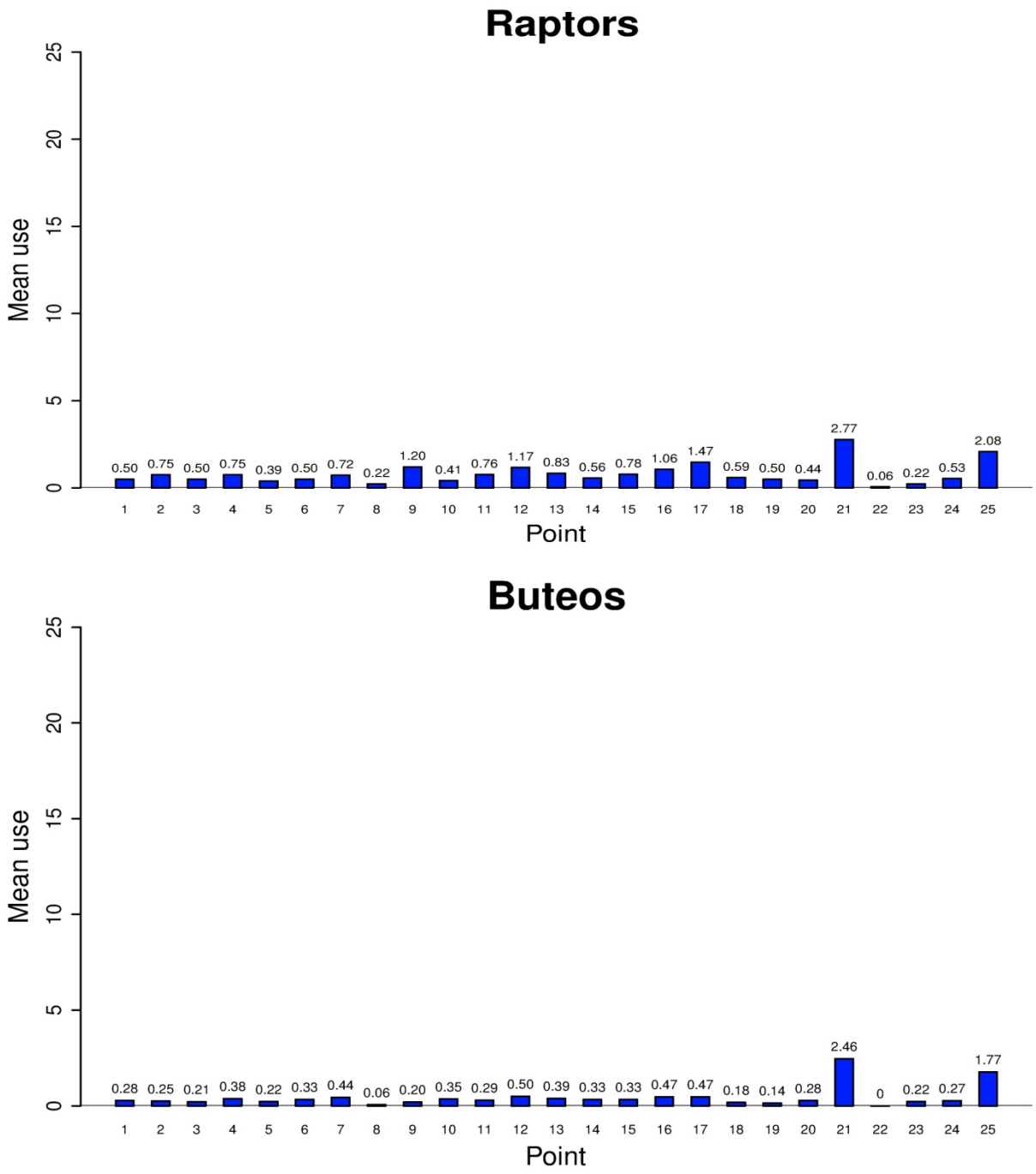


Figure 2 (*continued*). Mean use (number of birds/20-min survey) at each fixed-point survey point for all large birds, major bird types, and raptor subtypes at the Thunder Spirit Wind Resource Area from April 6, 2011, to March 13, 2012. Results are given for large birds within 800 meters of observer; passerine observations (excluding large corvids) were focused within 100 meters. Note variable scaling of y-axis.

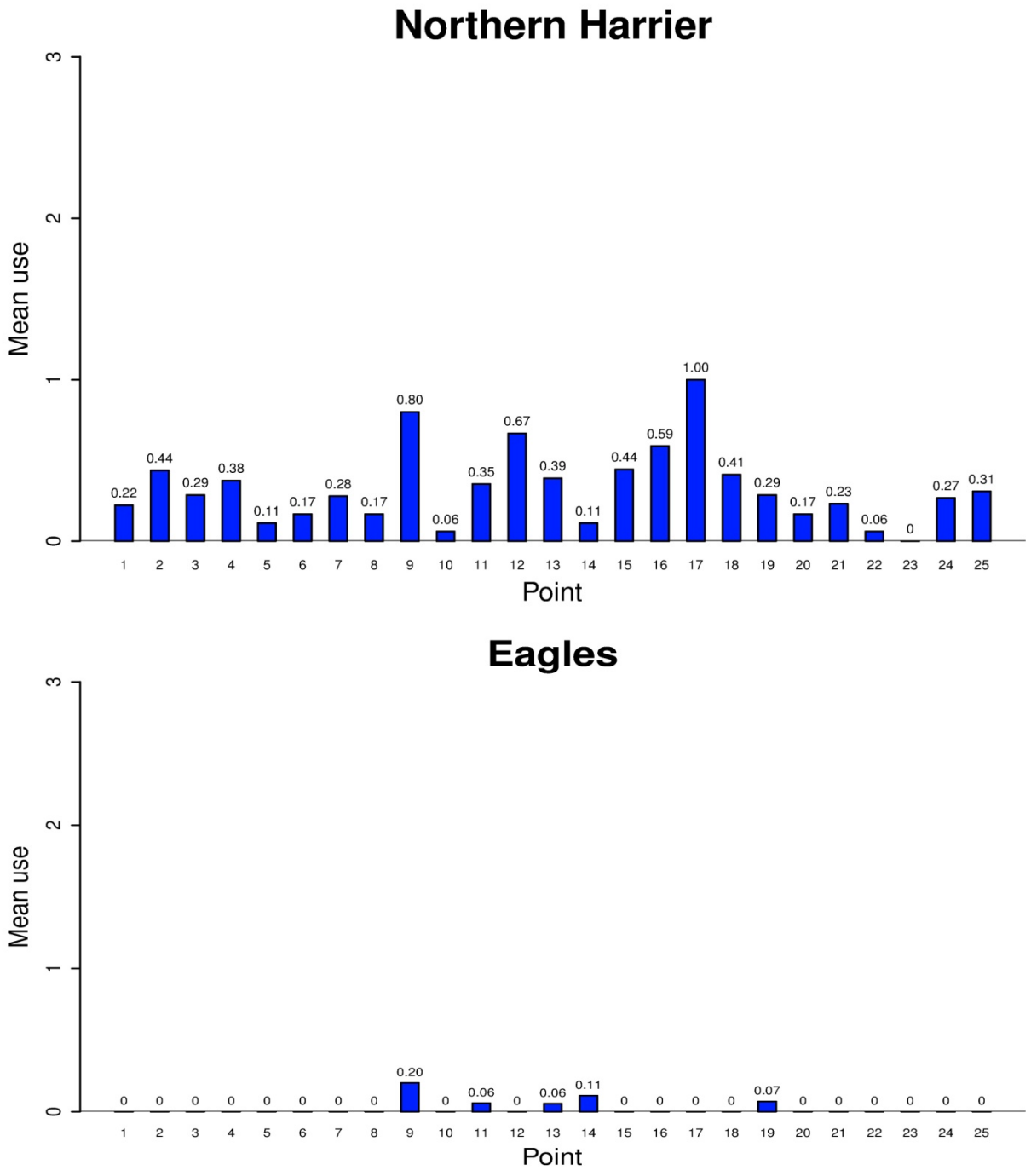


Figure 2 (*continued*). Mean use (number of birds/20-min survey) at each fixed-point survey point for all large birds, major bird types, and raptor subtypes at the Thunder Spirit Wind Resource Area from April 6, 2011, to March 13, 2012. Results are given for large birds within 800 meters of observer; passerine observations (excluding large corvids) were focused within 100 meters. Note variable scaling of y-axis.

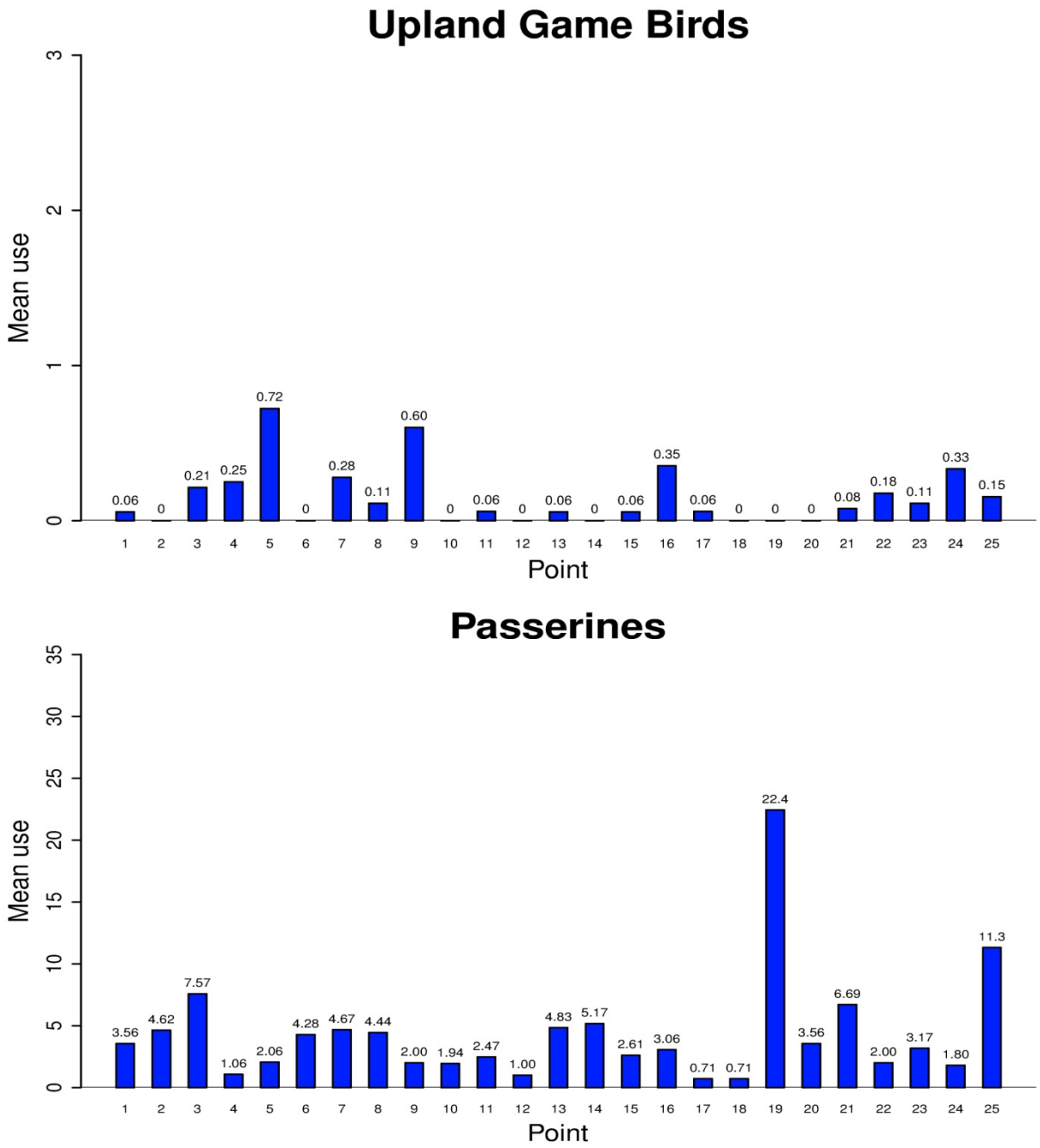


Figure 2 (*continued*). Mean use (number of birds/20-min survey) at each fixed-point survey point for all large birds, major bird types, and raptor subtypes at the Thunder Spirit Wind Resource Area from April 6, 2011, to March 13, 2012. Results are given for large birds within 800 meters of observer; passerine observations (excluding large corvids) were focused within 100 meters. Note variable scaling of y-axis.

Incidental Wildlife Observations

Twenty-seven bird species were observed incidentally, totaling 910 birds within 146 groups (Table 5). The most commonly observed bird was the Canada goose (*Branta canadensis*; 404 individuals), followed by the northern pintail (*Anas acuta*; 100 individuals) and sharp-tailed grouse (*Tympanuchus phasianellus*; 88 indivduals). Overall, seven species of raptors and four owl species were observed incidentally. Five bird species were only observed incidentally. Five mammal species was observed incidentally; the most commonly observed species were the pronghorn (*Antilocapra americana*; 87 individuals) and white-tailed deer (*Odocoileus virginianus*; 50 individuals).

Table 5. Incidental wildlife (number of groups and individuals) observed at the Thunder Spirit Wind Resource Area from April 6, 2011 to March 13, 2012.

Species	Scientific Name	Groups	Individuals
Canada goose	*Branta canadensis*	2	404
northern pintail	*Anas acuta*	1	100
sharp-tailed grouse	*Tympanuchus phasianellus*	13	88
mallard	*Anas platyrhynchos*	3	54
Swainson's hawk	*Buteo swainsoni*	25	51
redhead*	*Aythya americana*	1	50
gadwall	*Anas strepera*	2	38
red-tailed hawk	*Buteo jamaicensis*	33	36
northern harrier	*Circus cyaneus*	15	19
rough-legged hawk	*Buteo lagopus*	12	13
great horned owl*	*Bubo virginianus*	7	11
American wigeon	*Anas americana*	1	6
green-winged teal*	*Anas crecca*	1	6
American kestrel	*Falco sparverius*	4	5
loggerhead shrike	*Lanius ludovicianus*	5	5
unidentified hawk		4	5
burrowing owl*	*Athene cunicularia*	2	2
short-eared owl	*Asio flammeus*	2	2
unidentified raptor		2	2
upland sandpiper	*Bartramia longicauda*	2	2
brown thrasher	*Toxostoma rufum*	1	2
Sprague's pipit	*Anthus spragueii*	1	2
American bittern*	*Botaurus lentiginosus*	1	1
ferruginous hawk	*Buteo regalis*	1	1
golden eagle	*Aquila chrysaetos*	1	1
marbled godwit	*Limosa fedoa*	1	1
northern shoveler	*Anas clypeata*	1	1
snowy owl	*Bubo scandiacus*	1	1
willet	*Catoptrophorus semipalmatus*	1	1
Bird Subtotal	**27 Species**	**146**	**910**
pronghorn	*Antilocapra americana*	10	87
white-tailed deer	*Odocoileus virginianus*	14	50
mule deer	*Odocoileus hemionus*	1	7
coyote	*Canis latrans*	2	2
white-tailed jackrabbit	*Lepus townsendii*	1	1
Mammal Subtotal	**5 Species**	**28**	**147**

* bird species only observed incidentally

Sensitive Species Observations

Twenty-one sensitive bird species were observed during fixed-point surveys and incidentally (Table 6). The Swainson's hawk (150 individuals) was the most commonly observed sensitive species, followed by the northern harrier (142 individuals), and northern pintail (141 individuals). All of the species in Table 6 are included in the North Dakota 100 Species of Conservation Priority (NDGFD 2004). One species, the Sprague's pipit (*Anthus spragueii*), is a federal candidate species (USFWS 2011, 2012e); three individuals were observed during point surveys or incidentally. One bald eagle (*Haliaeetus leucocephalus*) and six golden eagles (*Aquila chrysaetos*) were observed. Both eagle species are also protected under the Bald and Golden Eagle Protection Act (BGEPA 1940).

Table 6. Number of groups, individuals, and status of sensitive species observed, regardless of distance from observer, during fixed-point bird use surveys and as incidental wildlife observations at the Thunder Spirit Wind Resource Area from April 6, 2011, to March 13, 2012.

			Fixed-Point		Incidental Observations		Total	
Species	**Scientific Name**	**Status**	**Groups**	**Individuals**	**Groups**	**Individuals**	**Groups**	**Individuals**
Swainson's hawk	*Buteo swainsoni*	ND Level I	47	99	25	51	72	150
northern harrier	*Circus cyaneus*	ND Level II	109	123	15	19	124	142
northern pintail	*Anas acuta*	ND Level II	16	41	1	100	17	141
sharp-tailed grouse	*Tympanuchus phasianellus*	ND Level II	6	10	13	88	19	98
lark bunting	*Calamospiza melanocorys*	ND Level I	32	88	0	0	32	88
redhead	*Aythya americana*	ND Level II	0	0	1	50	1	50
bobolink	*Dolichonyx oryzivorus*	ND Level II	21	28	0	0	21	28
grasshopper sparrow	*Ammodramus savannarum*	ND Level I	14	15	0	0	14	15
chestnut-collared longspur	*Calcarius ornatus*	ND Level I	10	15	0	0	10	15
loggerhead shrike	*Lanius ludovicianus*	ND Level II	8	9	5	5	13	14
golden eagle	*Aquila chrysaetos*	ND Level II, EA	5	5	1	1	6	6
marbled godwit	*Limosa fedoa*	ND Level I	3	5	1	1	4	6
short-eared owl	*Asio flammeus*	ND Level II	2	3	2	2	4	5
upland sandpiper	*Bartramia longicauda*	ND Level I	2	2	2	2	4	4
red-headed woodpecker	*Melanerpes erythrocephalus*	ND Level II	2	3	0	0	2	3
Sprague's pipit	*Anthus spragueii*	ND Level I, FC	1	1	1	2	2	3
burrowing owl	*Athene cunicularia*	ND Level II	0	0	2	2	2	2
ferruginous hawk	*Buteo regalis*	ND Level I	1	1	1	1	2	2
willet	*Catoptrophorus semipalmatus*	ND Level I	1	1	1	1	2	2
American bittern	*Botaurus lentiginosus*	ND Level I	0	0	1	1	1	1
bald eagle	*Haliaeetus leucocephalus*	ND Level II, EA	1	1	0	0	1	1
Total	**21 species**		**281**	**450**	**72**	**326**	**353**	**776**

FC = federal candidate species (USFWS 2011, 2012e);
ND Level I, Level II = North Dakota Species of Conservation Priority (NDGFD 2004);
EA = Bald and Golden Eagle Protection Act (BGEPA 1940)

DISCUSSION AND IMPACT ASSESSMENT

Fixed-Point Surveys

Large bird use, consisting largely of sandhill cranes, was highest in the spring (Appendix B-1). All of the cranes were observed on April 12, 2012 and all were flying, with over 90% of them flying in a northerly direction. This suggests that the cranes were migrating through the area. The cranes were observed near survey points 4 and 18 (Figure 2), which are along the eastern edge of the TSWRA (Figure 1) but reasons for this are unclear and they likely were simply flying over the site. Sandhill crane use at these two points greatly increased the overall large bird use estimate.

Small bird use was highest in winter, primarily due to horned larks which made up about 76% of passerine observations in winter (Appendix B-2). Horned larks, a common bird in North Dakota, showed significant increases in use of areas near turbines at the Combine Hills facility in Oregon, possibly because the cleared turbine pads and access roads provided habitat preferred by this species (Young et al. 2005). Horned larks are a common species observed within wind farms and are often the dominate species found as fatalities.

The Swainson's hawk was one of the raptors observed most often during fixed-point surveys (Appendix A). The hawk, which is a Species of Conservation Priority in North Dakota (NDGFD 2004), was also observed frequently incidentally (Table 5) and one nest was located during nest surveys in 2011 (Derby and Thorn 2013). The Swainson's hawk had the highest collision risk exposure index of any raptor (Appendix C-1). During fixed-point surveys, the hawk was observed most often at survey points 21 and 25 (Figure 2), but reasons for this are unclear.

Other survey points with relatively higher use were points 19 and 25 (passerines) and point 22 (waterfowl). Points 22, 21, 25, and 19 are all located in the southern part of the TSWRA (Figure 1) but the significance of this occurrence is unknown.

Potential Impacts

Impacts to wildlife and their habitats from wind energy facilities can be direct or indirect. Direct impacts are those with the potential to cause fatalities from construction and operation of the proposed wind energy facility. Indirect impacts include the displacement of wildlife, either temporarily or permanently, during construction of, or during the operational period of a wind energy facility.

Direct Effects

The most probable direct impact to birds from wind energy facilities is mortality or injury due to collisions with turbines or guy wires of met towers. Collisions may occur with resident birds foraging and flying within the study area or with migrant birds seasonally moving through the study area. Project construction could directly affect birds through potential fatalities caused by construction equipment. Potential mortality from construction equipment is expected to be low.

Equipment used in wind energy facility construction generally moves at slow rates or is stationary for long periods (e.g., cranes). The risk of direct mortality to birds from construction is most likely potential destruction of a nest for ground- and shrub-nesting species during initial site clearing. Impacts from the decommissioning of the facility are anticipated to be similar to construction in terms of noise, disturbance, and equipment.

Substantial data on bird mortality at wind energy facilities are available from studies across North America. Of 841 bird fatalities reported from California studies (>70% from the Altamont Pass facility in California), approximately 39% were raptors, about 19% were passerines (excluding house sparrows [*Passer domesticus*] and European starlings [*Sturnus vulgaris*]), and about 12% were owls (Erickson et al. 2002b). Non-protected birds (e.g., birds not protected by the Migratory Bird Treaty Act [MBTA 1918] or the Endangered Species Act [ESA 1973]), including house sparrows, European starlings, and rock pigeons (*Columba livia*), accounted for about 15% of the fatalities. Other bird types generally made up less than 10% of the fatalities (Erickson et al. 2002b). During 12 fatality monitoring studies conducted outside of California, raptor fatalities accounted for approximately 2% of the wind energy facility-related fatalities and raptor mortality averaged 0.03 fatalities/turbine/year (Erickson et al. 2002b). Passerines (excluding house sparrows and European starlings) were the most common collision victims, accounting for about 82% of the 225 fatalities documented.

Using mortality data from a 10-year period from wind energy facilities throughout the United States, the average number of bird collision fatalities was 3.1 fatalities per megawatt (MW) per year, or 2.3 fatalities per turbine per year (NWCC 2004). In a comparison of wind energy facilities in the Midwest, overall bird fatality rates ranged from 0.42 to 8.25 fatalities/MW/year (Appendix E). When examining fatality estimates from facilities in North America, overall bird fatality rates ranged from 0.15 to 11.02 fatalities/MW/year (Appendix E). Given that all the facilities in Appendix E documented some level of direct mortality to birds, it is reasonable to assume that the operation of a wind energy facility within the TSWRA would have some direct impact on birds migrating through the area, as well as on those birds residing in the area. The level of this anticipated impact is discussed below.

Raptor Use and Collision Risk Exposure

Although high numbers of raptor fatalities have been documented at some wind energy facilities (e.g., the Altamont Pass facility), a review of studies at wind energy facilities across the United States reported that only 3.2% of fatalities were raptors (Erickson et al. 2001b). While raptors occur in most areas with the potential for wind energy development, individual species appear to differ from one another in their susceptibility to collision (NRC 2007). Results from the Altamont Pass facility in California suggest that mortality for some species is not necessarily related to abundance (Orloff and Flannery 1992). American kestrels (*Falco sparverius*), red-tailed hawks, and golden eagles were killed more often than predicted based on abundance. For example, relatively few northern harrier fatalities have been reported at existing wind energy facilities, despite the fact they are commonly observed during fixed-point bird counts at these facilities (Erickson et al. 2001b, Whitfield and Madders 2006, Smallwood and Karas 2009). It is likely that

many factors, in addition to abundance, are important in predicting raptor mortality as well as other bird mortality.

There is some evidence that migrating raptors are more vulnerable to turbine collision than residents (Orloff and Flannery 1993, DeLucas et al. 2004). Migrating raptors are known to concentrate in rather narrow streams along linear topographic features such as coastlines, rivers, and ridges (Liguori 2005, USFWS 2008); ridges and coastlines are often ideal locations for wind energy facilities, which could place concentrations of raptors at risk of collision with wind energy facilities. Over large migration distances, raptors rely on vertical lift to promote soaring and gliding flight; this strategy allows migrants to conserve energy (Kerlinger 1989, Bildstein 2006). However, this tactic may also make migrant raptors more vulnerable to turbine collisions (Barrios and Rodriguez 2004, Hoover and Morrison 2005) because it could bring them into proximity with wind turbines located on ridges and coastlines. The TSWRA is not located near a coast line or other feature that would appear to funnel migrating raptors.

Although collision mortality is well documented at most wind energy facilities, population level effects attributable to collisions have not been detected (Carrete et al. 2009, Pearce-Higgins et al. 2012); however, few studies have addressed this issue (Johnson and Stephens 2011). Impacts to golden eagles in the Altamont Pass wind energy facility have been evaluated and investigated for over 25 years. Recent studies have not demonstrated breeding population level impacts despite high individual mortality (Hunt 2002). Based on a 4-year study, the resident golden eagle population appeared to be self-sustaining, despite sustaining comparatively high levels of fatalities. However, the effect of these fatalities on golden eagle populations wintering within and adjacent to the Altamont Pass facility was unknown (Hunt 2002). Additional research conducted by Hunt and Hunt (2006) found that all 58 territories occupied by golden eagle pairs in the Altamont Pass facility in 2000 remained active in 2005.

Collision risk exposure indices analysis may also provide insight into which species might be the most likely turbine casualties. However, the index only considers relative probability of collision exposure based on abundance, proportion of observations flying, and proportion of flight height of each species within the RSH for turbines likely to be used at the wind energy facility. This analysis is based on observations of birds during the surveys and does not take into consideration behavior (e.g. foraging, courtship), habitat selection, the varying ability among species to detect and avoid turbines, and other factors that may vary among species and influence likelihood for turbine collision. For these reasons, the index is only a relative index among species (i.e., comparison between species observed during studies at TSWRA) observed during the surveys and within the study area and cannot be compared to other wind resource areas. Actual risk for some species may be lower or higher than indicated by these data. In the TSWRA, the raptor species with the highest exposure index was the Swainson's hawk, with an exposure index of 0.15 (Table 4). The red-tailed hawk and northern harrier had exposure indices of 0.04, the rough-legged hawk (*Buteo lagopus*) had an index of 0.03, and other raptors had an exposure index of <0.01, primarily due to lower use estimates by these species or a relatively low proportion of flight heights observed in the RSH. Based on flight

information and abundance, it is expected that most raptor fatalities would be Swainson's hawks and red-tailed hawks.

Annual raptor use in the TSWRA (0.68 raptors/plot/20-min survey) was compared to annual raptor use at other wind energy facilities (Figure 3). The mean annual raptor use at these other wind energy facilities ranged from 0.06 raptors/20-min survey to 2.34 raptors/20-min survey. Based on the results from these facilities, a ranking of mean annual raptor use was developed as: low (0 – 0.5 raptors/plot/20-min survey); low to moderate (0.5 – 1.0); moderate (1.0 – 2.0); high (2.0 – 3.0); and very high (> 3.0). Using this ranking, mean raptor use in the TSWRA is considered to be low to moderate. Compared to the other wind energy facilities, raptor use in the TSWRA ranked 14 of 44 projects reviewed (Figure 3).

Overall raptor mortality was compared at other wind energy facilities across North America, some of which also had raptor use estimates (Appendix F). Estimated use values at the facilities ranged from 2.16 raptors/20-min survey at the Diablo Winds wind energy facility in California (WEST 2006, 2008) to 0.13 raptors /20-min survey at the Dry Lake I wind energy facility in Arizona (Thompson et al. 2011). Raptor fatality estimates at these sites ranged from 0.59 raptors/MW/year at the Munnsville wind facility (Stantec 2009b) to zero raptors/MW/year at numerous wind energy facilities. Assuming a positive correlation between use and fatality rates exists, Fatality rates at the TSWRA would be much lower than the fatality rates at Diablo Winds in California and would likely be similar to the rates seen at sites in the Pacific Northwest (Appendix F).

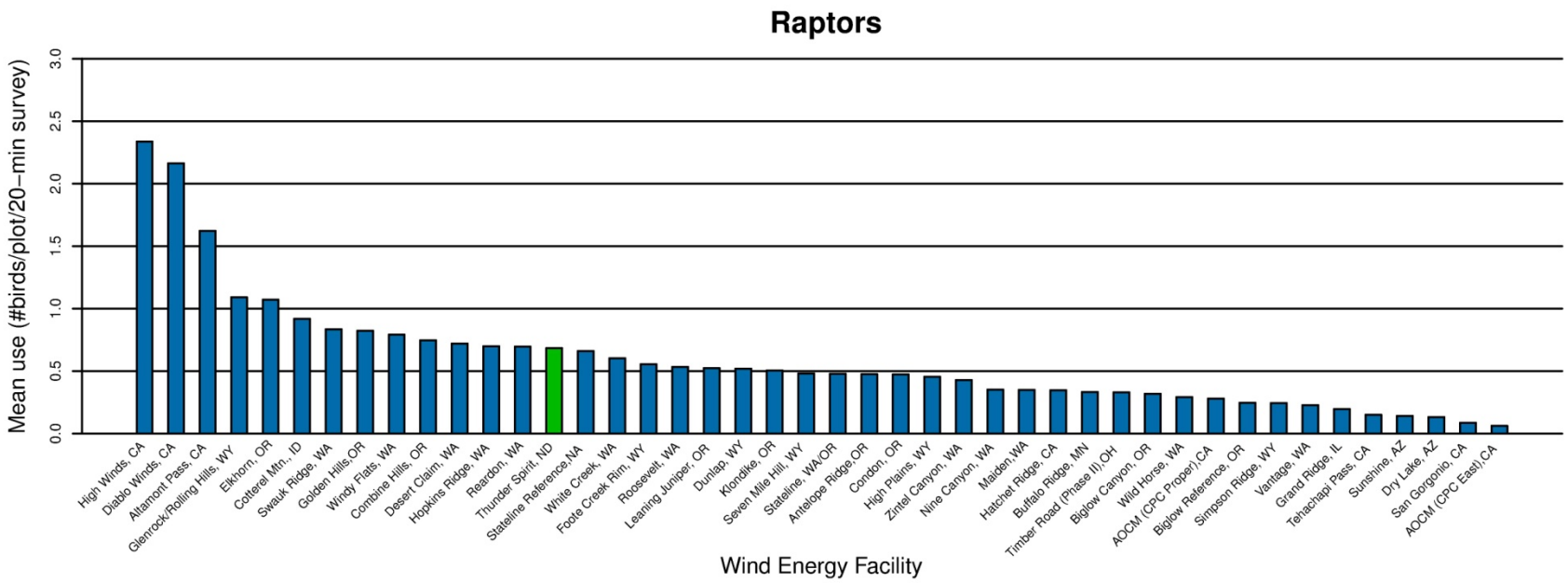


Figure 3. Comparison of annual raptor use (birds/plot/20-min survey) between the Thunder Spirit Wind Resource Area and other US wind energy facilities.

Data from the following sources:

Study and Location	Reference	Study and Location	Reference	Study and Location	Reference
Thunder Spirit, ND	This study.				
High Winds, CA	Kerlinger et al. 2005	Foote Creek Rim, WY	Johnson et al. 2000b	Timber Road (Phase II), OH	Good et al. 2010
Diablo Winds, CA	WEST 2006	Roosevelt, WA	NWC and WEST 2004	Biglow Canyon, OR	WEST 2005c
Altamont Pass, CA	Orloff and Flannery 1992	Leaning Juniper, OR	Kronner et al. 2005	Wild Horse, WA	Erickson et al. 2003d
Glenrock/Rolling Hills, WY	Johnson et al. 2008a	Dunlap, WY	Johnson et al. 2009a	AOCM (CPC Proper), CA	Chatfield et al. 2010a
Elkhorn, OR	WEST 2005a	Klondike, OR	Johnson et al. 2002a	Biglow Reference, OR	WEST 2005c
Cotterel Mtn., ID	BLM 2006	Seven Mile Hill, WY	Johnson et al. 2008b	Simpson Ridge, WY	Johnsonet al. 2000b
Swauk Ridge, WA	Erickson et al. 2003c	Stateline, WA/OR	Erickson et al. 2003b	Vantage, WA	WEST 2007
Golden Hills, OR	Jeffrey et al. 2008	Antelope Ridge, OR	WEST 2009	Grand Ridge, IL	Derby et al. 2009
Windy Flats, WA	Johnson et al. 2007	Condon, OR	Ericksonet al. 2002b	Tehachapi Pass, CA	Anderson et al. 2000, Ericksonet al. 2002b
Combine Hills, OR	Young et al. 2003c	High Plains, WY	Johnson et al. 2009b	Sunshine, AZ	WEST and the CPRS 2006
Desert Claim, WA	Young et al. 2003d	Zintel Canyon, WA	Erickson et al. 2002a, 2003a	Dry Lake, AZ	Young et al. 2007a
Hopkin's Ridge, WA	Young et al. 2003e	Nine Canyon, WA	Erickson et al. 2001a	San Gorgonio, CA	Andersonet al. 2000, Ericksonet al. 2002b
Reardon, WA	WEST 2005b	Maiden, WA	Young et al. 2002	AOCM (CPC East), CA	Chatfieldet al. 2010a
Stateline Reference	URS et al. 2001	Hatchet Ridge, CA	Young et al. 2007b		
White Creek, WA	NWC and WEST 2005	Buffalo Ridge, MN	Johnson et al. 2000a		

Sensitive Species Use

No federally-listed threatened or endangered species were observed in the TSWRA during bird use surveys or incidentally. One species, the Sprague's pipit, is classified as a candidate species for listing under the Endangered Species Act (USFWS 2010, 2012a; ESA 1973). Two eagle species were observed during the study; eagles are protected under the BGEPA (1940).

Bald Eagle

The bald eagle is a North Dakota Species of Conservation Priority (NDGFD 2004) and is also protected under the BGEPA (1940). Generally, bald eagles select habitats along major rivers, lakes, and reservoirs (USGS 2006a, 2006c). Nests are typically built in tall, large trees in mature forests. However, with increasing bald eagle populations, nesting eagles are also found in areas away from major waterbodies. Bald eagle nesting has not been documented in Adams County in recent years (USGS 2006a, 2006b; Johnson 2010). Bald eagles may also be found during migration and winter periods in areas away from major rivers if sufficient forage is available. Fish is the primary food source of the eagle, but the eagle may also feed on birds, mammals, and carrion. During this study, one bald eagle was observed (Appendix A) perched during fixed-point surveys in winter. The TSWRA does not appear to receive significant bald eagle use at any time during the year.

Golden Eagle

The golden eagle is also a North Dakota Species of Conservation Priority (NDGFD 2004) and is protected under the BGEPA. This eagle is a large bird of prey that prefers open country, such as prairies, tundra, or open areas in forest, particularly in hilly or mountainous terrain (All About Birds 2011). Golden eagles primarily eat small mammals such as rabbits, ground squirrels, and prairie dogs, although they are capable of taking larger prey. In North Dakota, golden eagles nest in the southwest portion of the state (DeLong 2004, USGS 2006d). Historically, a golden eagle nest was observed within seven miles of the western edge of the TSWRA (USFWS Ecological Services, Bismarck, North Dakota, 2012, pers. comm.). Five golden eagles were observed during fixed-point surveys and one was observed incidentally (Table 6); observations occurred in all seasons, possibly of the same bird or birds (Appendix A). Five birds were observed flying during fixed-point surveys; four of those were flying within the RSH at some point during the observation (Appendix C-1). The collision risk exposure index (<0.01) for golden eagles was relatively low. While there was not significant use of the project area during any season, use was consistent. It is not known if use was from birds that have nested at the location seven miles to the west.

Sprague's Pipit

This passerine species is endemic to mixed-grass prairies of the Northern Great Plains of North America. The decline in the pipit population is largely due to habitat conversion from native prairie to cropland and habitat degradation; pipits require large areas of unfragmented native prairie without shrubs or trees. In North Dakota, the pipits breed in suitable habitats found in the central and western portions of the state (USGS 2006e, Jones 2010). The pipit has been documented in Adams County and many other counties in North Dakota (USFWS 2012b, 2012c). One Sprague's pipit was observed in spring during fixed-point surveys (Appendix A).

Two pipits were observed incidentally during late spring. Minimizing impacts to larger tracts of native prairie would likely minimize potential impact to this species.

Non-Raptor Use and Collision Risk Exposure

Passerines

Passerines (primarily perching birds) have been the most abundant bird fatality at wind energy facilities, excluding facilities in California (Erickson et al. 2001b, 2002b), often accounting for more than 80% of the bird fatalities. Both migrant and resident passerine fatalities have been observed. Given that passerines made up a large proportion of the birds observed during this study, passerines would be expected to make up a large proportion of bird fatalities in the TSWRA. However, there has not been a clearly demonstrated correlation between high passerine use and high mortality as there appears to be with raptors. Collision risk exposure indices indicate that the snow bunting is a likely passerine (excluding large corvids) to be exposed to collision with wind turbine blades in the TSWRA during the winter. Another passerine species likely at risk based on abundance and flight behavior is the horned lark (Table 4). Most non-raptors had relatively low exposure indices due to the majority of individuals flying below the likely RSH. It is unlikely that non-raptor populations will be adversely affected by direct mortality from the operation of the wind energy facility given their overall populations and overall low impacts to any one species.

Waterbirds

Waterbirds (composed only of sandhill cranes) were the bird type with the highest collision risk exposure index of any bird type or species (3.02; Appendix C-1). All of the sandhill cranes observed during fixed-point surveys (1,125 individuals) were flying and 95.6% of those individuals were within the RSH at some point.

There is some potential for this species to collide with wind turbines at the TSWRA; however, this species is rarely reported as a fatality from wind energy facilities in the US, even though the sandhill crane is a relatively common species, and has never been found as a fatality within the migration corridor. Of publically available data, only three sandhill crane fatalities at wind energy facilities are known: one fatality at Altamont Pass in California (Smallwood and Karas 2009), and two fatalities from a facility in west Texas (N. Gates, USFWS, pers. comm., Stehn 2011).

Data are available from various wind energy facilities in North and South Dakota where migrating sandhill crane use was recorded in conjunction with post-construction fatality monitoring (Derby et al. 2012). For all six facilities combined, over 30,000 observations of sandhill cranes were recorded (flying or foraging) within the vicinity of the wind energy facilities during spring and fall studies, yet no crane fatalities were found during daily turbine checks. At Forward Energy Center, a wind energy facility in southern Wisconsin, located near the Horicon National Wildlife Refuge, no crane fatalities were found during fatality monitoring studies in the fall of 2008, spring and fall of 2009, and in the spring of 2010 (Grodsky and Drake 2011). Sandhill cranes do not appear to be overly susceptible to turbine collision at any time of they year, and this appears to be especially true during migration.

Because whooping (*Grus americana*) and sandhill cranes utilize similar habitats during migration and frequently travel in the same flocks, the presence of sandhill cranes may indicate suitability of an area for whooping cranes. The whooping crane is an endangered species protected under the ESA (ESA 1973, USFWS 2012d). The US Fish and Wildlife Service (USFWS) has expressed concern over potential impacts to whooping cranes from wind-energy facility development. Whooping cranes generally migrate at 1,000-5,000 ft, altitudes well above turbine height (Stehn 1998), and thus for the most part are unlikely to collide with turbines. However, as whooping cranes ascend and descend during takeoff and landing, or migrate during inclement weather, they may fly at lower altitudes and may fly within the flight altitudes corresponding to the rotor-swept areas. No sandhill crane use was documented on the ground, all use was as the cranes were migrating at height. It is unclear at what level the area may provide available roosting and foraging habitat for cranes.

The TSWRA is at the western edge of the approximately 200-mile wide migration corridor identified by the USFWS that passes through central North Dakota (CWCTP 2009). Although no whooping cranes were observed during this study, whooping cranes have been observed in the vicinity, as close as 9 miles to the southwest in 1994 (CWCTP 2011). Additional observations within about 30 miles of the TSWRA were recorded from 1970 to 2002 (CWCTP 2011).

The relatively low rate of crane collisions with turbines makes it unlikely that cranes will be affected by the proposed TSWRA.

Indirect Effects

The presence of wind turbines may alter the landscape so that wildlife use patterns are affected, displacing wildlife away from the project facilities and suitable habitat. In addition to direct effects through collision mortality, wind energy development results in indirect effects such as direct loss of habitat where infrastructure is placed and indirect loss of habitat through behavioral avoidance and perhaps habitat fragmentation. Examples of potential indirect loss of habitat near wind facilities include behavioral displacement (avoidance) by birds, which may lead to decreased overall habitat availability and/or breeding and nesting habitat for local populations. It also includes increased habitat fragmentation (e.g., more habitat edges through roads) which could provide more generalized habitats and resistance-free travel lanes for predators and competitors in, for example, large grasslands and forests. This may impact the survivorship and reproductive ability of birds in the facility vicinity. Wind energy facility construction appears to cause small-scale local displacement of some grassland passerines and is likely due to the birds avoiding turbine noise and maintenance activities. Construction also may reduce habitat effectiveness because of the presence of access roads and large gravel pads surrounding turbines (Leddy 1996, Johnson et al. 2000a).

Some studies from wind energy facilities in Europe consider displacement effects to have a greater impact on birds than collision mortality (Gill et al. 1996). The greatest concern with displacement impacts for wind energy facilities has been where these facilities have been constructed in native habitats such as grasslands or shrublands and particularly for raptors, passerines, and waterfowl (Leddy et al. 1999, Mabey and Paul 2007). Results from studies at

the Stateline wind energy facility in Washington and Oregon (Erickson et al. 2004) and the Buffalo Ridge wind energy facility in Minnesota (Johnson et al. 2000a) suggest that breeding birds are also affected by wind-facility operations at some level.

Raptor Displacement

In addition to possible direct effects on raptors within the study area (discussed above), indirect effects caused by disturbance-type impacts, such as construction activity near an active nest or primary foraging area, also have a potential to impact raptor species.

Birds displaced from wind energy facilities might move to areas with fewer disturbances, but with lower quality habitat, with an overall effect of reducing breeding success. Most studies on raptor displacement at wind energy facilities, however, indicate displacement effects to be negligible (Howell and Noone 1992; Johnson et al. 2000a, 2003; Madders and Whitfield 2006). Notable exceptions to this include a study in Scotland that described territorial golden eagles avoiding the entire wind energy facility area, except when intercepting non-territorial birds (Walker et al. 2005). A study at the Buffalo Ridge wind energy facility in Minnesota found evidence of northern harriers avoiding turbines on both a small scale (less than 100 m from turbines) and on a larger scale in the year following construction (Johnson et al. 2000a). Two years following construction however, no large-scale displacement of northern harriers was detected (Johnson et al. 2002b). However, at a wind facility in Wisconsin, raptor abundance (five species) was 47% less post-construction compared to pre-construction levels even though US breeding bird survey data for the area showed no difference among years in raptor abundance (Garvin et al. 2011).

Avoidance of wind turbines by nesting raptors has only been reported in one publically available study (Usgaard et al. 1997). Avoidance of wind turbines by nesting raptors occurred at the Buffalo Ridge wind energy facility in Minnesota, where raptor nest density on 101 square miles (mi^2; 262 square kilometer [km^2]) of land surrounding a wind energy facility was 5.94 nests/39 mi^2 (5.94 nests/101 km^2), yet no nests were present in the 12 mi^2 (31 km^2) facility itself, even though habitat was similar (Usgaard et al. 1997). However, this analysis assumes that raptor nests are uniformly distributed across the landscape, an unlikely event, and even though no nests were found, only two nests would be expected for an area 12 mi^2 in size if the nests were distributed uniformly.

Several studies have shown no avoidance behavior by nesting raptors (Erickson et al. 2004; Johnson et al. 2000, 2003). At a wind energy facility in eastern Washington, based on extensive monitoring using helicopter flights and ground observations, raptors still nested in the study area at approximately the same levels after construction, and several nests were located within a half-mile (0.8 km) of turbines (Erickson et al. 2004). At the Foote Creek Rim wind energy facility in southern Wyoming, one pair of red-tailed hawks nested within 0.3 miles (0.5 km) of the turbine strings, and seven red-tailed hawk nests, one great horned owl (*Bubo virginianus*) nest, and one golden eagle nest located within one mile of the facility successfully fledged young (Johnson et al. 2000b). The golden eagle pair successfully nested a half-mile from the facility for three different years after it became operational. A Swainson's hawk also nested within a

quarter-mile (0.4 km) of a turbine string at the Klondike I wind energy facility in Oregon after the facility was operational (Johnson et al. 2003).

The TSWRA contains potential raptor nesting opportunities in the form of scattered shelterbelts and tree rows. In 2011, a great horned owl nest was observed within the TSWRA and a Swainson's hawk nest was within a mile of the eastern edge of the study area. Historically, a golden eagle nest was located within seven miles of the western edge of the TSWRA. However, no eagle nests were observed during an aerial survey in 2011. Because limited or no displacement of nesting raptors has been documented at other sites and the likelihood of significant raptor nesting in the TSWRA is limited, there should be limited to no nesting displacement of raptors. The creation of spatial disturbance avoidance zones, or buffers, surrounding known raptor nests when siting turbines should limit potential displacement impacts, particularly during construction.

Displacement of Non-Raptor Bird Species

Passerines

Studies concerning displacement of non-raptor species have concentrated on grassland passerines and waterfowl/waterbirds (Winkelman 1990, Larsen and Madsen 2000, Mabey and Paul 2007). Wind energy facility construction appears to cause small scale local displacement of grassland passerines and is likely due to the birds avoiding turbine noise and maintenance activities. Construction also fragments the habitat because of the presence of access roads and large gravel pads surrounding turbines (Leddy 1996, Johnson et al. 2000a). Leddy et al. (1999) surveyed bird densities in Conservation Reserve Program grasslands at the Buffalo Ridge wind energy facility in Minnesota and found mean densities of 10 grassland bird species were four times higher at areas located 180 m (591 feet) from turbines than they were at grasslands nearer turbines. Johnson et al. (2000a) found reduced use of habitat by seven of 22 grassland-breeding birds following construction of the Minnesota Buffalo Ridge facility. Shaffer and Johnson (2009) examined displacement of grassland birds at two wind energy facilities in the northern Great Plains. Killdeer (*Charadrius vociferus*), western meadowlark, and chestnut-collared longspur (*Calcarius ornatus*) did not show any avoidance of wind turbines. However, grasshopper sparrow (*Ammodramus savannarum*) and clay-colored sparrow (*Spizella pallida*) showed avoidance out to 200 m (656 ft). Displacement of grassland passerines may be reduced by siting turbines away from grassland or native habitats. Turbines sited within agricultural land, as is commone in the TSWRA, should minimize displacement impacts to passerines.

Prairie Grouse

Ninety-eight sharp-tailed grouse observations were recorded during the study. In 2011, five leks were observed in or near the TSWRA during spring lek surveys (Derby and Thorn 2013). Much debate has occurred recently regarding the potential impacts of wind energy facilities on prairie grouse. Under a set of voluntary guidelines, the USFWS has taken a precautionary approach and recommends wind turbines be placed at least five miles (about eight km) from known prairie grouse lek locations (USFWS 2003). The USFWS argues that because prairie grouse evolved in habitats with little vertical structure, placement of tall man-made structures (e.g., wind

turbines) in occupied prairie grouse habitat may result in a decrease in habitat suitability (USFWS 2004). While the potential exists for wind turbines to displace prairie grouse from occupied habitat, studies examining the extent of this potential impacts are currently lacking.

CONCLUSIONS

The principal objectives of the study were to: 1) provide site-specific bird resource and use data and 2) provide information that could be used in project planning and design of the facility to minimize impacts to birds. Results pertaining to bat surveys are included in a separate report. Baseline surveys were conducted from April 6, 2011, through March 13, 2012.

Two species accounted for 58.2% of the observations: sandhill cranes and horned larks. Two hundred ninety-six individual raptors in 228 groups were recorded within the TSWRA, representing eight species. The northern harrier was the raptor species observed most often (123 individuals), followed by the Swainson's hawk (99). Raptor use was highest in fall (1.12 birds/plot/20-min survey) compared to spring (0.97), summer (0.74), and winter (0.18). Annual raptor use in the TSWRA (0.68 raptors/plot/20-min survey) was compared to annual raptor use at other wind energy facilities. Compared to the other wind energy facilities, raptor use in the TSWRA was low to moderate. Based on the relative abundance of Swainson's hawks throughout the year and a higher exposure index than other raptor species, there is higher potential for Swainson's hawks fatalities compared to other species. It is expected that risk to raptors would be slightly higher during fall.

No federally-listed threatened or endangered species were observed in the TSWRA. The Sprague's pipit, is a candidate species for listing under the Endangered Species Act; three individuals were observed during the study. One bald eagle and six golden eagles were observed; eagles are protected under the Bald and Golden Eagle Protection Act. Several species observed are North Dakota 100 Species of Conservation Priority.

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APPENDICES

Appendix A. Summary of number of bird groups (# grps) and individuals (# obs), regardless of distance from observer, observed during fixed-point use surveys at the Thunder Spirit Wind Resource Area, April 6, 2011 to March 13, 2012.

		Spring		Summer		Fall		Winter		Total	
Bird Type/Subtype/ Species	**Scientific Name**	**# grps**	**# obs**	**# grps**	**# obs**	**# grps**	**# obs**	**# grps**	**# obs**	**# grps**	**# obs**
Waterbirds		**4**	**1,125**	**0**	**0**	**0**	**0**	**0**	**0**	**4**	**1,125**
sandhill crane	*Grus canadensis*	4	1,125	0	0	0	0	0	0	4	1,125
Waterfowl		**50**	**98**	**17**	**34**	**1**	**6**	**6**	**110**	**74**	**248**
American wigeon	*Anas americana*	1	2	1	1	0	0	0	0	2	3
blue-winged teal	*Anas discors*	3	5	2	3	0	0	0	0	5	8
Canada goose	*Branta canadensis*	5	6	0	0	0	0	5	95	10	101
gadwall	*Anas strepera*	2	3	2	2	0	0	0	0	4	5
mallard	*Anas platyrhynchos*	21	51	10	24	0	0	0	0	31	75
northern pintail	*Anas acuta*	14	25	1	1	0	0	1	15	16	41
northern shoveler	*Anas clypeata*	4	6	0	0	0	0	0	0	4	6
unidentified duck		0	0	1	3	1	6	0	0	2	9
Shorebirds		**12**	**16**	**11**	**13**	**0**	**0**	**0**	**0**	**23**	**29**
killdeer	*Charadrius vociferus*	10	13	7	8	0	0	0	0	17	21
marbled godwit	*Limosa fedoa*	1	2	2	3	0	0	0	0	3	5
upland sandpiper	*Bartramia longicauda*	1	1	1	1	0	0	0	0	2	2
willet	*Catoptrophorus semipalmatus*	0	0	1	1	0	0	0	0	1	1
Gulls/Terns		**1**	**14**	**0**	**0**	**0**	**0**	**0**	**0**	**1**	**14**
ring-billed gull	*Larus delawarensis*	1	14	0	0	0	0	0	0	1	14
Raptors		**66**	**76**	**61**	**66**	**81**	**134**	**20**	**20**	**228**	**296**
Buteos		*30*	*33*	*21*	*21*	*48*	*99*	*10*	*10*	*109*	*163*
ferruginous hawk	*Buteo regalis*	0	0	0	0	1	1	0	0	1	1
red-tailed hawk	*Buteo jamaicensis*	8	8	7	7	25	27	2	2	42	44
rough-legged hawk	*Buteo lagopus*	6	6	0	0	5	5	8	8	19	19
Swainson's hawk	*Buteo swainsoni*	16	19	14	14	17	66	0	0	47	99
Northern Harrier		*35*	*42*	*38*	*43*	*31*	*33*	*5*	*5*	*109*	*123*
northern harrier	*Circus cyaneus*	35	42	38	43	31	33	5	5	109	123
Eagles		*1*	*1*	*1*	*1*	*1*	*1*	*3*	*3*	*6*	*6*
bald eagle	*Haliaeetus leucocephalus*	0	0	0	0	0	0	1	1	1	1
golden eagle	*Aquila chrysaetos*	1	1	1	1	1	1	2	2	5	5
Falcons		*0*	*0*	*0*	*0*	*1*	*1*	*0*	*0*	*1*	*1*
American kestrel	*Falco sparverius*	0	0	0	0	1	1	0	0	1	1
Other Raptors		*0*	*0*	*1*	*1*	*0*	*0*	*2*	*2*	*3*	*3*
unidentified hawk		0	0	1	1	0	0	2	2	3	3

Appendix A. Summary of number of bird groups (# grps) and individuals (# obs), regardless of distance from observer, observed during fixed-point use surveys at the Thunder Spirit Wind Resource Area, April 6, 2011 to March 13, 2012.

		Spring		Summer		Fall		Winter		Total	
Bird Type/Subtype/ Species	**Scientific Name**	**# grps**	**# obs**	**# grps**	**# obs**	**# grps**	**# obs**	**# grps**	**# obs**	**# grps**	**# obs**
Owls		**1**	**1**	**1**	**2**	**0**	**0**	**1**	**1**	**3**	**4**
short-eared owl	*Asio flammeus*	1	1	1	2	0	0	0	0	2	3
snowy owl	*Bubo scandiacus*	0	0	0	0	0	0	1	1	1	1
Upland Game Birds		**0**	**0**	**10**	**10**	**4**	**6**	**21**	**38**	**35**	**54**
ring-necked pheasant	*Phasianus colchicus*	0	0	10	10	0	0	19	34	29	44
sharp-tailed grouse	*Tympanuchus phasianellus*	0	0	0	0	4	6	2	4	6	10
Doves/Pigeons		**5**	**10**	**25**	**77**	**13**	**25**	**4**	**37**	**47**	**149**
mourning dove	*Zenaida macroura*	4	7	23	35	10	12	0	0	37	54
rock pigeon	*Columba livia*	1	3	2	42	3	13	4	37	10	95
Large Corvids		**4**	**30**	**3**	**3**	**0**	**0**	**0**	**0**	**7**	**33**
American crow	*Corvus brachyrhynchos*	4	30	3	3	0	0	0	0	7	33
Passerines[a]		**136**	**222**	**252**	**400**	**71**	**396**	**57**	**706**	**516**	**1,724**
American goldfinch	*Carduelis tristis*	0	0	3	5	0	0	0	0	3	5
American robin	*Turdus migratorius*	2	2	3	4	0	0	0	0	5	6
American tree sparrow	*Spizella arborea*	0	0	0	0	0	0	1	12	1	12
barn swallow	*Hirundo rustica*	5	7	11	20	3	7	0	0	19	34
blue jay	*Cyanocitta cristata*	0	0	1	1	0	0	0	0	1	1
bobolink	*Dolichonyx oryzivorus*	3	5	18	23	0	0	0	0	21	28
Brewer's blackbird	*Euphagus cyanocephalus*	2	19	1	1	0	0	0	0	3	20
brown-headed cowbird	*Molothrus ater*	3	5	7	11	0	0	0	0	10	16
brown thrasher	*Toxostoma rufum*	0	0	1	1	0	0	0	0	1	1
chestnut-collared longspur	*Calcarius ornatus*	5	7	5	8	0	0	0	0	10	15
chipping sparrow	*Spizella passerina*	1	1	2	3	0	0	0	0	3	4
clay-colored sparrow	*Spizella pallida*	4	4	3	3	0	0	0	0	7	7
common grackle	*Quiscalus quiscula*	2	3	6	11	1	1	0	0	9	15
dark-eyed junco	*Junco hyemalis*	1	1	0	0	0	0	0	0	1	1
eastern kingbird	*Tyrannus tyrannus*	2	2	11	17	1	2	0	0	14	21
eastern phoebe	*Sayornis phoebe*	1	1	0	0	0	0	0	0	1	1
grasshopper sparrow	*Ammodramus savannarum*	6	6	8	9	0	0	0	0	14	15
hermit thrush	*Catharus guttatus*	1	1	0	0	0	0	0	0	1	1
horned lark	*Eremophila alpestris*	16	30	13	19	23	288	39	507	91	844
house wren	*Troglodytes aedon*	0	0	1	1	0	0	0	0	1	1
lark bunting	*Calamospiza melanocorys*	2	6	29	81	1	1	0	0	32	88
lark sparrow	*Chondestes grammacus*	1	1	3	3	0	0	0	0	4	4
least flycatcher	*Empidonax minimus*	1	1	0	0	0	0	0	0	1	1
Lincoln's sparrow	*Melospiza lincolnii*	0	0	1	1	0	0	0	0	1	1

Appendix A. Summary of number of bird groups (# grps) and individuals (# obs), regardless of distance from observer, observed during fixed-point use surveys at the Thunder Spirit Wind Resource Area, April 6, 2011 to March 13, 2012.

		Spring		Summer		Fall		Winter		Total	
Bird Type/Subtype/ Species	**Scientific Name**	**# grps**	**# obs**	**# grps**	**# obs**	**# grps**	**# obs**	**# grps**	**# obs**	**# grps**	**# obs**
loggerhead shrike	*Lanius ludovicianus*	3	3	5	6	0	0	0	0	8	9
orchard oriole	*Icterus spurius*	1	1	0	0	0	0	0	0	1	1
pine siskin	*Carduelis pinus*	0	0	0	0	0	0	1	30	1	30
red-winged blackbird	*Agelaius phoeniceus*	13	19	36	56	0	0	0	0	49	75
savannah sparrow	*Passerculus sandwichensis*	5	5	6	7	0	0	0	0	11	12
snow bunting	*Plectrophenax nivalis*	0	0	0	0	0	0	1	20	1	20
Sprague's pipit	*Anthus spragueii*	1	1	0	0	0	0	0	0	1	1
tree swallow	*Tachycineta bicolor*	5	11	2	3	1	3	0	0	8	17
unidentified passerine		0	0	0	0	0	0	7	104	7	104
unidentified sparrow		0	0	1	1	11	45	1	25	13	71
vesper sparrow	*Pooecetes gramineus*	6	10	6	7	5	11	0	0	17	28
western kingbird	*Tyrannus verticalis*	2	2	19	43	1	1	0	0	22	46
western meadowlark	*Sturnella neglecta*	41	48	48	53	24	37	7	8	120	146
white-crowned sparrow	*Zonotrichia leucophrys*	1	20	0	0	0	0	0	0	1	20
yellow warbler	*Dendroica petechia*	0	0	2	2	0	0	0	0	2	2
Goatsuckers		**0**	**0**	**0**	**0**	**1**	**1**	**0**	**0**	**1**	**1**
common nighthawk	*Chordeiles minor*	0	0	0	0	1	1	0	0	1	1
Woodpeckers		**2**	**2**	**2**	**3**	**0**	**0**	**0**	**0**	**4**	**5**
northern flicker	*Colaptes auratus*	1	1	1	1	0	0	0	0	2	2
red-headed woodpecker	*Melanerpes erythrocephalus*	1	1	1	2	0	0	0	0	2	3
Total		**281**	**1,594**	**382**	**608**	**171**	**568**	**109**	**912**	**943**	**3,682**

[a] excluding large corvids

Appendix B-1. Mean bird use (number of birds/plot[a]/20-min survey), percent of total use (%), and frequency of occurrence (%) for large birds by season during fixed-point bird use surveys at the Thunder Spirit Wind Resource Area from April 6, 2011 to March 13, 2012.

	Bird Use				% of Use				% Frequency			
Bird Type/Subtype/Species	**Spring**	**Summer**	**Fall**	**Winter**	**Spring**	**Summer**	**Fall**	**Winter**	**Spring**	**Summer**	**Fall**	**Winter**
Waterbirds	**14.80**	**0**	**0**	**0**	**82.6**	**0**	**0**	**0**	**5.3**	**0**	**0**	**0**
sandhill crane	14.80	0	0	0	82.6	0	0	0	5.3	0	0	0
Waterfowl	**1.24**	**0.39**	**0.05**	**0.96**	**6.9**	**17.3**	**3.5**	**53.6**	**35.6**	**18.5**	**0.8**	**3.5**
American wigeon	0.02	0.01	0	0	0.1	0.4	0	0	1.2	1	0	0
blue-winged teal	0.06	0.03	0	0	0.3	1.4	0	0	3.8	2.2	0	0
Canada goose	0.08	0	0	0.83	0.4	0	0	46.3	6.4	0	0	2.6
gadwall	0.04	0.02	0	0	0.2	1.1	0	0	2.6	2.5	0	0
mallard	0.65	0.28	0	0	3.6	12.1	0	0	24.2	11.2	0	0
northern pintail	0.32	0.01	0	0.13	1.8	0.6	0	7.3	17.8	1.2	0	0.9
northern shoveler	0.08	0	0	0	0.4	0	0	0	5	0	0	0
unidentified duck	0	0.04	0.05	0	0	1.7	3.5	0	0	1.2	0.8	0
Shorebirds	**0.20**	**0.15**	**0**	**0**	**1.1**	**6.5**	**0**	**0**	**15.1**	**10.2**	**0**	**0**
killdeer	0.17	0.10	0	0	0.9	4.2	0	0	12.7	8.2	0	0
marbled godwit	0.02	0.03	0	0	0.1	1.4	0	0	1.2	2.2	0	0
upland sandpiper	0.01	0.01	0	0	<0.1	0.4	0	0	1.2	1	0	0
willet	0	0.01	0	0	0	0.4	0	0	0	1	0	0
Gulls/Terns	**0.18**	**0**	**0**	**0**	**1.0**	**0**	**0**	**0**	**1.3**	**0**	**0**	**0**
ring-billed gull	0.18	0	0	0	1.0	0	0	0	1.3	0	0	0
Raptors	**0.97**	**0.74**	**1.12**	**0.18**	**5.4**	**32.5**	**77.9**	**9.9**	**54.7**	**45.2**	**51.7**	**17.6**
Buteos	*0.42*	*0.24*	*0.82*	*0.09*	*2.3*	*10.4*	*57.6*	*5*	*32.9*	*19.2*	*34.2*	*9*
ferruginous hawk	0	0	<0.01	0	0	0	0.6	0	0	0	0.8	0
red-tailed hawk	0.10	0.08	0.22	0.02	0.6	3.5	15.7	0.9	9.1	8	20	1.7
rough-legged hawk	0.08	0	0.04	0.07	0.4	0	2.9	4.1	7.8	0	4.2	7.3
Swainson's hawk	0.24	0.16	0.55	0	1.3	6.8	38.4	0	18.6	14.5	12.5	0
Northern Harrier	*0.54*	*0.48*	*0.28*	*0.04*	*3.0*	*21.1*	*19.2*	*2.4*	*35.8*	*33.5*	*25.8*	*4.3*
northern harrier	0.54	0.48	0.28	0.04	3.0	21.1	19.2	2.4	35.8	33.5	25.8	4.3
Eagles	*0.01*	*0.01*	*<0.01*	*0.03*	*<0.1*	*0.4*	*0.6*	*1.5*	*1.3*	*1*	*0.8*	*2.6*
bald eagle	0	0	0	<0.01	0	0	0	0.5	0	0	0	0.9
golden eagle	0.01	0.01	<0.01	0.02	<0.1	0.4	0.6	1	1.3	1	0.8	1.8
Falcons	*0*	*0*	*<0.01*	*0*	*0*	*0*	*0.6*	*0*	*0*	*0*	*0.8*	*0*
American kestrel	0	0	<0.01	0	0	0	0.6	0	0	0	0.8	0
Other Raptors	*0*	*0.01*	*0*	*0.02*	*0*	*0.6*	*0*	*0.9*	*0*	*1.2*	*0*	*1.7*
unidentified hawk	0	0.01	0	0.02	0	0.6	0	0.9	0	1.2	0	1.7

Appendix B-1. Mean bird use (number of birds/plot[a]/20-min survey), percent of total use (%), and frequency of occurrence (%) for large birds by season during fixed-point bird use surveys at the Thunder Spirit Wind Resource Area from April 6, 2011 to March 13, 2012.

	Bird Use				% of Use				% Frequency			
Bird Type/Subtype/Species	**Spring**	**Summer**	**Fall**	**Winter**	**Spring**	**Summer**	**Fall**	**Winter**	**Spring**	**Summer**	**Fall**	**Winter**
Owls	**0.01**	**0.02**	**0**	**<0.01**	**<0.1**	**1.1**	**0**	**0.5**	**1.2**	**1.2**	**0**	**0.8**
short-eared owl	0.01	0.02	0	0	<0.1	1.1	0	0	1.2	1.2	0	0
snowy owl	0	0	0	<0.01	0	0	0	0.5	0	0	0	0.8
Upland Game Birds	**0**	**0.12**	**0.05**	**0.34**	**0**	**5.1**	**3.5**	**18.8**	**0**	**11.5**	**2.5**	**11.5**
ring-necked pheasant	0	0.12	0	0.30	0	5.1	0	16.8	0	11.5	0	11.5
sharp-tailed grouse	0	0	0.05	0.03	0	0	3.5	1.9	0	0	2.5	1.7
Doves/Pigeons	**0.13**	**0.82**	**0.21**	**0.31**	**0.7**	**36.1**	**14.5**	**17.3**	**6.3**	**22.2**	**10.8**	**2.5**
mourning dove	0.09	0.40	0.10	0	0.5	17.6	7	0	5	21.2	8.3	0
rock pigeon	0.04	0.42	0.11	0.31	0.2	18.5	7.6	17.3	1.2	2	2.5	2.5
Large Corvids	**0.39**	**0.03**	**0**	**0**	**2.2**	**1.4**	**0**	**0**	**5.1**	**3.2**	**0**	**0**
American crow	0.39	0.03	0	0	2.2	1.4	0	0	5.1	3.2	0	0
Goatsuckers	**0**	**0**	**<0.01**	**0**	**0**	**0**	**0.6**	**0**	**0**	**0**	**0.8**	**0**
common nighthawk	0	0	<0.01	0	0	0	0.6	0	0	0	0.8	0
Overall	**17.93**	**2.27**	**1.43**	**1.78**	**100**	**100**	**100**	**100**				

[a.] 800-meter radius for large birds

Appendix B-2. Mean bird use (number of birds/plot[a]/20-min survey), percent of total use (%), and frequency of occurrence (%) for small birds by season during fixed-point bird use surveys at the Thunder Spirit Wind Resource Area from April 6, 2011 to March 13, 2012.

	Bird Use				% of Use				% Frequency			
Type/Species	**Spring**	**Summer**	**Fall**	**Winter**	**Spring**	**Summer**	**Fall**	**Winter**	**Spring**	**Summer**	**Fall**	**Winter**
Passerines[b]	**2.81**	**4.48**	**3.30**	**5.99**	**99.1**	**99.8**	**100**	**100**	**78.2**	**90.8**	**51.7**	**30.9**
American goldfinch	0	0.06	0	0	0	1.3	0	0	0	3.5	0	0
American robin	0.03	0.04	0	0	0.9	1	0	0	2.6	3.5	0	0
American tree sparrow	0	0	0	0.10	0	0	0	1.7	0	0	0	0.8
barn swallow	0.09	0.23	0.06	0	3.1	5.2	1.8	0	6.3	13.0	2.5	0
blue jay	0	0.01	0	0	0	0.2	0	0	0	1.0	0	0
bobolink	0.07	0.26	0	0	2.3	5.9	0	0	3.9	19.5	0	0
Brewer's blackbird	0.23	0.01	0	0	8.0	0.3	0	0	1.2	1.2	0	0
brown-headed cowbird	0.07	0.13	0	0	2.3	2.8	0	0	3.9	8.0	0	0
brown thrasher	0	0.01	0	0	0	0.3	0	0	0	1.2	0	0
chestnut-collared longspur	0.09	0.09	0	0	3.1	2	0	0	6.3	5.5	0	0
chipping sparrow	0.01	0.04	0	0	0.4	0.8	0	0	1.2	2.5	0	0
clay-colored sparrow	0.05	0.03	0	0	1.8	0.7	0	0	5.1	3.2	0	0
common grackle	0.04	0.13	<0.01	0	1.3	2.9	0.3	0	2.4	5.8	0.8	0
dark-eyed junco	0.01	0	0	0	0.4	0	0	0	1.2	0	0	0
eastern kingbird	0.03	0.18	0.02	0	0.9	4.0	0.5	0	2.6	11.0	0.8	0
eastern phoebe	0.01	0	0	0	0.5	0	0	0	1.3	0	0	0
grasshopper sparrow	0.07	0.11	0	0	2.5	2.4	0	0	7.1	9.8	0	0
hermit thrush	0.01	0	0	0	0.5	0	0	0	1.3	0	0	0
horned lark	0.39	0.21	2.40	4.53	13.6	4.6	72.7	75.7	20.3	13.2	18.3	20.7
house wren	0	0.01	0	0	0	0.2	0	0	0	1.0	0	0
lark bunting	0.08	0.95	<0.01	0	2.8	21.1	0.3	0	2.6	24.2	0.8	0
lark sparrow	0.01	0.04	0	0	0.5	0.8	0	0	1.3	3.8	0	0
least flycatcher	0.01	0	0	0	0.5	0	0	0	1.3	0	0	0
Lincoln's sparrow	0	0.01	0	0	0	0.3	0	0	0	1.2	0	0
loggerhead shrike	0.04	0.07	0	0	1.4	1.5	0	0	3.9	4.8	0	0
orchard oriole	0.01	0	0	0	0.5	0	0	0	1.3	0	0	0
pine siskin	0	0	0	0.25	0	0	0	4.2	0	0	0	0.8
red-winged blackbird	0.24	0.58	0	0	8.6	13.0	0	0	16.7	28.8	0	0
savannah sparrow	0.06	0.08	0	0	2.3	1.8	0	0	6.5	6.8	0	0
snow bunting	0	0	0	0.17	0	0	0	2.8	0	0	0	0.8
Sprague's pipit	0.01	0	0	0	0.4	0	0	0	1.2	0	0	0
tree swallow	0.14	0.04	0.02	0	5.0	0.8	0.8	0	6.4	2.5	0.8	0
unidentified passerine	0	0	0	0.87	0	0	0	14.5	0	0	0	5.8

Appendix B-2. Mean bird use (number of birds/plot[a]/20-min survey), percent of total use (%), and frequency of occurrence (%) for small birds by season during fixed-point bird use surveys at the Thunder Spirit Wind Resource Area from April 6, 2011 to March 13, 2012.

	Bird Use				% of Use				% Frequency			
Type/Species	**Spring**	**Summer**	**Fall**	**Winter**	**Spring**	**Summer**	**Fall**	**Winter**	**Spring**	**Summer**	**Fall**	**Winter**
unidentified sparrow	0	0.01	0.38	0	0	0.2	11.4	0	0	1.0	9.2	0
vesper sparrow	0.12	0.08	0.09	0	4.3	1.7	2.8	0	7.4	6.5	4.2	0
western kingbird	0.02	0.44	<0.01	0	0.8	9.9	0.3	0	2.4	18	0.8	0
western meadowlark	0.60	0.60	0.31	0.07	21.1	13.4	9.3	1.2	51.5	48.5	20	5.2
white-crowned sparrow	0.26	0	0	0	9.3	0	0	0	1.3	0	0	0
yellow warbler	0	0.02	0	0	0	0.6	0	0	0	2.5	0	0
Woodpeckers	**0.03**	**0.01**	**0**	**0**	**0.9**	**0.2**	**0**	**0**	**1.3**	**1.0**	**0**	**0**
northern flicker	0.01	0.01	0	0	0.5	0.2	0	0	1.3	1.0	0	0
red-headed woodpecker	0.01	0	0	0	0.5	0	0	0	1.3	0	0	0
Overall	**2.84**	**4.49**	**3.30**	**5.99**	**100**	**100**	**100**	**100**				

[a] 100-meter (m) radius plot for small birds;
[b] excluding large corvids

Appendix C-1. Relative collision risk exposure index, mean bird use (birds/plot/20-min survey), and flight characteristics for large birds observed during fixed-point bird use surveys at the Thunder Spirit Wind Resource Area April 6, 2011 to March 13, 2012. Large bird observations were limited to within 800 meters of observer.

Species	Number of Groups Flying	Bird Use	% Flying	% Flying Within RSH[a] Based on Initial Observation	Exposure Index	% Within RSH at Any Time
sandhill crane	4	3.16	100	95.6	3.02	95.6
Canada goose	6	0.29	95.0	100	0.27	100
Swainson's hawk	37	0.20	77.8	94.8	0.15	97.4
rock pigeon	9	0.24	68.4	41.5	0.07	56.9
northern pintail	13	0.11	85.4	57.1	0.06	60.0
mallard	22	0.21	58.7	38.6	0.05	56.8
red-tailed hawk	29	0.09	70.5	64.5	0.04	90.3
American crow	3	0.09	87.9	51.7	0.04	51.7
northern harrier	103	0.31	93.5	13.0	0.04	21.7
rough-legged hawk	15	0.05	78.9	80.0	0.03	86.7
unidentified duck	2	0.02	100	100	0.02	100
golden eagle	5	0.01	100	60.0	<0.01	80.0
killdeer	14	0.06	85.7	11.1	<0.01	11.1
marbled godwit	2	0.01	60.0	66.7	<0.01	66.7
gadwall	3	0.01	80.0	25.0	<0.01	25.0
unidentified hawk	2	<0.01	66.7	50.0	<0.01	50.0
mourning dove	18	0.14	50.0	0	0	0
ring-necked pheasant	7	0.13	36.4	0	0	0
ring-billed gull	1	0.04	100	0	0	100
sharp-tailed grouse	3	0.02	60.0	0	0	0
blue-winged teal	2	0.02	37.5	0	0	0
northern shoveler	2	0.02	50.0	0	0	0
short-eared owl	1	<0.01	66.7	0	0	0
American wigeon	0	<0.01	0	0	0	0
upland sandpiper	1	<0.01	50.0	0	0	0
bald eagle	0	<0.01	0	0	0	0
snowy owl	0	<0.01	0	0	0	0
willet	1	<0.01	100	0	0	0
ferruginous hawk	0	<0.01	0	0	0	0
common nighthawk	1	<0.01	100	0	0	0
American kestrel	0	<0.01	0	0	0	0

[a] RSH: the likely “rotor swept height” for potential collision with a turbine blade, or 25 to150 meters (82 to 492 feet) above ground level

Appendix C-2. Relative collision risk exposure index, mean bird use (birds/plot/20-min survey), and flight characteristics for small birds observed during fixed-point bird use surveys at the Thunder Spirit Wind Resource Area from April 6, 2011 to March 13, 2012. Small bird observations were limited to within 100 meters of observer.

Species	Number of Groups Flying	Bird Use	% Flying	% Flying Within RSH[a] Based on Initial Observation	Exposure Index	% Within RSH at Any Time
unidentified passerine	6	0.28	99	44.7	0.12	59.2
snow bunting	1	0.05	100	100	0.05	100
horned lark	70	2.11	95.7	0.8	0.02	7.1
common grackle	8	0.04	93.3	7.1	<0.01	7.1
western meadowlark	41	0.37	36.3	0	0	0
lark bunting	20	0.26	54.1	0	0	0
red-winged blackbird	31	0.2	65.3	0	0	0
western kingbird	18	0.12	56.5	0	0	0
barn swallow	19	0.09	100	0	0	0
pine siskin	1	0.08	100	0	0	0
bobolink	11	0.08	57.1	0	0	0
unidentified sparrow	11	0.08	97.8	0	0	0
vesper sparrow	8	0.06	64.3	0	0	0
white-crowned sparrow	1	0.06	100	0	0	0
eastern kingbird	6	0.05	33.3	0	0	0
Brewer's blackbird	3	0.05	100	0	0	0
brown-headed cowbird	3	0.05	18.8	0	0	0
tree swallow	8	0.05	100	0	0	0
grasshopper sparrow	2	0.04	13.3	0	0	0
chestnut-collared longspur	9	0.04	86.7	0	0	0
savannah sparrow	5	0.03	50	0	0	0
American tree sparrow	1	0.03	100	0	0	0
loggerhead shrike	4	0.03	44.4	0	0	0
clay-colored sparrow	3	0.02	42.9	0	0	0
American robin	2	0.02	50	0	0	0
American goldfinch	1	0.02	60	0	0	0
lark sparrow	1	0.01	25	0	0	0
chipping sparrow	0	0.01	0	0	0	0
yellow warbler	1	<0.01	50	0	0	0
northern flicker	1	<0.01	50	0	0	0
Lincoln's sparrow	0	<0.01	0	0	0	0
brown thrasher	1	<0.01	100	0	0	0
red-headed woodpecker	0	<0.01	0	0	0	0
orchard oriole	1	<0.01	100	0	0	0
least flycatcher	0	<0.01	0	0	0	0
hermit thrush	1	<0.01	100	0	0	0
eastern phoebe	0	<0.01	0	0	0	0
dark-eyed junco	1	<0.01	100	0	0	0
Sprague's pipit	0	<0.01	0	0	0	0
house wren	0	<0.01	0	0	0	0
blue jay	0	<0.01	0	0	0	0

[a] RSH: the likely “rotor swept height” for potential collision with a turbine blade, or 25 to150 meters (82 to 492 feet) above ground level

Appendix D. Mean use (birds/20-minute survey) by survey point for all birds[a], major bird types, and raptor subtypes observed during fixed-point bird use surveys at the Thunder Spirit Wind Resource Area from April 6, 2011 to March 13, 2012.

Bird Type / Subtype	Survey Point																								
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**16**	**17**	**18**	**19**	**20**	**21**	**22**	**23**	**24**	**25**
Waterbirds	0	0	0	31.25	0	0	0	2.78	0	0	0	0	0	0	0	0	0	29.41	0	4.17	0	0	0	0	0
Waterfowl	0.39	0.12	0.86	0.12	0.06	1.50	1.06	0.28	0	0.18	0.41	0.50	0.67	0.67	0.28	0	0.12	0.41	0	0.11	0	3.53	1.00	1.47	1.31
Shorebirds	0	0	0.21	0	0.11	0.28	0.11	0	0	0.24	0	0	0.11	0.33	0.06	0.12	0	0	0	0	0.08	0.06	0	0	0
Gulls/ Terns	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.82	0	0	0
Raptors	0.50	0.75	0.50	0.75	0.39	0.50	0.72	0.22	1.20	0.41	0.76	1.17	0.83	0.56	0.78	1.06	1.47	0.59	0.50	0.44	2.77	0.06	0.22	0.53	2.08
Buteos	*0.28*	*0.25*	*0.21*	*0.38*	*0.22*	*0.33*	*0.44*	*0.06*	*0.20*	*0.35*	*0.29*	*0.50*	*0.39*	*0.33*	*0.33*	*0.47*	*0.47*	*0.18*	*0.14*	*0.28*	*2.46*	*0*	*0.22*	*0.27*	*1.77*
Northern Harrier	*0.22*	*0.44*	*0.29*	*0.38*	*0.11*	*0.17*	*0.28*	*0.17*	*0.80*	*0.06*	*0.35*	*0.67*	*0.39*	*0.11*	*0.44*	*0.59*	*1.00*	*0.41*	*0.29*	*0.17*	*0.23*	*0.06*	*0*	*0.27*	*0.31*
Eagles	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0.20*	*0*	*0.06*	*0*	*0.06*	*0.11*	*0*	*0*	*0*	*0*	*0.07*	*0*	*0*	*0*	*0*	*0*	*0*
Falcons	*0*	*0*	*0*	*0*	*0.06*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*
Other Raptors	*0*	*0.06*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0.06*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0.08*	*0*	*0*	*0*	*0*
Owls	0	0.06	0	0	0	0	0	0	0	0	0	0	0.06	0	0	0	0	0.12	0	0	0	0	0	0	0
Upland Game Birds	0.06	0	0.21	0.25	0.72	0	0.28	0.11	0.60	0	0.06	0	0.06	0	0.06	0.35	0.06	0	0	0	0.08	0.18	0.11	0.33	0.15
Doves/ Pigeons	0.06	0	1.14	0	1.56	1.83	0.17	0	0.20	0.24	0.12	0.33	0	0.06	0.17	0	0	0.12	0	2.11	0.08	0.12	0.56	0	0
Large Corvids	0.06	0	0.07	0	0.06	0	0	0	0	0	0.06	0	0	0	0	0.24	0	0	0	0.56	0	0	0.83	0	0
Goat-suckers	0	0	0.07	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
All Large Birds	**1.06**	**0.94**	**3.07**	**32.38**	**2.89**	**4.11**	**2.33**	**3.39**	**2.00**	**1.06**	**1.41**	**2.00**	**1.72**	**1.61**	**1.33**	**1.76**	**1.65**	**30.65**	**0.50**	**7.39**	**3.00**	**4.76**	**2.72**	**2.33**	**3.54**
Passerines	3.56	4.62	7.57	1.06	2.06	4.28	4.67	4.44	2.00	1.94	2.47	1.00	4.83	5.17	2.61	3.06	0.71	0.71	22.43	3.56	6.69	2.00	3.17	1.80	11.31
Wood-peckers	0	0	0	0	0.17	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
All Small Birds	**3.56**	**4.62**	**7.57**	**1.06**	**2.22**	**4.28**	**4.67**	**4.44**	**2.00**	**1.94**	**2.47**	**1.00**	**4.83**	**5.17**	**2.61**	**3.06**	**0.71**	**0.71**	**22.43**	**3.56**	**6.69**	**2.00**	**3.17**	**1.80**	**11.31**

[a] 800-meter radius for large birds and100-meter for small birds

Appendix E. Bird fatality estimates (bird fatalities/megawatt/year) and characteristics for wind energy facilities in North America, grouped by geographic region.

Wind Energy Facility	Fatality Estimate	Number of Turbines	Total Megawatts
Midwest			
Wessington Springs, SD	8.25	34	51
Blue Sky Green Field, WI	7.17	88	145
Cedar Ridge, WI (2009)	6.55	41	67.6
Buffalo Ridge, MN (Phase III; 1999)	5.93	138	103.5
Moraine II, MN	5.59	33	49.5
Barton I & II, IA	5.50	80	160
Buffalo Ridge I, SD (2010)	5.06	24	50.4
Buffalo Ridge, MN (Phase I; 1996)	4.14	73	25
Winnebago, IA	3.88	10	20
Rugby, ND	3.82	71	149
Cedar Ridge, WI (2010)	3.72	41	68
Buffalo Ridge, MN (Phase II; 1999)	3.57	143	107.25
Buffalo Ridge, MN (Phase I; 1998)	3.14	73	25
Ripley, Ont (2008)	3.09	38	76
Buffalo Ridge, MN (Phase I; 1997)	2.51	73	25
Buffalo Ridge, MN (Phase II; 1998)	2.47	143	107.25
Kewaunee County, WI	1.95	31	20.46
NPPD Ainsworth, NE	1.63	36	20.5
Elm Creek, MN	1.55	67	100
PrairieWinds ND1 (Minot), ND	1.48	80	115.5
Buffalo Ridge, MN (Phase I; 1999)	1.43	73	25
Top of Iowa, IA (2004)	0.81	89	80
Grand Ridge, IL	0.48	66	99
Top of Iowa, IA (2003)	0.42	89	80
Rocky Mountains			
Foote Creek Rim, WY (Phase I; 1999)	3.4	69	41.4
Foote Creek Rim, WY (Phase I; 2000)	2.42	69	41.4
Foote Creek Rim, WY (Phase I; 2001-2002)	1.93	69	41.4
Summerview, Alb (2006)	1.06	39	70.2
Southern Plains			
Buffalo Gap I, TX	1.32	67	134
Barton Chapel, TX	1.15	60	120
Buffalo Gap II, TX	0.15	155	233

Appendix E. Bird fatality estimates (bird fatalities/megawatt/year) and characteristics for wind energy facilities in North America, grouped by geographic region.

Wind Energy Facility	Fatality Estimate	Number of Turbines	Total Megawatts
Northeast			
Mount Storm, WV (2009)	5.73	132	264
Maple Ridge, NY (2007)	3.44	195	321.75
Lempster, NH (2009)	3.38	12	24
Casselman, PA (Spring & Fall 2008)	3.13	23	34.5
Noble Bliss, NY (2008)	2.86	67	100
Mountaineer, WV (2003)	2.69	44	66
Stetson Mountain, ME (2009)	2.68	38	57
Noble Ellenburg, NY (2009)	2.66	54	80
Lempster, NH (2010)	2.64	12	24
Mount Storm, WV (2010)	2.6	132	264
Noble Bliss, NY (2009)	2.28	67	100
Noble Clinton, NY (2008)	2.17	67	100
Maple Ridge, NY (2008)	2.07	195	321.75
Noble Altona, NY	1.84	65	97.5
Mars Hill, ME (2008)	1.76	28	42
Noble Wethersfield, NY	1.7	84	126
Mars Hill, ME (2007)	1.67	28	42
Noble Chateaugay, NY	1.66	71	106.5
Munnsville, NY (2008)	1.48	23	34.5
Noble Ellenburg, NY (2008)	1.4	54	80
Cohocton/Dutch Hill, NY (2009)	1.39	50	125
Cohocton/Dutch Hills, NY (2010)	1.32	50	125
Noble Clinton, NY (2009)	1.11	67	100
Southeast			
Buffalo Mountain, TN (2000-2003)	11.02	3	1.98
Buffalo Mountain, TN (2005)	1.1	18	28.98
Southwest			
Dry Lake I, AZ	2.22	30	63
California			
Pine Tree, CA	8.3	90	135
Shiloh I, CA	6.96	100	150
Dillon, CA	4.71	45	45
Diablo Winds, CA	4.29	31	20.46
High Winds, CA (2004)	1.62	90	162
High Winds, CA (2005)	1.1	90	162
Alite, CA	0.55	8	24

Appendix E. Bird fatality estimates (bird fatalities/megawatt/year) and characteristics for wind energy facilities in North America, grouped by geographic region.

Wind Energy Facility	Fatality Estimate	Number of Turbines	Total Megawatts
Pacific Northwest			
Leaning Juniper, OR	6.66	67	100.5
Biglow Canyon, OR (Phase II; 2009/2010)	5.53	65	150
Tuolumne (Windy Point I), WA	3.2	62	136.6
Stateline, OR/WA (2002)	3.17	454	263
Klondike II, OR	3.14	50	75
Klondike III (Phase I), OR	3.02	125	223.6
Hopkins Ridge, WA (2008)	2.99	87	156.6
Klondike IIIa (Phase II), OR	2.8	51	76.5
Nine Canyon, WA	2.76	37	48.1
Stateline, OR/WA (2003)	2.68	454	263
Combine Hills, OR	2.56	41	41
Big Horn, WA	2.54	133	199.5
Biglow Canyon, OR (Phase I; 2009)	2.47	76	125.4
Hay Canyon, OR	2.21	48	100.8
Elkhorn, OR (2010)	1.95	61	101
Pebble Springs, OR	1.93	47	98.7
Biglow Canyon, OR (Phase I; 2008)	1.76	76	125.4
Wild Horse, WA	1.55	127	229
Goodnoe, WA	1.4	47	94
Hopkins Ridge, WA (2006)	1.23	83	150
Stateline, OR/WA (2006)	1.23	454	263
Klondike, OR	0.95	16	24
Vansycle, OR	0.95	38	24.9
Elkhorn, OR (2008)	0.64	61	101
Marengo I, WA (2009)	0.27	78	140.4
Marengo II, WA (2009)	0.16	39	70.2

Appendix E. Bird fatality estimates (bird fatalities/megawatt/year) and characteristics for wind energy facilities in North America.

Data from the following sources:

Wind Energy Facility	Fatality Estimate	Wind Energy Facility	Fatality Estimate
Alite, CA	Chatfield et al. 2010b	Klondike III, OR	Gritski et al. 2010
Barton I&II, IA	Derby et al. 2011a	Klondike IIIa, OR	Gritski et al. 2011
Barton Chapel, TX	WEST 2011	Leaning Juniper, OR	Kronneret al. 2007
Big Horn, WA	Kronner et al. 2008	Lempster, NH (2009)	Tidhar et al. 2010
Biglow Canyon, OR (Phase I; 08)	Jeffrey et al. 2009b	Lempster, NH (2010)	Tidhar et al. 2011
Biglow Canyon, OR (Phase I; 09)	Enk et al. 2010	Maple Ridge, NY (07)	Jain et al. 2009a
Biglow Canyon, OR (Phase II; 09-10)	Enk et al. 2011b	Maple Ridge, NY (08)	Jain et al. 2009b
Blue Sky Green Field, WI	Gruver et al. 2009	Marengo I, WA (09)	URS Corporation 2010b
Buffalo Gap I, TX	Tierney 2007	Marengo II, WA (09)	URS Corporation 2010c
Buffalo Gap II, TX	Tierney 2009	Mars Hill, ME (07)	Stantec 2008
Buffalo Mountain, TN (00-03)	Nicholson et al. 2005	Mars Hill, ME (08)	Stantec 2009a
Buffalo Mountain, TN (05)	Fiedler et al. 2007	Moraine II, MN	Derby et al. 2010e
Buffalo Ridge, MN (Phase I; 96)	Johnson et al. 2000a	Mount Storm, WV (09)	Young et al. 2009a, 2010b
Buffalo Ridge, MN (Phase I; 97)	Johnson et al. 2000a	Mount Storm, WV (10)	Young et al. 2010a, 2011
Buffalo Ridge, MN (Phase I; 98)	Johnson et al. 2000a	Mountaineer, WV	Kerns and Kerlinger 2004
Buffalo Ridge, MN (Phase I; 99)	Johnson et al. 2000a	Munnsville, NY (08)	Stantec 2009b
Buffalo Ridge, MN (Phase II; 98)	Johnson et al. 2000a	Nine Canyon, WA	Erickson et al. 2003a
Buffalo Ridge, MN (Phase II; 99)	Johnson et al. 2000a	Noble Altona, NY	Jain et al. 2011a
Buffalo Ridge, MN (Phase III; 99)	Johnson et al. 2000a	Noble Bliss, NY (08)	Jain et al. 2009c
Buffalo Ridge I, SD (10)	Derby et al. 2010c	Noble Bliss, NY (09)	Jain et al. 2010c
Casselman, PA (Spring & Fall 08)	Arnett et al. 2009	Noble Chateaugay, NY	Jain et al. 2011b
Cedar Ridge, WI (09)	BHE Environmental 2010	Noble Clinton, NY (08)	Jain et al. 2009d
Cedar Ridge, WI (10)	BHE Environmental 2011	Noble Clinton, NY (09)	Jain et al. 2010a
Cohocton/Dutch Hill, NY (09)	Stantec 2010	Noble Ellenburg, NY (08)	Jain et al. 2009e
Cohocton/Dutch Hill, NY (10)	Stantec 2011	Noble Ellenburg, NY (09)	Jain et al. 2010b
Combine Hills, OR	Young et al. 2006	Noble Wethersfield, NY	Jain et al. 2011c
Diablo Winds, CA	WEST 2006, 2008	NPPD Ainsworth, NE	Derby et al. 2007
Dillon, CA	Chatfield et al. 2009	Pebble Springs, OR	Gritski and Kronner 2010b
Dry Lake I, AZ	Thompson et al. 2011	Pine Tree, CA	BioResource Consultants 2010
Elkhorn, OR (2008)	Jeffreyet al. 2009a	PrairieWinds ND1 (Minot), ND	Derby et al. 2011c
Elkhorn, OR (2010)	Enk et al. 2011a	Ripley, Ont (08)	Jacques Whitford 2009
Elm Creek, MN	Derby et al. 2010d	Rugby, ND	Derby et al. 2011b
Foote Creek Rim, WY (Phase I; 99)	Young et al. 2003a	Shiloh I, CA	Kerlinger et al. 2010
Foote Creek Rim, WY (Phase I; 00)	Young et al. 2003a	Stateline, OR/WA (02)	Erickson et al. 2004
Foote Creek Rim, WY (Ph. I; 01-02)	Young et al. 2003a	Stateline, OR/WA (03)	Erickson et al. 2004
Goodnoe, WA	URS Corporation 2010a	Stateline, OR/WA (06)	Erickson et al. 2007
Grand Ridge, IL	Derby et al. 2010a	Stetson Mountain, ME (09)	Stantec 2009c
Hay Canyon, OR	Gritski and Kronner 2010a	Summerview, Alb (2006)	Brown and Hamilton 2006
High Winds, CA (2004)	Kerlinger et al. 2006	Top of Iowa, IA (03)	Jain 2005
High Winds, CA (2005)	Kerlinger et al. 2006	Top of Iowa, IA (04)	Jain 2005
Hopkins Ridge, WA (2006)	Young et al. 2007c	Tuolumne (Windy Point I), WA	Enz and Bay 2010
Hopkins Ridge, WA (2008)	Young et al. 2009b	Vansycle, OR	Ericksonet al. 2000
Kewaunee County, WI	Howe et al. 2002	Wessington Springs, SD	Derbyet al. 2010b
Klondike, OR	Johnsonet al. 2003	Wild Horse, WA	Erickson et al. 2008
Klondike II, OR	NWC and WEST 2007	Winnebago, IA	Derby et al. 2010f

Appendix F. Raptor use estimates (raptors/plot/20-min survey), fatality estimates (fatalities/megawatt/year), and characteristics for wind energy facilities in North America, grouped by geographic region.

Wind Energy Facility	Use Estimate	Raptor Fatality Estimate	Number of Turbines	Total Megawatts
Midwest				
Buffalo Ridge, MN (Phase I; 1996)		0.47	73	25
Moraine II, MN		0.37	33	49.5
Winnebago, IA		0.27	10	20
Buffalo Ridge I, SD (2010)		0.2	24	50.4
NPPD Ainsworth, NE		0.06	36	20.5
Wessington Springs, SD	0.232	0.06	34	51
PrairieWinds ND1 (Minot), ND		0.05	80	115.5
Rugby, ND		0.05	71	149
Kewaunee County, WI		0	31	20.46
Buffalo Ridge, MN (Phase I; 1997)		0	73	25
Buffalo Ridge, MN (Phase I; 1998)		0	73	25
Buffalo Ridge, MN (Phase I; 1999)		0	73	25
Grand Ridge, IL	0.195	0	66	99
Elm Creek, MN		0	67	100
Buffalo Ridge, MN (Phase III; 1999)		0	138	103.5
Buffalo Ridge, MN (Phase II; 1998)		0	143	107.25
Buffalo Ridge, MN (Phase II; 1999)		0	143	107.25
Blue Sky Green Field, WI		0	88	145
Barton I & II, IA		0	80	160
Rocky Mountains				
Summerview, Alb (2006)		0.11	39	70.2
Foote Creek Rim, WY (Phase I; 1999)	0.554	0.08	69	41.4
Foote Creek Rim, WY (Phase I; 2000)		0.05	69	41.4
Foote Creek Rim, WY (Phase I; 2001-2002)		0	69	41.4
Southern Plains				
Barton Chapel, TX		0.25	60	120
Buffalo Gap I, TX		0.1	67	134
Buffalo Gap II, TX		0	155	233
Northeast				
Munnsville, NY (2008)		0.59	23	34.5
Noble Ellenburg, NY (2009)		0.49	54	80
Noble Ellenburg, NY (2008)		0.32	54	80
Noble Clinton, NY (2008)		0.29	67	100
Maple Ridge, NY (2007)		0.25	195	321.75
Noble Clinton, NY (2009)		0.24	67	100
Noble Bliss, NY (2009)		0.18	67	100
Noble Bliss, NY (2008)		0.1	67	100
Mount Storm, WV (2010)		0.1	132	264
Maple Ridge, NY (2008)		0.03	195	321.75
Lempster, NH (2009)		0	12	24
Lempster, NH (2010)		0	12	24
Casselman, PA (Spring & Fall 2008)		0	23	34.5
Mars Hill, ME (2007)		0	28	42
Mars Hill, ME (2008)		0	28	42
Noble Altona, NY		0	65	97.5
Mount Storm, WV (2009)		0	132	264
Southeast				
Buffalo Mountain, TN (2000-2003)		0	3	1.98
Buffalo Mountain, TN (2005)		0	18	28.98

Appendix F. Raptor use estimates (raptors/plot/20-min survey), fatality estimates (fatalities/megawatt/year), and characteristics for wind energy facilities in North America, grouped by geographic region.

Wind Energy Facility	Use Estimate	Raptor Fatality Estimate	Number of Turbines	Total Megawatts
	Southwest			
Dry Lake I, AZ	0.13	0	30	63
	California			
Shiloh I, CA		0.42	100	150
Diablo Winds, CA	2.161	0.4	31	20.46
Pine Tree, CA		0.133	90	135
Alite, CA		0.12	8	24
Dillon, CA		0	45	45
	Pacific Northwest			
Tuolumne (Windy Point I), WA	0.77	0.29	62	136.6
Goodnoe, WA		0.17	47	94
Leaning Juniper, OR	0.522	0.16	67	100.5
Klondike III (Phase I), OR		0.15	125	223.6
Hopkins Ridge, WA (2006)	0.698	0.14	83	150
Biglow Canyon, OR (Phase II; 2009/2010)		0.14	65	150
Big Horn, WA	0.511	0.11	133	199.5
Stateline, OR/WA (2006)		0.11	454	263
Stateline, OR/WA (2002)	0.478	0.09	454	263
Stateline, OR/WA (2003)		0.09	454	263
Elkhorn, OR (2010)		0.08	61	101
Hopkins Ridge, WA (2008)		0.07	87	156.6
Wild Horse, WA	0.291	0.07	127	229
Klondike II, OR	0.504	0.06	50	75
Klondike IIIa (Phase II), OR		0.06	51	76.5
Elkhorn, OR (2008)	1.07	0.06	61	101
Marengo II, WA (2009)		0.05	39	70.2
Pebble Springs, OR		0.04	47	98.7
Biglow Canyon, OR (Phase I; 2009)		0.04	76	125.4
Nine Canyon, WA	0.35	0.03	37	48.1
Biglow Canyon, OR (Phase I; 2008)		0.03	76	125.4
Klondike, OR	0.504	0	16	24
Vansycle, OR	0.66	0	38	24.9
Combine Hills, OR	0.746	0	41	41
Hay Canyon, OR		0	48	100.8
Marengo I, WA (2009)		0	78	140.4

Appendix F. Raptor use estimates (raptors/plot/20-min survey), fatality estimates (fatalities/megawatt/year), and characteristics for wind energy facilities in North America.

Data from the following sources:

Wind Energy Facility	Use Estimate	Fatality Estimate	Wind Energy Facility	Use Estimate	Fatality Estimate
Alite, CA		Chatfieldet al. 2010b	Klondike III (Phase I), OR		Gritski et al. 2010
Barton I&II, IA		Derby et al. 2011a	Klondike IIIa (Phase II), OR		Gritski et al. 2011
Barton Chapel, TX		WEST 2011	Leaning Juniper, OR	Kronneret al. 2005	Kronneret al. 2007
Big Horn, WA	Johnson and Erickson 2004	Kronner et al. 2008	Lempster, NH (09)		Tidhar et al. 2010
Biglow Canyon, OR (Phase I; 08)		Jeffrey et al. 2009b	Lempster, NH (10)		Tidhar et al. 2011
Biglow Canyon, OR (Phase I; 09)		Enk et al. 2010	Maple Ridge, NY (07)		Jainet al. 2009a
Biglow Canyon, OR (Phase II; 09/10)		Enket al. 2011b	Maple Ridge, NY (08)		Jain et al. 2009b
Blue Sky Green Field, WI		Gruveret al. 2009	Marengo I, WA (09)		URS Corporation 2010b
Buffalo Gap I, TX		Tierney 2007	Marengo II, WA (09)		URS Corporation 2010c
Buffalo Gap II, TX		Tierney 2009	Mars Hill, ME (07)		Stantec 2008
Buffalo Mountain, TN (00-03)		Nicholsonet al. 2005	Mars Hill, ME (08)		Stantec 2009a
Buffalo Mountain, TN (05)		Fiedleret al. 2007	Moraine II, MN		Derbyet al. 2010e
Buffalo Ridge, MN (Phase I; 1996)		Johnsonet al. 2000a	Mount Storm, WV (09)		Younget al. 2009a, 2010b
Buffalo Ridge, MN (Phase I; 1997)		Johnsonet al. 2000a	Mount Storm, WV (10)		Younget al. 2010a, 2011
Buffalo Ridge, MN (Phase I; 1998)		Johnsonet al. 2000a	Munnsville, NY (08)		Stantec 2009b
Buffalo Ridge, MN (Phase I; 1999)		Johnsonet al. 2000a	Nine Canyon, WA	Ericksonet al. 2001a	Erickson et al. 2003a
Buffalo Ridge, MN (Phase II; 1998)		Johnsonet al. 2000a	Noble Altona, NY		Jain et al. 2011a
Buffalo Ridge, MN (Phase II; 1999)		Johnsonet al. 2000a	Noble Bliss, NY (08)		Jain et al. 2009c
Buffalo Ridge, MN (Phase III; 1999)		Johnsonet al. 2000a	Noble Bliss, NY (09)		Jainet al. 2010c
Buffalo Ridge I, SD (10)		Derbyet al. 2010c	Noble Clinton, NY (08)		Jainet al. 2009d
Casselman, PA (Spring & Fall 08)		Arnett et al. 2009	Noble Clinton, NY (09)		Jainet al. 2010a
Combine Hills, OR	Young et al. 2003c	Younget al. 2006	Noble Ellenburg, NY (08)		Jainet al. 2009e
Diablo Winds, CA	WEST 2006	WEST 2006, 2008	Noble Ellenburg, NY (09)		Jainet al. 2010b
Dillon, CA		Chatfield et al. 2009	NPPD Ainsworth, NE		Derbyet al. 2007
Dry Lake, AZ	Thompsonet al. 2011	Thompsonet al. 2011	Pebble Springs, OR		Gritski and Kronner 2010b
Elkhorn, OR (08)	WEST 2005a	Jeffreyet al. 2009a	Pine Tree, CA		BioResource Consultants 2010
Elkhorn, OR (10)		Enk et al. 2011a	PrairieWinds ND1 (Minot), ND		Derbyet al. 2011c
Elm Creek, MN		Derbyet al. 2010d	Rugby, ND		Derby et al. 2011b
Foote Creek Rim, WY (Phase I; 99)	Johnsonet al. 2000b	Young et al. 2003a	Shiloh I, CA		Kerlingeret al. 2010
Foote Creek Rim, WY (Phase I; 00)		Young et al. 2003a	Stateline, OR/WA (02)	Ericksonet al. 2003b	Erickson et al. 2004
Foote Creek Rim, WY (Phase I; 01-02)		Young et al. 2003a	Stateline, OR/WA (03)		Erickson et al. 2004
Goodnoe, WA		URS Corporation 2010a	Stateline, OR/WA (06)		Erickson et al. 2007
Grand Ridge, IL	Derbyet al. 2009	Derbyet al. 2010a	Summerview, Alb (06)		Brown and Hamilton 2006
Hay Canyon, OR		Gritski and Kronner 2010a	Tuolumne (Windy Point I), WA	Johnson et al. 2006	Enz and Bay 2010
Hopkins Ridge, WA (06)	Younget al. 2003e	Young et al. 2007c	Vansycle, OR	WCIA and WEST 1997	Ericksonet al. 2000
Hopkins Ridge, WA (08)		Young et al. 2009b	Wessington Springs, SD	Derby et al. 2008	Derbyet al. 2010b
Kewaunee County, WI		Howe et al. 2002	Wild Horse, WA	Erickson et al. 2003d	Erickson et al. 2008
Klondike, OR	Johnsonet al. 2002a	Johnsonet al. 2003	Winnebago, IA		Derbyet al. 2010f
Klondike II, OR	Johnson 2004	NWC and WEST 2007			

Bat Acoustic Studies for the Thunder Spirit Wind Resource Area Adams County, North Dakota

Final Report

May – October 2011



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WEST Inc.

NATURAL RESOURCES ◆ SCIENTIFIC SOLUTIONS

Draft Pre-Decisional Document - Privileged and Confidential - Not For Distribution

EXECUTIVE SUMMARY

Thunder Spirit Wind LLC contracted with Western EcoSystems Technology, Inc. to develop and implement a standardized protocol for baseline studies of bat use for the Thunder Spirit Wind Resource Area (TSWRA). The bat acoustic survey conducted at the TSWRA was designed to achieve several objectives: 1) estimate levels of bat activity throughout the TSWRA during summer reproduction and fall migration; 2) characterize patterns of temporal variation in levels of bat activity; 3) estimate the activity levels of species of interest (i.e., hoary bats and eastern red bats); and 4) assess the potential risk wind energy development poses to bats flying at the approximate height of turbine blades.

Passive acoustic sampling using AnaBat II SD1 ultrasonic bat call detectors was used to quantify bat use in the TSWRA between May 25 and October 20, 2011, for a total of 489 detector-nights. AnaBat bat call detectors were paired at one meteorological tower, where detectors were placed near the ground (one meter) and within the rotor-swept height (approximately 50 meters). Two other acoustic monitoring stations were placed near the ground (one meter).

Four hundred and six bat passes were recorded during the survey period; overall bat activity was 0.78 ± 0.08 bat passes per detector-night. AnaBats at ground stations (TS1g, TS2g, and TS3g) recorded 364 bat passes on 374 detector-nights for a mean of 0.92 bat passes per detector-night, while the raised station (TS1r) recorded 42 bat passes on 115 detector nights for a mean of 0.37 passes per detector-night. Similarly low call rates were recorded at two ground detectors in 2007.

Bat activity in the TSWRA was higher at the ground stations (0.92) than at the raised station (0.37). TS3g recorded the fewest bat passes per detector-night (0.65), while TS1g recorded the most (1.44). Activity at TS2g (0.67) was very similar to TS3g. The raised detector recorded the fewest bat passes of all AnaBats (0.37).

Overall bat activity was higher during the fall, averaging 1.13 bat passes per detector-night compared to 0.62 in summer. Generally, bat activity was relatively low until mid-July, rose during the period from July 23 to September 2, and then fell to lower levels again for the rest of the monitoring period. The week of highest overall bat activity, while still low overall, was the week of July 27 to August 2 (2.61 passes per detector-night).

Bat activity at ground stations was lower in the summer (0.73 bat passes per detector-night) and higher in fall (1.30). Weekly bat activity at ground stations was generally low from late May to late July, rose in July, August, and early September, then was lower for the rest of the monitoring period. The raised station also had lower bat activity in the summer (0.28 bat passes per detector-night) and higher bat activity in the fall (0.61). Weekly bat activity at the raised station was first recorded in early July, was somewhat higher in August and September, and then ceased in mid-September.

Passes by high-frequency (HF) bats (62.8% of all passes) outnumbered passes by low-frequency (LF) bats (37.2%), and this pattern was largely consistent among ground stations. LF passes outnumbered HF passes at the raised station. HF and LF bat activity was higher in fall (0.67 bat passes per detector-night and 0.46 respectively) than in summer (0.43 and 0.19 respectively). The week of peak activity for HF bat species was July 27 to August 2; for LF bat species, the week of peak activity was August 24 to August 30. Weekly bat activity for both HF and LF bat species was relatively low early in the monitoring period. HF bat activity was highest from late July though August while LF bat species had the highest activity in late August and early September.

Fourteen bat passes (3.4% of bat passes) were attributable to hoary bats; hoary bats were recorded at all stations except station TS2g and were detected more by TS1g and the raised detector than by any other detectors. Passes attributable to eastern red bats accounted for 1.2% of all bat passes; eastern red bat calls were recorded at stations TS1r and TS2g only. Eastern red bat activity was highest during late summer and early fall (July 30 - August 8). More hoary bats were detected (14) than eastern red bats (5) within the TSWRA. The week of peak activity for the eastern red bat was July 30 to August 8; for the hoary bat, the week of peak activity was July 26 to August 1.

STUDY PARTICIPANTS

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REPORT REFERENCE

Derby, C., and T. Sichmeller. 2013. Bat Acoustic Studies for the Thunder Spirit Wind Resource Area, Adams County, North Dakota. Final Report: May – October, 2011. Prepared for Thunder Spirit Wind LLC, Argyle, New York. Prepared by Western EcoSystems Technology, Inc. (WEST), Bismarck, North Dakota.

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INTRODUCTION

Thunder Spirit Wind LLC (Thunder Spirit) is considering the development of the Thunder Spirit Wind Resource Area (TSWRA) in Adams County, North Dakota. Thunder Spirit contracted with Western EcoSystems Technology, Inc. (WEST) to develop and implement a standardized protocol for baseline studies of bat use for the TSWRA. The bat acoustic survey conducted at the TSWRA was designed to achieve several objectives: 1) estimate levels of bat activity throughout the TSWRA during summer reproduction and fall migration; 2) characterize patterns of temporal variation in levels of bat activity; 3) estimate the activity levels of species of interest (i.e., hoary bats [*Lasiurus cinereus*] and eastern red bats [*Lasiurus borealis*]); and 4) assess the potential risk wind energy development poses to bats flying at the approximate height of turbine blades. Passive acoustic sampling using AnaBat II SD1 ultrasonic bat call detectors was used to quantify bat use in the TSWRA.

Survey methods followed the recommendations of the Wind Energy Guidelines (USFWS 2012) and Kunz et al. (2007a) to determine effort for acoustic monitoring studies. The following final report describes the results of acoustic monitoring surveys conducted at the TSWRA between May 25 and October 20, 2011.

STUDY AREA

The proposed TSWRA is in Adams County, North Dakota, approximately 3.6 kilometers (2.2 miles) northeast of Hettinger, North Dakota (Figure 1). The general boundary of the TSWRA encompasses about 9,310.2 hectares (ha; 23,006 acres [ac]). The area is a mixed landscape of grassland (about 53%) and agricultural areas (about 46%), including small areas of rural homes, shrubs and trees, and other developed areas. Elevation ranges from 779 to 902 feet (ft; 237.4 to 274.9 meters [m]) above sea level. There are about 210.4 ha (520 ac) of wetlands in 97 basins, excluding streams, in the TSWRA; about 96% of those wetlands are freshwater emergent wetlands (NWI 2011).

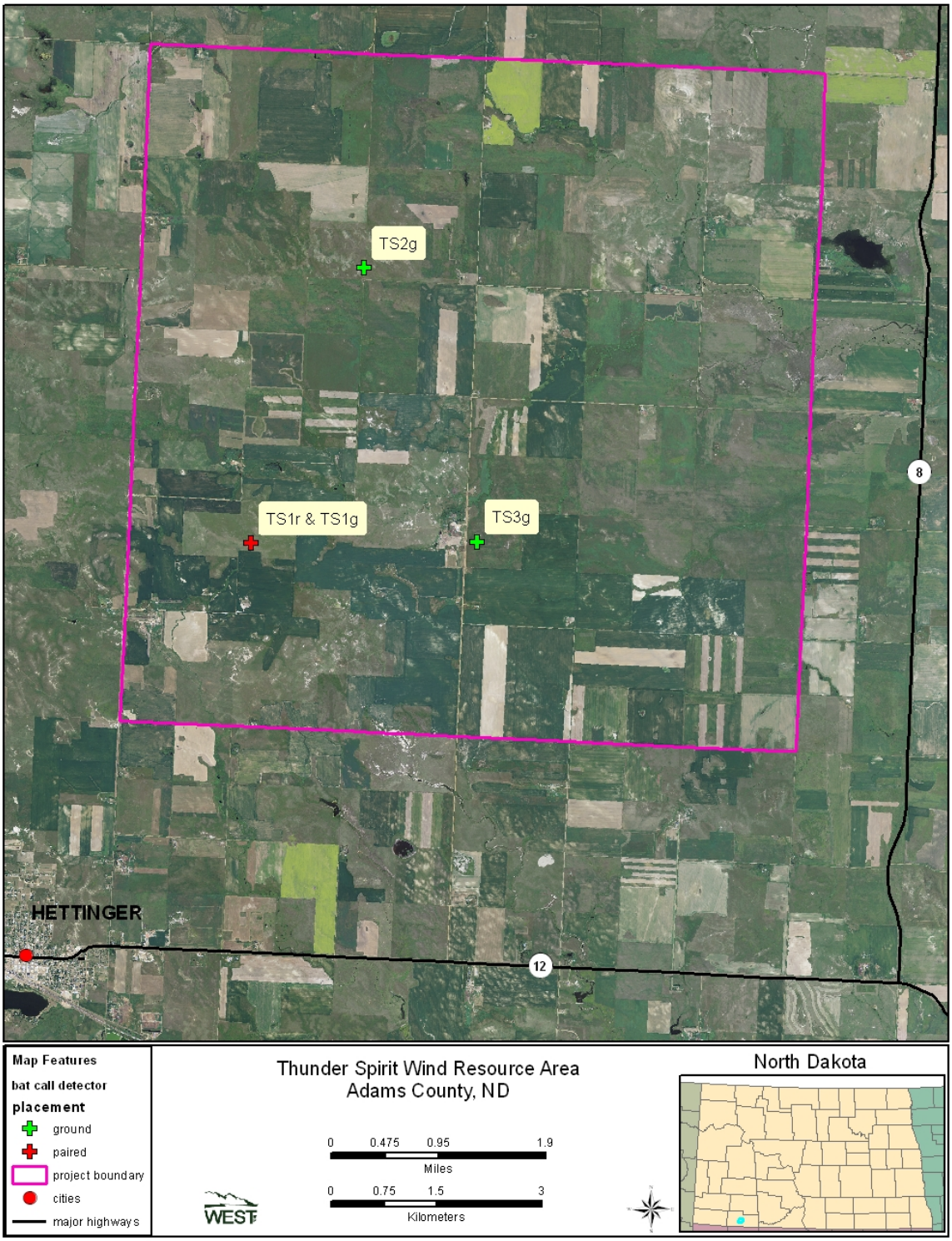


Figure 1. Project location and bat acoustic call sampling stations at the Thunder Spirit Wind Resource Area.

Bat Species of North Dakota

Ten species of bat have the potential to occur in North Dakota (Table 1; Harvey et al. 1999, BCI 2011). There are three Level III Species of Conservation Priority (NDGFD 2004) known to occur in North Dakota (Table 1).

Table 1. Bat species with potential to occur in North Dakota (Harvey et al. 1999, Bat Conservation International 2012), categorized by echolocation call frequency.

Common Name	Scientific Name
High-frequency (> 30 kHz)	
eastern red bat[1, 2]	*Lasiurus borealis*
little brown bat[1]	*Myotis lucifugus*
long-legged bat[1, 3]	*Myotis volans*
northern long-eared bat[1]	*Myotis septentrionalis*
western long-eared bat[1, 3]	*Myotis evotis*
western small-footed bat[3]	*Myotis ciliolabrum*
Low-frequency (< 30 kHz)	
big brown bat[1]	*Eptesicus fuscus*
hoary bat[1, 2]	*Lasiurus cinereus*
silver-haired bat[1, 2]	*Lasionycteris noctivagans*
Townsend's big-eared bat	*Corynorhinus townsendii*

[1] species known to have been killed at wind energy facilities; species found as fatalities reported by Kunz et al. 2007b
[2] long-distance migrant
[3] Level III Species of Conservation Priority (NDGFD 2004))

METHODS

Bat Acoustic Surveys

The objectives of the bat acoustic surveys were to: 1) estimate levels of bat activity throughout the TSWRA during summer reproduction and fall migration; 2) characterize patterns of temporal variation in levels of bat activity; 3) estimate the activity levels of species of interest (i.e., hoary bats and eastern red bats); and 4) assess the potential risk wind energy development poses to bats flying 30 to 80 m (98 to 262 ft) above ground level (AGL), within the approximate height of turbine blades.

Detector Stations

Bat call detectors are commonly used in baseline wildlife surveys to calculate an index of impacts to bats from wind energy development (Arnett 2007, Kunz et al. 2007a). Species activity levels and composition can vary with altitude (Baerwald and Barclay 2009; Collins and Jones 2009), so monitoring at different heights is important for characterizing overall bat use patterns (Kunz et al. 2007b). Ground-based detectors likely detect a more complete sample of the bat species present within the project area, whereas elevated detectors may give a more accurate assessment of risk to bat species flying at turbine blade height (Kunz et al. 2007b).

The detection range of AnaBat bat call detectors depends on a number of factors (e.g., echolocation call characteristics, microphone sensitivity, habitat, the orientation of the flying bat, atmospheric conditions; Limpens and McCracken 2004), but is generally less than 30 m (98 ft) due to atmospheric absorption of echolocation pulses (Fenton 1991). To standardize acoustic sampling effort across the TSWRA, AnaBat detectors were calibrated and sensitivity levels were set to six (Larson and Hayes 2000), which reduced interference from extraneous ultrasonic noise (Brooks and Ford 2005).

Four AnaBat™ II SD1 bat call detectors (Titley™ Scientific, Australia) were used during the 2011 study. Two AnaBats were paired at one meteorological (met) tower, with one detector at ground level (approximately one m AGL) and another within the rotor-swept height (approximately 50 m [164 ft] AGL; Figure 1). The other two detectors were placed at ground stations in short grass habitats near agricultural fields.

Ground AnaBats were placed inside a plastic weather-resistant container with a hole cut in the side through which the microphone extended. Each microphone was encased in a 45-degree angle poly-vinyl chloride (PVC) tube; holes were drilled in the PVC tubes to allow water to drain out. The raised AnaBat microphone was elevated on the met tower using a pulley system and housed in a Bat-Hat (EME Systems, California). Bat-Hat weatherproof housing was modified by replacing the Plexiglas reflector plate with a 45-degree angle PVC elbow. The Bat-Hat was altered because detectors protected using un-modified Bat-Hats may detect lower activity and species richness than are actually present, while detectors protected with a 45-degree PVC elbow have been found to detect similar numbers and quality of bat calls as detectors exposed to the environment (Britzke et al. 2010).

Monitoring Schedule

Bat calls were monitored in the TSWRA using four AnaBat II SD1 ultrasonic detectors from May 25 to October 20, 2011. This date range gives complete coverage of summer reproduction (May 25 to July 31) and fall migration (August 1 to October 20) periods. AnaBats were programmed to turn on approximately 30 minutes (min) before sunset and turn off approximately 30 min after sunrise each night.

Data Collection and Call Analysis

AnaBat bat call detectors use a broadband high-frequency microphone to detect the echolocation calls of bats. Incoming echolocation calls are digitally processed and stored by the detector. The integrated zero crossings analysis interface module (ZCAIM) produces a file that, when viewed in appropriate software (i.e., Analook ®; 2008, C. Corben), displays digital sonograms of the echolocation calls that show change in frequency over time. Frequency versus time displays were used to separate bat calls from other types of ultrasonic noise (e.g., wind, insects, etc.) and to identify the call frequency classification and species (when possible) of bat that generated the calls. Data determined to be noise (produced by a source other than a bat) or call notes that did not meet the pre-specified criteria to be termed a pass were removed from the analysis.

For each detector location, bat passes were sorted into two groups based on their minimum frequency; this grouping corresponded roughly to the bat species groups of interest. For example, most species of *Myotis* bats, as well as eastern red bats, echolocate at frequencies greater than 30 kilohertz (kHz; High Frequency [HF]), whereas species such as the big brown bat (*Eptesicus fuscus*), silver-haired bat (*Lasionycteris noctivagans*), and hoary bat typically emit echolocation calls below 30 kHz (Low Frequency [LF]). To establish which species may have produced passes in each category, a list of species expected to occur in the study area was compiled from range maps (Table 1; Harvey et al. 1999, BCI 2011).

An experienced bat acoustic analyst qualitatively identified the echolocation calls of hoary bats and eastern red bats recorded by AnaBat bat call detectors through visual comparison of echolocation call metrics (e.g., minimum frequency, slope, duration) to reference calls of known bats (Yates and Muzika 2006). Calls that had a distinct U-shape and that exhibited variability in the minimum frequency across the call sequence were identified as belonging to the *Lasiurus* genus (C. Corben, pers. comm.). Hoary and eastern red bats were distinguished based on minimum frequency. Hoary bats typically produce calls with minimum frequencies between 18 and 24 kHz, whereas eastern red bats typically emit calls with minimum frequencies between 30 and 43 kHz (J. Szewczak, pers. comm.). Only sequences containing three or more calls were used for species identification. These are conservative parameters and given the high intraspecific variability of *Lasiurus* calls and the number of call files that were too fragmented for proper identification, it is likely that more hoary and eastern red bat calls were recorded than were positively identified.

Statistical Analysis

The standard metric used for measuring bat activity was the number of bat passes per detector-night, and this metric was used as an index of bat activity in the project area. A bat pass was defined as a sequence of echolocation calls produced by an individual bat consisting of series of at least two calls (pulses) with no pause between calls of more than one second (White and Gehrt 2001, Gannon et al. 2003). A detector-night was defined as one detector operating for one entire night. The terms bat pass and bat call are used interchangeably in this report. Bat passes per detector-night were calculated for all bats, for HF and LF categories, and for hoary bats and eastern red bats. Because individuals cannot be differentiated by their calls, bat pass data represent relative levels of bat activity rather than the total numbers of individuals present (e.g., several calls could be from several bats or from the same bat recorded multiple times). To assess potential for bat mortality, the number of bat passes per detector-night recorded at TSWRA was compared to existing data at other wind-energy facilities in the Midwest (Appendix A).

The period of peak sustained bat activity was defined as the seven-day period with the highest average bat activity. This and all multi-detector averages in this report were calculated by averaging the average activity of each detector. If multiple seven-day periods equaled the peak sustained bat activity rate, all dates in these seven-day periods were reported.

The fall migration period (July 30 – October 14) represents the period between dissolution of maternity colonies and onset of the swarming and hibernation seasons (Fleming and Eby 2005). During this time, bats begin moving toward wintering areas and many species of bats initiate reproductive behaviors (Cryan 2008). This period of increased landscape-scale movement and reproductive behavior is often associated with increased levels of bat fatalities at operational wind energy facilities (Arnett et al. 2008).

RESULTS

Bat Acoustic Surveys

Bat activity was monitored at three locations (Figure 1) using four AnaBats for a total of 489 detector-nights between May 25 and October 20, 2011. AnaBats were operating for 82% of the sampling period (Figure 2); the raised detector (TS1r) had a broken cable for a couple of weeks and TS3g had an internal clock issue near the end of the survey period.

Four hundred and six bat passes were recorded during the survey period; overall bat activity was 0.78 ± 0.08 bat passes per detector-night (Table 2). AnaBats at ground stations (TS1g, TS2g, and TS3g) recorded 364 bat passes on 374 detector-nights for a mean (± standard error) of 0.92 ± 0.09 bat passes per detector-night, while the raised station (TS1r) recorded 42 bat passes on 115 detector nights for a mean of 0.37 ± 0.08 per detector-night (Table 2).

Spatial Variation

Bat activity in the TSWRA was higher at the ground stations (0.92 ± 0.09) than at the raised station (0.37 ± 0.08; Table 2; Figure 3). Among ground stations, TS3g recorded the fewest bat passes per detector-night (0.65 ± 0.12), while TS1g recorded the most (1.44 ± 0.19). Activity at TS2g (0.67 ± 0.09) was very similar to TS3g. The raised detector recorded the fewest bat passes of all AnaBats (0.37 ± 0.08; Table 2, Figure 3).

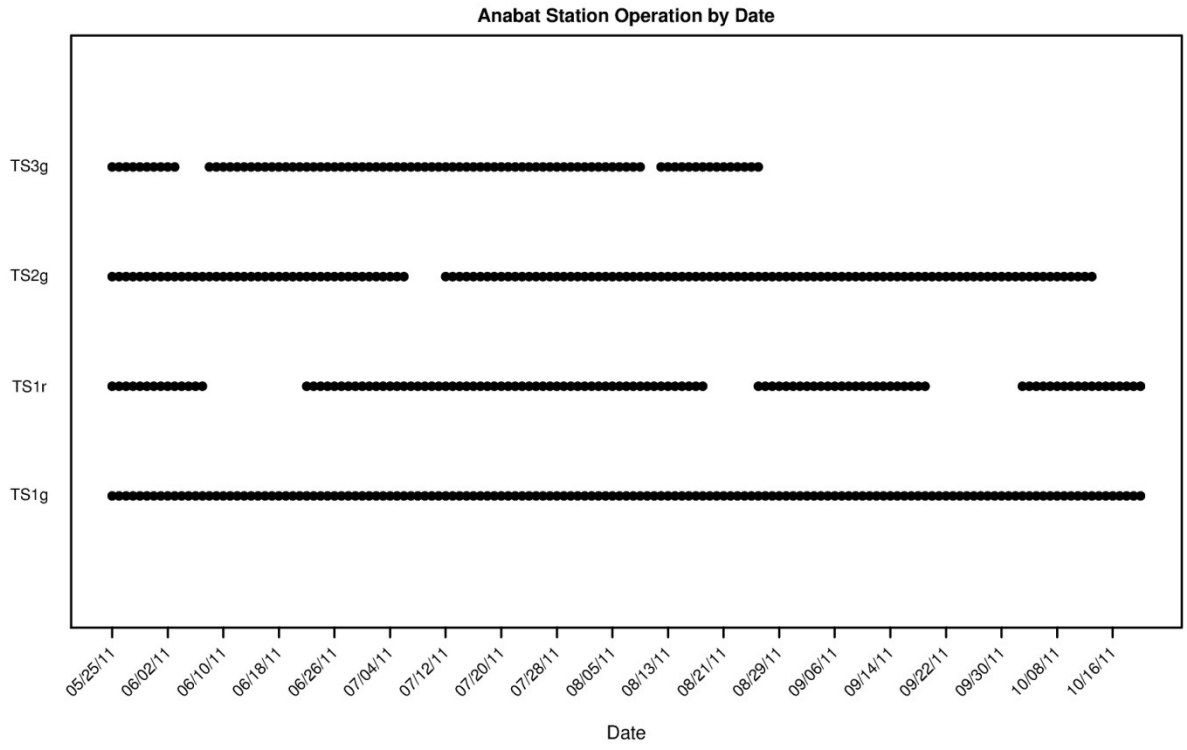


Figure 2. Number of AnaBat bat call detectors (n = 4) operating at the Thunder Spirit Wind Resource Area during each night from May 25 to October 20, 2011.

Table 2. Number of bat passes by frequency (high-frequency [HF], low-frequency [LF]), species, and all bats; detector-nights; and bat passes per detector-night at ground and raised stations at the Thunder Spirit Wind Resource Area from May 25 to October 20, 2011.

AnaBat Station	Location	# of HF Bat Passes	# of LF Bat Passes	# of Eastern Red Bat Passes*	# of Hoary Bat Passes**	Total Bat Passes	Detector-Nights	Bat Passes/ Night***
TS1g	ground	147	68	0	9	215	149	1.44±0.19
TS1r	raised	12	30	2	4	42	115	0.37±0.08
TS2g	ground	56	36	3	0	92	137	0.67±0.09
TS3g	ground	40	17	0	1	57	88	0.65±0.12
Total Ground		**243**	**121**	**3**	**10**	**364**	**374**	**0.92±0.09**
Total Raised		**12**	**30**	**2**	**4**	**42**	**115**	**0.37±0.08**
Overall		**255**	**151**	**5**	**14**	**406**	**489**	**0.78±0.08**

* eastern red bat passes were included in high-frequency (HF) numbers.
** hoary bat passes were included in low-frequency (LF) numbers.
*** ± bootstrapped standard error.

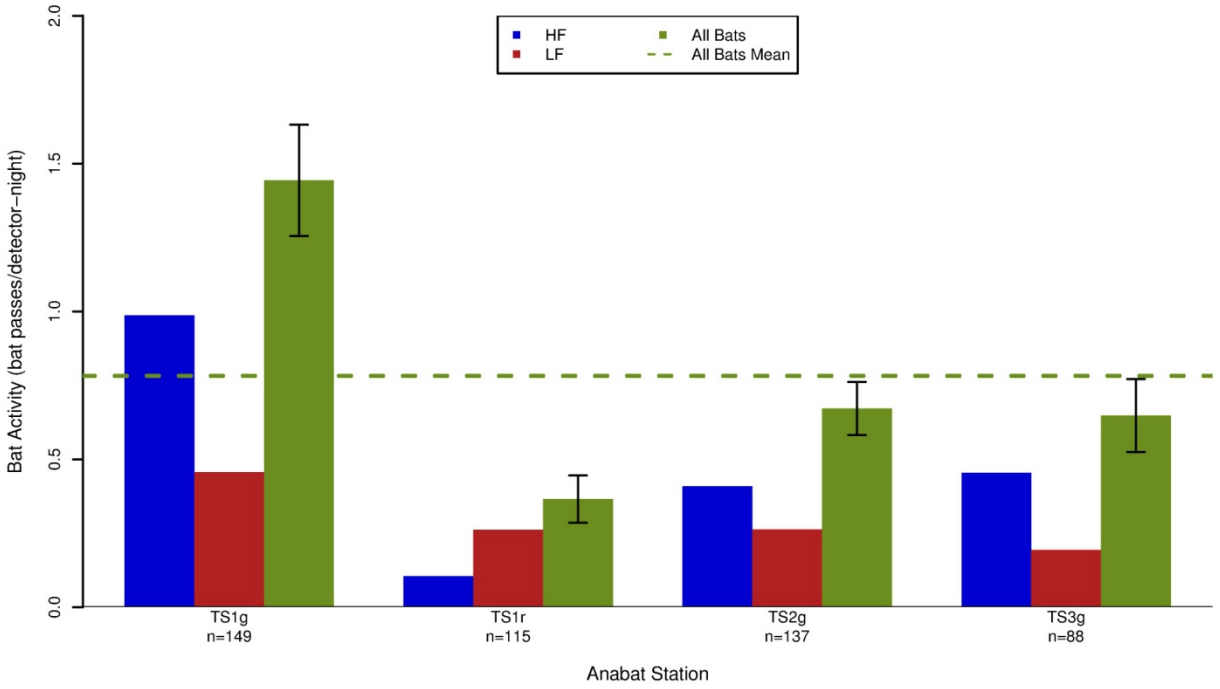


Figure 3. Number of high-frequency (HF) and low-frequency (LF) bat passes per detector-night recorded at AnaBat bat call detector stations in the Thunder Spirit Wind Resource Area from May 25 to October 20, 2011. The bootstrapped standard errors are represented by the black error bars on the 'All Bats' columns.

Temporal Variation

Overall bat activity was higher during the fall, averaging 1.13 bat passes per detector-night compared to 0.62 in summer (Table 3; Figure 4). Generally, bat activity was very low until mid-July, higher during the period from July 23 to September 2, and lower again for the rest of the monitoring period (Figure 5). The week of highest overall bat activity was the week of July 27 to August 2 (2.61 passes per detector-night; Table 4).

Bat activity at ground stations was lower in the summer (0.73 bat passes per detector-night) and higher in fall (1.30; Table 3, Figure 4). Weekly bat activity at ground stations was generally low from late May to late July, higher in late July, August, and early September, and lower for the rest of the monitoring period (Figure 6).

The raised station also had lower bat activity in the summer (0.28 bat passes per detector-night) and higher bat activity in the fall (0.61; Table 3, Figure 4). Weekly bat activity at the raised station was first recorded in early July, was somewhat higher in August and September, and then ceased in mid-September (Figure 6).

Table 3. Bat activity (bat passes per detector-night) by call frequency (high-frequency [HF] and low-frequency [LF]) and for all bats, by season and overall, recorded at ground (n = 3) and raised stations (n = 1) in the Thunder Spirit Wind Resource Area from May 25 to October 20, 2011.

Station	Call Frequency	Summer May 25 – Jul 31	Fall Aug 1 – Oct 20	Fall Migration Aug 1 – Sep 29	Overall May 25 – Oct 20
TS1g	LF	0.25	0.63	0.71	0.46
	HF	0.96	1.01	1.19	0.99
	AB	1.21	1.64	1.91	1.44
TS1r	LF	0.17	0.34	0.44	0.26
	HF	0.11	0.10	0.18	0.10
	AB	0.28	0.44	0.61	0.37
TS2g	LF	0.22	0.30	0.29	0.26
	HF	0.37	0.45	0.47	0.41
	AB	0.59	0.74	0.76	0.67
TS3g	LF	0.11	0.42	0.38	0.19
	HF	0.28	0.92	0.85	0.45
	AB	0.39	1.33	1.23	0.65
Ground Station Totals	**LF**	0.19±0.04	0.46±0.07	0.45±0.07	
	HF	0.53±0.09	0.84±0.11	0.79±0.12	
	AB	0.73±0.12	1.30±0.14	1.24±0.14	
Raised Station Totals	**LF**	0.17±0.08	0.44±0.10	0.34±0.09	
	HF	0.11±0.06	0.18±0.07	0.10±0.04	
	AB	0.28±0.12	0.61±0.14	0.44±0.10	
Overall	**LF**	0.19±0.04	0.46±0.07	0.42±0.07	
	HF	0.43±0.08	0.67±0.09	0.62±0.09	
	AB	0.62±0.11	1.13±0.13	1.04±0.12	

Table 4. The week of highest bat activity (bat passes per detector-night) sorted by call frequency (high-frequency [HF] and low-frequency [LF]), species, and all bats at the Thunder Spirit Wind Resource Area for the period May 25 to October 20, 2011.

Species/Group	Week of Highest Bat Activity	Bat Passes per Detector-Night
HF	7/27 – 8/02	1.93
LF	8/24 – 8/30	1.30
Eastern Red Bats	7/30 – 8/08	0.11
Hoary Bats	7/26 – 8/01	0.25
All Bats	7/27 – 8/02	2.61

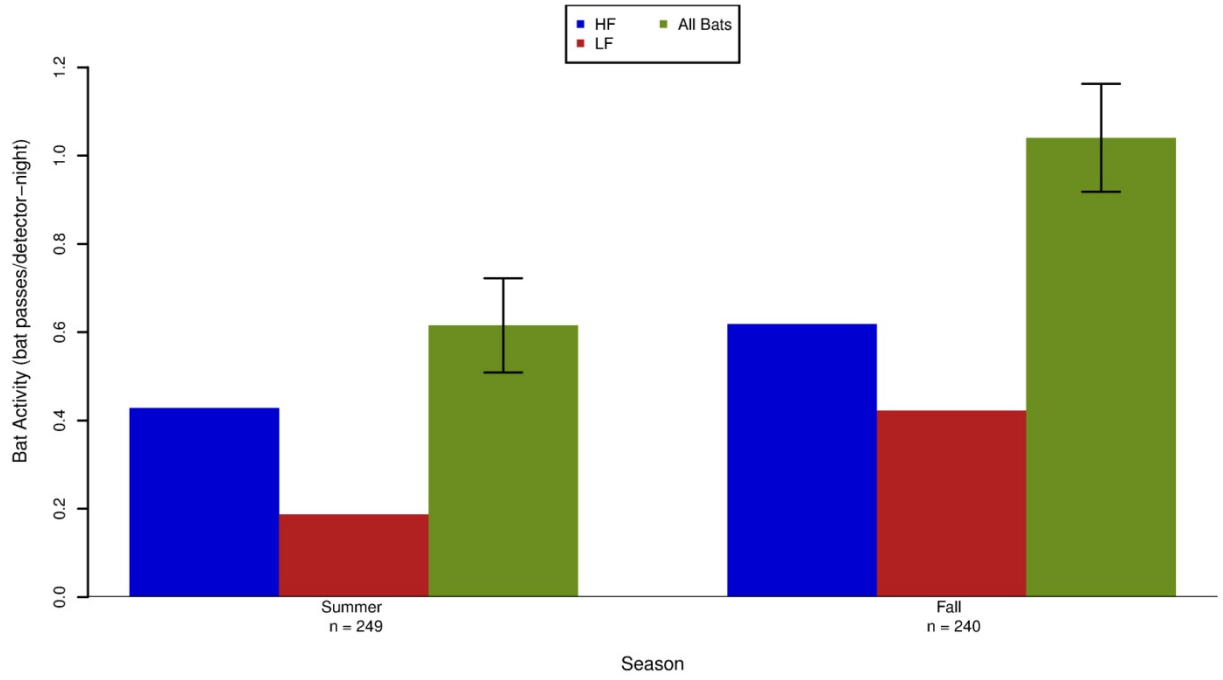


Figure 4. Seasonal bat activity (bat passes per detector-night) by high-frequency (HF), low-frequency (LF), and all bats at the Thunder Spirit Wind Resource Area from May 25 to October 20, 2011. The bootstrapped standard errors are represented on the 'All Bats' columns.

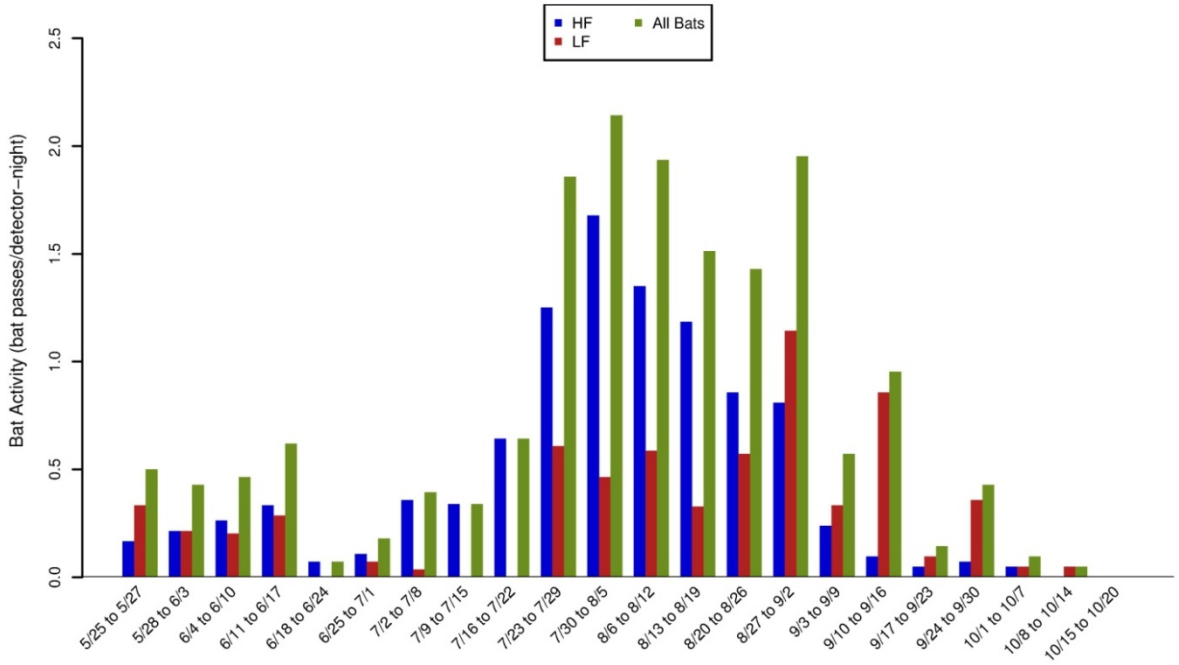


Figure 5. Weekly bat activity (bat passes per detector-night) by high-frequency (HF), low-frequency (LF), and all bats at the Thunder Spirit Wind Resource Area for the period May 25 to October 20, 2011.

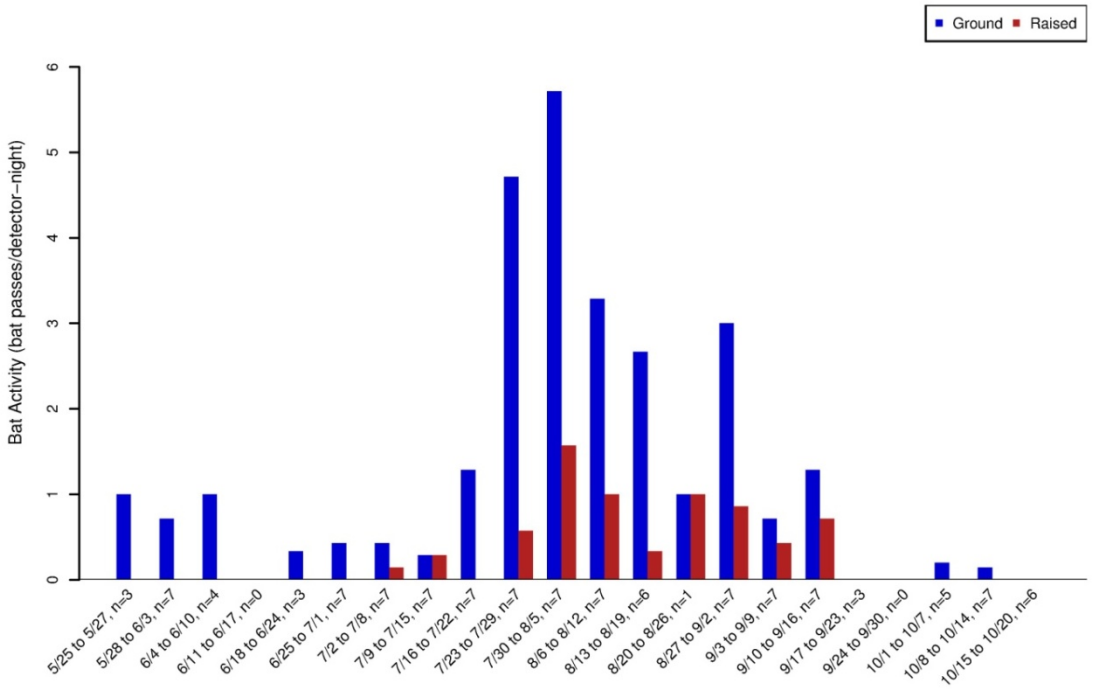


Figure 6. Weekly bat activity (bat passes per detector-night) at ground and raised stations at the Thunder Spirit Wind Resource Area from May 25 to October 20, 2011.

Species Composition

Frequencies

Passes by HF bats (62.8% of all passes) outnumbered passes by LF bats (37.2%), and this pattern was largely consistent among ground stations (Table 2). LF passes outnumbered HF passes at the raised station TS1r (Table 2). HF and LF bat activity was higher in fall (0.67 bat passes per detector-night and 0.46 respectively) than in summer (0.43 and 0.19 respectively; Table 3; Figure 4). The week of peak activity for HF bat species was July 27 to August 2; for LF bat species, the week of peak activity was August 24 to August 30 (Table 4). Weekly bat activity for both HF and LF bat species was relatively low early in the monitoring period (Figure 5). HF bat activity was highest from late July though August while LF bat species had the highest activity in late August and early September.

Species

Fourteen bat passes (3.4% of bat passes) were attributable to hoary bats; hoary bats were recorded at all stations except station TS2g and were detected more by TS1g and the raised detector (TS1r) than by any other detectors (Table 2; Figure 7). Passes attributable to eastern red bats accounted for 1.2% of all bat passes; eastern red bat calls were recorded at stations TS1r and TS2g but not at TS1g or TS3g (Table 2; Figure 7).

Eastern red bat activity was highest during late summer and early fall (July 30 - August 8; Table 4, Figure 8). More hoary bats were detected (14) than eastern red bats (5) within the TSWRA (Table 2). The week of peak activity for the eastern red bat was July 30 to August 8; for the hoary bat, the week of peak activity was July 26 to August 1 (Table 4).

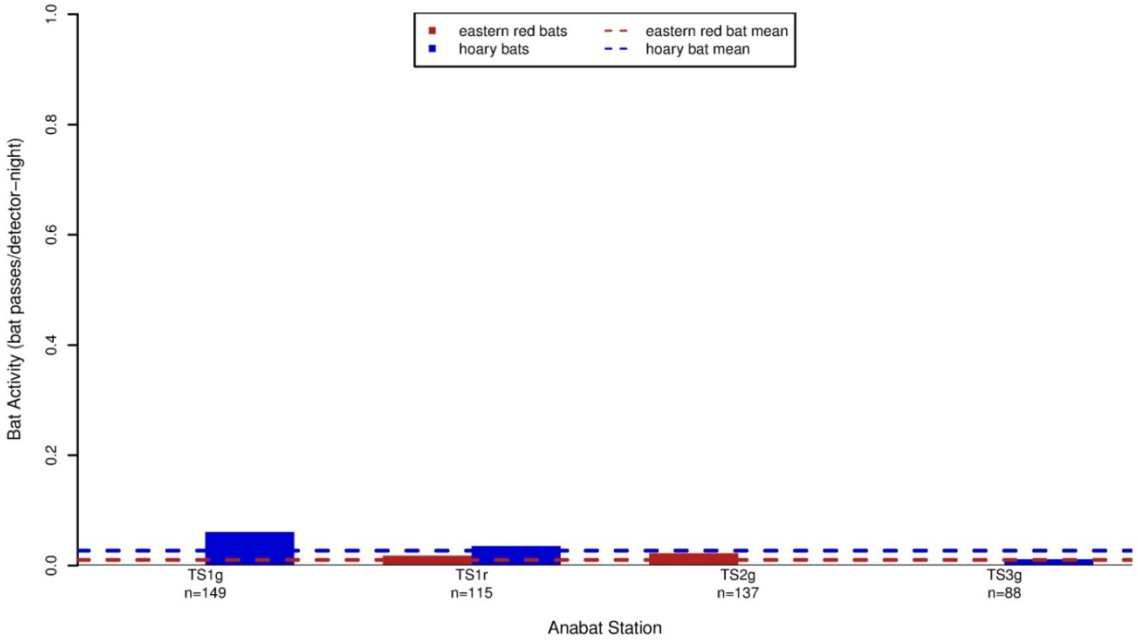


Figure 7. Number of passes per detector–night by eastern red bats and hoary bats at ground (n = 3) and raised stations (n = 1) at the Thunder Spirit Wind Resource Area from May 25 to October 20, 2011.

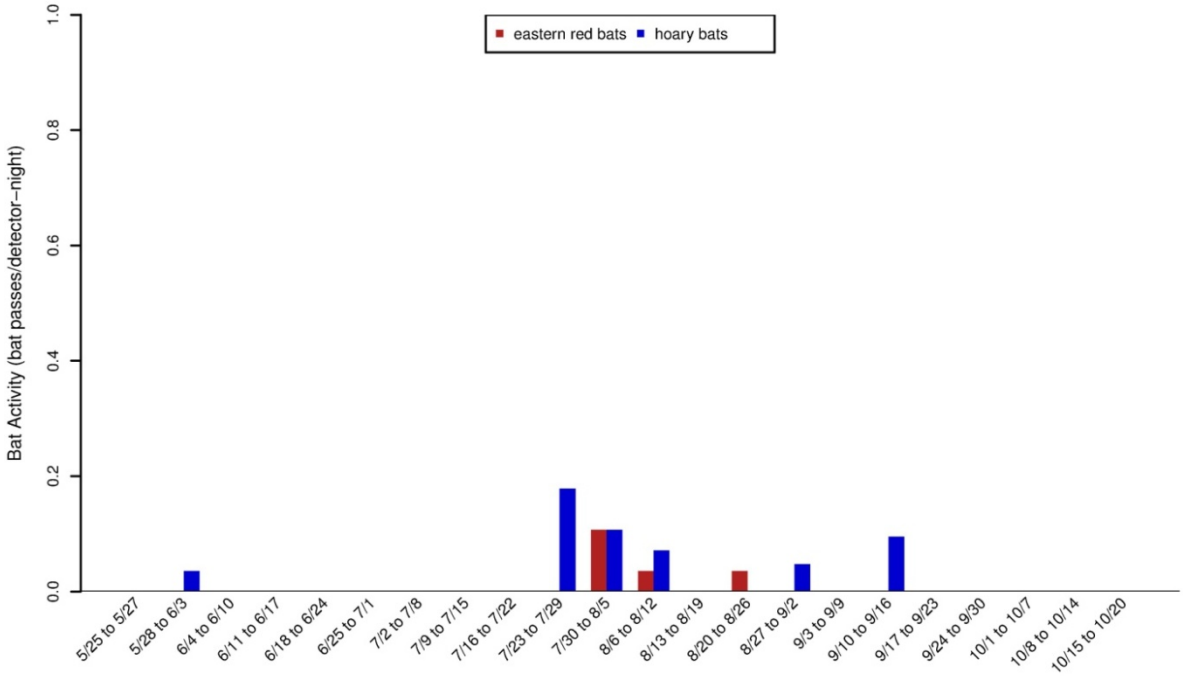


Figure 8. Weekly activity (bat passes per detector-night) of hoary bat and eastern red bats at the Thunder Spirit Wind Resource Area from May 25 to October 20, 2011.

DISCUSSION

Potential Bat Impacts

Assessing the potential impacts of wind energy development to bats at the TSWRA is complicated because the causes of bat fatalities at turbines are poorly understood (Kunz et al. 2007a, 2007b; Baerwald et al. 2008; Cryan and Barclay 2009; Long et al. 2010a, 2010b) and monitoring elusive, night-flying animals is inherently difficult (O'Shea et al. 2003). Although installed capacity for wind energy has increased rapidly in recent years, release of study results from these existing wind energy facilities has lagged behind the influx of newly proposed facilities (Kunz et al. 2007b); therefore, it is often the case that information gleaned from existing wind energy facilities is not available to inform assessments at proposed facilities. To date, post-construction monitoring studies of wind energy facilities suggest that:

1) Bat mortality shows a rough positive correlation with bat activity (Kunz et al. 2007b);

2) The majority of fatalities occur during the post-breeding or fall migration season (roughly August and September; Johnson 2005, Arnett et al. 2008);

3) Migratory tree-roosting species (e.g., eastern red, hoary, and silver-haired bats) account for approximately 75% of reported bats killed (Arnett et al. 2008, Gruver et al. 2009), and;

4) The level of bat fatalities may depend on many variables, including local environmental characteristics and/or specific weather conditions, but no single predictive factor has yet been identified. However, some of the highest reported bat fatality rates recorded to date have occurred at wind energy facilities located along forested ridge tops in the eastern and northeastern US and at some wind energy facilities in agricultural regions of the Midwest (Appendix A).

Based on these patterns, current guidance to estimate potential fatality levels at a proposed wind energy facility involves evaluation of on-site acoustic monitoring data in terms of activity levels, seasonal variation, and species composition (Kunz et al. 2007b), as well as comparison to regional fatality patterns.

Overall Bat Activity

To date, relatively few studies of wind energy facilities have recorded both bat passes per detector-night and bat fatality rates (Appendix A). Although it has been assumed that an association may exist for pre-construction activity and post-construction fatalities (Kunz et al. 2007b), to date such a relationship has not been established empirically due to insufficient data.

For those studies that measured both activity and fatality rates, about 75% of data were collected using bat call detectors placed near the ground and none of the detectors were located near features considered attractive to bats. Therefore, this report relies largely on the

mean bat activity for ground-based detectors to assess potential risk of bat fatalities at the TSWRA relative to other studies with similar data (see Appendix A).

While inconsistencies among studies (e.g., differences in study period length and timing, type of equipment, placement of equipment, and presentation of data) do not allow for direct comparison across studies, some generalizations can be made. For facilities that have estimated pre-construction activity and post-construction fatalities, the highest number of bat passes per detector night (38.3) corresponds with the highest number of bat fatalities/megawatt (MW)/year (31.69). The facilities with the lowest bat activity (1.9 bat passes per detector night) had fatality estimates of 4.5 bat fatalities/MW /year or less. However, for the facilities presented in Appendix A, there does not appear to be a consistent relationship between bat activity and bat fatalities for the projects in between the lowest and highest. For example, fatalities were relatively moderate (10.27 fatalities/MW/study period) at the Top of Iowa wind energy facility in 2004 despite high activity (35.7 bat passes/detector-night; Jain 2005), and lower bat activity at the Blue Sky Green Field, Wisconsin wind energy facility (7.7 bat passes/detector-night; Gruver 2008) corresponded with a relatively high fatality estimate (24.57 fatalities/MW/study period; Gruver et al. 2009).

It is unclear whether monitoring bat activity near ground level accurately represents activity at all heights or if it is an effective method for estimating bat fatality rates. Researchers have suggested that bat activity near the ground may not be representative of bat fatality rates (Hayes and Gruver 2000, Baerwald and Barclay 2009). At the TSWRA, fall bat activity recorded by the ground detectors was higher (0.92 ± 0.09) than activity at the raised detector (0.37 ± 0.08; Table 2). However, with only one raised detector, conclusions based on a comparison between ground and raised detectors should be made with caution.

Overall bat activity recorded within the TSWRA (0.78 ± 0.08) bat passes per detector-night; Table 2) is considered relatively low and was lower than any bat activity estimate given in Appendix A. In addition, the bat activity level at two stations within the TSWRA in 2007 was also low (1.13 passes/detector night; Derby et al. 2008). Thus, based on the expected relationship between pre-construction bat activity and post-construction fatalities, bat fatality rates at the TSWRA would be expected to be low.

Spatial Variation

The proposed wind energy facility is not located near any large, known bat colonies or other features that are likely to attract large numbers of bats. As well, the TSWRA does not contain topographic features that may funnel migrating bats and is lacking large tracts of forest cover, unlike facilities with higher fatality rates in the eastern US. All the detectors were located in grassland with agricultural areas nearby, which is typical of the TSWRA. This suggests that the data recorded at the stations should be indicative of bat use of the area. Bat activity recorded at the ground detectors varied between stations. The raised detector recorded approximately half the number of bat calls as the ground detectors at all but one ground detector (TS3g).

Temporal Variation

Higher overall bat activity occurred within the TSWRA during the fall. The week of highest bat activity was the week of July 27 to August 2. Higher activity in July likely corresponds with the reproductive seasons of bats, when pups are being weaned and foraging rates are high among adult females and newly flying juveniles (Barclay 1989).

At both ground and raised stations, the highest number of bat passes was recorded during the fall. This likely corresponds with the fall migration period in which bats may be moving through the area (Fleming and Eby 2005). Most bat fatality studies at wind energy facilities in the US have shown a peak in fatality rates in August and September (the fall migration period) and generally lower fatality rate earlier in the summer and very low fatality rate during the spring (Johnson 2005, Arnett et al. 2008). While the survey effort varied among the different studies, a general association between the timing of increased bat call rates and timing of fatality rate was suggested in the studies that combine activity and fatality surveys, with both call rates and fatalities peaking during the fall migration period. Based on the available data, it is expected that bat fatalities at the TSWRA, which are expected to be lower overall, will be highest late summer to early fall.

Species Composition

Approximately 62.8% of passes recorded at the detector stations were by HF bats, suggesting higher relative abundance of species such as eastern red bats and little brown bats (Table 1). Some HF bat carcasses (e.g., little brown bat) have been found in relatively high proportions during fatality monitoring studies (e.g., Kerns and Kerlinger 2004, Jain 2005, Brown and Hamilton 2006, Gruver et al. 2009). However, *Myotis* species are typically less commonly recorded in the rotor-swept height or as fatalities at post-construction studies at wind energy facilities than other species, such as hoary and eastern red bats (Kunz et al. 2007b, Arnett et al. 2008). The remaining 37.2% of bat passes at the TSWRA were LF bats (e.g., hoary bat, silver-haired bat, and big brown bat; Table 2).

Raised detector stations mimic potential turbine locations, and it is expected that bat species flying at rotor-swept height and detected at raised stations are the most vulnerable to collision with turbine blades. Hoary bats were detected at each ground station except TS2g and at the raised station, indicating that this species has an elevated collision risk as well. Some low-frequency species, such as hoary bat and silver-haired bat, have been found as fatalities in higher proportions than other species (Arnett et al. 2008). Hoary bats and silver-haired bats could potentially have a higher collision risk within the TSWRA.

Eastern red bats (five total passes) were detected at only one ground station (TS2g) and at the raised station (TS1r), and may have a higher risk of collision injury or fatality than other bat species (Table 2). In some regions, eastern red bats account for the majority of bat fatalities found during searches (Arnett et al. 2008). At five Midwestern wind energy facilities, eastern red bats accounted for 22.3% of all bat fatalities and were the second most commonly found species (Jain 2005; Johnson et al. 2002, 2003a, 2004; Howe et al. 2002; Kerlinger et al. 2007; Gruver et al. 2009).

Potential Bat Fatality Rates

Bat fatality rates from studies at wind energy facilities across North America have ranged from 0.1 to 38.3 bat fatalities/MW/year (Appendix A). In general, fatality rates have been highest in the northeast and lowest in the northwest, although a high degree of variation in fatality rates is present for most regions. To date, the highest levels of bat fatalities have been reported from turbines set on forested Appalachian ridges (Arnett et al. 2008). Bat fatality studies have been conducted at 17 wind energy facilities located in the Midwest, but only one public study of bat fatality rates at wind energy facilities has been conducted in North Dakota. Thus far, bat fatality rates at wind energy facilities located in agricultural regions of Illinois, Iowa, Minnesota, North Dakota, South Dakota, and Wisconsin have ranged from 0.16 to 30.61 bats/MW/year (Appendix A), with the higher rates coming from Wisconsin, Illinois, and eastern Minnesota and Iowa. However, recent reports of moderate to high levels of bat fatalities in agricultural settings in Iowa (Jain 2005); Alberta, Canada (Baerwald 2008); suggest that the lack of forested areas does not guarantee low bat fatality rates at wind energy facilities.

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Appendix A. North American Fatality Summary Tables

Appendix A. Wind energy facilities in North America with fatality data for bat species, grouped by geographic region. Bat activity rates are included where available.

Wind Energy Facility	Bat Activity Estimate[A]	Bat Activity Dates	Fatality Estimate[B]	No. of Turbines	Total MW
Thunder Spirit (this study)	**0.78**[C]	5/25/11-10/20/11			
		Midwest			
Cedar Ridge, WI (2009)	9.97 [C,E,F]	7/16/07-9/30/07	30.61	41	67.6
Blue Sky Green Field, WI	7.7 [F]	7/24/07-10/29/07	24.57	88	145
Cedar Ridge, WI (2010)	9.97 [C,E,F]	7/16/07-09/30/07	24.12	41	68
Forward Energy Center, WI	6.97	8/5/08-11/08/08	18.17	86	129
Top of Iowa, IA (2004)	35.7	5/26/04-9/24/04	10.27	89	80
Crystal Lake II, IA			7.42	80	200
Top of Iowa, IA (2003)			7.16	89	80
Kewaunee County, WI			6.45	31	20.46
Ripley, Ont. (2008)			4.67	38	76
Winnebago, IA			4.54	10	20
Buffalo Ridge, MN (Phase II; 2001/Lake Benton I)	2.2 [D]	6/15/01-9/15/01	4.35	143	107.25
Buffalo Ridge, MN (Phase III; 2001/Lake Benton II)	2.2 [D]	6/15/01-9/15/01	3.71	138	103.5
Crescent Ridge, IL			3.27	33	54.45
Buffalo Ridge, MN (Phase III; 1999)			2.72	138	103.5
Buffalo Ridge, MN (Phase II; 1999)			2.59	143	107.25
Moraine II, MN			2.42	33	49.5
Buffalo Ridge, MN (Phase II; 1998)			2.16	143	107.25
Prairie Winds (Minot), ND			2.13	80	115.5
Grand Ridge, IL			2.1	66	99
Buffalo Ridge, MN (Phase III; 2002/Lake Benton II)	1.9 [D]	6/15/02-9/15/02	1.81	138	103.5
Buffalo Ridge, MN (Phase II; 2002/Lake Benton I)	1.9 [D]	6/15/02-9/15/02	1.64	143	107.25
Elm Creek, MN			1.49	67	100
Wessington Springs, SD			1.48	34	51
NPPD Ainsworth, NE			1.16	36	20.5
Buffalo Ridge, MN (Phase I; 1999)			0.74	73	25
Buffalo Ridge I, SD (2010)			0.16	24	50.4
		Rocky Mountains			
Summerview, Alb. (2008)	7.65 [D]	07/15/06-07-09/30/06-07	11.42	39	70.2
Judith Gap, MT			8.93	90	135
Foote Creek Rim, WY (Phase I; 1999)			3.97	69	41.4
Foote Creek Rim, WY (Phase I; 2001-2002)	2.2 [D,E]	6/15/01-9/1/01	1.57	69	41.4
Foote Creek Rim, WY (Phase I; 2000)	2.2 [D,E]	6/15/00-9/1/00	1.05	69	41.4
		Southern Plains			
Barton Chapel, TX			3.06	60	120
Buffalo Gap II, TX			0.14	155	233
Buffalo Gap I, TX			0.1	67	134

Appendix A. Wind energy facilities in North America with fatality data for bat species, grouped by geographic region. Bat activity rates are included where available.

Wind Energy Facility	Bat Activity Estimate[A]	Bat Activity Dates	Fatality Estimate[B]	No. of Turbines	Total MW
Southwest					
Dry Lake, AZ	8.8	4/29/10-11/10/10	4.29	30	63
California					
Shiloh I, CA			3.92	100	150
High Winds, CA (2004)			2.51	90	162
Dillon, CA			2.17	45	45
High Winds, CA (2005)			1.52	90	162
Alite, CA			0.24	8	24
Pacific Northwest					
Biglow Canyon, OR (Phase II; 2009/2010)			2.71	65	150
Nine Canyon, WA			2.47	37	48.1
Stateline, OR/WA 2003			2.29	454	263
Biglow Canyon, OR (Phase I; 2008)			1.99	76	125.4
Leaning Juniper, OR			1.98	67	100.5
Big Horn, WA			1.9	133	199.5
Combine Hills, OR			1.88	41	41
Pebble Springs, OR			1.55	47	98.7
Hopkins Ridge, WA (2008)			1.39	87	156.6
Elkhorn, OR (2008)			1.26	61	101
Vansycle, OR			1.12	38	24.9
Klondike III, OR			1.11	122	375
Stateline, OR/WA 2002			1.09	454	263
Tuolumne (Windy Point I), WA			0.94	62	136.6
Klondike, OR			0.77	16	24
Hopkins Ridge, WA (2006)			0.63	83	150
Biglow Canyon, OR (Phase I; 2009)			0.58	76	125.4
Hay Canyon, OR			0.53	48	100.8
Klondike II, OR			0.41	50	75
Wild Horse, WA			0.39	127	229
Goodnoe, WA			0.34	47	94
Marengo II, WA (2009)			0.27	39	70.2
Marengo I, WA (2009)			0.17	39	70.2
Klondike IIIa, OR			0.16	125	375
Northeast					
Mountaineer, WV	38.3[E]	8/1/04-9/14/04	31.69	44	68
Mount Storm, WV (2009)			24.32	132	264
Mount Storm, WV (2010)			15.18	132	264
Casselman, PA (Spring & Fall 2008)			12.61	23	34.5
Maple Ridge, NY (2006)			11.21	120	198
Maple Ridge, NY (2007)			9.42	195	321.7 5
Cohocton/Dutch Hill, NY (2009)			8.62	50	125
Noble Bliss, NY (2008)			7.8	67	100
Mount Storm, WV (Fall 2008)	35.2	7/20/08-10/12/08	6.62	82	164
Wolfe Island, Ont (July-December 2009)			6.42	86	197.8
Maple Ridge, NY (2008)			4.96	195	321.7 5
Noble Clinton, NY (2009)	1.9[C]	8/1/09-09/31/09	4.5	67	100
Noble Ellenburg, NY (2009)	16.1[C]	8/16/09-09/15/09	3.91	54	80
Noble Bliss, NY (2009)			3.85	67	100

Appendix A. Wind energy facilities in North America with fatality data for bat species, grouped by geographic region. Bat activity rates are included where available.

Wind Energy Facility	Bat Activity Estimate[A]	Bat Activity Dates	Fatality Estimate[B]	No. of Turbines	Total MW
Lempster, NH (2010)			3.57	12	24
Noble Ellenburg, NY (2008)			3.46	54	80
Noble Clinton, NY (2008)	2.1 [C]	8/8/08-09/31/08	3.14	67	100
Lempster, NH (2009)			3.11	12	24
Mars Hill, ME (2007)			2.91	28	42
Munnsville, NY (2008)			1.93	23	34.5
Stetson Mountain, ME (2009)	28.5	7/10/09-10/15/09	1.4	38	57
Mars Hill, ME (2008)			0.45	28	42
Southeast					
Buffalo Mountain, TN (2005)			39.70	18	28.98
Buffalo Mountain, TN (2000-2003)	23.7 [E]		31.54	3	1.98

A = Bat passes per detector-night
B = Number of fatalities per megawatt per year
C = Activity rate based on data collected at various heights; all other activity rates are from ground-based units only
D = Activity rate was averaged across phases and/or years
E = Activity rate calculated by WEST from data presented in referenced report
F= Activity rate based on pre-construction monitoring; data for all other activity and fatality rates were collected concurrently

Appendix A1 (*continued*). Wind energy facilities in North America with fatality data for bat species, grouped by geographic region. Bat activity rates are included where available.

Data from the following sources:

Project, Location	Activity Reference	Fatality Reference	Project, Location	Activity Reference	Fatality Reference
Alite, CA		Chatfield et al. 2010	Klondike, OR		Johnson et al. 2003b
Barton Chapel, TX		WEST 2011	Klondike II, OR		NWC and WEST 2007
Big Horn, WA		Kronner et al. 2008	Klondike III, OR		Gritski et al. 2009a
Biglow Canyon, OR (Phase I; 2008)		Jeffrey et al. 2009a	Klondike IIIa, OR		Gritski et al. 2009b
Biglow Canyon, OR (Phase I; 2009)		Enk et al. 2010	Leaning Juniper, OR		Kronner et al. 2007
Biglow Canyon, OR (Phase II; 2009/2010)		Enk et al. 2011	Lempster, NH (2009)		Tidhar et al. 2010
Blue Sky Green Field, WI	Gruver 2008	Gruver et al. 2009	Lempster, NH (2010)		Tidhar et al. 2011
Buffalo Gap I, TX		Tierney 2007	Maple Ridge, NY (2006)		Jain et al. 2007
Buffalo Gap II, TX		Tierney 2009	Maple Ridge, NY (2007)		Jain et al. 2009a
Buffalo Mountain, TN (2000-2003)	Fiedler 2004	Nicholson et al. 2005	Maple Ridge, NY (2008)		Jain et al. 2009d
Buffalo Mountain, TN (2005)		Fiedler et al. 2007	Marengo I, WA (2009)		URS Corporation 2010b
Buffalo Ridge, MN (Phase I; 1999)		Johnson et al. 2000	Marengo II, WA (2009)		URS Corporation 2010c
Buffalo Ridge, MN (Phase II; 1998)		Johnson et al. 2000	Mars Hill, ME (2007)		Stantec 2008
Buffalo Ridge, MN (Phase II; 1999)		Johnson et al. 2000	Mars Hill, ME (2008)		Stantec 2009a
Buffalo Ridge, MN (Phase II; 2001/Lake Benton I)	Johnson et al. 2004	Johnson et al. 2004	Moraine II, MN		Derby et al. 2010d
Buffalo Ridge, MN (Phase II; 2002/Lake Benton I)	Johnson et al. 2004	Johnson et al. 2004	Mount Storm, WV (Fall 08)	Young et al. 2009b	Young et al. 2009b
Buffalo Ridge, MN (Phase III; 1999)		Johnson et al. 2000	Mount Storm, WV (2009)		Young et al. 2009a, 2010a
Buffalo Ridge, MN (Phase III; 2001/Lake Benton II)	Johnson et al. 2004	Johnson et al. 2004	Mount Storm, WV (2010)		Young et al. 2010b, 2011
Buffalo Ridge, MN (Phase III; 2002/Lake Benton II)	Johnson et al. 2004	Johnson et al. 2004	Mountaineer, WV	Arnett et al. 2005, Arnett pers. comm.	Arnett et al. 2005
Buffalo Ridge I, SD (2010)		Derby et al. 2010b	Munnsville, NY (2008)		Stantec 2009b
Casselman, PA (Spring & Fall 2008)		Arnett et al. 2009	Nine Canyon, WA		Erickson et al. 2003
Cedar Ridge, WI (2009)	BHE Environmental 2008	BHE Environmental 2010	Noble Bliss, NY (2008)		Jain et al. 2009e
Cedar Ridge, WI (2010)	BHE Environmental 2008	BHE Environmental 2011	Noble Bliss, NY (2009)		Jain et al. 2010a
Cohocton/Dutch Hill, NY (2009)		Stantec 2010	Noble Clinton, NY (2008)	Reynolds 2010a	Jain et al. 2009c
Combine Hills, OR		Young et al. 2006	Noble Clinton, NY (2009)	Reynolds 2010a	Jain et al. 2010b
Crescent Ridge, IL		Kerlinger et al. 2007	Noble Ellenburg, NY (08)		Jain et al. 2009b
Crystal Lake II, IA		Derby et al. 2010a	Noble Ellenburg, NY (09)	Reynolds 2010b	Jain et al. 2010c
Dillon, CA		Chatfield et al. 2009	NPPD Ainsworth, NE		Derby et al. 2007
Dry Lake, AZ	Thompson et al. 2011	Thompson et al. 2011	Pebble Springs, OR		Gritski and Kronner 2010b
Elkhorn, OR (2008)		Jeffrey et al. 2009b	Prairie Winds ND1 (Minot), ND		Derby et al. 2011
Elm Creek, MN		Derby et al. 2010c	Ripley, Ont (2008)		Jacques Whitford 2009
Foote Creek Rim, WY (Phase I; 1999)		Young et al. 2003	Shiloh I, CA		Kerlinger et al. 2010
Foote Creek Rim, WY (Phase I; 2000)	Gruver 2002	Young et al. 2003	Stateline, OR/WA 2002		Erickson et al. 2004
Foote Creek Rim, WY (Phase I; 2001-2002)	Gruver 2002	Young et al. 2003	Stateline, OR/WA 2003		Erickson et al. 2004
Forward Energy Center, WI	Watt and Drake 2011	Grodsky and Drake 2011	Stetson Mountain, ME (2009)	Stantec 2009c	Stantec 2009c
Goodnoe, WA		URS Corporation 2010a	Summerview, Alb (2008)	Baerwald 2008	Baerwald 2008
Grand Ridge, IL		Derby et al. 2010g	Top of Iowa, IA (2003)		Jain 2005
Hay Canyon, OR		Gritski and Kronner 2010a	Top of Iowa, IA (2004)	Jain 2005	Jain 2005
High Winds, CA (2004)		Kerlinger et al. 2006	Tuolumne (Windy Point I), WA		Enz and Bay 2010
High Winds, CA (2005)		Kerlinger et al. 2006	Vansycle, OR		Erickson et al. 2000
Hopkins Ridge, WA (2006)		Young et al. 2007	Wessington Springs, SD		Derby et al. 2010f
Hopkins Ridge, WA (2008)		Young et al. 2009c	Wild Horse, WA		Erickson et al. 2008
Judith Gap, MT		TRC 2008	Winnebago, IA		Derby et al. 2010e
Kewaunee County, WI		Howe et al. 2002	Wolfe Island, Ont (July-December 2009)		Stantec Ltd. 2010

Wildlife Baseline Studies for the Thunder Spirit Wind Farm Adams County, North Dakota

Sharp-tailed Grouse Lek and Raptor Nest Report Spring 2011

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NATURAL RESOURCES ◆ SCIENTIFIC SOLUTIONS

Draft Pre-Decisional Document - Privileged and Confidential - Not For Distribution

EXECUTIVE SUMMARY

Western EcoSystems Technology, Inc. conducted aerial sharp-tailed grouse lek and aerial and ground-based raptor nest surveys in April and May 2011 at the Thunder Spirit Wind Farm which is located northeast of the city Hettinger in central Adams County, North Dakota. This report presents results of those surveys.

Aerial sharp-tailed grouse lek surveys were conducted during three time periods (April 27-28, May 3, and May 5, 2011) at the Thunder Spirit Wind Farm. During each period, approximately 327.1 kilometers (203.3 miles) of transects were surveyed. A total of five potential sharp-tailed grouse leks were recorded with two of those outside the project boundary but within 1 mile of the boundary.

Two raptor nests were documented during both aerial and ground-based surveys in or within 16.1 kilometers (10 miles) of the Thunder Spirit Wind Farm. Both were active with a great horned owl nest within the project boundary and a Swainson's hawk nest located approximately 1.2 kilometers (0.75 miles) outside the boundary. No nests were observed which had the structure consistent with that of an eagle nest. Both native and planted grassland habitat is present in and around the Thunder Spirit Wind Farm and could provide suitable nesting habitat for the ground nesting northern harrier and burrowing owl.

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INTRODUCTION

Thunder Spirit Wind LLC is proposing to construct a wind energy facility in Adams County North Dakota referred to as the Thunder Spirit Wind Farm (TSWF). Thunder Spirit Wind, LLC contracted Western EcoSystems Technology, Inc. (WEST) to develop and implement a standardized protocol for baseline wildlife studies at the TSWF to estimate impacts of the proposed wind energy facility on wildlife and to assist with siting turbines to minimize impacts to wildlife resources.

This report presents results of aerial sharp-tailed grouse (*Tympanuchus phasianellus*) lek surveys, aerial, large raptor nest surveys, and ground base raptor nest surveys conducted during April and May 2011. Data includes sharp-tailed grouse observations and locations and raptor nest locations and status.

STUDY AREA

The TSWF, currently about 23,006 acres (ac; 93.1 square kilometers [km^2]; 36.0 square miles [mi^2]) is located in southwest North Dakota and more specifically northeast of the city of Hettinger in central Adams County. The landscape within the TSWF is rolling to flat with several low buttes and ridges found within the project area. Most of the historical short-grass prairie has been converted to agricultural use with crop production and livestock grazing the primary practices. Trees and shrubs can be found mainly around farmsteads and within planted shelter belts. There is a mixture of natural and man-made wetlands scattered throughout the TSWF.

METHODS

Aerial Sharp-tailed Grouse Lek Surveys

The objective of the aerial sharp-tailed grouse lek survey was to determine the approximate location of sharp-tailed grouse leks and provide a general sense of sharp-tailed grouse use within and immediately adjacent to the TSWF during the normal lekking period (early April through mid-May). Survey methodology was similar to that used for greater prairie chickens (*Tympanuchus cupido*) in Oklahoma (Martin and Knopf 1981).

Survey Methods

North/south running transects started 800 meters (m; 0.5 miles [mi]) outside the east/west project boundary and were placed at approximate 400 m (0.25 mi) intervals, covering the entire TSWF (Figure 1). Each transect was approximately 11.3 km (7 mi) long and extended 800 m (0.5 mi) beyond the north/south boundary. Each transect was flown by fixed-winged aircraft at an approximate height of 30 to 46 m (100 – 150 feet [ft]) during three separate survey periods. Surveys began approximately one half hour before sunrise. The location of any suspected sharp-tailed grouse lek was recorded with a global positioning system (GPS) unit. The number and activity of birds at each location was also recorded.

Raptor Nest Surveys

The objective of the raptor nest surveys was to locate and record potential raptor nests that may be subject to disturbance and/or displacement effects by wind-energy facility construction and/or operation. Surveys were focused on large, stick nest structures, and did not include searches for cavity nests or nests on the ground.

Survey Methods

Two survey methods were used to document potential raptor nests within and adjacent to the NRWRA. Suitable habitat (large trees, power poles, rocky outcroppings) within a 16.1 kilometer (km; 10 mi) buffer surrounding the project boundary was surveyed by fixed-winged aircraft to document large nest structures indicative of eagle nests. A GPS unit was used to record potential eagle nest locations.

A second type of raptor nest survey was ground based and completed by having a field biologist record potential raptor nests while conducting weekly avian use surveys during leaf off conditions within and immediately adjacent to the project. Potential raptor nests were recorded on aerial photo maps and digitized with geographic information system (GIS) software. Other information recorded included nest status, nest height, and nest material.

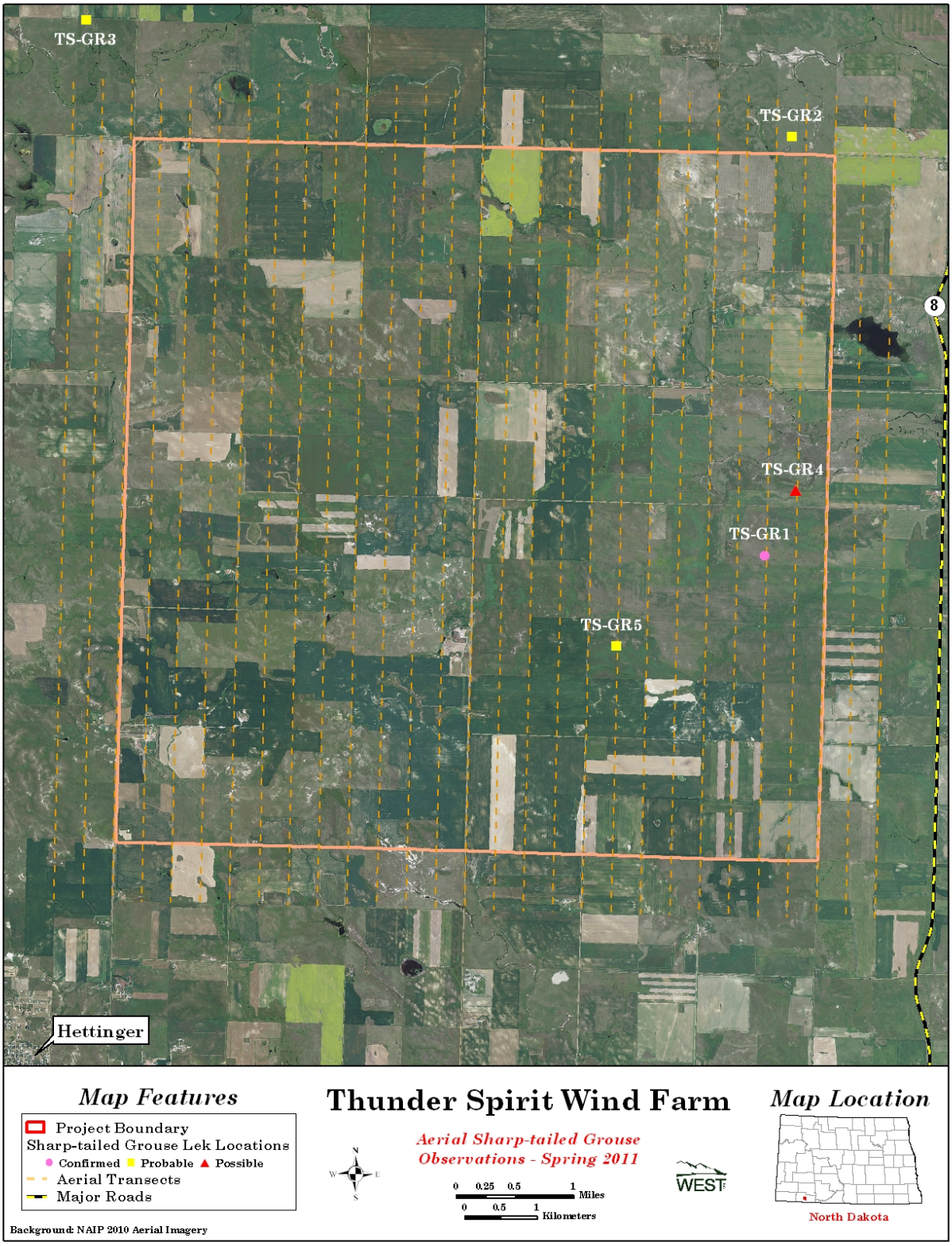


Figure 1. Sharp-tailed grouse observations at the Thunder Spirit Wind Farm during spring 2011.

RESULTS

Aerial Sharp-tailed Grouse Lek Surveys

Approximately 327.1 km (203.3 mi) of transects were surveyed during each of three time periods (April 27 & 28, May 3, and May 5). One confirmed (birds observed in courtship behavior at the same location during more than one survey) lek; three probable (birds observed in courtship behavior during only one survey) leks; one possible (birds observed in the same general location during more than one survey but showing little or no courtship behavior) lek were identified (Table 1; Figure 1). Confirmed lek TS-GR1 was located within the project boundary in planted grassland habitat (Figure 1). Two of the three probable leks were located in native prairie habitat, outside of the project boundary while the third was within the boundary in alfalfa hay cropland (Figure 1). The one possible lek, TS-GR4, was located in an unknown grassland habitat type, inside the project boundary (Figure 1).

Table 1. Summary of aerial sharp-tailed grouse surveys conducted during spring 2011 at the Thunder Spirit Wind Farm.

Survey Period	Date First Observed	Observation ID	Highest Total	Number Displaying	Lek
1	4/28/2011	TS-GR1	7	7	confirmed
	4/28/2011	TS-GR2	18	+/-13	probable
2	5/3/2011	TS-GR3	6	4	probable
	5/3/2011	TS-GR4	4	0	possible
3	5/5/2011	TS-GR5	17	+/-13	probable

Raptor Nest Surveys

Two active raptor nests were recorded during aerial and ground surveys (Figure 2). Neither of which were occupied by eagles. Nest TS-RN1 was located within the TSWF and occupied by a great horned owl (*Bubo virginianus*; Figure 2). An active Swainson's hawk (*Buteo swainsoni*) nest (TS-RN2) was located approximately 1.2 km (0.75 mi) outside of the eastern project boundary (Figure 2). No other potential raptor nest structures were observed during aerial or ground surveys.

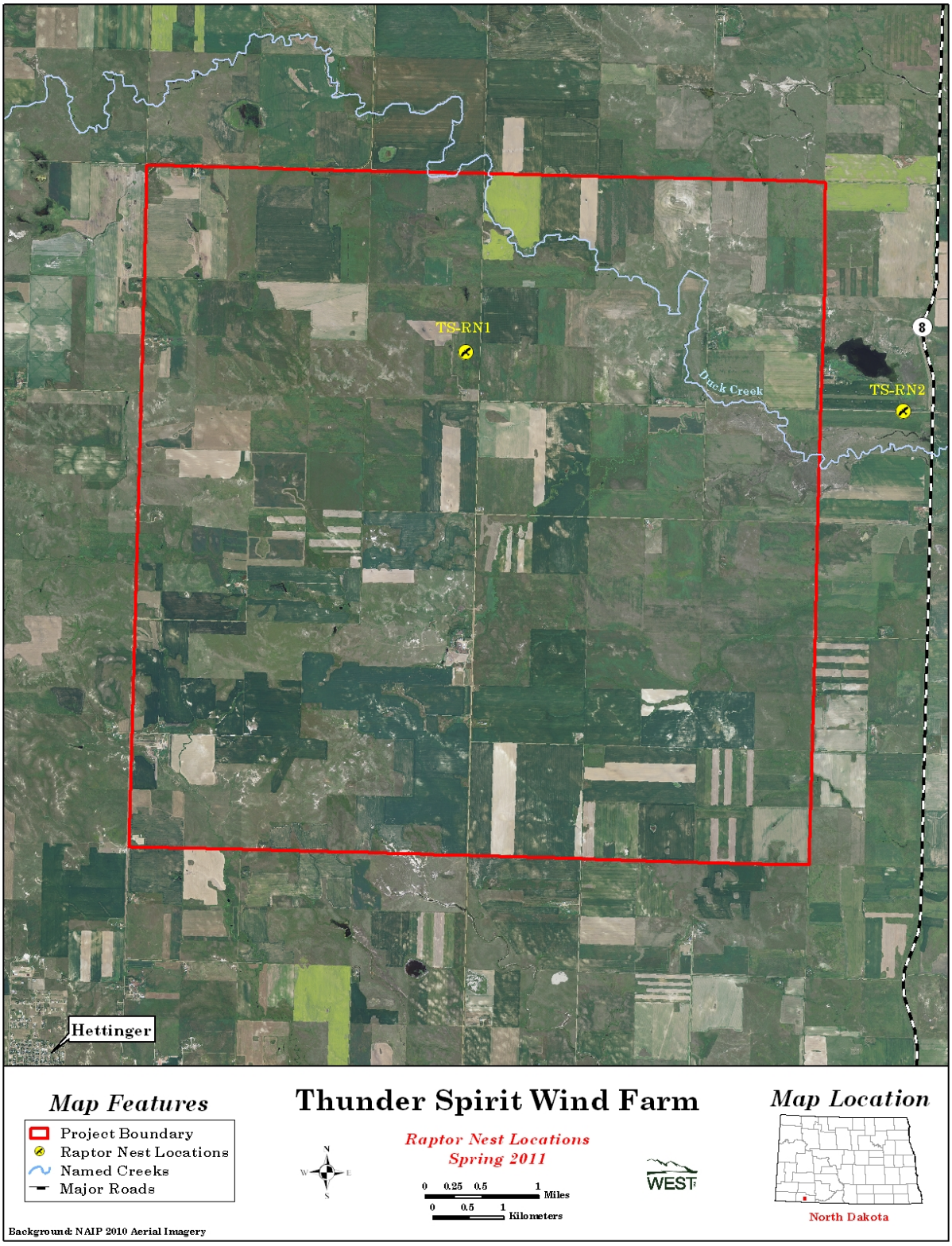


Figure 2. Raptor nest locations at the Thunder Spirit Wind Farm during spring 2011.

DISCUSSION

Aerial Sharp-tailed Grouse Lek Surveys

The start of aerial surveys was delayed due to persistent snow cover across the project area and the availability of survey aircraft. Aircraft availability also caused all three surveys to be conducted within a nine day period in late April/early May. This time frame however, likely fell during peak sharp-tailed grouse lekking activity within this part of their range (SDGFP undated). Also, the TSWF and 0.8 km (0.5 mi) buffer were completely surveyed during each survey period. Therefore, it is likely the majority of leks used in 2011 within and immediately adjacent to the project were detected.

Observation TS-GR4 was considered a possible lek location even though no courtship behavior was observed because of the habitat in which the birds were observed in and reluctance of the birds to leave the area. All other sharp-tailed grouse observation locations had males displaying during one or more survey periods.

Raptor Nest Survey

Based on both ground and aerial surveys, it does not appear that the TSWF and surrounding area has high raptor nesting density. Although no potential eagle nests were observed in or within 16.1 km (10 mi) of the project boundary, it is possible a nest went undetected, especially during aerial surveys of the buffer area, because only the most likely eagle nesting habitat was surveyed in the buffer. There is a historic golden eagle nest approximately 5 miles west of the project boundary that was not detected during surveys.

Both native and planted grassland habitat is present in and around the TSWF and could provide suitable nesting habitat for the ground nesting northern harrier (*Circus cyaneus*) and burrowing owl (*Athene cunicularia*).

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Shadow Flicker Impact Analysis for the Thunder Spirit Wind Energy Project

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May 2013

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ATTACHMENT

Attachment A. Detailed Summary of WindPro Shadow Flicker Analysis Results

1.0 OVERVIEW

A wind turbine's moving blades can cast a moving shadow on locations within a certain distance of a turbine. These moving shadows are called shadow flicker, and can be a temporary phenomenon experienced at nearby residences or public gathering places. The impact area depends on the time of year and day (which determine the sun's azimuth and altitude angles) and the wind turbine's physical characteristics (height, rotor diameter, blade width, and orientation of the rotor blades). Shadow flicker generally occurs during low angle sunlight conditions, typically during sunrise and sunset times of the day. However, when the sun angle gets very low (less than 3 degrees), sunlight passes through more atmosphere and becomes too diffused to form a coherent shadow. Shadow flicker will not occur when the sun is obscured by clouds or fog, at night, or when the source turbine(s) are not operating.

Shadow flicker intensity is defined as the difference in brightness at a given location in the presence and absence of a shadow. Shadow flicker intensity diminishes with greater receptor-to-turbine separation distance. Shadow flicker intensity for receptor-to-turbine distances beyond 2,000 meters (6,562 feet) is very low and generally considered imperceptible. In general, increasing proximity to turbines may make shadow flicker more noticeable, with the largest number of shadow flicker hours, along with greatest shadow flicker intensity, occurring nearest the wind turbines.

Thunder Spirit Wind, LLC (Thunder Spirit), an affiliate of Global Winds Harvest, Inc., is proposing to install up to 75 wind turbines with a maximum nameplate capacity of 150 MW (the number of turbines depending on the size of turbine used) as part of the Thunder Spirit Wind Energy Project (the Project) in Adams County, North Dakota. Because the Project is using a minimum turbine siting setback requirement of 2,640 feet (805 meters) to all non-participating residences, the most sensitive receptors (potentially occupied non-participating residences) are generally not located in potential shadow flicker impact zones.

The three wind turbine models being considered for the Project, and evaluated for potential shadow flicker impacts, have the following characteristics:

- **Vestas V100 2.0** – 3-blade 100-meter diameter rotor, with a hub height of 80 meters. The Vestas V100 2.0 has a normal high rotor speed of 14.9 rotations per minute (rpm) which translates to a blade pass frequency of 0.7Hertz (Hz) which is less than 1 alternation per second. Although 85 Vestas turbines are included in this impact analysis to account for alternate locations that may be used, a maximum of 75 of these turbines will be constructed.

- **Siemens Energy, Inc. (Siemens) SWT 2.3-108** – 3-blade 108-meterdiameter rotor, with a hub height of 80 meters. The Siemens SWT 2.3-108 has a normal high rotor speed of 16 rpm which translates to a blade pass frequency of 0.8 Hz (less than 1 alternation per second). Although 85 Siemens turbines are included in this impact analysis to account for alternate locations that may be used, a maximum of 65 of these turbines will be constructed.

- **Acciona AW116/3000** – 3-blade 116-meterdiameter rotor, with a hub height of 92 meters. The Acciona AW116/3000 has a normal high rotor speed of 15.6 rpm which translates to a blade pass frequency of 0.8 Hz (less than 1 alternation per second). Although 85 Acciona turbines are included in this impact analysis to account for alternate locations that may be used, a maximum of 50 of these turbines will be constructed.

The project layout has been designed so that any of the three turbine models can be sited within the 85 locations. Because the layout has not been finalized, the shadow flicker impact analysis considered all 85 turbines, which represents 10-35 more turbines than will be constructed for the three scenarios.

Shadow flicker frequency is related to the wind turbine's rotor blade speed and the number of blades on the rotor. From a health standpoint, the low flicker frequencies associated with wind turbines, are harmless. For comparison, strobe lights used in discotheques have frequencies which range from about 3 Hz to 10 Hz (1 Hz = 1 flash per second). As a result, public concerns that flickering light from wind turbines can have negative health effects, such as triggering seizures in people with epilepsy are unfounded. Epilepsy Action (working name for the British Epilepsy Foundation) states that there is no evidence that wind turbines can cause seizures (Epilepsy Action 2008). However, they recommend that wind turbine flicker frequency be limited to 3 Hz. Since the proposed Project's wind turbine blade pass frequency is approximately 0.7-0.8 Hz (less than 1 alternation per second), no negative health effects to individuals with photosensitive epilepsy are anticipated.

Shadow flicker impacts are not regulated in applicable state or federal law, and there is no permitting threshold with regard to hours per year of anticipated impacts to a receptor from a wind energy project. Due to the significant growth of the wind energy industry in recent years, some states have published model bylaws for local governments to adopt or modify at their own discretion which sometimes include guidance and recommendations for shadow flicker levels and mitigation. In lieu of specific regulations, a general precedent has been established in the industry both abroad and in the United States that fewer than 30 hours per year of shadow flicker impacts is acceptable to receptors in terms of nuisance and well below health hazard concerns. In a German court case, for example, a judge found 30 hours of actual shadow flicker per year at a certain neighbor's property to be tolerable (WindPower 2003). The 30 hours per year threshold value has been widely used in the industry as a target value in the absence of formal guidelines. However, predicted shadow flicker greater than this threshold does not necessarily create a nuisance and is still well below concerns for impacts to health.

2.0 WINDPRO SHADOW FLICKER ANALYSIS

An analysis of potential shadow flicker impacts from the Project was conducted using the WindPro software package. The turbine array provided by Thunder Spirit (layout dated April 26, 2013), which includes 85 turbines, was included in the analysis. The analysis evaluated the following three turbine scenarios:

- Scenario A – 85 Vestas V100 2.0 turbines (only 75 of these turbines would be constructed)
- Scenario B – 85 Siemens SWT 2.3-108 turbines (only 65 of these turbines would be constructed)
- Scenario C – 85 Acciona AW116/3000 turbines (only 50 of these turbines would be constructed)

The WindPro analysis was conducted to determine shadow flicker impacts under realistic impact conditions (actual expected shadow). This analysis calculated the total amount of time (hours and minutes per year) that shadow flicker could occur at receptors out to one mile (5,280 feet). The realistic impact condition scenario is based on the following assumptions:

- The elevation and position geometries of the wind turbines and surrounding receptors (potentially occupied residences). Elevations were determined using United States Geological Survey (USGS) digital elevation model (DEM) data. Positions geometries were determined using geographic information system (GIS) and referenced to Universal Transverse Mercator (UTM) Zone 13 (NAD83).
- The position of the sun and the incident sunlight relative to the wind turbine and receptors on a minute-by-minute basis over the course of a year.
- Historical sunshine availability (percent of total hours available). Historical sunshine rates for the area (as summarized by the National Climatic Data Center (NCDC 2008) for nearby Bismarck, North Dakota) used in this analysis are as follows:

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
53%	53%	58%	58%	61%	64%	73%	72%	65%	58%	43%	47%

- Estimated wind turbine operations and orientation (based on approximately 1 year of wind data from June 2011 through May 2012 (wind speed / wind direction frequency distribution) measured at on-site meteorological towers).
- Receptor viewpoints (i.e., house windows) are assumed to always be directly facing turbine to sun line of sight (“greenhouse mode”).

WindPro incorporates terrain elevation contour information and the analysis accounts for terrain elevation differences. The sun’s path with respect to each turbine location is calculated by the software to determine the cast shadow paths every minute over a full year. Sun angles less than 3 degrees above the horizon were excluded, for the reasons identified earlier in this section.

It should be noted however, that WindPro provides a conservative estimate of shadow flicker as obstacles such as trees, haze, and visual obstructions (window facing, coverings) are not fully accounted despite the likelihood of their reducing or eliminating shadow flicker impacts to receptors. A total of 26 receptor locations (potentially occupied residences) were identified within one mile of proposed Project turbines A receptor in the model is defined as a 1 meter squared area (approximate size of a typical window), 1 meter (3.28 feet) aboveground level. Approximate eye level is set at 1.5 meters (4.94 feet). Figure 1 shows the receptor locations and proposed Project turbines considered for Scenarios A, B, and C.

3.0 SHADOW FLICKER ANALYSIS RESULTS

As expected, WindPro predicts that shadow flicker impacts will be greatest at locations nearer to the wind turbines. Figures 2A, 2B, and 2C describe the WindPro predicted shadow flicker impact areas for turbine Scenarios A, B, and C, respectively. A detailed WindPro shadow flicker analysis summary, for each of the modeled receptor location, is provided in Attachment A. Tables 1A, 1B, and 1C present the WindPro predicted shadow flicker impacts for the top ten worst case receptors for turbine Scenarios A, B, and C, respectively. Considering all turbine scenarios, only 2 of the 26 receptors modeled had expected shadow flicker impacts of more than 30 hours per year. The maximum predicted shadow flicker impact at a receptor is 76 hours 58 minutes per year (receptor #28), which is approximately 1.7 percent of the potential available daylight hours.

Table 1A. WindPro Predicted Shadow Flicker Impacts for Receptors with Maximum Expected Impacts – Turbine Scenario A (85 Vestas V100 2.0 Turbines)

Receptor ID*	Receptor Description	Shadow Hours per Year (expected) [hh:mm / year]
28	Participating Landowner	58:20
67	Abandoned/Participating	26:52
23	Non-participating Receptor	16:37
2	Non-participating Receptor	13:06
9	Non-participating Receptor	9:29
10	Participating Landowner	9:26
14	Non-participating Receptor	9:10
11	Participating Landowner	8:35
8	Participating Landowner	8:31
3	Non-participating Receptor	8:14

Table 1B. WindPro Predicted Shadow Flicker Impacts for Receptors with Maximum Expected Impacts – Turbine Scenario B (85 Siemens SWT 2.3-108 Turbines)

Receptor ID*	Receptor Description	Shadow Hours per Year (expected) [hh:mm / year]
28	Participating Landowner	65:20
67	Abandoned/Participating	30:25
23	Non-participating Receptor	19:03
2	Non-participating Receptor	14:32
10	Participating Landowner	11:07
14	Non-participating Receptor	10:59
11	Participating Landowner	9:42
7	Non-participating Receptor	9:23
9	Non-participating Receptor	8:27
8	Participating Landowner	8:15

Table 1C. WindPro Predicted Shadow Flicker Impacts for Receptors with Maximum Expected Impacts – Turbine Scenario C (85 Acciona AW116/3000 Turbines)

Receptor ID*	Receptor Description	Shadow Hours per Year (expected) [hh:mm / year]
28	Participating Landowner	76:58
67	Abandoned/Participating	34:40
23	Non-participating Receptor	24:59
2	Non-participating Receptor	21:15
14	Non-participating Receptor	16:44
7	Non-participating Receptor	15:30
9	Non-participating Receptor	14:50
10	Participating Landowner	14:31
3	Non-participating Receptor	12:59
11	Participating Landowner	12:25

The shadow flicker impact prediction statistics are summarized in Tables 2A, 2B, and 2C.

Table 2A. Statistical Summary of WindPro Predicted Shadow Flicker Impacts at Modeled Receptor Locations – Turbine Scenario A (85 Vestas V100 2.0 Turbines)

Cumulative Shadow Flicker Time (expected)	Number of Receptors
Total	26
= 0 Hours	8
> 0 Hours < 10 Hours	14
≥ 10 Hours < 20 Hours	2
≥ 20 Hours < 30 Hours	1
≥ 30 Hours	1

Table 2B. Statistical Summary of WindPro Predicted Shadow Flicker Impacts at Modeled Receptor Locations – Turbine Scenario B (85 Siemens SWT 2.3-108 Turbines)

Cumulative Shadow Flicker Time (expected)	Number of Receptors
Total	26
= 0 Hours	8
> 0 Hours < 10 Hours	12
≥ 10 Hours < 20 Hours	4
≥ 20 Hours < 30 Hours	0
≥ 30 Hours	2

Table 2C. Statistical Summary of WindPro Predicted Shadow Flicker Impacts at Modeled Receptor Locations – Turbine Scenario C (85 Acciona AW116/3000Turbines)

Cumulative Shadow Flicker Time (expected)	Number of Receptors
Total	26
= 0 Hours	8
> 0 Hours < 10 Hours	5
≥ 10 Hours < 20 Hours	9
≥ 20 Hours < 30 Hours	2
≥ 30 Hours	2

The slightly higher shadow flicker impacts for Scenario C (Acciona turbines), can be explained by the difference in turbine design specifications (i.e., its taller tower and longer blades). Note: Although 85 turbines were used in the model, only 50 of these turbines will actually be constructed.

4.0 CONCLUSION

The analysis of potential shadow flicker impacts from the Project on nearby receptors shows that shadow flicker impacts within the area of study are expected to be minor and well within acceptable ranges for avoiding nuisance and/or health hazards. The two receptors that exceed the target of 30 hours per year under the most conservative conditions are participating landowners, with land under lease to Thunder Spirit. The analysis assumes that the receptors all have a direct in-line view of the incoming shadow flicker sunlight and does not account for trees or other obstructions which may block sunlight. In reality, the windows of many houses will not face the sun directly for the key shadow flicker impact times. Adding to the analysis' conservatism is that potential shadow flicker impacts for wind turbines up to one mile (5,280 feet) away from a receptor were determined, and Thunder Spirit will only construct 150 MW (i.e. not all 85 turbines modeled will be constructed). For these reasons, shadow flicker impacts are expected to be considerably less than estimated in this conservative analysis, and shadow flicker is not expected to be a significant environmental impact. Mitigation measures such as strategic vegetative screening and/or installation of curtains and blinds on the windows facing the turbine casting the shadows are effective and economically viable options that Thunder Spirit could consider on an individual basis with landowners, if necessary.

5.0 REFERENCES

Epilepsy Action. 2008. British Epilepsy Association. http://www.epilepsy.org.uk/info/photo_other.html. Accessed 3/1/10.

National Climatic Data Center (NCDC). 2008. Sunshine Average Percent of Possible. http://www.ncdc.noaa.gov/oa/climate/online/ccd/pctpos.txt. Accessed 3/1/10

WindPower. 2003. Danish Wind industry Association. Shadow Casting From Wind Turbines. http://guidedtour.windpower.org/en/tour/env/shadow/index.htm, Accessed 4/28/10

FIGURES

Figure 1

Residential Receptors Modeled With WindPro to Predict Expected Shadow Flicker Impacts

Thunder Spirit Wind Energy Project
Thunder Spirit Wind, LLC
Adams County, North Dakota

May 2013

Legend

- Proposed Turbine Location (4/26/2013)
- Collector Substation Construction Footprint (20 Acres)
- Project Area

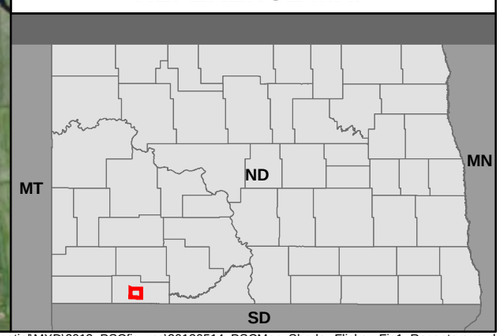
Receptor

- Signed Easement (Occupied)
- Signed Easement (Unoccupied)
- Not Signed (Occupied)
- Not Signed (Unoccupied)

N
W E
S

0 0.5 1 Miles

REFERENCE MAP



Path: P:\Global Winds Harvest\Thunder Spirit - ND\GIS\Spatial\MXD\2013_PSCfigures\20130514_PSCMap_ShadowFlicker_Fig1_Receptors.mxd

Figure 2A

WindPro Predicted Expected Shadow Flicker Impact Areas: Vestas Turbines

Thunder Spirit Wind Energy Project
Thunder Spirit Wind, LLC
Adams County, North Dakota

May 2013

Legend

- Proposed Turbine Location (4/26/2013)
- Collector Substation Construction Footprint (20 Acres)

Shadow Flicker Iso Line (Vestas)

- 15 hrs/yr
- 30 hrs/yr
- 50 hrs/yr
- 75 hrs/yr
- 100 hrs/yr
- Project Area

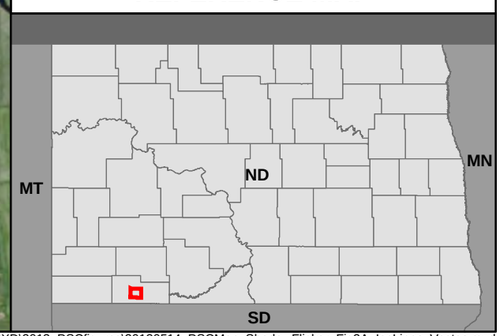
Receptor

- Signed Easement (Occupied)
- Signed Easement (Unoccupied)
- Not Signed (Occupied)
- Not Signed (Unoccupied)

N W E S

0 0.5 1 Miles

REFERENCE MAP



Path: P:\Global Winds Harvest\Thunder Spirit - ND\GIS\Spatial\MXD\2013_PSCfigures\20130514_PSCMap_ShadowFlicker_Fig2A_IsoLines_Vestas.mxd

Figure 2B

WindPro Predicted Expected Shadow Flicker Impact Areas: SiemensTurbines

Thunder Spirit Wind Energy Project
Thunder Spirit Wind, LLC
Adams County, North Dakota

May 2013

Legend

- Proposed Turbine Location (4/26/2013)
- Collector Substation Construction Footprint (20 Acres)

Shadow Flicker Iso Line (Siemens)

- 15 hrs/yr
- 30 hrs/yr
- 50 hrs/yr
- 75 hrs/yr
- 100 hrs/yr
- Project Area

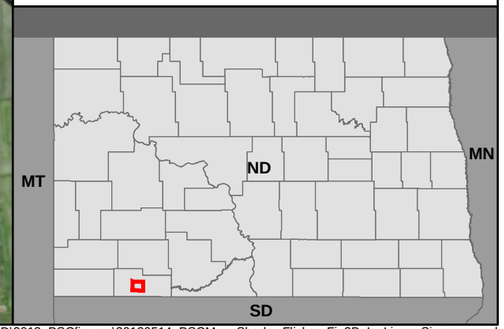
Receptor

- Signed Easement (Occupied)
- Signed Easement (Unoccupied)
- Not Signed (Occupied)
- Not Signed (Unoccupied)

N
W E
S

0 0.5 1 Miles

REFERENCE MAP



Path: P:\Global Winds Harvest\Thunder Spirit - ND\GIS\Spatial\MXD\2013_PSCfigures\20130514_PSCMap_ShadowFlicker_Fig2B_IsoLines_Siemens.mxd

Figure 2C

WindPro Predicted Expected Shadow Flicker Impact Areas: Acciona Turbines

Thunder Spirit Wind Energy Project
Thunder Spirit Wind, LLC
Adams County, North Dakota

May 2013

Legend

- Proposed Turbine Location (4/26/2013)
- Collector Substation Construction Footprint (20 Acres)

Shadow Flicker Iso Line (Acciona)

- 15 hrs/yr
- 30 hrs/yr
- 50 hrs/yr
- 75 hrs/yr
- 100 hrs/yr
- Project Area

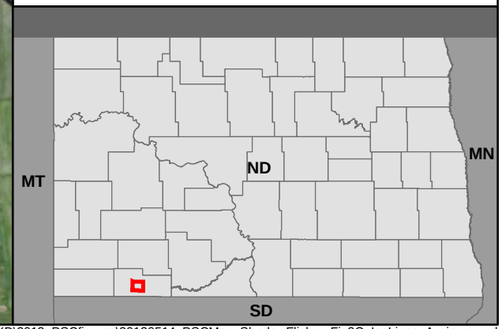
Receptor

- Signed Easement (Occupied)
- Signed Easement (Unoccupied)
- Not Signed (Occupied)
- Not Signed (Unoccupied)

N
W E
S

0 0.5 1 Miles

REFERENCE MAP



Path: P:\Global Winds Harvest\Thunder Spirit - ND\GIS\Spatial\MXD\2013_PSCfigures\20130514_PSCMap_ShadowFlicker_Fig2C_IsoLines_Acciona.mxd

ATTACHMENT A.

Detailed Summary of WindPro Shadow Flicker Analysis Results

Thunder Spirit Wind Energy Project
WindPro Shadow Flicker Analysis Results Summary
Turbine Scenario A (85 Vestas V100 2.0 Turbines)

Thunder Spirit Receptor ID	UTM-E (m)	UTM-N (m)	WindPro Predicted Expected Shadow Flicker (Hours per Year)
1	684417	5101848	0:00
2	684186	5105014	13:06
3	683913	5107467	8:14
6	689550	5106924	4:14
7	691200	5107045	7:47
8	691878	5107932	8:31
9	691131	5105359	9:29
10	688659	5103520	9:26
11	688595	5103125	8:35
12	685925	5100457	0:00
13	683758	5108307	6:03
14	682164	5106780	9:10
15	681853	5106609	7:54
17	683711	5100496	0:00
22	693510	5107659	0:00
23	693669	5103124	16:37
24	690307	5099887	0:00
26	685692	5100065	0:00
28	688638	5102441	58:20
29	692214	5104878	3:36
30	688431	5107000	7:13
67	685223	5108470	26:52
166	693657	5102971	4:24
169	693696	5102962	5:26
183	685531	5100343	0:00
190	684117	5099602	0:00

Thunder Spirit Wind Energy Project
WindPro Shadow Flicker Analysis Results Summary
Turbine Scenario B (85 Siemens SWT 2.3-108 Turbines)

Thunder Spirit Receptor ID	UTM-E (m)	UTM-N (m)	WindPro Predicted Expected Shadow Flicker (Hours per Year)
1	684417	5101848	0:00
2	684186	5105014	14:32
3	683913	5107467	6:07
6	689550	5106924	3:06
7	691200	5107045	9:23
8	691878	5107932	8:15
9	691131	5105359	8:27
10	688659	5103520	11:07
11	688595	5103125	9:42
12	685925	5100457	0:00
13	683758	5108307	6:47
14	682164	5106780	10:59
15	681853	5106609	7:58
17	683711	5100496	0:00
22	693510	5107659	0:00
23	693669	5103124	19:03
24	690307	5099887	0:00
26	685692	5100065	0:00
28	688638	5102441	65:20
29	692214	5104878	2:51
30	688431	5107000	4:14
67	685223	5108470	30:25
166	693657	5102971	5:19
169	693696	5102962	6:12
183	685531	5100343	0:00
190	684117	5099602	0:00

Thunder Spirit Wind Energy Project
WindPro Shadow Flicker Analysis Results Summary
Turbine Scenario C (85 Acciona AW116/3000 Turbines)

Thunder Spirit Receptor ID	UTM-E (m)	UTM-N (m)	WindPro Predicted Expected Shadow Flicker (Hours per Year)
1	684417	5101848	0:00
2	684186	5105014	21:15
3	683913	5107467	12:59
6	689550	5106924	7:33
7	691200	5107045	15:30
8	691878	5107932	12:05
9	691131	5105359	14:50
10	688659	5103520	14:31
11	688595	5103125	12:25
12	685925	5100457	0:00
13	683758	5108307	8:38
14	682164	5106780	16:44
15	681853	5106609	11:02
17	683711	5100496	0:00
22	693510	5107659	0:00
23	693669	5103124	24:59:00
24	690307	5099887	0:00
26	685692	5100065	0:00
28	688638	5102441	76:58:00
29	692214	5104878	7:13
30	688431	5107000	12:07
67	685223	5108470	34:40:00
166	693657	5102971	7:24
169	693696	5102962	8:18
183	685531	5100343	0:00
190	684117	5099602	0:00

To: Global Winds Harvest Inc. and Thunder Spirit Wind, LLC
From: Tetra Tech, Inc.
Subject: Thunder Spirit Wind Farm –Acoustic Modeling Analysis
Date: May 29, 2013

Global Winds Harvest Inc. and Thunder Spirit Wind, LLC (Thunder Spirit) are proposing to construct and operate the Thunder Spirit Wind Farm (the "Project") in Adams County, North Dakota. The proposed Project layout includes locations for up to 85 wind turbine generators (WTGs) as well as a supporting collector substation. These 85 locations represent the locations where up to 75 turbines would be constructed plus 10 alternate locations. Tetra Tech conducted acoustic modeling analyses for the Project layout configuration received on April 26, 2013 using the three candidate WTG models presented in Table 1. For the worst case consideration of these analyses, all 85 locations were assumed to host turbines of all three candidate turbines, even though a maximum of 50 x 3MW turbines, 66 x 2.3MW, or 75 x 2MW turbines will ultimately be constructed.

Table 1.Thunder Spirit Wind Farm Project –WTG Candidates and Layout Configurations

WTG Model	Quantity*	MW per WTG	Hub Height (m)	Rotor Diameter (m)	Maximum Sound Power Level (dBA)**
Acciona 116/3000	85	3.0	92	116	107.4
Vestas V100 2.0	85	2.0	80	100	105.5
Siemens 2.3-108	85	2.3	80	108	107

*Although 85 WTGs were used in this analysis to account for a worst case scenario, Thunder Spirit plans to only install enough WTGs to support a total nameplate capacity of 150 MW.

**A confidence interval of 2dBA was applied to the maximum sound power level for all WTG models.

This technical memo summarizes the applicable noise criteria, acoustic model inputs, and the results for the three WTG models under consideration. More detailed results are provided for the worst case scenario (i.e., the WTG model generating the highest received sound levels or the greatest number of potential exceedance conditions at noise-sensitive receptors (NSRs)).

Applicable Noise Criteria

Tetra Tech completed a regulatory review, which showed that there are no noise requirements applicable to the Project at the state level. At the county level, the Adams County Zoning Ordinance provides limits in Section 6.7:

> *6.7 Noise*
>
> *Sustained noise of over 80 dB during the day and 70 dB at night is not allowed.*

There are no federal noise requirements specific to the Project; however the U.S. Environmental Protect Agency (EPA) has issued relevant guidance. In 1974, the EPA published "Information on Levels of Environmental Noise Requisite to Protect Public Health and Welfare with an Adequate Margin of Safety". This report represents the only published study that includes a large database of community reaction to noise to which a proposed project can be readily compared. This publication evaluates the effects of environmental noise with respect to health

and safety, and provides information for state and local governments to use in developing their own ambient noise standards.

For outdoor residential areas and other locations in which "quiet" is a basis for use, the recommended EPA guideline is an L_{dn} of 55 dBA. Provided that Project operations meet this criterion, EPA concludes that adjacent NSRs would regard this noise level as generally acceptable. Assuming the wind turbine is operating continuously and is the dominant contributor of sound at the receiver location, the L_{dn} is approximately 6.4 dBA above the measured L_{eq}. Consequently, an L_{dn} of 55 dBA corresponds to a continuous L_{eq} of 48.6 dBA. The EPA guideline has been accepted as the basis of assessing project acceptability in the permitting of recently proposed wind farms in the state of North Dakota.

Acoustic Modeling Methodology and Inputs

Acoustic modeling was conducted using DataKustic GmbH's CadnaA, the computer-aided noise abatement program (v 4.3.143). The engineering methods specified in this standard consist of full (1/1) octave band algorithms that incorporate geometric spreading due to wave divergence, reflection from surfaces, atmospheric absorption, screening by topography and obstacles, ground effects, source directivity, heights of both sources and receptors, seasonal foliage effects, and meteorological conditions. The CadnaA acoustic modeling analysis incorporated site-specific topographic and terrain data and a mixed (semi-reflective) ground factor of G=0.5 was used.

Sound attenuation by the atmosphere is not strongly dependent on temperature and humidity; however, the temperature of 10^{o}C (50^{o}F) and 70 percent relative humidity parameters were selected as reasonably representative of conditions favorable to sound propagation. The ISO 9613-2 standard calculates attenuation for meteorological conditions favorable to propagation, i.e., downwind sound propagation or what might occur typically during a moderate atmospheric ground level inversion, which is typically assumed to be regulatory worst case. Conversely, there may be meteorological conditions from time to time that may aid in the long range propagation of sound. These anomalous meteorological conditions may include ground-based atmospheric temperature inversions and wind gradients that bend sound downwards, which may affect long range sound propagation. Received sound levels during anomalous meteorological conditions were also estimated using a range dependent correction factor.

Sound power specifications were obtained by Global Winds Harvest from manufacturers for the three WTG models under consideration. Table 2 provides a summary of the sound power data correlated by wind speed at reference rotor hub height assuming a roughness length coefficient of 0.05 meters. The roughness length describes the change in wind speed at increased elevation and will vary based on actual terrain. WTG source emission data are reported per test methodologies developed by the International Electrotechnical Commission (IEC) Standard 61400-11, "Wind turbine generator systems – Part 11: Acoustic noise measurement techniques", 2nd Ed., 2002. The methodology has been specifically developed to allow WTG manufacturers to check the emitted noise levels of their WTGs prior to formal certification. The IEC 61400-11:2002 standard provides a uniform methodology for measuring the noise emissions of a WTG from cut-in through full rotational wind speeds.

The IEC testing standard deviation values σ_T, σ_R and σ_P for measured apparent sound power levels are described by IEC/TS 61400-14, where σ_T is the total standard deviation, σ_R is the standard deviation for test reproducibility, and σ_P is the standard deviation for product variation. For an established WTG model, it has been deemed reasonable to assume a σ_R< 0.8 dB and σ_P< 0.8dB as typical values leading to a calculated K-factor (i.e., uncertainty factor) of K < 2 dB

for a 95% confidence level. The mean apparent sound power level (L_{WA}) from *n* IEC 61400-11 testing reports is calculated as $L_W = L_{WA} + K$ where $K = 1{,}645\sigma_T$ resulting from *n* measurements performed according to the IEC 61400-11 standard. It is assumed that the WTG models for the Project will have similar sound power profiles as those used in the acoustic modeling analysis; however, it is possible that the final manufacturer warranty values may vary slightly.

Table 2. WTG Broadband Sound Power Levels (dBA) Correlated with Wind Speed

	WTG L_{max} Sound Power Level at Reference Wind Speed									
Wind Speed (m/s)	3 m/s	4 m/s	5 m/s	6 m/s	7 m/s	8 m/s	9 m/s	10 m/s	11 m/s	12 m/s
Acciona AW116/3000	--	--	--	106.5	107.4	107.3	107.2	107.0	--	--
Vestas V100 2.0	94.0	96.1	100.3	103.6	105.0	105.0	105.0	105.0	105.0	105.0
Siemens 2.3-108*	--	90.5	93.4	96.6	99.9	103.7	106.8	107.0	107.0	107.0

Note: "—" Indicates data unavailable for associated wind speed. Assumed cut-in was reported for the lowest wind speed for which data was reported.

*Referenced to hub height for a stated roughness length of 0.05m. The roughness length describes the change of wind speed at increased elevation and will vary based on actual terrain.

Sources: Acciona Wind Power, 2012; Vestas Wind Systems, 2012; and Siemens Wind Power, 2013

The Project collector substation was also assessed as part of the acoustic modeling analysis. Substations typically house one or more transformers, which are catalogued by megavolt ampere (MVA) ratings that indicate the maximum power output capacity. The National Electrical Manufacturers Association (NEMA) published NEMA Standards TR1-1993 (R2000) to establish the maximum noise level allowed for transformers. Transformer sound source levels for the future transformer were calculated assuming a 60 MVA rating and dimensions of approximately 5.3 meters (17.4 feet) width, by 6.3 (20.6 feet) meters length and 5.5 meters (18 feet) height, which results in an overall NEMA sound rating of 76 dBA. This information will be confirmed by the Project during final engineering design. Substations with transformer sizes of 10 to 150 MVA can present a noise concern if they are less than a few hundred feet to the closest NSR. Based on the current Project schematic design (dated April 26, 2013), the substation will be located in the southwest portion of the Project area approximately 330 meters (1,083feet) northwest of the closest receptor (ID 183).

Acoustic Model Results

To assess the noise emission of a wind farm prior to construction and to estimate compliance status with permitting requirements, it is necessary to have prediction models with which a noise emission source level measured at a given reference point can be certified. A generally accepted approach for modeling a WTG as an idealized point source is described in ISO9613-2, "Attenuation of Sound during Propagation Outdoors". With known emission levels and this type of sound propagation model, noise levels can be computed at arbitrary distances on a cumulative basis for the major wind speed directions. CadnaA, the program used for the Project acoustic analysis, conforms to this standard, applying its sound propagation algorithms.

To demonstrate the range of future noise levels within the Project area, sound modeling was completed to address multiple operating scenarios. Acoustic modeling for each WTG model under consideration was completed for operational conditions consisting of WTGs at cut-in rotation (slowest possible speed needed to generate electricity). Below this wind speed range there is insufficient strength in the wind for the WTGs to operate effectively and the noise emitted decreases rapidly. Modeling was also developed to describe maximum rotation (highest possible speed), and maximum rotation during anomalous meteorological conditions (non-standard atmospheric conditions conducive to long range sound propagation). The modeling results were compared to the EPA 48.6 dBA guideline criteria for the purposes of

assessing the potential for adverse noise impacts. Table 3 summarizes the number of NSRs within selected sound pressure level ranges under each of the identified operational conditions. The tabulated results are independent of the existing acoustic environment, (i.e. are representative of expected Project-generated sound levels only).

Table 3. Summary of Project Sound Levels at NSRs by WTG Model

Sound Level (dBA)	Number of NSRs Exceeding Sound Level Ranges								
	Acciona AW116/3000			Vestas V100 2.0			Siemens 2.3-108		
	Cut-in	Maximum	Maximum - Anomalous	Cut-in	Maximum	Maximum - Anomalous	Cut-in	Maximum	Maximum - Anomalous
> 48.6 EPA	**1**	**2**	**3**	**0**	**1**	**2**	**0**	**1**	**2**
> 50	1	1	1	0	1	1	0	1	1
45 to 50	7	9	11	0	2	5	0	7	10
40 to 45	11	10	12	0	15	15	0	11	12
35 to 40	5	4	2	2	6	5	1	5	3
< 35	2	2	0	24	2	0	25	2	0

As presented in Table 3 the modeling results indicate that received sound levels under maximum rotation and maximum rotation during anomalous events may potentially exceed the EPA 48.6 dBA guideline criteria at several NSR locations for all WTG models. Acciona exhibited the greatest potential impacts, yielding the highest received sound levels at NSRs and 1 potential exceedance at cut-in wind speed, 2 potential exceedances at maximum rotation and 3 potential exceedances at maximum rotation under anomalous meteorological conditions. However, these exceedances occurred at NSR ID 28, which is a Project participant and the structure is not occupied full time, and at NSR IDs 67 and 183, which have both been identified as abandoned residences. Attachment 1 presents the received sound levels at each of the 26 NSRs for the AW116/3000 WTG model as well as the receptor type, landowner status and UTM coordinates. Sound contour maps displaying the corresponding Project operational sound levels in color-coded isopleths are also provided in Figures 1 to 3 for cut-in rotation, maximum rotation, and maximum rotation under anomalous meteorological conditions. Isopleths are projected onto scaled aerial photographs at a height of 1.52 meters above grade (i.e., the approximate audible height of a stand person's ears).

The sound level from each WTG is assumed to be the nominally maximum downwind sound level in all directions simultaneously. In other words, although physically impossible, an omnidirectional wind is assumed. In reality, noise propagation biases towards downwind locations and therefore predicted values shall be over-estimations upwind of the proposed WTGs. Examples of additional conservatisms include:

- Observer Outside – the predicted sound levels occur outside; sound levels inside of any dwelling will be 10 to 20 dBA lower;
- Ground absorption values - Although, in reality, the ground of the survey area is predominantly porous (acoustically absorptive) it has been modeled as 'mixed', i.e. a combination of hard and porous, corresponding to a ground absorption coefficient of 0.5. It has been found that a middle value of 0.5 is appropriate for rural farming country in the sense that predicted sound levels agree very well with measurements of turbine-only sound levels over a variety of wind speeds.;
- Trees and other non-terrain shielding effects have not been considered; and

- The analyses and generated results reflect the maximum Project output with a layout for 85 WTGs; however, the Project will only employ enough WTGs to support an output of 150 MW. Therefore, actual received sound levels from Project operations at NSRs may be less than indicated dependent in part on WTG positions in the as-built layout.

In conclusion, the acoustic modeling analysis, demonstrates the Project has been adequately designed inclusive of a number of conservative assumptions to generate sound levels below EPA guidelines at all occupied non-participant NSRs. Noise levels due to the operation of the proposed wind farm have been predicted at nearby properties and, at all of these properties considered noise sensitive based on present day use, the predicted noise levels are 48.6 dBA or below, under all considered wind speeds.

ATTACHMENT 1

Tabulated Results and Sound Contour Figures for the Acciona AW116/3000 WTG Model

Acciona AW116/3000 WTG - Received Sound Levels by NSR

NSR ID	Receptor Type	Landowner Status	UTM Coordinates		Received Sound Level (dBA)		
					Acciona AW116/3000		
			Easting (m)	Northing (m)	Cut-in*	Maximum	Anomalous Meteorological Conditions
1	Residence	Participant	684417	5101848	39	40	42
2	Residence	Non-Participant	684186	5105014	43	44	45
3	Residence	Non-Participant	683913	5107467	43	44	45
6	Residence	Participant	689550	5106924	45	46	47
7	Residence	Non-Participant	691200	5107045	45	46	47
8	Residence	Participant	691878	5107932	46	46	47
9	Residence	Non-Participant	691131	5105359	45	46	47
10	Residence	Participant	688659	5103520	46	47	48
11	Residence	Participant	688595	5103125	46	47	47
12	Residence	Participant	685925	5100457	39	40	43
13	Residence	Non-Participant	683758	5108307	40	41	42
14	Residence	Non-Participant	682164	5106780	41	42	43
15	Residence	Participant	681853	5106609	39	40	41
17	Residence	Non-Participant	683711	5100496	33	34	37
22	Residence	Non-Participant	693510	5107659	38	38	40
23	Residence	Non-Participant	693669	5103124	43	44	45
24	Residence	Non-Participant	690307	5099887	39	40	41
26	Residence	Non-Participant	685692	5100065	43	44	47
28	Residence	Participant	688638	5102441	**53**	**54**	**54**
29	Residence	Non-Participant	692214	5104878	43	44	45
30	Residence	Participant	688431	5107000	45	45	46
67	Residence - Abandoned	Participant	685223	5108470	48	**49**	**49**
166	Residence - Abandoned	Non-Participant	693657	5102971	43	43	44
169	Residence - Abandoned	Non-Participant	693696	5102962	42	43	44
183	Residence - Abandoned	Non-Participant	685531	5100343	47	48	**50**
190	Residence	Non-Participant	684117	5099602	33	34	37

Note: Values in **red** indicate exceedances of the EPA 48.6 dBA criterion.
*Cut-in represented as 6 m/s as provided in the manufacturer specification.

Figure 1. Received Sound Levels –AW116/3000 WTG at Cut-in Rotational Wind Speed

Figure 1

Received Sound Levels:
AW116/3000 WTG at
Cut-in Rotational Wind Speed

Thunder Spirit Wind Energy Project
Thunder Spirit Wind, LLC
Adams County, North Dakota

May 2013

Legend

- Proposed Turbine Location (4/26/2013)
- Collector Substation Construction Footprint (20 Acres)
- Isopleth Range Exceeding EPA Guideline (>48.6 dBA)
- Project Area

Isopleth Ranges (dBA)

35 - 40 | 40 - 45 | 45 - 50 | 50 - 55 | > 55

Receptor

- Signed Easement (Occupied)
- Signed Easement (Unoccupied)
- Not Signed (Occupied)
- Not Signed (Unoccupied)

N W E S

0 0.5 1 2 Miles

Substation Detail Inset

0 200 400 800 Feet

REFERENCE MAP

MT ND SD MN

Path: P:\Global Winds Harvest\Thunder Spirit - ND\GIS\Spatial\MXD\2013_PSCfigures\20130514_PSCMap_Noise_Fig1_Cut-In.mxd

Figure 2. Received Sound Levels – AW116/3000 WTG at Maximum Rotational Wind Speed

Figure 2

Received Sound Levels:
AW116/3000 WTG at
Maximum Rotational Wind Speed

Thunder Spirit Wind Energy Project
Thunder Spirit Wind, LLC
Adams County, North Dakota

May 2013

Legend

- Proposed Turbine Location (4/26/2013)
- Collector Substation Construction Footprint (20 Acres)
- Isopleth Range Exceeding EPA Guideline (>48.6 dBA)
- Project Area

Isopleth Ranges (dBA)

35 - 40 | 40 - 45 | 45 - 50 | 50 - 55 | > 55

Receptor

- Signed Easement (Occupied)
- Signed Easement (Unoccupied)
- Not Signed (Occupied)
- Not Signed (Unoccupied)

N W E S

0 0.5 1 2 Miles

Substation Detail Inset

0 200 400 800 Feet

REFERENCE MAP

MT ND SD MN

Path: P:\Global Winds Harvest\Thunder Spirit - ND\GIS\Spatial\MXD\2013_PSCfigures\20130514_PSCMap_Noise_Fig2_MaxRot.mxd

Figure 3. Received Sound Levels – AW116/3000 WTG at Maximum Rotational Wind Speed under Anomalous Conditions

Figure 3

Received Sound Levels:
AW116/3000 WTG at
Maximum Rotational Wind Speed
under Anomalous Conditions

Thunder Spirit Wind Energy Project
Thunder Spirit Wind, LLC
Adams County, North Dakota

May 2013

Legend

- Proposed Turbine Location (4/26/2013)
- Collector Substation Construction Footprint (20 Acres)
- Project Area

Isopleth Ranges (dBA)

35 - 40 | 40 - 45 | 45 - 50 | 50 - 55 | > 55

- Isopleth Range Exceeding EPA Guideline (>48.6 dBA)

Receptor

- Signed Easement (Occupied)
- Signed Easement (Unoccupied)
- Not Signed (Occupied)
- Not Signed (Unoccupied)

N
W E
S

0 0.5 1 2 Miles

Substation Detail Inset

0 200 400 800 Feet

REFERENCE MAP

MT ND MN SD

Path: P:\Global Winds Harvest\Thunder Spirit - ND\GIS\Spatial\MXD\2013_PSCfigures\20130514_PSCMap_Noise_Fig3_AnomMet.mxd

Wind Power GeoPlanner™

AM and FM Radio Report

Thunder Spirit Wind



Prepared on Behalf of
Thunder Spirit Wind,
LLC

June 21, 2011

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1. Introduction

In this report, Comsearch analyzed AM and FM radio broadcast stations whose service could potentially be affected by the proposed Thunder Spirit wind energy project in Adams County, North Dakota.

2. Summary of Results

AM Radio Analysis
Comsearch found two database records[1] for AM stations within 35 kilometers of the project site, as shown in Table 1 and Figure 1. Both are non-directional stations.

ID	Call Sign	Status	Frequency (kHz)	Transmit ERP (kW)	City	State	Distance to Center of the Project (km)
1	KNDC	LIC	1490	1.0	HETTINGER	ND	12.28
2	KBJM	LIC	1400	1.0	LEMMON	SD	33.01

Table 1: AM Radio Stations

LIC = Licensed and Operational
kHz = kiloHertz
ERP = Transmit Effective Radiated Power
kW = kilowatts
km = kilometers

[1] Comsearch makes no warranty as to the accuracy of the data included in this report beyond the date of the report. The data presented in this report is derived from the AM/FM station's FCC license.

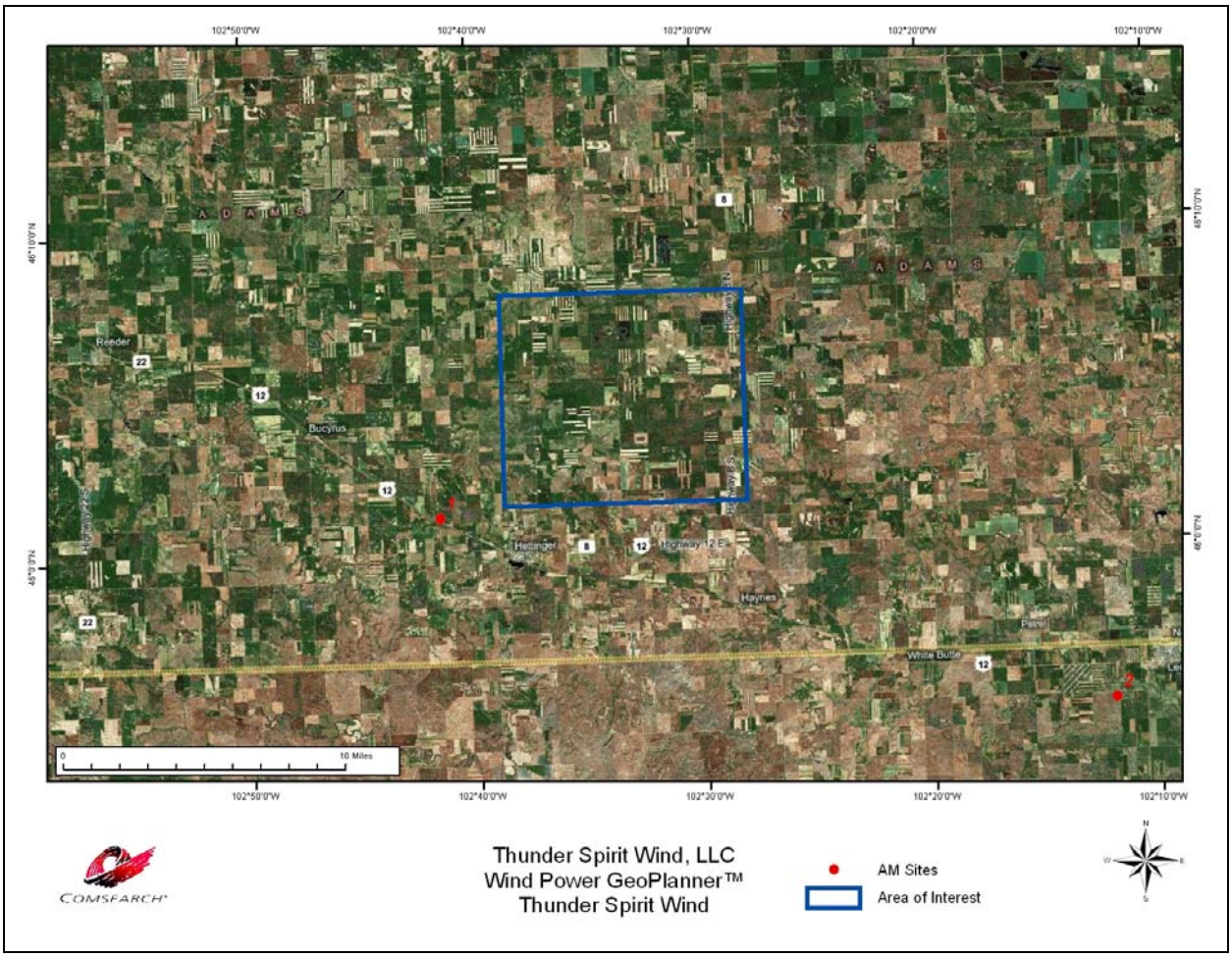


Figure 1: Plot of AM Radio Stations

FM Radio Analysis

Comsearch determined that there were three database records for FM stations within a 35 kilometer radius of the project, as shown in Table 2 and Figure 2. Two of the stations are translator stations that operate at low power and have limited range. The one full-power station is licensed under call sign KNDH and is located in Hettinger, North Dakota.

ID	Call Sign	Status	Frequency (MHz)	Transmit ERP (kW)	City	State	Distance to Center of the Project (km)
1	K220FG	LIC	91.9	0.009	HETTINGER	ND	10.17
2	KNDH	LIC	102.3	51.0	HETTINGER	ND	19.78
3	DK249AI	LIC	97.7	0.008	LEMMON	SD	33.53

Table 2: FM Radio Stations

LIC = Licensed and Operational
MHz = megaHertz
ERP = Transmit Effective Radiated Power
kW = kiloWatts
km = kilometers

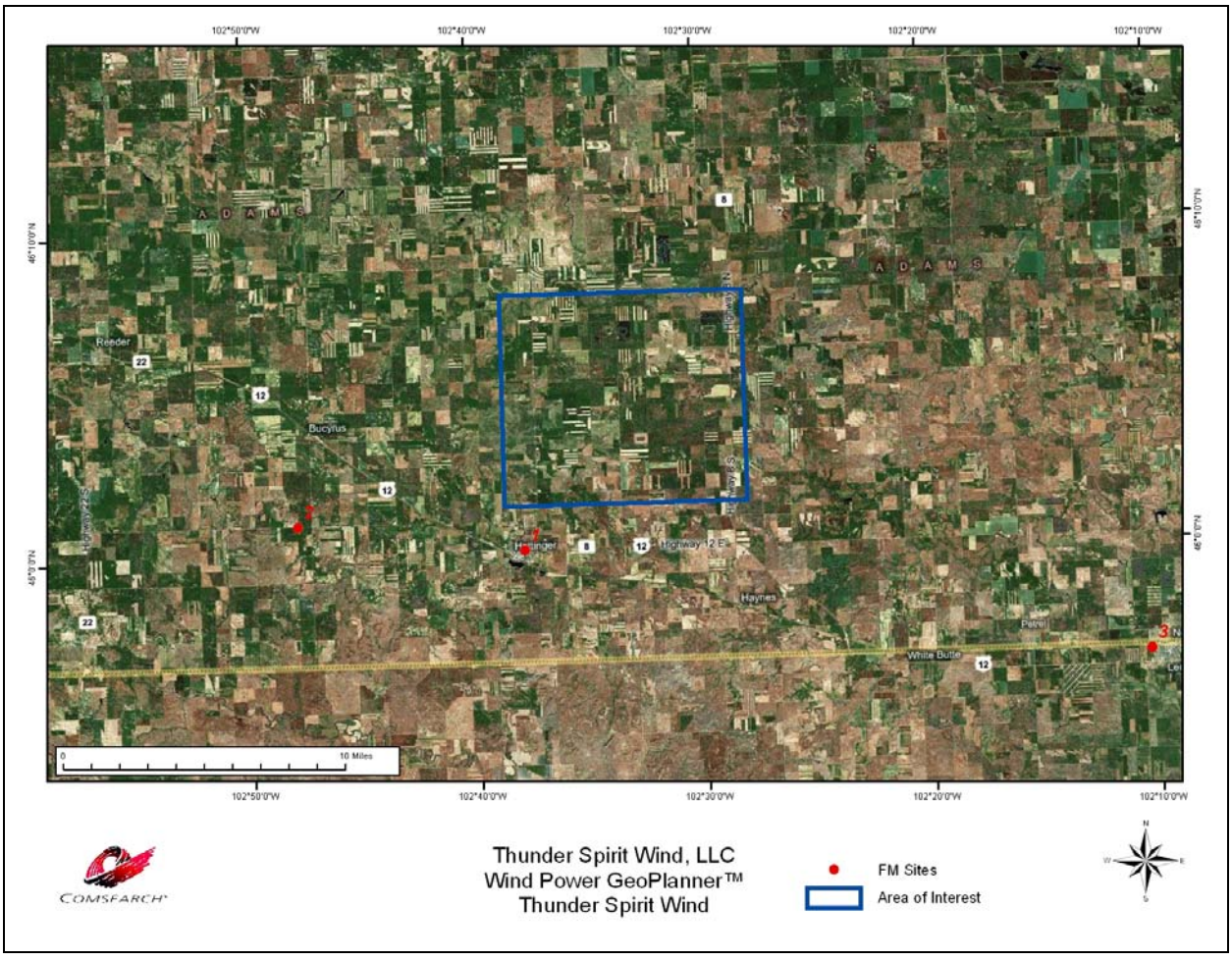


Figure 2: Plot of FM Radio Stations

3. Impact Assessment

Potential problems with AM broadcast coverage are only anticipated when AM broadcast stations with directive antennas are within 3.2 kilometers of wind turbine towers and AM broadcast stations with non-directive antennas are within 0.8 kilometers. The closest station to the Thunder Spirit project, KNDC, is non-directive and located 3.7 kilometers from the boundary of the project area of interest. Therefore, no impact to the coverage of AM stations should result due to the presence of the proposed turbines.

The coverage of FM stations, when the stations are at distances greater than 4.0 kilometers from wind turbines, is not subject to degradation. The closest operational FM station to the Thunder Spirit project, K220FG, is a translator station located 2.5 kilometers from the boundary of the project area of interest. The height of the FM translator antenna above ground is 38 meters. If the planned wind turbines have a hub height of 100 meters and a blade diameter of 92 meters the blades will have a minimum height above ground level of 54 meters. This means that the wind turbine blades will be 16 meters above the FM translator's antenna and will not affect the coverage of the station. If the planned wind turbines have a hub height of 80 meters and a blade diameter of 92 meters the blades will have a minimum height above ground level of 34 meters. This would potentially obstruct the FM translator's antenna which is at 38 meters height, if the turbines are located less then 4 kilometers from the antenna.

4. Recommendations

Since no impact on the AM broadcast stations was identified in our analysis, no recommendations or mitigation techniques are required for them. Our analysis of the FM broadcast stations determined that, if the 100 meter hub height is used for the wind turbines, no issues with the FM stations in the area will occur. However, if an 80 meter hub height is used there is a possibility of reduced coverage of the FM translator station K220FG in the azimuths obstructed by the turbines. Therefore, it is recommended that wind turbines located within 4 kilometers of the station utilize a 100 meter hub height. If the shorter hub height is used, the turbines should be located at distances greater than 4 kilometers from the FM station antenna to avoid reducing the station's coverage. If necessary, a more thorough analysis can be performed once the turbine locations are known.

5. Contact Us

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Wind Power GeoPlanner™

Cable and Satellite Report

Thunder Spirit Wind



Prepared on Behalf of
Thunder Spirit Wind,
LLC

June 21, 2011

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1. Introduction

A headend facility is the core of a cable television (CATV) system. The facility handles many types of functions including reception and processing of broadcast or "off-air" television signals and reception, decryption and modulation of satellite programming for distribution to their cable TV subscribers. Wind turbines may affect cable headend facilities that are receiving wireless off-air television and satellite signals. In addition, wind turbines may attenuate the signal transmitted and received in satellite uplinks and receive earth stations. This report provides information on cable and satellite sites identified within or near a defined area of interest for the proposed wind energy facilities. This information is useful in the planning stages of the wind energy facilities to avoid any potential impact to the current cable and satellite services provided in that region.

This study was performed for Thunder Spirit Wind, LLC.

2. Summary of Results

Our cable and satellite data[1] is derived from a variety of sources including the FCC's cable and international bureau databases. We identified the physical system IDs (PSIDs), community units and cable operators in the area of interest. In general, each unique PSID corresponds to a principal headend facility with multiple community units served by that facility. A summary of the cable systems near the area of interest appears in the table below.

PSID	Cable Operator	Community Unit	Community Name	County	ST
010394	Midcontinent Communications	ND0152	Hettinger	Adams	ND
021454	Consolidated Cable Vision INC	ND0327	Hettinger	Adams	ND

Table 1: Summary of Cable Communities

In addition to the PSIDs which are area-based, we also identified and plotted site-based FCC-licensed headend facilities[2] and satellite earth stations[3]. The data is imported into GIS software and the structures are geographically mapped in the wind energy area of interest defined by the customer. Each cable or satellite site on the map is identified with an ID number associated with site information provided in a data table.

[1] Comsearch makes no warranty as to the accuracy of the data included in this report beyond the date of the report.

[2] Cable headend locations are derived from the cable provider's office locations and the FCC's aeronautical notification form for cable systems. These locations should be verified with the local cable office.

[3] Earth station locations are known if they provide non-temporary services. VSAT terminals, DBS dishes (DirecTV and DISH, e.g) and other receive-only earth stations are not required to be licensed with the FCC.

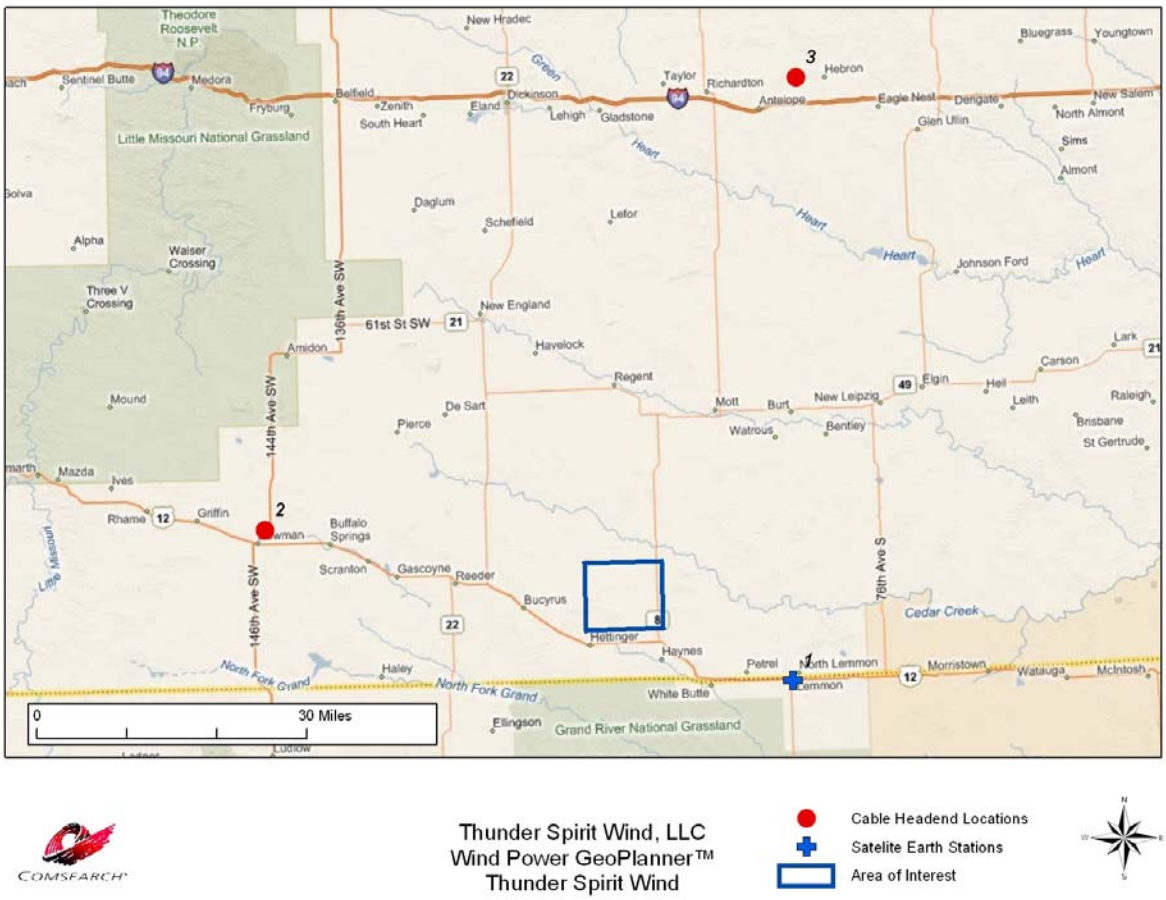


Figure 1: Cable Headends and Satellite Earth Stations near the Area of Interest

ID	Callsign / PSID	Type	Licensee	Latitude (NAD83)	Longitude (NAD83)
1	KV72	Satellite Earth Station	Midcontinent Communications	45-56-02 N	102-10-18 W
2	10394	Cable Headend	Midcontinent Communications	46-12-05 N	103-23-22 W
3	21454	Cable Headend	Consolidated Cable Vision INC	46-54-20 N	102-06-50 W

Table 2: Cable Headends and Satellite Earth Stations Site Data

3. Impact Assessment

In planning the wind energy turbine locations in the area of interest, a conservative approach would dictate not locating any turbines in close proximity to the cable and satellite structures to avoid any possible impact to the communications services provided by these facilities. Since all of the cable and satellite sites identified near the Thunder Spirit Wind project are well outside the area of interest, no impact to their services is expected.

4. Recommendations

Since no impact on the cable and satellite sites was identified in our analysis, no recommendations or mitigation techniques are required for this project.

5. Contact Us

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Wind Power GeoPlanner™

Mobile Phone Carrier Report

Thunder Spirit Wind



Prepared on Behalf of
Thunder Spirit Wind,
LLC

June 17, 2011

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1. Introduction

Comsearch has developed and maintains comprehensive technical databases containing information on licensed mobile phone carriers across the US. Mobile phone carriers operate in multiple frequency bands and are often referred to as Advanced Wireless Service (AWS), Personal Communication Service (PCS), and Cellular. They hold licenses on an area-wide basis which are typically comprised of several counties.

This report focuses on the potential impact of wind turbines on mobile phone operations in and around the project area. Comsearch provides additional wind energy services, a description of which is available upon request.

2. Summary of Results

Methodology

Our mobile phone analysis was performed using Comsearch's proprietary carrier database, which is derived from a variety of sources including the Federal Communications Commission (FCC). Since mobile phone market boundaries differ from service to service, we disaggregated the carriers' licensed areas down to the county level. Then we compiled a list of all mobile phone carriers in the main counties that intersect the area of interest. The area of interest was defined by the client and encompasses the planned turbine locations. A depiction of the wind project area and counties appears below.

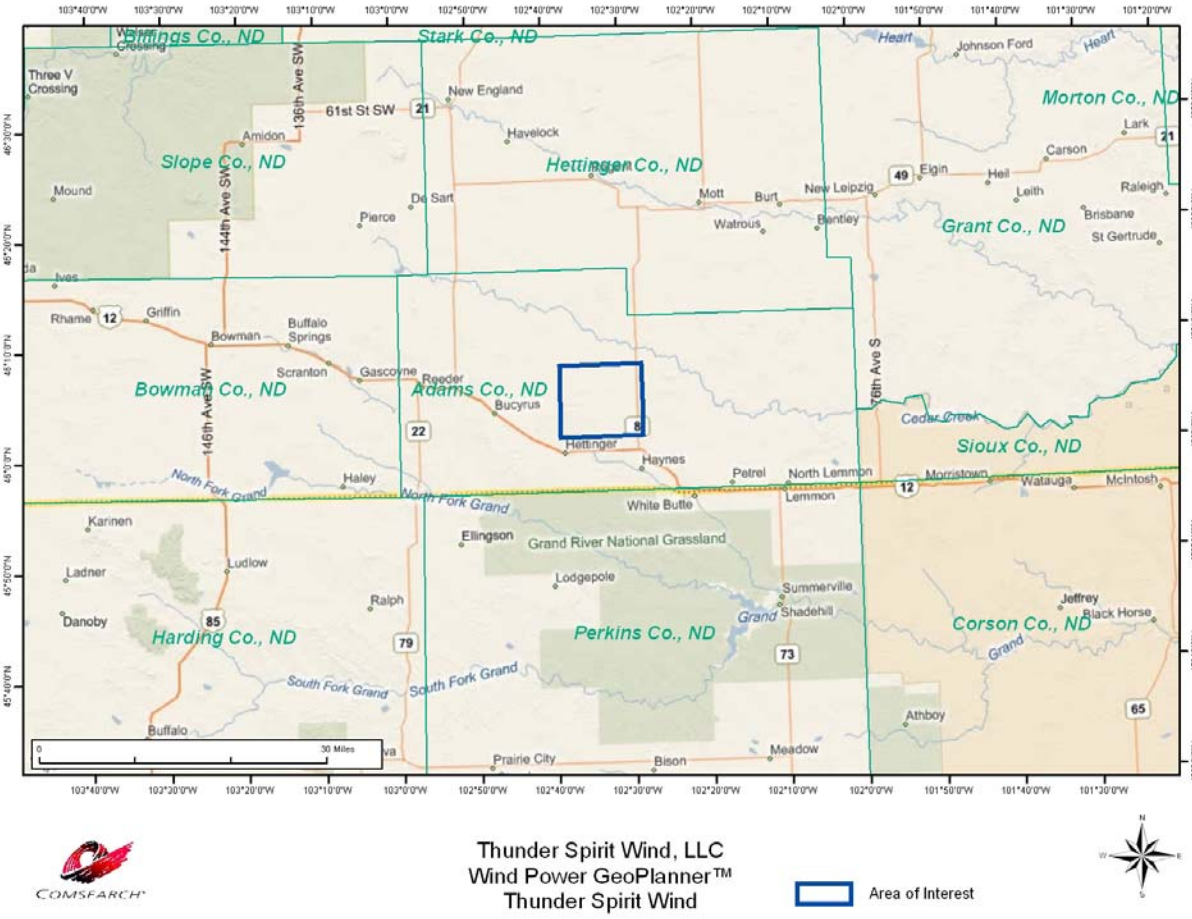


Figure 1: Counties that intersect the Area of Interest

Results

The Thunder Spitit Wind Project is located entirely in Adams County, North Dakota. We have identified the type of service, channel block, market ID and FCC callsign for each carrier in the county of interest (see Table 1). A description of the various service types and geographic market areas appears below.

AWS: AWS licensees won their spectrum in an auction that started in August 2006. The licenses are authorized by 734 Cellular Market Areas (CMA) for Block A, 176 Economic Areas (BEA) for Blocks B and C, and 12 Regional Economic Area Groupings (REA) for Blocks D, E and F. This spectrum at 1.7 and 2.1 GHz was allocated for mobile broadband and advanced wireless services. Partitioning and leases are permitted in the band.

Cellular: Licensees are authorized by Metropolitan and Rural Statistical Areas, also known as CMAs. Unserved areas can be covered by licensees other than the original A or B block licensee. To determine the most realistic coverage, we compiled the Cellular Geographic Service Areas (CGSA) from the 32 dBu contours defined by Part 22.911(a) of the FCC rules. Mobile services are provided at 800 MHz and partitioning and leases are permitted in the band.

PCS: There have been nine auctions for this band, with the last one being held in August 2008. Licensees are authorized by 51 Major Trading Areas (MTA) for Blocks A and B, and 493 Basic Trading Areas (BTA) for Blocks C through F. This band has been heavily partitioned and disaggregated both by counties and by smaller polygons within counties (known as undefined areas or partial counties). The 1.9 GHz PCS carriers provide mobile services and leases are permitted in the band.

Service	Mobile Phone Carrier	Channel Block	County	ST	Market ID	Callsign
AWS	Reservation Telephone Cooperative	A	Adams	ND	CMA583	WQGL811
AWS	MTPCS	B	Adams	ND	BEA115	WQGB385
AWS	AT&T	C	Adams	ND	BEA115	WQGB431
AWS	AT&T	D	Adams	ND	REA005	WQGA787
AWS	Cricket	E	Adams	ND	REA005	WQGD769
AWS	T-Mobile	F	Adams	ND	REA005	WQGB378
CELL	AT&T	A	Adams	ND	CMA583	KNKN343
CELL	Verizon	B	Adams	ND	CMA583	KNKN481
PCS	Sprint Nextel	A	Adams	ND	MTA012	KNLF223
PCS	AT&T	B	Adams	ND	MTA012	WPRU654
PCS	AT&T	B	Adams	ND	MTA012	WQMC354
PCS	AT&T	B	Adams	ND	MTA012	WQMC355
PCS	T-Mobile	B	Adams	ND	MTA012	KNLF224
PCS	AT&T	C	Adams	ND	BTA045	WPSJ965
PCS	AT&T	C	Adams	ND	BTA045	WPUI379
PCS	BEK Communications	C	Adams	ND	BTA045	WPTK619
PCS	Verizon	D	Adams	ND	BTA045	KNLH649
PCS	Long Lines Wireless	E	Adams	ND	BTA045	KNLG791
PCS	AT&T	F	Adams	ND	BTA045	KNLF939

Table 1: Mobile Phone Carriers in the Area of Interest

Impact Assessment

The telephone communications in the mobile phone carrier bands are typically unaffected by the presence of the wind turbines and we do not anticipate any significant harmful effect to mobile phone services in the Thunder Spirit project area. Mobile phone systems are designed with multiple base transmitter stations covering a specific area. Since mobile telephone signals are designed with overlap between adjacent base transmitter sites in order to provide handoff between cells, any signal blockage caused by the wind turbines does not materially degrade the reception because the end user may be receiving from multiple transmitter locations. For example, if a particular turbine attenuates the signal reception into a mobile phone, the phone may receive an alternate signal from a different transmit location, resulting in no disruption in service. Mobile phone systems that are implemented in urban areas near large structures and buildings often have to combat even more problematic signal attenuation and reflection conditions than rural areas containing a wind energy turbine facility.

In the unlikely event that a mobile phone carrier believes their coverage has been compromised by the presence of the wind energy facility, they have many options to improve their signal coverage to the area through optimization of a nearby base transmitter or even adding a new sector or cell site. Utility towers, meteorological towers or even the turbine towers within the wind project area can serve as the platform for a base transmit site or cell enhancer.

3. Contact Us

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Wind Power GeoPlanner™

Tower Structures Report

Thunder Spirit Wind



Prepared on Behalf of
Thunder Spirit Wind,
LLC

June 17, 2011

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1. Introduction

Comsearch compiles and provides information on communications towers identified within or near a defined area of interest related to proposed wind energy facilities. This information is useful in the planning stages of the wind energy facilities to identify the communication tower locations and owner-operator information. This data can be used in support of the wind energy facilities communications needs or to avoid any potential impact to the current communications services provided in that region.

2. Summary of Results

Methodology

Our tower structures report is derived from a variety of sources including the FCC's Antenna Structure Registration (ASR) database and the top ten nationwide tower owner databases. The data is imported into GIS software and the structures are geographically mapped with the wind energy area of interest defined by the customer. Each tower location on the map is identified with an ID number associated with detailed structure information provided in a data table.



Figure 1: Tower structures near the Area of Interest

Results

Figure 1 identifies four tower structures in close proximity to the wind energy area of interest using the data sources described in our methodology above. Specific information about these structures is provided in Table 1 including location coordinates, structure height above ground level, and owner-operator name. All four of these are located in the township of Hettinger.

Tower ID	ASR Number (if known)	Owner-Operator	Structure Height AGL (m)	City	ST	Latitude (NAD83)	Longitude (NAD83)
1	1038535	Montana Dakota Utilities Co	62.0	Hettinger	ND	46.000833	-102.612778
2	1059684	Badlands Cellular of North Dakota Limited Partnership	18.3	Hettinger	ND	46.002500	-102.631111
3	1276698	BNSF Railway Co	36.6	Hettinger	ND	45.998306	-102.636167
4	1276966	Badlands Cellular of North Dakota Limited Partnership	59.7	Hettinger	ND	46.001611	-102.613778

Table 1: Summary of Tower Structures

In planning the wind energy turbine locations, a conservative approach would dictate not locating any turbines in close proximity to existing tower structures to avoid any possible impact to the communications services provided by the structures. Reasonable distance between communication towers and wind turbine towers is a function of two things: (1) the physical turning radius of the wind turbine blades and (2) the characteristics of the communication systems on the communication tower.

Since wind turbine blades can rotate 360º, the first consideration of separation distance to other structures is clearance of the blades. If the blade radius is 50 meters, than a separation distance greater than 50 meters is necessary. From a practical standpoint, a setback distance greater than the maximum height of the turbine is necessary to insure a “fall” safety zone in the unlikely event of a turbine tower failure. Setback requirements for “fall” safety are typically specified by the local zoning ordinances.

The separation distance required based on the characteristics of the communication systems will vary depending on the type(s) of communication antennas located on the tower. For example, AM, FM and TV communication antennas should be separated by distances that allow for normal coverage. For FM and TV stations, the separation distances can be as great as 4 kilometers and for AM stations 3.2 kilometers.

For land mobile radio (LMR) and mobile telephone service, close proximity and turbine blade radius do not degrade coverage and therefore should not limit the turbine placement. A conservative approach would dictate not locating any turbines within 77.5 meters of land mobile or mobile phone fixed base stations to avoid any possible impact to the communications services provided by these stations. This distance is based on FCC interference emissions from electrical devices in the land mobile and mobile telephone frequency bands.

For RADAR, special studies are conducted to determine reasonable distance from turbine towers, taking into account the unique characteristics of the RADAR. For microwave links and WiFi operation, line-of-sight (LOS) is used as the criteria for separation distance as well as physical clearance of the turbine blades. Finally, the tower structures identified could be a potential benefit in support of communications network needs for the wind energy facility. An example would be the implementation of a Supervisory Control and Data Acquisition (SCADA) system that monitors and provides communications access to the wind energy facility.

For the Thunder Spirit Wind project, four towers were identified within four kilometers of the area of interest. As long as the turbines maintain sufficient distance from the towers as specified above, there will be no impact on the communication services provided by the towers.

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Wind Power GeoPlanner™

Land Mobile and Emergency Services Report

Thunder Spirit Wind



Prepared on Behalf of
Thunder Spirit Wind,
LLC

May 20, 2013

COMSEARCH®
A CommScope Company

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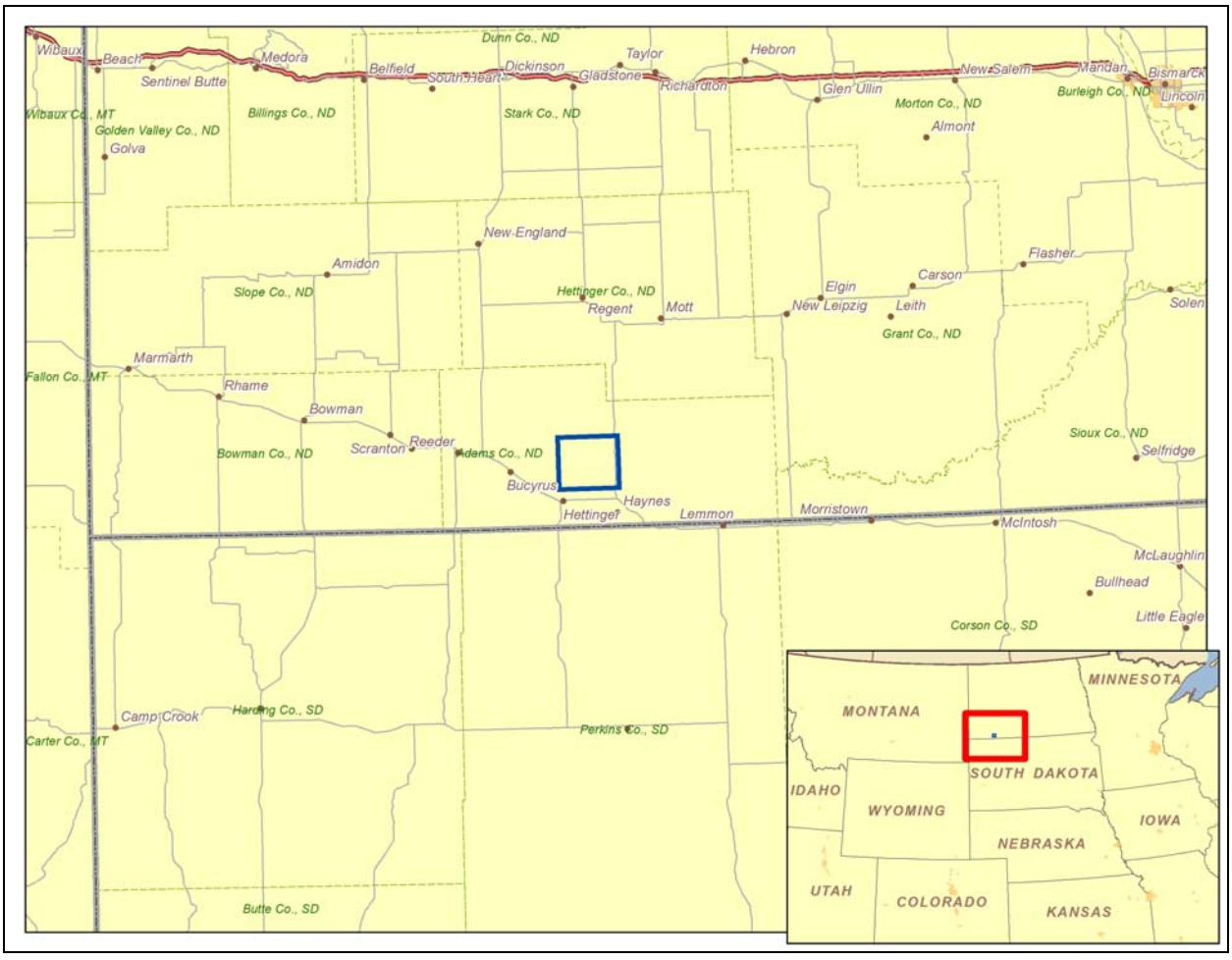
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1. Introduction

An assessment of the emergency services in the Thunder Spirit Wind project area was performed by Comsearch to identify potential impact from the planned turbines. We evaluated the registered frequencies for the following types of first responder entities: police, fire, emergency medical services, emergency management, hospitals, public works, transportation and other state, county, and municipal agencies. We also identified all industrial and business land mobile radio (LMR) systems and commercial E911 operators within the proposed wind energy facility boundaries. This information is useful in the planning stages of the wind energy facility because the data can be used in support of facility communications needs and to evaluate any potential impact on the emergency services provided in that region. An overview of the project area, which is located in Adams County, North Dakota, appears below.

This study was performed on behalf of Thunder Spirit Wind, LLC.



2. Summary of Results

Our land mobile and emergency services incumbent data[1] was derived from the FCC's Universal Licensing System (ULS) and the FCC's Public Safety & Homeland Security bureau. We identified both site-based licenses as well as regional area-wide licenses designated for public safety use. The site-based licenses were imported into GIS software and geographically mapped within the wind energy project area of interest as defined by the customer. Each site on the map was given an ID number and associated with site information provided in a data table. A depiction of the fixed-site licenses in and around the project area appears in Figure 1, below.

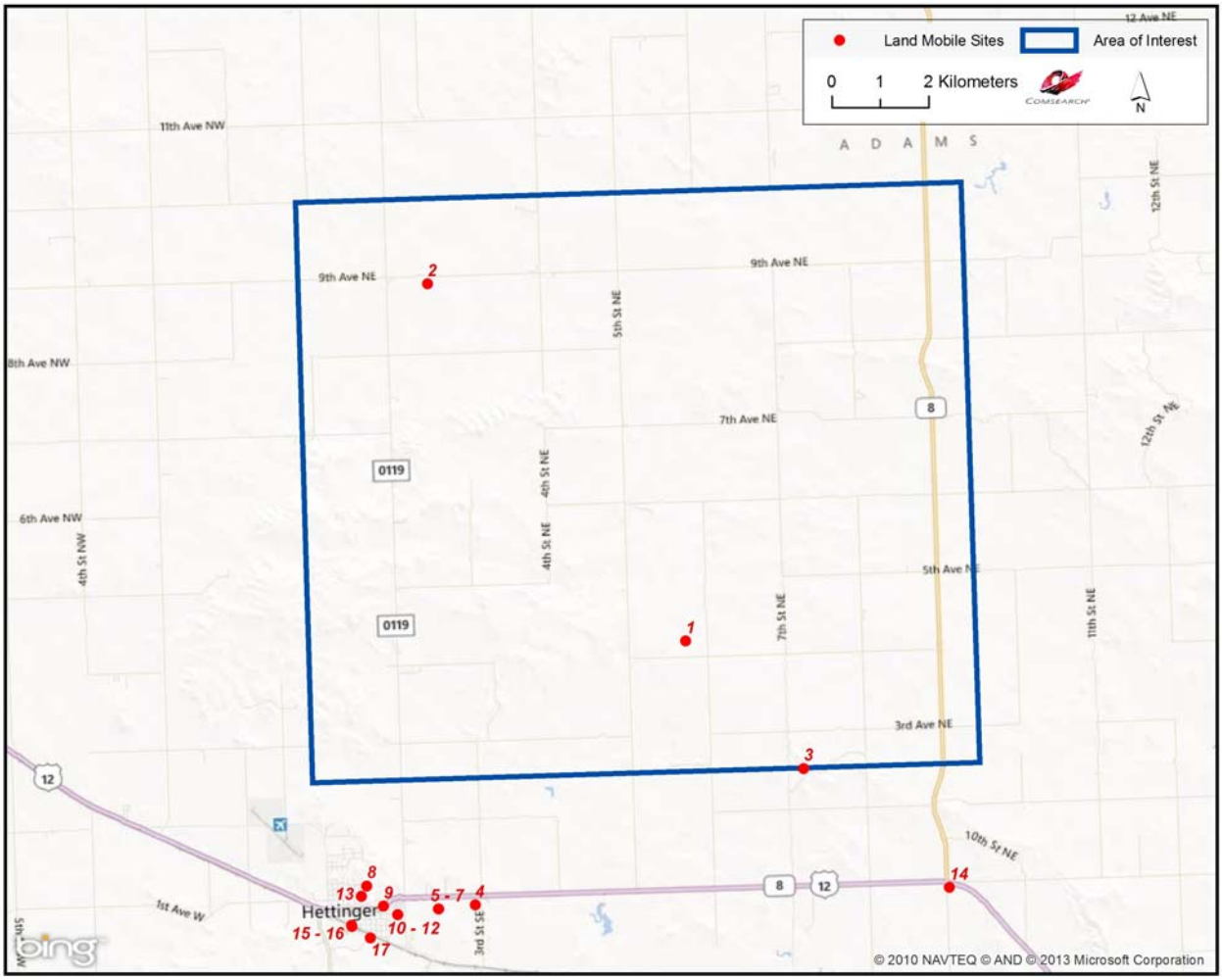


Figure 1: Land Mobile & Emergency Service Sites near the Project Area of Interest

[1] Comsearch makes no warranty as to the accuracy of the data included in this report beyond the date of the report. The data presented in this report is derived from the land mobile station's FCC license and governed by Comsearch's data license notification and agreement located at http://www.comsearch.com/files/data_license.pdf

Site-Based Licenses

Figure 1 identifies seventeen site-based licenses near the project area of interest. Some of these sites are licensed to first responder entities that provide critical public safety and emergency communications to the Thunder Spirit Wind project area. Specific information about these sites is provided in Table 1, including location coordinates, frequency band, antenna height above ground level, and licensee name.

ID	Call Sign	Frequency Band (MHz)	Licensee	Antenna Height AGL (m)	City/State	Latitude (NAD83)	Longitude (NAD83)	Distance to Center of AOI (km)
1	WQPQ617	450-470	Christman, Jordan	16.8	Hettinger, ND	46.049444	-102.544417	3.47
2	KXU669	150-174	Erickson, Bruce G	24.0	Hettinger, ND	46.117500	-102.610722	5.97
3	WQCF492	150-174	Miller, Henry	13.0	Hettinger, ND	46.025000	-102.513889	6.89
4	WNQB944	450-470	Weaver, John A	15.0	Hettinger, ND	46.001389	-102.602944	9.43
5	KAB821	25-50	Montana-Dakota Utilities Co.	62.0	Hettinger, ND	46.000833	-102.612778	9.81
6	WPWW658	800/900	Consolidated Telcom	62.0	Hettinger, ND	46.000833	-102.612778	9.81
7	WQCA298	800/900	Consolidated Telcom	62.0	Hettinger, ND	46.000833	-102.612778	9.81
8	KZO413	150-174	West River Regional Medical Center	24.0	Hettinger, ND	46.005556	-102.631833	10.12
9	WQKY798	450-470	Western Horizon Living Center	-	Hettinger, ND	46.001667	-102.627500	10.29
10	KNFS826	150-174	Adams, County of	21.0	Hettinger, ND	46.000000	-102.623778	10.30
11	WCB227	150-174	Adams, County of	21.0	Hettinger, ND	46.000000	-102.623778	10.30
12	WNNM520	150-174	Adams, County of	15.0	Hettinger, ND	46.000000	-102.623778	10.30
13	WPWX971	150-174	North Dakota State NDDES	20.0	Hettinger, ND	46.003611	-102.633333	10.36
14	WQQT638	450-470	Basin Electric Power Cooperative	24.7	Hettinger, ND	46.001917	-102.475889	10.63
15	WQNV761	25-50	BNSF Railway Co.	26.2	Hettinger, ND	45.998306	-102.636167	10.97
16	WQOF534	150-174	BNSF Railway Co.	3.0	Hettinger, ND	45.998056	-102.636111	10.99
17	WXG667	450-470	Stippich, Inc.	52.0	Hettinger, ND	45.995833	-102.631278	11.00

Table 1: Summary of Land Mobile & Emergency Service Sites near the Project Area of Interest

Area-Wide Licenses

The regional area-wide licenses are compiled from FCC data sources and identified for each county in the wind project area. The Thunder Spirit Wind project is located in Adams County, North Dakota, part of Public Safety Region #32, which contains all of the counties in North Dakota. The regional public safety operation is overseen by the entity listed below.

Mike Lynk
Chair
North Dakota Division of State Radio Communications
Director, Vice Chair of North Dakota State Interoperability Executive Committee
phone: 701-328-8100
fax: 701-328-8181
email: mlynk@nd.gov

The chairperson for Region #32 is a representative for all public safety entities in the region and is responsible for coordinating current and future public safety use in the wireless spectrum. In the bands licensed by the FCC for area-wide first responders, which include 220 MHz, 700 MHz, 800 MHz and 4.9 GHz, as well as the traditional Part 90 public safety pool of frequencies, nine licenses were found for the State of North Dakota and one for the County of Adams (see Table 2). These area-wide licenses are designated for mobile use only.

ID	Frequency Band (MHz)	Licensee	Area of Operation
1	150-174	Adams, County of	Countywide: Adams
2	25-50	American National Red Cross	Statewide: ND
3	150-174	Metro Area Ambulance Service, Inc.	Statewide: ND
4	450-470, 2450-2500	Minot Police Department	Statewide: ND
5	150-174	National Ski Patrol System, Inc.	Statewide: ND
6	0-10, 150-174, 450-470	North Dakota, State of	Statewide: ND
7	150-174	North Dakota Department of Health	Statewide: ND
8	150-174, 4940-4990	North Dakota Department of Transportation	Statewide: ND
9	150-174, 450-470	North Dakota Division of State Radio Communications	Statewide: ND
10	450-470	North Dakota EMS Association	Statewide: ND

Table 2: Summary of Regional Licenses

E911 Operators

Wireless operators are granted area-wide licenses from the FCC to deploy their cellular networks, which often include handsets with E911 capabilities. Since mobile phone market boundaries differ from service to service, we disaggregated the carriers' licensed areas down to the county level. We have identified the type of service for each carrier in Adams County in Table 3, below.

Mobile Phone Carrier	County	State	Service[2]
AT&T	Adams	ND	AWS / CELL / PCS
BEK Communications	Adams	ND	PCS
Long Lines	Adams	ND	AWS
Reservation Telephone Cooperative	Adams	ND	PCS
Sprint Nextel	Adams	ND	PCS
T-Mobile	Adams	ND	AWS / PCS
Verizon	Adams	ND	AWS / CELL / PCS

Table 3: Mobile Phone Carriers in the Area of Interest with E911 Service

3. Impact Assessment

The first responder, industrial/business land mobile sites, area-wide public safety, and commercial E-911 communications as described in this report are typically unaffected by the presence of wind turbines and we do not anticipate any significant harmful effect to these services in the Thunder Spirit Wind project area. Although each of these services operates in different frequency ranges and provides different types of service including voice, video and data applications, there is commonality among these different networks in regards to the impact of wind turbines on their service. Each of these networks is designed to operate reliably in a non-line-of-sight (NLOS) environment. Many land mobile systems are designed with multiple base transmitter stations covering a large geographic area with overlap between adjacent transmitter sites in order to provide handoff between cells, and any signal blockage caused by the wind turbines does not materially degrade the reception because the end user is likely receiving signals from multiple transmitter locations. Additionally, the frequencies of operation for these services have characteristics that allow the signal to propagate through wind turbines. As a result, very little, if any, change in their coverage should occur when the wind turbines are installed.

[2] AWS: Advanced Wireless Service at 1.7/2.1 GHz
CELL: Cellular Service at 800 MHz
PCS: Personal Communication Service at 1.9 GHz

When planning the wind energy turbine locations in the area of interest, a conservative approach would dictate not locating any turbines within 77.5 meters of land mobile fixed-base stations to avoid any possible impact to the communications services provided by these stations. This distance is based on FCC interference emissions from electrical devices in the land mobile frequency bands. As long as the turbines are located more than 77.5 meters from the land mobile stations, they will meet the setback distance criteria for FCC interference emissions in the land mobile bands.

4. Recommendations & Mitigation Measures

In the event that a public safety entity believes its coverage has been compromised by the presence of the wind energy facility, it has many options to improve its signal coverage to the area through optimization of a nearby base station or even adding a repeater site. Utility towers, meteorological towers or even the turbine towers within the wind project area can serve as the platform for a base station or repeater site.

5. Contact Us

For questions or information regarding the Emergency Services Report, please contact:

Contact person:	Denise Finney
Title:	Account Manager
Company:	Comsearch
Address:	19700 Janelia Farm Blvd., Ashburn, VA 20147
Telephone:	703-726-5650
Fax:	703-726-5595
Email:	dfinney@comsearch.com
Web site:	www.comsearch.com

Wind Power GeoPlanner™

Microwave Study

Thunder Spirit Wind



Prepared on Behalf of
Thunder Spirit Wind,
LLC

May 14, 2013

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1. Introduction

Comsearch has developed and maintains comprehensive technical databases containing information on licensed microwave networks throughout the United States. Microwave bands that may be affected by the installation of wind turbine facilities operate over a wide frequency range (900 MHz – 23 GHz). These systems are the telecommunication backbone of the country, providing long-distance and local telephone service, backhaul for cellular and personal communication service, data interconnects for mainframe computers and the Internet, network controls for utilities and railroads, and various video services. This report focuses on the potential impact of wind turbines on licensed, proposed and applied non-federal government microwave systems.

2. Project Overview

Project Information

Name: Thunder Spirit Wind

County: Adams

State: North Dakota

Number of Turbines: TBD

Blade Diameter: 116 meters

Hub Height: 92 meters

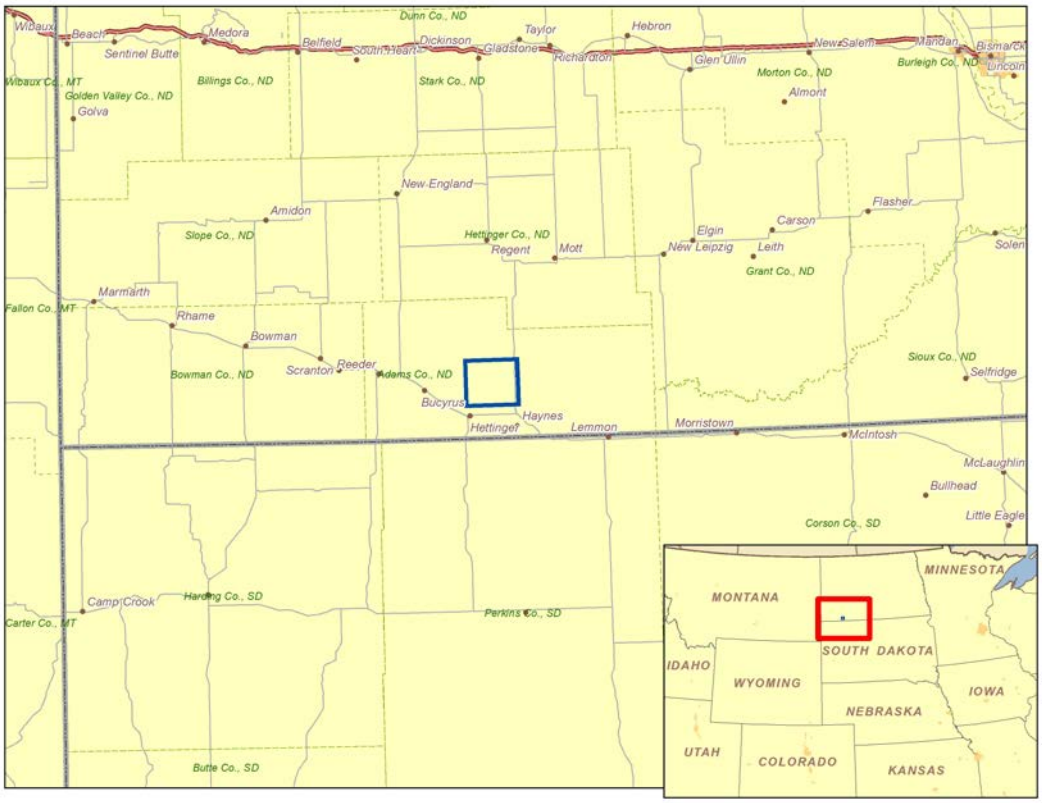


Figure 1: Area of Interest

3. Microwave Study Results

Our obstruction analysis was performed using Comsearch's proprietary microwave database, which contains all non-government licensed, proposed and applied paths from 0.9 - 23 GHz[1]. First, we determined all microwave paths that intersect the area of interest[2]. The area of interest encompasses the planned turbine locations. In this case, Comsearch identified no microwave paths that intersect the project area. Thus, there are no potential obstructions at this time[3].

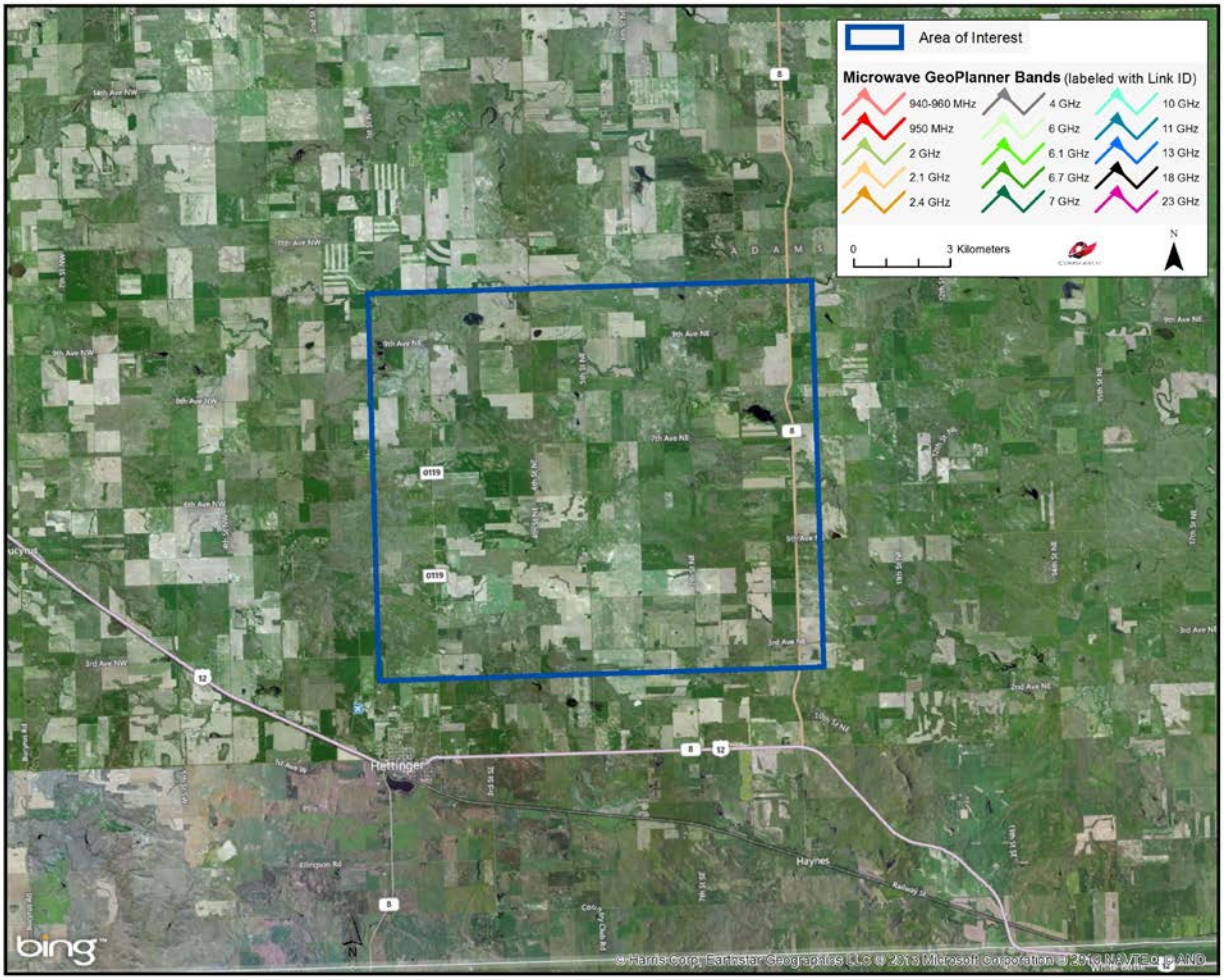


Figure 2: Microwave Paths that Intersect the Area of Interest

[1] Please note that this analysis does not include unlicensed microwave paths or federal government paths that are not registered with the FCC.

[2] We use FCC-licensed coordinates to determine which paths intersect the area of interest. It is possible that as-built coordinates may differ slightly from those on the FCC license.

[3] Comsearch makes no warranty as to the accuracy of the data included in this report beyond the date of the report. The data provided in this report is governed by Comsearch's data license notification and agreement located at http://www.comsearch.com/files/data_license.pdf.

4. Contact Us

For questions or information regarding the Microwave Study, please contact:

Contact person:	Denise Finney
Title:	Account Manager
Company:	Comsearch
Address:	19700 Janelia Farm Blvd., Ashburn, VA 20147
Telephone:	703-726-5650
Fax:	703-726-5595
Email:	dfinney@comsearch.com
Web site:	www.comsearch.com

Wind Power GeoPlanner™

Off-Air TV Analysis

Thunder Spirit Wind



Prepared on Behalf of
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May 20, 2013

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1. Introduction

In this report, Comsearch analyzed the off-air television stations whose service could potentially be affected by the proposed Thunder Spirit Wind project in Adams County, North Dakota. Off-air stations are television broadcasters that transmit signals that can be received directly on a television receiver from terrestrially located broadcast facilities. Comsearch examined the coverage of the off-air TV stations and the communities in the area that could potentially have degraded television reception because of the location of the proposed wind energy projects.

2. Summary of Results

The proposed wind energy project area and local communities are depicted in Figure 1, below.

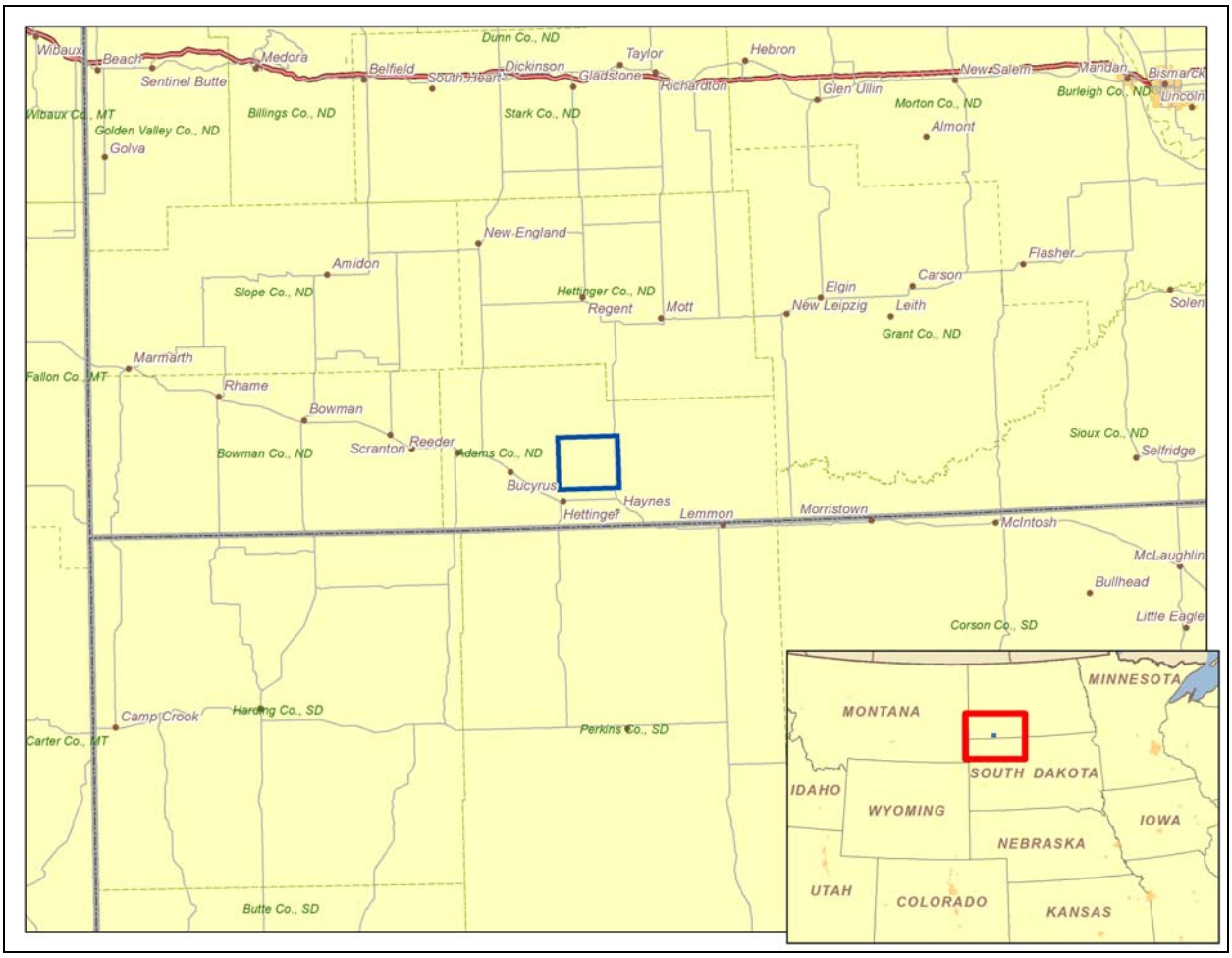


Figure 1: Wind Farm Project Area and Local Communities

To begin the analysis, Comsearch compiled all off-air television stations[1] within 150 kilometers of the project area of interest (AOI). Appendix A contains a tabular summary of these stations. A plot depicting their locations appears in Figure 2, below.

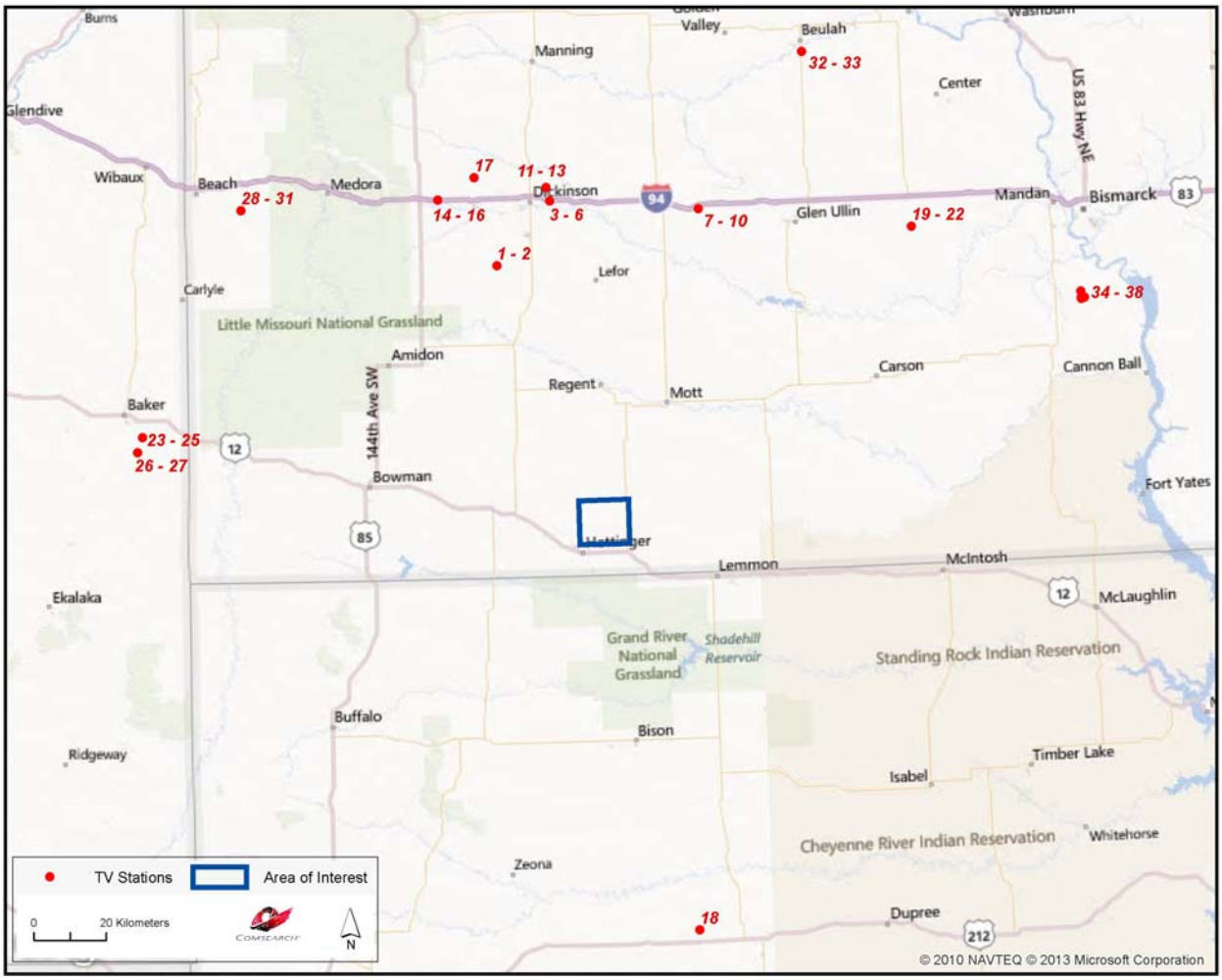


Figure 2: Plot of Off-Air TV Stations within 150 Kilometers of Project Area

TV stations at a distance of 75 kilometers or less are the most likely to provide off-air coverage to the project area and neighboring communities. These stations are listed in Table 1, below, and a plot depicting these locations is provided in Figure 3. There are a total of two database records for stations within approximately 75 kilometers of the wind energy project. These

[1] Comsearch makes no warranty as to the accuracy of the data included in this report beyond the date of the report. The data presented in this report is derived from the TV station's FCC license and governed by Comsearch's data license notification and agreement located at http://www.comsearch.com/files/data_license.pdf.

represent full-power digital stations KDSE and KXMA-TV, both of which are licensed and operational.

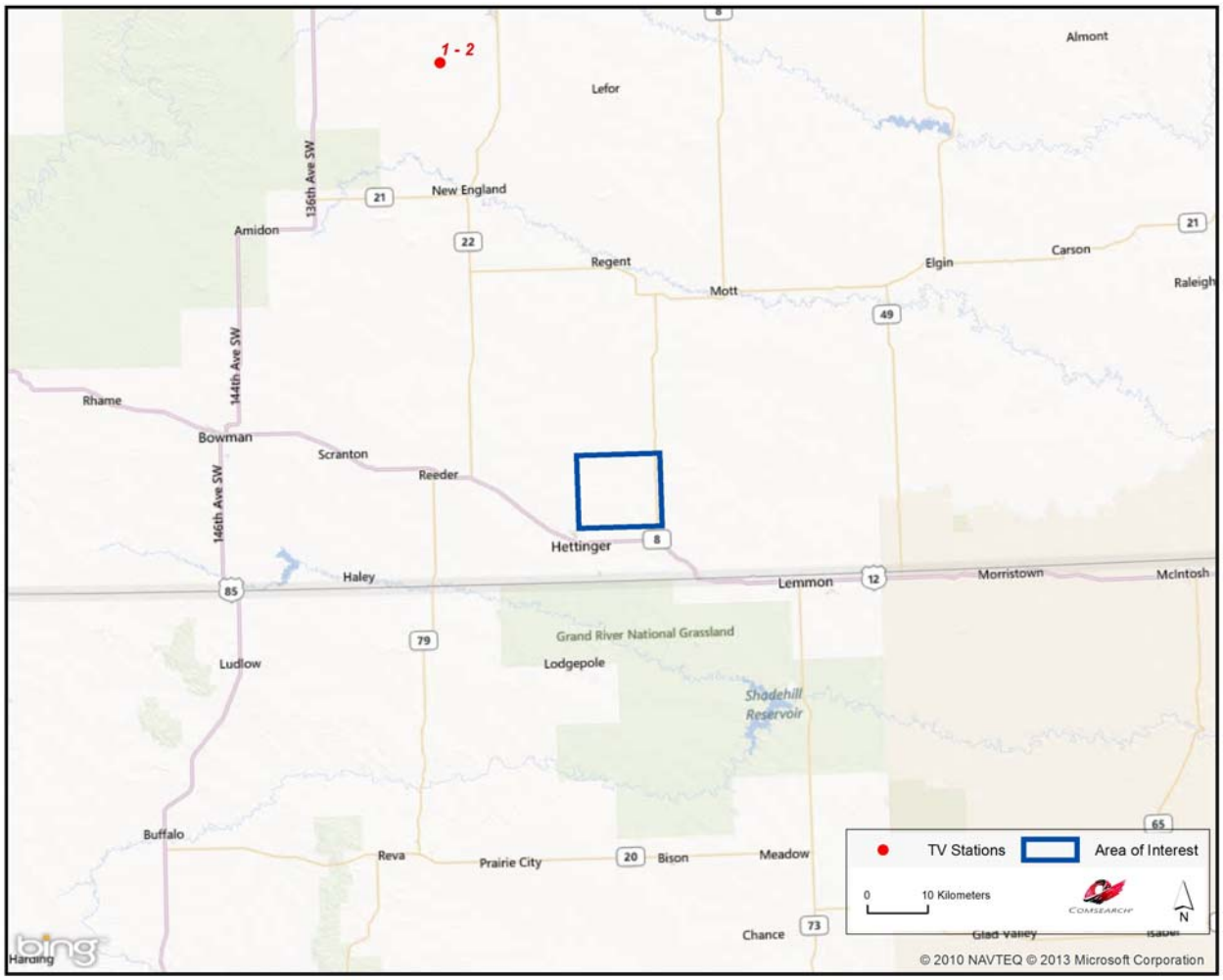


Figure 3: Plot of Off-Air TV Stations within 75 Kilometers of Project Area

ID	Call Sign	Status	Service[2]	Channel	City	State	Distance to Center of AOI (km)
1	KDSE	LIC	DT	9	DICKINSON	ND	77.05
2	KXMA-TV	LIC	DT	19	DICKINSON	ND	77.05

Table 1: Off-Air TV Stations within 75 Kilometers of Project Area

3. Impact Assessment

The two full-power digital stations may have their reception disrupted in and around the Thunder Spirit Wind project area, primarily in locations on the opposite side of the project area, relative to the station antennas. Communities and homes directly to the south and east of the project may have degraded reception of stations KDSE and KXMA-TV, which broadcast from northwest of the project area, after the wind turbines are installed.

However, based on the low number of full-power TV channels available in the immediate vicinity of the project area, it is unlikely that off-air television stations are the primary mode of television service for the local communities. TV cable service, where available, and direct broadcast satellite service (DBS) are more likely the dominant modes of service delivery.

4. Recommendations

Both cable service and direct broadcast satellite service will be unaffected by the presence of the wind turbine facility and may be offered to those residents who can show that their off-air TV reception has been disrupted by the presence of the wind turbines after they are installed.

[2] Definitions of U.S. service and status codes:
DT – Digital television broadcast station
LIC – Licensed and operational station

5. Contact Us

For questions or information regarding the Off-Air TV Analysis, please contact:

Contact person:	Lester Polisky
Title:	Senior Principal Engineer
Company:	Comsearch
Address:	19700 Janelia Farm Blvd., Ashburn, VA 20147
Telephone:	703-726-5860
Fax:	703-726-5595
Email:	lpolisky@comsearch.com
Web site:	www.comsearch.com

6. Appendix A

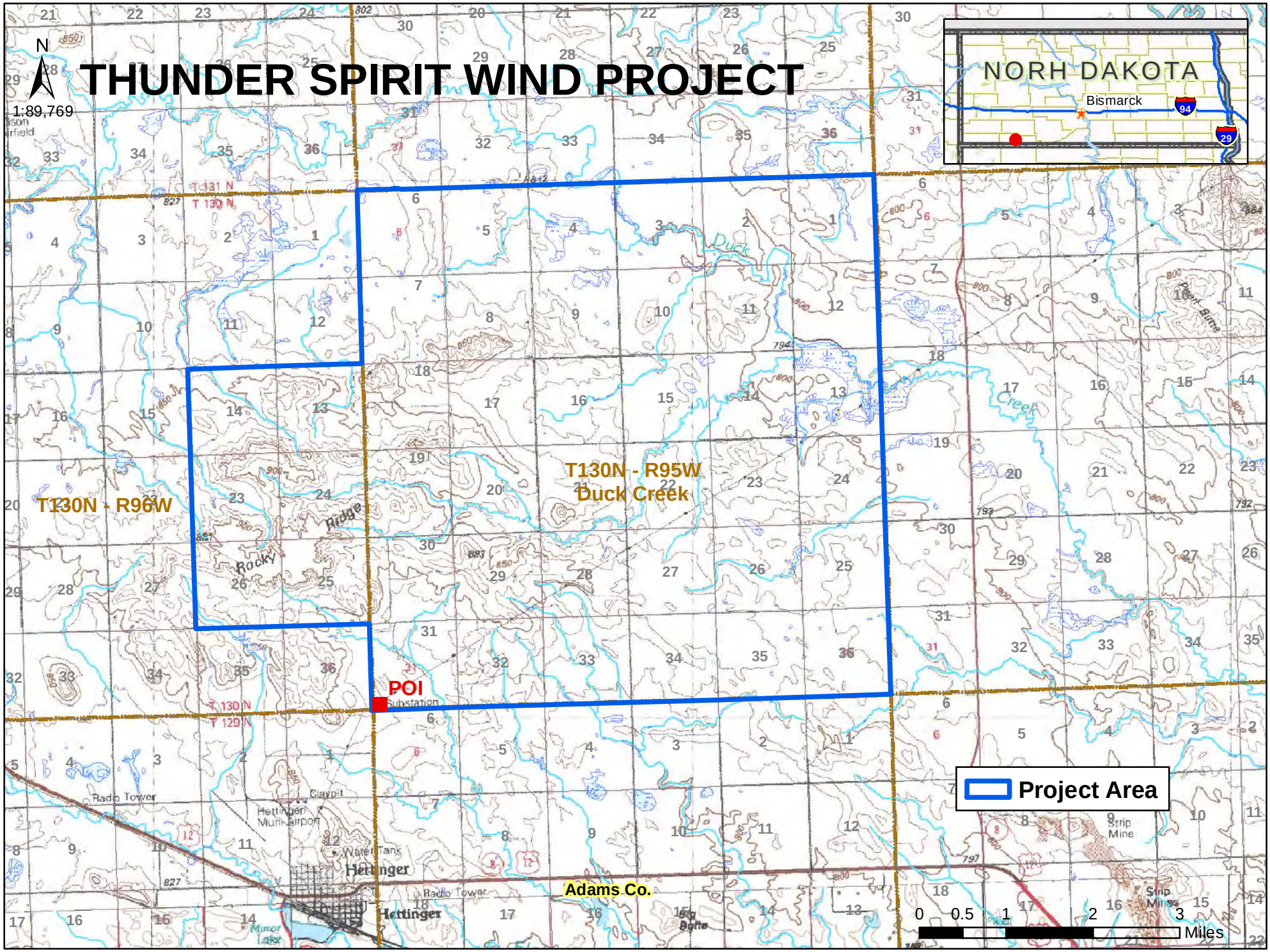
ID	Call Sign	Status	Service[3]	Channel	City	State	Distance to Center of AOI (km)
1	KDSE	LIC	DT	9	DICKINSON	ND	77.05
2	KXMA-TV	LIC	DT	19	DICKINSON	ND	77.05
3	K14ON-D	CP	LD	14	DICKINSON	ND	90.35
4	K17KN-D	CP	LD	17	DICKINSON	ND	90.35
5	K26KW-D	CP	LD	26	DICKINSON	ND	90.35
6	K39LK-D	CP	LD	39	DICKINSON	ND	90.35
7	K24KA-D	CP	LD	24	HEBRON	ND	90.73
8	K27KZ-D	CP	LD	27	HEBRON	ND	90.73
9	K33LM-D	CP	LD	33	HEBRON	ND	90.73
10	K49LY-D	CP	LD	49	HEBRON	ND	90.73
11	K38HA-D	LIC	LD	38	DICKINSON	ND	94.24
12	K42FY	LIC	TX	42	DICKINSON	ND	94.24
13	K42FY	CP	LD	42	WILLISTON	ND	94.24
14	K22KG-D	CP	LD	22	BELFIELD	ND	100.52
15	K31LR-D	CP	LD	31	BELFIELD	ND	100.52
16	K46MQ-D	CP	LD	46	BELFIELD	ND	100.52
17	KQCD-TV	LIC	DT	7	DICKINSON	ND	102.14
18	KPSD-TV	LIC	DT	13	EAGLE BUTTE	SD	116.27
19	K29KA-D	CP	LD	29	NEW SALEM	ND	118.26
20	K36LL-D	CP	LD	36	NEW SALEM	ND	118.26
21	K42KI-D	CP	LD	42	NEW SALEM	ND	118.26
22	K47NG-D	CP	LD	47	NEW SALEM	ND	118.26
23	K04IH-D	LIC	LD	4	BAKER	MT	130.09
24	DK10JP	APP	LD	27	BAKER	MT	130.09
25	K27LT-D	LIC	LD	27	BAKER	MT	130.09
26	K08IP-D	LIC	LD	8	BAKER	MT	130.74
27	K13OW-D	LIC	LD	13	BAKER	MT	130.74
28	K16JP-D	CP	LD	16	SENTINEL BUTTE	ND	132.65

[3] Definitions of service and status codes :
TV – Analog television broadcast station
DT – Digital television broadcast station
DS – Digital special temporary authority (STA)
LP – Low power analog television broadcast station
LD – Low power digital television broadcast station
CA – Class A analog television broadcast station
DC – Class A digital television broadcast station
TX – Translator station
LIC – Licensed and operational station
CP – Construction permit granted
CP MOD – Modification of construction permit
APP – Application for construction permit, not yet operational
STA – Special transmit authorization, usually granted by FCC for temporary operation

ID	Call Sign	Status	Service[3]	Channel	City	State	Distance to Center of AOI (km)
29	K25MC-D	CP	LD	25	SENTINEL BUTTE	ND	132.65
30	K34LU-D	CP	LD	34	SENTINEL BUTTE	ND	132.65
31	K48MZ-D	CP	LD	48	SENTINEL BUTTE	ND	132.65
32	K07EZ	LIC	TX	7	BEULAH	ND	141.65
33	K09EZ	LIC	TX	9	BEULAH	ND	141.65
34	KBMY	LIC	DT	17	BISMARCK	ND	146.09
35	KXMB-TV	LIC	DT	12	BISMARCK	ND	146.18
36	KBME-TV	LIC	DT	22	BISMARCK	ND	146.54
37	KFYR-TV	LIC	DT	31	BISMARCK	ND	146.82
38	KNDX	LIC	DT	26	BISMARCK	ND	146.99

Table A: Off-Air TV Stations within 150 Kilometers of Project Area

Appendix B
Agency Correspondence


THUNDER SPIRIT WIND PROJECT
N
1:89,769
NORTH DAKOTA
Bismarck
94
29
T130N - R96W
T130N - R95W
Duck Creek
POI
Substation
Project Area
Adams Co.
Hettinger
Radio Tower
Claypit
Hettinger Municipal Airport
Water Tank
Strip Mine
Rocky Ridge
Duck Creek
0 0.5 1 2 3
Miles

TETRA TECH

May 17, 2013

Mr. Jeffrey Towner
Field Supervisor
USFWS North Dakota Field Office
3425 Miriam Avenue
Bismarck, North Dakota 58501-792604

RE: Application to the North Dakota Public Service Commission for Certificate of Site Compatibility for the Thunder Spirit Wind Energy Project in Adams County, North Dakota (Case No. PU-11-601)

Dear Mr. Towner:

Tetra Tech has been contracted by Thunder Spirit Wind, LLC to prepare an application for a Certificate of Site Compatibility, in accordance with Section 49-22-07 NDCC. The proposed Thunder Spirit Wind Energy Project (Project) would be constructed on up to 40 square miles of leased private property approximately 2 miles northeast of Hettinger, North Dakota. As currently planned, the Project would produce approximately 150 megawatts (MW) and would consist of up to 75 wind turbine generators as well as meteorological towers, access roads, underground collection lines, a substation, and operations and maintenance facilities. There will be one section of tie-line (less than a mile in length) connecting the Project substation to an existing substation located in the southwest corner of Section 31 of Township 130 North, Range 95 West. The proposed Project area shown in the attached figure is the primary focus of our investigation.

Per Section 69-06-01-05 of the North Dakota Public Service Commission (PSC)'s administrative rules, we are consulting the U.S. Fish and Wildlife Service for assistance in identifying concerns or issues within the boundaries of the tracts listed below that would influence a decision regarding the use of the land, as well as applicable permits that may be required from your office.

This information will be used to help guide Project development in a manner that identifies and avoids impacts to sensitive resources where practicable. We have sent similar query letters to other agencies including, but not limited to, the North Dakota Game and Fish Department and the U.S. Army Corps of Engineers.

I understand that in September 2011 your office provided information on known eagle nests in the vicinity of the Project area, that you received information regarding biological surveys completed for the Project as of 2011, and that Terry Ellsworth from your staff met with the Project developer in November 2011 to discuss the Project.

Since then, while continuing to refine the Project's interconnection, land, and power sale efforts, the Project's developers have continued to monitor and assess avian use patterns. We have prepared a summary of biological information prepared to date for the Project for your review, attached as Appendix 1.

If possible, Thunder Spirit Wind would like to set up a meeting or conference call to discuss the Project once you have reviewed this information.

Please contact me at Tracey.Dubuque@tetratech.com or (617) 433-7552 if you have any questions. Thank you for your assistance.

Respectfully submitted,

TETRA TECH, INC

Tracey Dubuque, P.E.
Senior Project Manager

160 Federal Street, 3rd Floor, Boston, MA 02110
Tel 617.443.7500 Fax 617.737.3480
www.tetratech.com

Figure 1

Thunder Spirit Wind Energy Project
Thunder Spirit Wind, LLC
Adams County, North Dakota

May 2013

Legend

- Project Area
- Wind Energy Facility Perimeter (4/26/2013)
- Proposed Turbine Location (4/26/2013)
- Approximate POI
- Met Tower Locations
- Proposed Collector Substation (4/8/2013)
- Overhead Line (4/8/2013)
- Collection Line (4/26/2013)
- Access Road (4/26/2013)
- Laydown Area (20 Acres)
- Collector Substation/O&M Building Construction Footprint (20 Acres)

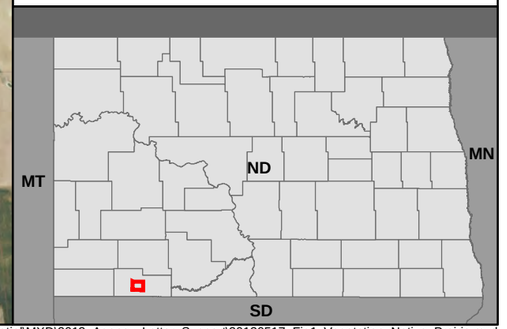
Vegetation/Native Prairie Classes

- Agriculture
- Developed Lands
- Native Prairie
- Native Prairie/Hayfields
- Pasture/Hayfields
- Road
- Shrubs/Trees
- Wetlands

N
W E
S

0 0.5 1 Miles

REFERENCE MAP



Path: P:\Global Winds Harvest\Thunder Spirit - ND\GIS\Spatial\MXD\2013_Agency_Letter_Support\20130517_Fig1_Vegetation_Native_Prairie.mxd

Summary of Thunder Spirit Wildlife Studies

May 2013

On behalf of Thunder Spirit Wind, LLC, Western EcoSystems Technology, Inc. (WEST) conducted two years of avian point count surveys, one season of sharp-tailed grouse surveys, one season of raptor nest surveys and two years of passive acoustic bat monitoring surveys within the proposed Thunder Spirit Wind Resource Area (Project) in Adams County, North Dakota in 2007 and 2011-2012 (Figure 1). The Project area has both grasslands and agricultural areas with limited wetland areas. The overall methodology and level of effort expended thus far to identify, avoid, and mitigate potential wildlife and habitat impacts is in accordance with the tiered approach described in the *Land-Based Wind Energy Guidelines* (USFWS 2012). In particular, the field work conducted in 2007 was intended as a Tier 1 Preliminary Site Evaluation, the more extensive and focused work of 2011-2012 as a Tier 2 Site Characterization effort, and ongoing studies to learn more about eagle use of the project area are in keeping with Tier 3 efforts (Field Studies to Document Site Wildlife Conditions and Predicted Project Impacts).

Avian Point Count Surveys

The first season of avian point count surveys were conducted at 20 locations within the Project area from 5 June 2007 to 29October 2007 (Derby et al. 2008). An additional year of avian point count surveys were conducted at 25 point locations within the Project area from 6April 2011 to 13March 2012 (Derby et al. 2013).Surveys were conducted in accordance with industry-standard due diligence avian survey protocol.In 2007, surveys were conducted biweekly, at approximately 14 day intervals, during the summer season (June 5 – August 10) and weekly, at approximately 7 day intervals, during the fall season (August 24 – October 29). The 2011-2012 surveys were conducted biweekly, at approximately 14 day intervals, during spring (March 15 – May 31) and fall (September 1 – November 15) seasons and reduced to once per month, at approximately 28 day intervals, during the summer (June 1 – August 31) and winter seasons (November 16 – March 14).

In the 2007 avian surveys, 57 avian species were observed during the avian point count surveys, including six species observed only incidentally to point count surveys (Derby et al. 2009). Four species dominated the observations, European starling, horned lark, ring-necked pheasant and western meadowlark, which accounted for 61.5 percent of all observations (Derby et al. 2009). Nine species of raptors were observed, including golden eagles (2 individuals). Golden eagle observations occurred during the fall surveys and the individuals were observed flying within the anticipated rotor-swept area (RSA; Derby et al. 2009). Fourteen sensitive species listed as North Dakota Species of Conservation Priority (including the golden eagle) were observed. No other threatened or endangered (T&E) species were observed during these surveys.

In the 2011-2012 avian surveys, 73 avian species were observed during the avian point count surveys, including five species observed only incidentally to point count surveys (Derby et al. 2013).Two species, sandhill crane and horned lark, accountedfor 53.5 percent of all observations with 7.1 percent of the horned larks and 95.6 percent of all sandhill cranes recorded flying within the anticipated RSA (Derby et al. 2013). These cranes were all observed among 4 flocks on a single day in April 2012. Eight species of raptors were observed, including golden and bald eagles (6 individuals and 1 individual, respectively). Golden eagles were observed in all survey seasons in 2011-2012 with four observations recorded flying within the anticipated RSA (Derby et al. 2013).The bald eagle was observed perched during the winter survey. Twenty-one sensitive species, listed as North Dakota Species of Conservation Priority,(including the eagles) were observed including the federal candidate species Sprague's pipit (Derby et al. 2013).One Sprague's pipit was observed during the spring point count survey while two other individuals were observed during the late spring as incidental observations. No other threatened or endangered species were observed during these surveys.

Sharp-tailed Grouse Lek Surveys

One season of sharp-tailed grouse lek surveys were conducted in spring 2011 (Derby and Thorn 2013).Three aerial transect surveys (fixed-wing plane) were conducted over a single nine-day period in late April-early May 2011. Surveys followed a protocol that is consistent with prairie-chicken aerial leks surveys, as described by Martin and Knopf (1981).The leks observed were defined as either confirmed (1 lek; observed courtship behavior during more than one surveys), probable (3 leks; observed courtship behavior during one surveys) and possible (1 lek; little to no courtship behavior but individuals observed in same general location during more than one survey)(Derby and Thorn 2013).

Five grouse leks were identified, including one confirmed lek, three probable leks, and one possible lek (Derby and Thorn 2013). The confirmed lek was located within the Project area in planted grassland habitat. Two of the three probable leks were located in native prairie habitat outside of the Project area while the third was within the Project area in alfalfa hay cropland (Derby and Thorn 2013). The one possible lek was located in an unknown grassland habitat type inside the Project area (Derby and Thorn 2013). The two leks outside the Project area were within the 1.6 kilometer (km; 1 mile) survey buffer (Derby and Thorn 2013)

Raptor Nest Surveys

Aerial and ground raptor nest surveys were conducted in spring 2011 (Derby and Thorn 2013). Aerial nest surveys were conducted within the Project area and 16.1 km (10 mile) buffer from a fixed-wing aircraft and, focused on potential nest structures for eagles. Ground-based raptor nest surveys were conducted concurrent to avian point count surveys.

Two active raptor nests were identified including one nest occupied by great-horned owls within the Project area and one nest occupied by Swainson's hawks approximately 1.2 km (0.75 miles) east of the Project (Derby and Thorn 2013). Although no eagle nests were identified during the aerial surveys, WEST requested a database review of known eagle nest locations within 10 miles of the Project area from USFWS. One known historic golden eagle nest approximately 5 miles west of the Project boundary was identified by the USFWS, but was not identified during the 2011 season.

Passive Acoustic Bat Monitoring Surveys

The first year of passive acoustic monitoring surveys was conducted from 23July to 15 October, 2007 with two ground-level AnaBat II (Titley^{TM}Scientific, Australia) ultrasonic bat call detectors placed in the southwestern and northwestern portions of the Project area; (Derby et al. 2008). A second year of passive acoustic monitoring surveys was conducted within the Project area from 25 May to 20 October 2011 using AnaBat SD1 ultrasonic bat call detectors (Derby and Sichmeller 2013). Incoming echolocation calls are digitally processed and stored by the detector. The integrated zero crossings analysis interface module (ZCAIM) produces a file that, when viewed in appropriate software (i.e., Analook®; 2008, C. Corben), displays digital sonograms of the echolocation calls that show change in frequency over time (Derby and Sichmeller 2013). Frequency versus time displays were used to separate bat calls from other types of ultrasonic noise (e.g.wind, insects, etc.) and to identify the call frequency classification and species (when possible) of bat that generated the calls (Derby and Sichmeller 2013).One pair of detectors was placed at a pre-existing meteorological tower in the southwest corner of the Project area with one unit placed near the approximate turbine rotor-swept area (50m) and another at ground-level. Two additional ground-level detectors were placed in suitable bat foraging habitat in shortgrass habitats near agricultural fields in the south-central and northwest sections of the Project area.

In 2007, detectors collected 126 bat passes, defined as a sequence of echolocation calls produced by an individual bat as indicated by at least two calls (pulses) with no pause between calls of more than one second (Derby et al. 2009).Overall bat activity was 1.13 bat passes per detector night, and the bat activity between detectors was relatively similar (1.0 bat passes per detector night at the northwestern detector, and 1.13 bat passes per detector night at the southwestern detector; Derby et al. 2009). Of the bat passes not identifiable to species, calls were mainly low frequency species, such as silver-haired bat, big

brown bat, Townsend's bat and hoary bat.Bat passes identifiable to species included the hoary and eastern red bat (Derby et al. 2009). Neither of the bat species identified to species are "Species of conservation priority," although both have been identified as fatalities at wind projects in North America.

In 2011, bat detectors were operational for approximately 82% of the survey period, and collected 406 bat passes (Derby and Sichmeller 2013). Overall bat activity was 0.78 bat passes per detector night, and the majority of calls were recorded at the ground-level detectors (364 bat passes; Derby and Sichmeller 2013). Of bat passes not identifiable to species, calls were mainly high-frequency bats, defined by report authors as *Myotis* species and eastern red bat.Of bat passes identifiable to species, hoary and eastern red bat were identified (Derby and Sichmeller 2013). Neither of these species are "Species of conservation priority," although both have been identified as fatalities at wind projects in North America.

Habitat Mapping

In 2011, WEST conducted a desktop habitat mapping of the Project area using 2004 GAP Land Data for North Dakota. In 2013, Tetra Tech conducted additional field reconnaissance to determine the location and potential impacts to any wetlands and to verify the condition of the grassland habitat features with respect to potential impacts to native prairie. This reconnaissance included additional information on the dominant plant species which were then used to identify grassland habitats that are pasture and hayfields from actual native prairie habitats. Project facilities are located on land parcels comprised of the following categories:

Vegetation Class	Acres*
Agriculture	7240.4
Developed Lands	193.6
Native Prairie	3727.9
Native Prairie/Hayfields	799.3
Pasture/Hayfields	2464.7
Road	137.2
Shrubs/Trees	42.2
Wetlands	269.5

*Acres calculation is comprised from the Wind Energy Facility Perimeter as shown on Figure 1.

ONGOING STUDIES

Helicopter Surveys for Eagle Nests

Because eagles were observed in all seasons during the 2011-2012 field effort, in 2013, WEST is implementing a dedicated eagle nest survey using a helicopter within the Project area and a surrounding 10-mile buffer area. Detection levels can be higher using this type of aircraft compared to a fixed-wing. WEST will also request another database search to determine whether eagle nests have been documented and reported since 2011.

Grassland Surveys

Thirty six turbines are currently sited in Native Prairie and Native Prairie/Hayfields based on the 2011 desktop survey. Current 2013 survey efforts are underway to update the current land use by refining and differentiate between actual native prairie and planted herbaceous grasslands such as hayfields and pastures for cattle. Hayfields and pastures are often planted with species that are introduced, such as smooth brome, crested wheatgrass, alfalfa and sweet clover although some plantings are native grass species. In addition to planted fields, smooth brome and other non-native species often invades into areas of native prairie and further degrades the value of the habitat for wildlife. It is also very likely that additional areas classified as grasslands may have been turned into agriculture or some other form of development since the 2011 desktop mapping. Updated land use may help further site Project features away from sensitive areas.

Bird and Bat Conservation Strategy

Thunder Spirit and WEST are currently developing a Bird and Bat Conservation Strategy (BBCS) that outlines the species of concern for the Project, how investigations were done to identify use of the area and results of those studies, what actions were done and will be done to avoid, minimize, and mitigate potential impacts, and what measures will be taken during the operation of the Project. This plan will include specific sections on golden eagles, Sprague's pipit, and sharp-tailed grouse but will also include other species of concern.

PSC Site Compatibility Permit Process

As part of the PSC process, Thunder Spirit will continue to gather information in order to arrive at a determination as to whether the location, construction, and operation of the proposed Project facilities produce minimal adverse effects on the environment and upon the welfare of the citizens of North Dakota. Also, Thunder Spirit will demonstrate whether the proposed Project iscompatible with the environmental preservation and the efficient use of resources. The application is currently scheduled to be submitted to the PSC inJune 2013.

REFERENCES

Derby; C., A. Dahl, and K. Seginak.2009. Baseline Wildlife Studies for the Two Creeks Wind Resource Area Adams County, North Dakota – Final Report: June 2007 – October 2007. Prepared for Two Winds, LLC.65 pp.

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Derby; C. and T. Thorn. 2013. Wildlife Baseline Studies for the Thunder Spirit Wind Resource Area, Adams County, North Dakota - Sharp-tailed Grouse Lek and Raptor Nest Report: Spring 2011.Prepared for Thunder Spirit Wind, LLC.10 pp.

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Martin; S.A. and F.L. Knopf. 1981. Aerial Survey of Greater Prairie Chicken Leks. WildlifeSociety Bulletin 9(3): 219-221.

USFWS 2012. Draft U.S. Fish and Wildlife Service Land-Based Wind Energy Guidelines. September 13, 2011. Available online at http://www.fws.gov/windenergy/docs/WEG_final.pdf, accessed February 2013.

TETRA TECH

April 22, 2013

Mr. Daniel Cimarosti
Regulatory Program Manager
U.S. Army Corps of Engineers Omaha District, North Dakota Regulatory Office
1513 South 12th Street
Bismarck, ND 58504

RE: Application to the North Dakota Public Service Commission for Certificate of Site Compatibility for the Thunder Spirit Wind Energy Project in Adams County, North Dakota (Case No. PU-11-601)

Dear Mr. Cimarosti:

Tetra Tech has been contracted by Thunder Spirit Wind, LLC (an affiliate of Global Winds Harvest, Inc.) to prepare an application for a Certificate of Site Compatibility, in accordance with Section 49-22-07 NDCC. The proposed Thunder Spirit Wind Energy Project (Project) would be constructed on up to 40 square miles of leased private property. The southwest Project area boundary is approximately 2 miles northeast of Hettinger, North Dakota. As currently planned, the Project would produce approximately 150 megawatts (MW) and would consist of up to 75 wind turbine generators as well as meteorological towers, access roads, underground collection lines, a substation, and operations and maintenance facilities. The proposed Project area shown in the attached figure is the primary focus of our investigation.

Per Section 69-06-01-05 of the North Dakota Public Service Commission (PSC)'s administrative rules, we are consulting the U.S. Army Corps of Engineers for assistance in identifying concerns or issues within the boundaries of the tracts listed below that would influence a decision regarding the use of the land, as well as applicable permits that may be required from your office.

This information will be used to help guide Project development in a manner that identifies and avoids impacts to sensitive resources where practicable. We have sent similar query letters to other agencies including, but not limited to, the U.S. Fish and Wildlife Service and North Dakota Game and Fish Department.

We would appreciate a response by May 24, 2013. Please contact me at Tracey.Dubuque@tetratech.com or (617) 433-7552 if you have any questions. Thank you for your assistance.

Respectfully submitted,

TETRA TECH, INC

Tracey Dubuque, P.E.
Senior Project Manager

160 Federal Street, 3rd Floor, Boston, MA 02110
Tel 617.443.7500 Fax 617.737.3480
www.tetratech.com

TETRA TECH

April 22, 2013

Mr. Merlan E. Paaverud, Jr.
Director
State Historical Society of North Dakota
612 East Boulevard Avenue
Bismarck, ND 58505

RE: Application to the North Dakota Public Service Commission for Certificate of Site Compatibility for the Thunder Spirit Wind Energy Project in Adams County, North Dakota (Case No. PU-11-601)

Dear Mr. Paaverud:

Tetra Tech has been contracted by Thunder Spirit Wind, LLC (an affiliate of Global Winds Harvest, Inc.) to prepare an application for a Certificate of Site Compatibility, in accordance with Section 49-22-07 NDCC. The proposed Thunder Spirit Wind Energy Project (Project) would be constructed on up to 40 square miles of leased private property. The southwest Project area boundary is approximately 2 miles northeast of Hettinger, North Dakota. As currently planned, the Project would produce approximately 150 megawatts (MW) and would consist of up to 75 wind turbine generators as well as meteorological towers, access roads, underground collection lines, a substation, and operations and maintenance facilities. The proposed Project area shown in the attached figure is the primary focus of our investigation.

Per Section 69-06-01-05 of the North Dakota Public Service Commission (PSC)'s administrative rules, we are consulting the State Historical Society of North Dakota for assistance in identifying concerns or issues within the boundaries of the tracts listed below that would influence a decision regarding the use of the land, as well as applicable permits that may be required from your office.

This information will be used to help guide Project development in a manner that identifies and avoids impacts to sensitive resources where practicable. We have sent similar query letters to other agencies including, but not limited to, the U.S. Fish and Wildlife Service, U.S, Army Corps of Engineers, and North Dakota Game and Fish Department.

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Senior Project Manager

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www.tetratech.com

TETRA TECH

April 22, 2013

Mr. Mark Zimmerman
Director
North Dakota Parks and Recreation Department
1600 E. Century Ave, Suite 3
Bismarck, North Dakota 58503

RE: Application to the North Dakota Public Service Commission for Certificate of Site Compatibility for the Thunder Spirit Wind Energy Project in Adams County, North Dakota (Case No. PU-11-601)

Dear Mr. Zimmerman:

Tetra Tech has been contracted by Thunder Spirit Wind, LLC (an affiliate of Global Winds Harvest, Inc.) to prepare an application for a Certificate of Site Compatibility, in accordance with Section 49-22-07 NDCC. The proposed Thunder Spirit Wind Energy Project (Project) would be constructed on up to 40 square miles of leased private property. The southwest Project area boundary is approximately 2 miles northeast of Hettinger, North Dakota. As currently planned, the Project would produce approximately 150 megawatts (MW) and would consist of up to 75 wind turbine generators as well as meteorological towers, access roads, underground collection lines, a substation, and operations and maintenance facilities. The proposed Project area shown in the attached figure is the primary focus of our investigation.

Per Section 69-06-01-05 of the North Dakota Public Service Commission (PSC)'s administrative rules, we are consulting the North Dakota Parks and Recreation Department for assistance in identifying concerns or issues within the boundaries of the tracts listed below that would influence a decision regarding the use of the land, as well as applicable permits that may be required from your office.

This information will be used to help guide Project development in a manner that identifies and avoids impacts to sensitive resources where practicable. We have sent similar query letters to other agencies including, but not limited to, the U.S. Fish and Wildlife Service, U.S, Army Corps of Engineers, and North Dakota Game and Fish Department.

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TETRA TECH

April 22, 2013

Mr. Scott Davis
Executive Director
North Dakota Indian Affairs Commission
600 East Boulevard Avenue
1st Floor – Judicial Wing, Room #117
Bismarck, North Dakota 58505

RE: Application to the North Dakota Public Service Commission for Certificate of Site Compatibility for the Thunder Spirit Wind Energy Project in Adams County, North Dakota (Case No. PU-11-601)

Dear Mr. Davis:

Tetra Tech has been contracted by Thunder Spirit Wind, LLC (an affiliate of Global Winds Harvest, Inc.) to prepare an application for a Certificate of Site Compatibility, in accordance with Section 49-22-07 NDCC. The proposed Thunder Spirit Wind Energy Project (Project) would be constructed on up to 40 square miles of leased private property. The southwest Project area boundary is approximately 2 miles northeast of Hettinger, North Dakota. As currently planned, the Project would produce approximately 150 megawatts (MW) and would consist of up to 75 wind turbine generators as well as meteorological towers, access roads, underground collection lines, a substation, and operations and maintenance facilities. The proposed Project area shown in the attached figure is the primary focus of our investigation.

Per Section 69-06-01-05 of the North Dakota Public Service Commission (PSC)'s administrative rules, we are consulting the North Dakota Indian Affairs Commission for assistance in identifying concerns or issues within the boundaries of the tracts listed below that would influence a decision regarding the use of the land, as well as applicable permits that may be required from your office.

This information will be used to help guide Project development in a manner that identifies and avoids impacts to sensitive resources where practicable. We have sent similar query letters to other agencies including, but not limited to, the U.S. Fish and Wildlife Service, U.S, Army Corps of Engineers, and North Dakota Game and Fish Department.

We would appreciate a response by May 24, 2013. Please contact me at Tracey.Dubuque@tetratech.com or (617) 433-7552 if you have any questions. Thank you for your assistance.

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TETRA TECH

April 22, 2013

Mr. Edward C. Murphy
State Geologist
North Dakota Geological Survey
600 East Boulevard Avenue
Bismarck ND 58505-0840

RE: Application to the North Dakota Public Service Commission for Certificate of Site Compatibility for the Thunder Spirit Wind Energy Project in Adams County, North Dakota (Case No. PU-11-601)

Dear Mr. Murphy:

Tetra Tech has been contracted by Thunder Spirit Wind, LLC (an affiliate of Global Winds Harvest, Inc.) to prepare an application for a Certificate of Site Compatibility, in accordance with Section 49-22-07 NDCC. The proposed Thunder Spirit Wind Energy Project (Project) would be constructed on up to 40 square miles of leased private property. The southwest Project area boundary is approximately 2 miles northeast of Hettinger, North Dakota. As currently planned, the Project would produce approximately 150 megawatts (MW) and would consist of up to 75 wind turbine generators as well as meteorological towers, access roads, underground collection lines, a substation, and operations and maintenance facilities. The proposed Project area shown in the attached figure is the primary focus of our investigation.

Per Section 69-06-01-05 of the North Dakota Public Service Commission (PSC)'s administrative rules, we are consulting the North Dakota Geological Survey for assistance in identifying concerns or issues within the boundaries of the tracts listed below that would influence a decision regarding the use of the land, as well as applicable permits that may be required from your office.

This information will be used to help guide Project development in a manner that identifies and avoids impacts to sensitive resources where practicable. We have sent similar query letters to other agencies including, but not limited to, the U.S. Fish and Wildlife Service, U.S, Army Corps of Engineers, and North Dakota Game and Fish Department.

We would appreciate a response by May 24, 2013. Please contact me at Tracey.Dubuque@tetratech.com or (617) 433-7552 if you have any questions. Thank you for your assistance.

Respectfully submitted,

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TETRA TECH

May 17, 2013

Mr. Terry Steinwand
Director
North Dakota Game and Fish Department
100 N. Bismarck Expressway
Bismarck, ND 58501-5095

RE: Application to the North Dakota Public Service Commission for Certificate of Site Compatibility for the Thunder Spirit Wind Energy Project in Adams County, North Dakota (Case No. PU-11-601)

Dear Mr. Steinwand:

Tetra Tech has been contracted by Thunder Spirit Wind, LLC to prepare an application for a Certificate of Site Compatibility, in accordance with Section 49-22-07 NDCC. The proposed Thunder Spirit Wind Energy Project (Project) would be constructed on up to 40 square miles of leased private property approximately 2 miles northeast of Hettinger, North Dakota. As currently planned, the Project would produce approximately 150 megawatts (MW) and would consist of up to 75 wind turbine generators as well as meteorological towers, access roads, underground collection lines, a substation, and operations and maintenance facilities. There will be one section of tie-line (less than a mile in length) connecting the Project substation to an existing substation located in the southwest corner of Section 31 of Township 130 North, Range 95 West. The proposed Project area shown in the attached figure is the primary focus of our investigation.

Per Section 69-06-01-05 of the North Dakota Public Service Commission (PSC)'s administrative rules, we are consulting with the North Dakota Game and Fish Department for assistance in identifying concerns or issues within the boundaries as shown on Figure 1 that would influence a decision regarding the use of the land, as well as applicable permits that may be required from your office.

This information will be used to help guide Project development in a manner that identifies and avoids impacts to sensitive resources where practicable. We have sent similar query letters to other agencies including, but not limited to, the U.S. Fish and Wildlife Service and the U.S. Army Corps of Engineers.

We have prepared a summary of biological information prepared to date for the Project for your review, attached as Appendix 1.

We would appreciate a response by May 31, 2013. Please contact me at Tracey.Dubuque@tetratech.com or (617) 433-7552 if you have any questions. Thank you for your assistance.

Respectfully submitted,

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Figure 1

Thunder Spirit Wind Energy Project
Thunder Spirit Wind, LLC
Adams County, North Dakota

May 2013

Legend

- Project Area
- Wind Energy Facility Perimeter (4/26/2013)
- Proposed Turbine Location (4/26/2013)
- Approximate POI
- Met Tower Locations
- Proposed Collector Substation (4/8/2013)
- Overhead Line (4/8/2013)
- Collection Line (4/26/2013)
- Access Road (4/26/2013)
- Laydown Area (20 Acres)
- Collector Substation/O&M Building Construction Footprint (20 Acres)

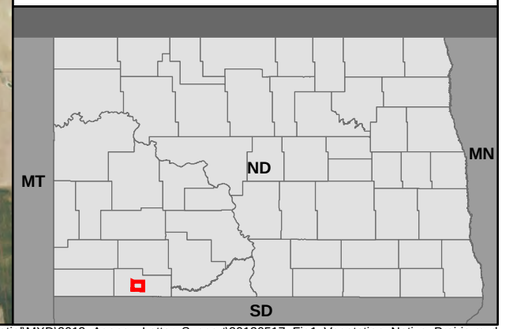
Vegetation/Native Prairie Classes

- Agriculture
- Developed Lands
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- Road
- Shrubs/Trees
- Wetlands

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REFERENCE MAP



Path: P:\Global Winds Harvest\Thunder Spirit - ND\GIS\Spatial\MXD\2013_Agency_Letter_Support\20130517_Fig1_Vegetation_Native_Prairie.mxd

Summary of Thunder Spirit Wildlife Studies

May 2013

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Raptor Nest Surveys

Aerial and ground raptor nest surveys were conducted in spring 2011 (Derby and Thorn 2013). Aerial nest surveys were conducted within the Project area and 16.1 km (10 mile) buffer from a fixed-wing aircraft and, focused on potential nest structures for eagles. Ground-based raptor nest surveys were conducted concurrent to avian point count surveys.

Two active raptor nests were identified including one nest occupied by great-horned owls within the Project area and one nest occupied by Swainson's hawks approximately 1.2 km (0.75 miles) east of the Project (Derby and Thorn 2013). Although no eagle nests were identified during the aerial surveys, WEST requested a database review of known eagle nest locations within 10 miles of the Project area from USFWS. One known historic golden eagle nest approximately 5 miles west of the Project boundary was identified by the USFWS, but was not identified during the 2011 season.

Passive Acoustic Bat Monitoring Surveys

The first year of passive acoustic monitoring surveys was conducted from 23July to 15 October, 2007 with two ground-level AnaBat II (Titley^{TM}Scientific, Australia) ultrasonic bat call detectors placed in the southwestern and northwestern portions of the Project area; (Derby et al. 2008). A second year of passive acoustic monitoring surveys was conducted within the Project area from 25 May to 20 October 2011 using AnaBat SD1 ultrasonic bat call detectors (Derby and Sichmeller 2013). Incoming echolocation calls are digitally processed and stored by the detector. The integrated zero crossings analysis interface module (ZCAIM) produces a file that, when viewed in appropriate software (i.e., Analook®; 2008, C. Corben), displays digital sonograms of the echolocation calls that show change in frequency over time (Derby and Sichmeller 2013). Frequency versus time displays were used to separate bat calls from other types of ultrasonic noise (e.g.wind, insects, etc.) and to identify the call frequency classification and species (when possible) of bat that generated the calls (Derby and Sichmeller 2013).One pair of detectors was placed at a pre-existing meteorological tower in the southwest corner of the Project area with one unit placed near the approximate turbine rotor-swept area (50m) and another at ground-level. Two additional ground-level detectors were placed in suitable bat foraging habitat in shortgrass habitats near agricultural fields in the south-central and northwest sections of the Project area.

In 2007, detectors collected 126 bat passes, defined as a sequence of echolocation calls produced by an individual bat as indicated by at least two calls (pulses) with no pause between calls of more than one second (Derby et al. 2009).Overall bat activity was 1.13 bat passes per detector night, and the bat activity between detectors was relatively similar (1.0 bat passes per detector night at the northwestern detector, and 1.13 bat passes per detector night at the southwestern detector; Derby et al. 2009). Of the bat passes not identifiable to species, calls were mainly low frequency species, such as silver-haired bat, big

brown bat, Townsend's bat and hoary bat.Bat passes identifiable to species included the hoary and eastern red bat (Derby et al. 2009). Neither of the bat species identified to species are "Species of conservation priority," although both have been identified as fatalities at wind projects in North America.

In 2011, bat detectors were operational for approximately 82% of the survey period, and collected 406 bat passes (Derby and Sichmeller 2013). Overall bat activity was 0.78 bat passes per detector night, and the majority of calls were recorded at the ground-level detectors (364 bat passes; Derby and Sichmeller 2013). Of bat passes not identifiable to species, calls were mainly high-frequency bats, defined by report authors as *Myotis* species and eastern red bat.Of bat passes identifiable to species, hoary and eastern red bat were identified (Derby and Sichmeller 2013). Neither of these species are "Species of conservation priority," although both have been identified as fatalities at wind projects in North America.

Habitat Mapping

In 2011, WEST conducted a desktop habitat mapping of the Project area using 2004 GAP Land Data for North Dakota. In 2013, Tetra Tech conducted additional field reconnaissance to determine the location and potential impacts to any wetlands and to verify the condition of the grassland habitat features with respect to potential impacts to native prairie. This reconnaissance included additional information on the dominant plant species which were then used to identify grassland habitats that are pasture and hayfields from actual native prairie habitats. Project facilities are located on land parcels comprised of the following categories:

Vegetation Class	Acres*
Agriculture	7240.4
Developed Lands	193.6
Native Prairie	3727.9
Native Prairie/Hayfields	799.3
Pasture/Hayfields	2464.7
Road	137.2
Shrubs/Trees	42.2
Wetlands	269.5

*Acres calculation is comprised from the Wind Energy Facility Perimeter as shown on Figure 1.

ONGOING STUDIES

Helicopter Surveys for Eagle Nests

Because eagles were observed in all seasons during the 2011-2012 field effort, in 2013, WEST is implementing a dedicated eagle nest survey using a helicopter within the Project area and a surrounding 10-mile buffer area. Detection levels can be higher using this type of aircraft compared to a fixed-wing. WEST will also request another database search to determine whether eagle nests have been documented and reported since 2011.

Grassland Surveys

Thirty six turbines are currently sited in Native Prairie and Native Prairie/Hayfields based on the 2011 desktop survey. Current 2013 survey efforts are underway to update the current land use by refining and differentiate between actual native prairie and planted herbaceous grasslands such as hayfields and pastures for cattle. Hayfields and pastures are often planted with species that are introduced, such as smooth brome, crested wheatgrass, alfalfa and sweet clover although some plantings are native grass species. In addition to planted fields, smooth brome and other non-native species often invades into areas of native prairie and further degrades the value of the habitat for wildlife. It is also very likely that additional areas classified as grasslands may have been turned into agriculture or some other form of development since the 2011 desktop mapping. Updated land use may help further site Project features away from sensitive areas.

Bird and Bat Conservation Strategy

Thunder Spirit and WEST are currently developing a Bird and Bat Conservation Strategy (BBCS) that outlines the species of concern for the Project, how investigations were done to identify use of the area and results of those studies, what actions were done and will be done to avoid, minimize, and mitigate potential impacts, and what measures will be taken during the operation of the Project. This plan will include specific sections on golden eagles, Sprague's pipit, and sharp-tailed grouse but will also include other species of concern.

PSC Site Compatibility Permit Process

As part of the PSC process, Thunder Spirit will continue to gather information in order to arrive at a determination as to whether the location, construction, and operation of the proposed Project facilities produce minimal adverse effects on the environment and upon the welfare of the citizens of North Dakota. Also, Thunder Spirit will demonstrate whether the proposed Project iscompatible with the environmental preservation and the efficient use of resources. The application is currently scheduled to be submitted to the PSC inJune 2013.

REFERENCES

Derby; C., A. Dahl, and K. Seginak.2009. Baseline Wildlife Studies for the Two Creeks Wind Resource Area Adams County, North Dakota – Final Report: June 2007 – October 2007. Prepared for Two Winds, LLC.65 pp.

Derby; C. and T. Sichmeller.2013. Bat Acoustic Studies for the Thunder Spirit Wind Resource Area, Adams County, North Dakota – Final Report: May – October 2011.Prepared for Thunder Spirit Wind, LLC. 40 pp.

Derby; C. and T. Thorn. 2013. Wildlife Baseline Studies for the Thunder Spirit Wind Resource Area, Adams County, North Dakota - Sharp-tailed Grouse Lek and Raptor Nest Report: Spring 2011.Prepared for Thunder Spirit Wind, LLC.10 pp.

Derby; C., A. Dahl, and S. Nomani.2013.Wildlife Baseline Studies for the Thunder Spirit Wind Resource Area, Adams County, North Dakota – Final Report: April 2011 – March 2012.Prepared forThunder Spirit Wind, LLC. 76 pp.

Martin; S.A. and F.L. Knopf. 1981. Aerial Survey of Greater Prairie Chicken Leks. WildlifeSociety Bulletin 9(3): 219-221.

USFWS 2012. Draft U.S. Fish and Wildlife Service Land-Based Wind Energy Guidelines. September 13, 2011. Available online at http://www.fws.gov/windenergy/docs/WEG_final.pdf, accessed February 2013.

TETRA TECH

April 22, 2013

Mr. Larry Gangl
District Engineer
North Dakota Department of Transportation, Dickinson District
1700 Third Avenue West, Suite 101
Dickinson, ND 58601-3009

RE: Application to the North Dakota Public Service Commission for Certificate of Site Compatibility for the Thunder Spirit Wind Energy Project in Adams County, North Dakota (Case No. PU-11-601)

Dear Mr. Gangl:

Tetra Tech has been contracted by Thunder Spirit Wind, LLC (an affiliate of Global Winds Harvest, Inc.) to prepare an application for a Certificate of Site Compatibility, in accordance with Section 49-22-07 NDCC. The proposed Thunder Spirit Wind Energy Project (Project) would be constructed on up to 40 square miles of leased private property. The southwest Project area boundary is approximately 2 miles northeast of Hettinger, North Dakota. As currently planned, the Project would produce approximately 150 megawatts (MW) and would consist of up to 75 wind turbine generators as well as meteorological towers, access roads, underground collection lines, a substation, and operations and maintenance facilities. The proposed Project area shown in the attached figure is the primary focus of our investigation.

Per Section 69-06-01-05 of the North Dakota Public Service Commission (PSC)'s administrative rules, we are consulting the North Dakota Department of Transportation for assistance in identifying concerns or issues within the boundaries of the tracts listed below that would influence a decision regarding the use of the land, as well as applicable permits that may be required from your office.

This information will be used to help guide Project development in a manner that identifies and avoids impacts to sensitive resources where practicable. We have sent similar query letters to other agencies including, but not limited to, the U.S. Fish and Wildlife Service, U.S, Army Corps of Engineers, and North Dakota Game and Fish Department.

We would appreciate a response by May 24, 2013. Please contact me at Tracey.Dubuque@tetratech.com or (617) 433-7552 if you have any questions. Thank you for your assistance.

Respectfully submitted,

TETRA TECH, INC

Tracey Dubuque, P.E.
Senior Project Manager

160 Federal Street, 3rd Floor, Boston, MA 02110
Tel 617.443.7500 Fax 617.737.3480
www.tetratech.com

TETRA TECH

April 22, 2013

Dr. Terry Dwelle, M.D., M.P.H.T.M.
State Health Officer
North Dakota Department of Health
600 East Boulevard Avenue
Bismarck, North Dakota 58505-0200

RE: Application to the North Dakota Public Service Commission for Certificate of Site Compatibility for the Thunder Spirit Wind Energy Project in Adams County, North Dakota (Case No. PU-11-601)

Dear Dr. Dwelle:

Tetra Tech has been contracted by Thunder Spirit Wind, LLC (an affiliate of Global Winds Harvest, Inc.) to prepare an application for a Certificate of Site Compatibility, in accordance with Section 49-22-07 NDCC. The proposed Thunder Spirit Wind Energy Project (Project) would be constructed on up to 40 square miles of leased private property. The southwest Project area boundary is approximately 2 miles northeast of Hettinger, North Dakota. As currently planned, the Project would produce approximately 150 megawatts (MW) and would consist of up to 75 wind turbine generators as well as meteorological towers, access roads, underground collection lines, a substation, and operations and maintenance facilities. The proposed Project area shown in the attached figure is the primary focus of our investigation.

Per Section 69-06-01-05 of the North Dakota Public Service Commission (PSC)'s administrative rules, we are consulting the North Dakota Department of Health for assistance in identifying concerns or issues within the boundaries of the tracts listed below that would influence a decision regarding the use of the land, as well as applicable permits that may be required from your office.

This information will be used to help guide Project development in a manner that identifies and avoids impacts to sensitive resources where practicable. We have sent similar query letters to other agencies including, but not limited to, the U.S. Fish and Wildlife Service, U.S, Army Corps of Engineers, and North Dakota Game and Fish Department.

We would appreciate a response by May 24, 2013. Please contact me at Tracey.Dubuque@tetratech.com or (617) 433-7552 if you have any questions. Thank you for your assistance.

Respectfully submitted,

TETRA TECH, INC

Tracey Dubuque, P.E.
Senior Project Manager

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TETRA TECH

April 22, 2013

Mr. Todd Sando, P.E.
State Engineer
North Dakota State Water Commission
900 East Boulevard, Dept. 770
Bismarck, North Dakota 58505-0850

RE: Application to the North Dakota Public Service Commission for Certificate of Site Compatibility for the Thunder Spirit Wind Energy Project in Adams County, North Dakota (Case No. PU-11-601)

Dear Mr. Sando:

Tetra Tech has been contracted by Thunder Spirit Wind, LLC (an affiliate of Global Winds Harvest, Inc.) to prepare an application for a Certificate of Site Compatibility, in accordance with Section 49-22-07 NDCC. The proposed Thunder Spirit Wind Energy Project (Project) would be constructed on up to 40 square miles of leased private property. The southwest Project area boundary is approximately 2 miles northeast of Hettinger, North Dakota. As currently planned, the Project would produce approximately 150 megawatts (MW) and would consist of up to 75 wind turbine generators as well as meteorological towers, access roads, underground collection lines, a substation, and operations and maintenance facilities. The proposed Project area shown in the attached figure is the primary focus of our investigation.

Per Section 69-06-01-05 of the North Dakota Public Service Commission (PSC)'s administrative rules, we are consulting the North Dakota State Water Commission for assistance in identifying concerns or issues within the boundaries of the tracts listed below that would influence a decision regarding the use of the land, as well as applicable permits that may be required from your office.

This information will be used to help guide Project development in a manner that identifies and avoids impacts to sensitive resources where practicable. We have sent similar query letters to other agencies including, but not limited to, the U.S. Fish and Wildlife Service, U.S, Army Corps of Engineers, and North Dakota Game and Fish Department.

We would appreciate a response by May 24, 2013. Please contact me at Tracey.Dubuque@tetratech.com or (617) 433-7552 if you have any questions. Thank you for your assistance.

Respectfully submitted,

TETRA TECH, INC

Tracey Dubuque, P.E.
Senior Project Manager

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TETRA TECH

April 22, 2013

Mr. Gary D. Preszler
Commissioner
North Dakota State Land Department
P. O. Box 5523
Bismarck, North Dakota 58506-5523

RE: Application to the North Dakota Public Service Commission for Certificate of Site Compatibility for the Thunder Spirit Wind Energy Project in Adams County, North Dakota (Case No. PU-11-601)

Dear Mr. Preszler:

Tetra Tech has been contracted by Thunder Spirit Wind, LLC (an affiliate of Global Winds Harvest, Inc.) to prepare an application for a Certificate of Site Compatibility, in accordance with Section 49-22-07 NDCC. The proposed Thunder Spirit Wind Energy Project (Project) would be constructed on up to 40 square miles of leased private property. The southwest Project area boundary is approximately 2 miles northeast of Hettinger, North Dakota. As currently planned, the Project would produce approximately 150 megawatts (MW) and would consist of up to 75 wind turbine generators as well as meteorological towers, access roads, underground collection lines, a substation, and operations and maintenance facilities. The proposed Project area shown in the attached figure is the primary focus of our investigation.

Per Section 69-06-01-05 of the North Dakota Public Service Commission (PSC)'s administrative rules, we are consulting the North Dakota State Land Department for assistance in identifying concerns or issues within the boundaries of the tracts listed below that would influence a decision regarding the use of the land, as well as applicable permits that may be required from your office.

This information will be used to help guide Project development in a manner that identifies and avoids impacts to sensitive resources where practicable. We have sent similar query letters to other agencies including, but not limited to, the U.S. Fish and Wildlife Service, U.S, Army Corps of Engineers, and North Dakota Game and Fish Department.

We would appreciate a response by May 24, 2013. Please contact me at Tracey.Dubuque@tetratech.com or (617) 433-7552 if you have any questions. Thank you for your assistance.

Respectfully submitted,

TETRA TECH, INC

Tracey Dubuque, P.E.
Senior Project Manager

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Tel 617.443.7500 Fax 617.737.3480
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TETRA TECH

April 22, 2013

Mr. Doug Goehring
Agriculture Commissioner
North Dakota Department of Agriculture
600 East Boulevard Avenue, Department 602
Bismarck, North Dakota 58505-0020

RE: Application to the North Dakota Public Service Commission for Certificate of Site Compatibility for the Thunder Spirit Wind Energy Project in Adams County, North Dakota (Case No. PU-11-601)

Dear Mr. Goehring:

Tetra Tech has been contracted by Thunder Spirit Wind, LLC (an affiliate of Global Winds Harvest, Inc.) to prepare an application for a Certificate of Site Compatibility, in accordance with Section 49-22-07 NDCC. The proposed Thunder Spirit Wind Energy Project (Project) would be constructed on up to 40 square miles of leased private property. The southwest Project area boundary is approximately 2 miles northeast of Hettinger, North Dakota. As currently planned, the Project would produce approximately 150 megawatts (MW) and would consist of up to 75 wind turbine generators as well as meteorological towers, access roads, underground collection lines, a substation, and operations and maintenance facilities. The proposed Project area shown in the attached figure is the primary focus of our investigation.

Per Section 69-06-01-05 of the North Dakota Public Service Commission (PSC)'s administrative rules, we are consulting the North Dakota Department of Agriculture for assistance in identifying concerns or issues within the boundaries of the tracts listed below that would influence a decision regarding the use of the land, as well as applicable permits that may be required from your office.

This information will be used to help guide Project development in a manner that identifies and avoids impacts to sensitive resources where practicable. We have sent similar query letters to other agencies including, but not limited to, the U.S. Fish and Wildlife Service, U.S, Army Corps of Engineers, and North Dakota Game and Fish Department.

We would appreciate a response by May 24, 2013. Please contact me at Tracey.Dubuque@tetratech.com or (617) 433-7552 if you have any questions. Thank you for your assistance.

Respectfully submitted,

TETRA TECH, INC

Tracey Dubuque, P.E.
Senior Project Manager

160 Federal Street, 3rd Floor, Boston, MA 02110
Tel 617.443.7500 Fax 617.737.3480
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TETRA TECH

April 22, 2013

Mr. Larry Taborsky
Director
North Dakota Aeronautics Commission
P. O. Box 5020
Bismarck, North Dakota 58502-5020

RE: Application to the North Dakota Public Service Commission for Certificate of Site Compatibility for the Thunder Spirit Wind Energy Project in Adams County, North Dakota (Case No. PU-11-601)

Dear Mr. Taborsky:

Tetra Tech has been contracted by Thunder Spirit Wind, LLC (an affiliate of Global Winds Harvest, Inc.) to prepare an application for a Certificate of Site Compatibility, in accordance with Section 49-22-07 NDCC. The proposed Thunder Spirit Wind Energy Project (Project) would be constructed on up to 40 square miles of leased private property. The southwest Project area boundary is approximately 2 miles northeast of Hettinger, North Dakota. As currently planned, the Project would produce approximately 150 megawatts (MW) and would consist of up to 75 wind turbine generators as well as meteorological towers, access roads, underground collection lines, a substation, and operations and maintenance facilities. The proposed Project area shown in the attached figure is the primary focus of our investigation.

Per Section 69-06-01-05 of the North Dakota Public Service Commission (PSC)'s administrative rules, we are consulting the North Dakota Aeronautics Commission for assistance in identifying concerns or issues within the boundaries of the tracts listed below that would influence a decision regarding the use of the land, as well as applicable permits that may be required from your office.

This information will be used to help guide Project development in a manner that identifies and avoids impacts to sensitive resources where practicable. We have sent similar query letters to other agencies including, but not limited to, the U.S. Fish and Wildlife Service, U.S, Army Corps of Engineers, and North Dakota Game and Fish Department.

We would appreciate a response by May 24, 2013. Please contact me at Tracey.Dubuque@tetratech.com or (617) 433-7552 if you have any questions. Thank you for your assistance.

Respectfully submitted,

TETRA TECH, INC

Tracey Dubuque, P.E.
Senior Project Manager

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TETRA TECH

April 22, 2013

Mr. Rob Buckmier
Chair
Adams County Soil Conservation District
602 Second Avenue North, Box 872
Hettinger, ND 58639-0872

RE: Application to the North Dakota Public Service Commission for Certificate of Site Compatibility for the Thunder Spirit Wind Energy Project in Adams County, North Dakota (Case No. PU-11-601)

Dear Mr. Buckmier:

Tetra Tech has been contracted by Thunder Spirit Wind, LLC (an affiliate of Global Winds Harvest, Inc.) to prepare an application for a Certificate of Site Compatibility, in accordance with Section 49-22-07 NDCC. The proposed Thunder Spirit Wind Energy Project (Project) would be constructed on up to 40 square miles of leased private property. The southwest Project area boundary is approximately 2 miles northeast of Hettinger, North Dakota. As currently planned, the Project would produce approximately 150 megawatts (MW) and would consist of up to 75 wind turbine generators as well as meteorological towers, access roads, underground collection lines, a substation, and operations and maintenance facilities. The proposed Project area shown in the attached figure is the primary focus of our investigation.

Per Section 69-06-01-05 of the North Dakota Public Service Commission (PSC)'s administrative rules, we are consulting the Adams County Soil Conservation District for assistance in identifying concerns or issues within the boundaries of the tracts listed below that would influence a decision regarding the use of the land, as well as applicable permits that may be required from your office.

This information will be used to help guide Project development in a manner that identifies and avoids impacts to sensitive resources where practicable. We have sent similar query letters to other agencies including, but not limited to, the U.S. Fish and Wildlife Service, U.S, Army Corps of Engineers, and North Dakota Game and Fish Department.

We would appreciate a response by May 24, 2013. Please contact me at Tracey.Dubuque@tetratech.com or (617) 433-7552 if you have any questions. Thank you for your assistance.

Respectfully submitted,

TETRA TECH, INC

Tracey Dubuque, P.E.
Senior Project Manager

160 Federal Street, 3rd Floor, Boston, MA 02110
Tel 617.443.7500 Fax 617.737.3480
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TETRA TECH

March 28, 2013

Susan Quinnell
Review and Compliance Coordinator
North Dakota State Historic Preservation Office
612 East Boulevard Drive
Bismarck, North Dakota 58505

Subject: **Request for Comment on the Area of Potential Effects for Visual Effects for the Thunder Spirit Wind Energy Center (ND SHPO REF: 11-1854), Adams County, North Dakota.**

Dear Ms. Quinnell:

On July 1, 2011, Thunder Spirit Wind, LLC received a letter from the State Historical Society of North Dakota (SHSND) indicating the agency's review of the Class I Cultural Resource Inventory (ND SHPO REF: 11-1854). In this letter, SHSND recommended the completion of a Class II Reconnaissance Survey for standing structures and a Class III Pedestrian Survey for areas to be directly impacted by the project. Tetra Tech will update the Class I Cultural Resource Inventory and conduct a Class III Pedestrian Survey in spring 2013.

In regards to the Class II Reconnaissance Survey for standing structures, Tetra Tech requests the SHPO's comments on the size of the area of potential effects (APE) for visual effects for the Thunder Spirit Wind Energy Center. Tetra Tech also requests that the SHPO identify those properties (inventoried or un-inventoried) that should be included within the Class II Reconnaissance Survey. Tetra Tech has provided a map (hard copy and electronic copy) of the proposed turbine layout dated March 22, 2013.

Please feel free to contact me by telephone (612-643-2237) or by email (adam.holven@tetratech.com) if you have any questions concerning this request.

Sincerely,

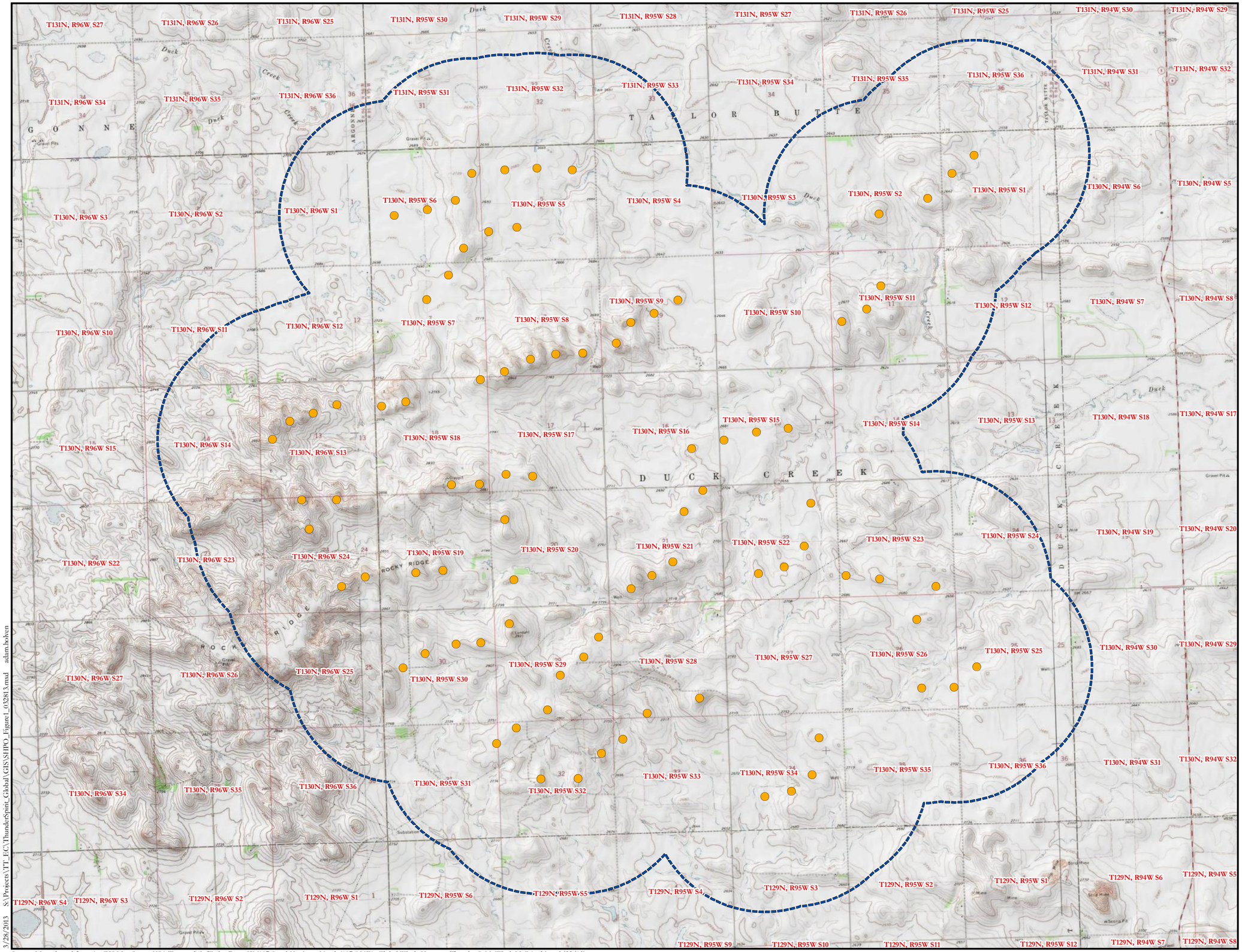
Adam Holven
Senior Archaeologist/Project Manager

Enclosures

cc:

Mr. Dan Albano, Thunder Spirit Wind, LLC
Ms. Tracey Dubuque, Tetra Tech
Ms. Kimberely Gorman, Tetra Tech

2001 Killebrew Drive, Suite 141, Bloomington, MN 55425
Tel 612.643.2200 Fax 612.643.2201 www.tetratech.com





Facility Layout 3/22/2013

- Proposed Turbine Location
- 1-mile Turbine Layout Buffer

0 0.5 1 1.5 Miles

N

Figure 1:
Turbine Location
with 1-mile Buffer
Thunder Spirit Wind Energy Center
Adams County, North Dakota

Global Winds Harvest

TETRA TECH

3/28/2013 S:\Projects\TT_EC\ThunderSpirit_Global\GIS\SHPO_Figure1_032813.mxd adam.bolven

Source: Map adapted from ArcGIS Map Server USA Topos - 24k (Taylor Butte SE [1974] and Hettinger North [1974] ND); Global Winds Harvest - Thunder Spirit Wind, LLC (turbines 3/22/13).

TETRA TECH EC, INC.

1000 The American Road, Morris Plains, NJ 07950
Tel 973.630.8000 Fax 973.630.8325

RECORD OF TELEPHONE CONVERSATION

CALLER:	**James Sexton**	**DATE:**	**May 13, 2013**
DISCUSSION WITH:	Susan Quinnell, State Historical Society of North Dakota		
SUBJECT:	**Level of Effort for Documenting Historic Structures within 1.0 mile of the proposed Thunder Spirit Wind Farm**		

Spoke with Susan Quinnell at the SHSND to clarify what they were seeking in terms of a report/site forms. She stated that as I was a qualified architectural historian that the SHSND would require site forms only for those properties which were determined in the field (and with research) to be potentially National Register eligible. (This is instead of their policy requiring site forms for all farmsteads 50 years old or older.) The AH report will serve to provide documentation of the survey and the buildings observed.

COMMISSIONER
DOUG GOEHRING

NORTH DAKOTA
DEPARTMENT OF AGRICULTURE
STATE CAPITOL
600 E BOULEVARD AVE DEPT 602
BISMARCK ND 58505-0020

ndda@nd.gov
www.agdepartment.com

May 1, 2013

Ms. Tracey Dubuque, P.E.
Senior Project Manager
160 Federal Street, 3rd Floor
Boston, MA 02110

RE: Application to the North Dakota Public Service Commission for Certificate of Site Compatibility for the Thunder Spirit Wind Energy Project in Adams County, North Dakota (Case No. PU-11-601)

Dear Ms. Dubuque:

Thank you for consulting the North Dakota Department of Agriculture in regards to the proposed Thunder Spirit Wind Energy Project. Given the description of the proposed Project, we have no concerns or issues within the boundaries of the tracts listed in your initial letter at this time.

We wish you the best of luck with the proposed Project and please feel free to contact us in the future with any other questions or concerns.

Sincerely,

Doug Goehring
North Dakota Agriculture Commissioner

Griger, Anne-Marie

From: Sue Kvas <sue_kvas@fws.gov>
Sent: Wednesday, April 17, 2013 2:28 PM
To: Griger, Anne-Marie
Subject: RE: USFWS fee title land and easements in Adams County, ND

Anne-Marie,

The USFWS has not land interests in Adams County

From: Griger, Anne-Marie [mailto:Anne-Marie.Griger@tetratech.com]
Sent: Wednesday, April 17, 2013 12:52 PM
To: Sue_Kvas@fws.gov
Cc: Dubuque, Tracey; Mann, Emily
Subject: USFWS fee title land and easements in Adams County, ND

Hello Sue,

Can you please let us know if there are any USFWS fee title lands and/or easements within one-mile of the project boundary depicted in the attached shapefiles?

Thanks,

Anne-Marie

Anne-Marie Griger, AICP | **Environmental Planner**
Direct: 512. 213.8501
anne-marie.griger@tetratech.com

Tetra Tech, Inc.
8911 N. Capital of Texas Hwy, Bldg 2 Suite # 2310
Austin, TX 78759

STATE HISTORICAL SOCIETY OF NORTH DAKOTA

Jack Dalrymple
Governor of North Dakota

North Dakota State Historical Board

Gereld Gerntholz
Valley City - President

Calvin Grinnell
New Town – Vice President

A. Ruric Todd III
Jamestown- Secretary

Albert I. Berger
Grand Forks

Diane K. Larson
Bismarck

Chester E. Nelson, Jr.
Bismarck

Margaret Puetz
Bismarck

Sara Otte Coleman
Director
Tourism Division

Kelly Schmidt
State Treasurer

Alvin A. Jaeger
Secretary of State

Mark Zimmerman
Director
Parks and Recreation Department

Grant Levi
Acting Director
Department of Transportation

Merlan E. Paaverud, Jr.
Director

Accredited by the American Alliance of Museums since 1989

April 29, 2013

Mr. Tracey Dubuque, PE
Senior Project manager
Tetra Tech
160 Federal Street, 3rd Floor
Boston, MA 02110

ND SHPO REF: 11-1854 PSC/Thunder Spirit Wind for Global Winds Harvest Wind Energy Center in Adams County (ND PSC Case No. PU-11-601) Adams County, North Dakota

Dear Mr. Dubuque,

Attached please find a copy of our correspondence to date on the above-captioned project. We understand that these surveys are underway.

Thank you for the opportunity to review this project to date. We look forward to further review of cultural resource surveys and site forms. If you have any questions please contact Paul Picha, Chief Archaeologist (701) 328-3574 or Susan Quinnell, Review and Compliance Coordinator at (701) 328-3576, e-mail squinnell@nd.gov

Sincerely,

Merlan E. Paaverud, Jr.
State Historic Preservation Officer (North Dakota) and
Director, State Historical Society of North Dakota

COPY

STATE HISTORICAL SOCIETY OF NORTH DAKOTA

Jack Dalrymple
Governor of North Dakota

North Dakota State Historical Board

Chester E. Nelson, Jr.
Bismarck - President

Gereld Gerntholz
Valley City - Vice President

Richard Kloubec
Fargo - Secretary

Albert I. Berger
Grand Forks

Calvin Grinnell
New Town

Diane K. Larson
Bismarck

A. Ruric Todd III
Jamestown

Sara Otte Coleman
Director
Tourism Division

Kelly Schmidt
State Treasurer

Alvin A. Jaeger
Secretary of State

Mark A. Zimmerman
Director
Parks and Recreation Department

Francis Ziegler
Director
Department of Transportation

Merlan E. Paaverud, Jr.
Director

Accredited by the American Association of Museums since 1986

July 1, 2011

Mr. Dan Albano
Thunder Spirit Wind, LLC
197 North Street Road
Argle, NY 12809

ND SHPO REF: 11-1854 PSC/Thunder Spirit Wind for Global Winds Harvest Wind Energy Center in Adams County, North Dakota

Dear Mr. Albano,

We reviewed your preliminary information on ND SHPO REF: 11-1854 PSC/Thunder Spirit Wind for Global Winds Harvest Wind Energy Center in Adams County, North Dakota. There is potential for unrecorded and recorded cultural resource properties in a variety of physiographic settings in the overall project area. If the project requires permits issued by a federal and/or state agency (e.g., WAPA, RUS, COE, USFWS, BOR, PSC) then the respective agencies are to be consulted regarding their recommendations on the project. As a potential federal undertaking, we encourage agency consultation as part of the review process. Consultation should also include tribal nations, North Dakota Indian Affairs, ND DOT regarding any Scenic Byways, and managers or owners of properties maintained for recreational or scenic value.

Thank you for the Class I Cultural Resource Inventory (file and records search with project maps) submittal. A Class II (reconnaissance) survey is warranted for standing structures in the visual Area of Potential Effect (APE). Class III (pedestrian) surveys will be warranted for all areas directly impacted by the project, including crane paths, access roads, transmissions lines and turbine pads. We encourage that tribal monitors be invited to survey the APE. As part of the Class III Inventory, NDCRS site updates should be submitted on all sites resurveyed.

Thank you for the opportunity to review this project to date. We look forward to further review of cultural resource surveys and site forms. If you have any questions please contact Paul Picha, Chief Archaeologist (701) 328-3574 or Susan Quinnell, Review and Compliance Coordinator at (701) 328-3576, e-mail squinnell@nd.gov

Sincerely,

Merlan E. Paaverud, Jr.
State Historic Preservation Officer (North Dakota) and
Director, State Historical Society of North Dakota

C: Patrick Fahn, PSC

11-1854

Quinnell, Susan L.

From: Quinnell, Susan L.
Sent: Tuesday, April 02, 2013 11:05 AM
To: adam.holven@tetratech.com
Subject: APE for Visual Effects for the Thunder Spirit wind Energy Center ND SHPO Ref: 11-1854
Attachments: doc07002520130402110509.pdf

Hi Adam,

Here is a PDF of your map we received yesterday. I put circles or squares around the areas we would like to see a Class II (reconnaissance) survey. That means I'd like to see a photo of each of these 27 sites, keyed to a map. Then if you find any of these 27 sites that have buildings/structures 50 years or older, please fill out a site form with eligibility recommendations on the buildings/structures that are 50 years or older.

Please let me know that you received this e-mail and if you have any questions.
Thanks,

Susan Quinnell
Review and Compliance Coordinator
ND State Historic Preservation Office
State Historical Society of North Dakota
North Dakota Heritage Center
612 East Boulevard Avenue
Bismarck ND 58505-0830

701-328-3576
701-328-3710 FAX

27 properties

TETRA TECH

March 28, 2013

Susan Quinnell
Review and Compliance Coordinator
North Dakota State Historic Preservation Office
612 East Boulevard Drive
Bismarck, North Dakota 58505

Subject: **Request for Comment on the Area of Potential Effects for Visual Effects for the Thunder Spirit Wind Energy Center (ND SHPO REF: 11-1854), Adams County, North Dakota.**

Dear Ms. Quinnell:

On July 1, 2011, Thunder Spirit Wind, LLC received a letter from the State Historical Society of North Dakota (SHSND) indicating the agency's review of the Class I Cultural Resource Inventory (ND SHPO REF: 11-1854). In this letter, SHSND recommended the completion of a Class II Reconnaissance Survey for standing structures and a Class III Pedestrian Survey for areas to be directly impacted by the project. Tetra Tech will update the Class I Cultural Resource Inventory and conduct a Class III Pedestrian Survey in spring 2013.

In regards to the Class II Reconnaissance Survey for standing structures, Tetra Tech requests the SHPO's comments on the size of the area of potential effects (APE) for visual effects for the Thunder Spirit Wind Energy Center. Tetra Tech also requests that the SHPO identify those properties (inventoried or un-inventoried) that should be included within the Class II Reconnaissance Survey. Tetra Tech has provided a map (hard copy and electronic copy) of the proposed turbine layout dated March 22, 2013.

Please feel free to contact me by telephone (612-643-2237) or by email (adam.holven@tetratech.com) if you have any questions concerning this request.

Sincerely,

Adam Holven
Senior Archaeologist/Project Manager

Enclosures

cc:

Mr. Dan Albano, Thunder Spirit Wind, LLC
Ms. Tracey Dubuque, Tetra Tech
Ms. Kimberely Gorman, Tetra Tech

RECEIVED
APR 01 2013
State Historical Society
N.D. Heritage Center
Bismarck, ND

2001 Killebrew Drive, Suite 141, Bloomington, MN 55425
Tel 612.643.2200 Fax 612.643.2201 www.tetratech.com

Dubuque, Tracey

From: Quinnell, Susan L. <squinnell@nd.gov>
Sent: Tuesday, April 02, 2013 12:05 PM
To: Holven, Adam
Subject: APE for Visual Effects for the Thunder Spirit wind Energy Center ND SHPO Ref: 11-1854
Attachments: doc07002520130402110509.pdf

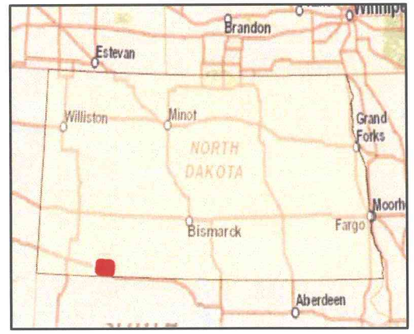
Hi Adam,

Here is a PDF of your map we received yesterday. I put circles or squares around the areas we would like to see a Class II (reconnaissance) survey. That means I'd like to see a photo of each of these 27 sites, keyed to a map. Then if you find any of these 27 sites that have buildings/structures 50 years or older, please fill out a site form with eligibility recommendations on the buildings/structures that are 50 years or older.

Please let me know that you received this e-mail and if you have any questions.
Thanks,

Susan Quinnell
Review and Compliance Coordinator
ND State Historic Preservation Office
State Historical Society of North Dakota
North Dakota Heritage Center
612 East Boulevard Avenue
Bismarck ND 58505-0830

701-328-3576
701-328-3710 FAX



Facility Layout 3/22/2013

- Proposed Turbine Location
- 1-mile Turbine Layout Buffer

X = no architectural survey required in that section of land

O on □ = Class III survey of buildings/structures w Site Form filled out on any structures/buildings found to be 50 years +.

0 0.5 1 1.5 Miles

Figure 1:
Turbine Location
with 1-mile Buffer
Thunder Spirit Wind Energy Center
Adams County, North Dakota

Global Winds Harvest

TETRA TECH

3/28/2013 S:\Projects\TT_EC\ThunderSpirit_Global\GIS\SHPO_Figure1_032813.mxd adam.holven

Source: Map adapted from ArcGIS Map Server USA Topos - 24k (Taylor Butte SE [1974] and Hettinger North [1974] ND); Global Winds Harvest - Thunder Spirit Wind, LLC (turbines 3/22/13).

Jack Dalrymple, Governor
Mark A. Zimmerman, Director

1600 East Century Avenue, Suite 3
Bismarck, ND 58503-0649
Phone 701-328-5357
Fax 701-328-5363
E-mail parkrec@nd.gov
www.parkrec.nd.gov

May 10, 2013

Tracey Dubuque
Tetra Tech
160 Federal Street, 3rd Floor
Boston, MA 02110

Re: Thunder Spirit Wind Energy Project, Adams County, North Dakota

Dear Tracey Dubuque,

The North Dakota Parks and Recreation Department (the Department) has reviewed the above referenced proposal Thunder Spirit Wind Energy Project on 40 square miles of leased probate property in Adams County.

Our agency scope of authority and expertise covers recreation and biological resources (in particular rare plants and ecological communities). The project as defined does not affect state park lands that we manage or Land and Water Conservation Fund recreation projects that we coordinate.

The North Dakota Natural Heritage biological conservation database has been reviewed to determine if any plant or animal species of concern or other significant ecological communities are known to occur within an approximate one-mile radius of the project area. Based on this review, there are no documented occurrences in our database within or adjacent to project area. Because this information is not based on a comprehensive inventory, there may be species of concern or otherwise significant ecological communities in the area that are not represented in the database. The lack of data for any project area cannot be construed to mean that no significant features are present. The absence of data may indicate that the project area has not been surveyed, rather than confirm that the area lacks natural heritage resources.

Given the potential for not only habitat disturbance and disruption but the threat to nesting, feeding and migratory bird and bats in the area we suggest that all efforts be made to avoid impacts to wildlife species and their habitats. In an effort to avoid or minimize impacts to wildlife and their habitats we encourage proper evaluation of all potential wind energy sites. To identify and assess adverse impacts to wildlife we suggest pre and post construction avian and bat monitoring studies be conducted.

The Department recommends that the project be accomplished with minimal impacts and that all efforts be made to ensure that critical habitats not be disturbed in the project area to help secure rare species conservation in North Dakota. Regarding any reclamation efforts, we recommend that any impacted areas be revegetated with species native to the project area.

We appreciate your commitment to rare plant, animal and ecological community conservation, management and inter-agency cooperation to date. For additional information please contact me at (701-328-5370 or kgduttenhefner@nd.gov). Thank you for the opportunity to comment on this proposed project.

Sincerely,

Kathy Duttenhefner, Coordinator
Natural Resources Division

R:USNDNHI*2013_061 KD5/10/2013DL5.24.2013

North Dakota State Water Commission

900 EAST BOULEVARD AVENUE, DEPT 770 • BISMARCK, NORTH DAKOTA 58505-0850
701-328-2750 • TDD 701-328-2750 • FAX 701-328-3696 • INTERNET: http://swc.nd.gov

May 16, 2013

Tracey Dubuque
Tetra Tech
160 Federal Street, 3rd Floor
Boston, MA 02110

Dear Ms. Dubuque:

This is in response to your request for review of environmental impacts associated with (Case No. PU-11-601) – Thunder Spirit Wind Energy Project located in Adams County, ND.

The proposed project has been reviewed by State Water Commission staff and the following comments are provided:

- There are no floodplains identified and/or mapped where this proposed project is to take place. The area is designated as a Zone D. It is also believed that the project will not affect an identified floodplain as identified by the National Flood Insurance Program (NFIP). The NFIP map used to make this determination is: Adams County, Date 1/2/1987.

- A Drain Permit from the State Engineer may be needed for this project if wetlands are filled. Please contact Dwight Comfort at 701-328-4960, if you have any questions regarding the permit. The permit application is enclosed.

- It is the responsibility of the project sponsor to ensure that local, state and federal agencies are contacted for any required approvals, permits, and easements.

- All waste material associated with the project must be disposed of properly and not placed in identified floodway areas.

- No sole-source aquifers have been designated in ND.

There are no other concerns associated with this project that affect State Water Commission or State Engineer regulatory responsibilities.

Thank you for the opportunity to provide review comments. If you have any questions, please call me at 701-328-4967.

Sincerely,

Linda Weispfenning
Water Resource Planner

LW:dp/1570
Encl.

JACK DALRYMPLE, GOVERNOR
CHAIRMAN

TODD SANDO, P.E.
SECRETARY AND STATE ENGINEER

APPLICATION FOR SURFACE DRAIN
OFFICE OF THE STATE ENGINEER
Water Development Division
SFN 2830 (8/11)

DATE RECEIVED BY OFFICE OF THE STATE ENGINEER

I, the undersigned, am applying for a permit under NDCC Section 61-32-03, to drain a pond, slough, lake, or sheetwater, or any series thereof, which has a watershed area comprising 80 acres or more.

No._____ (OSE USE ONLY)

This application must be accompanied by FSA aerial photos or equivalent showing the location of the proposed drain(s).

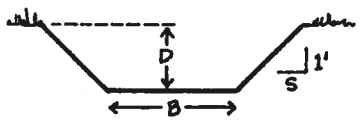
(1)	WATER RESOURCE DISTRICT IN WHICH PROJECT IS LOCATED:				
(2)	LEGAL DESCRIPTION - DRAIN CENTERLINE: [use separate sheet(s) if necessary]	1/4	SECTION	TOWNSHIP	RANGE
		1/4	SECTION	TOWNSHIP	RANGE
		1/4	SECTION	TOWNSHIP	RANGE
(3)	LEGAL DESCRIPTION - DRAIN OUTLET:	1/4 1/4	SECTION	TOWNSHIP	RANGE

(4) PURPOSE:

(5) Drain Method: ☐ Pumping ☐ Filling ☐ Gravity

(6) DESCRIPTION OF AREA TO BE DRAINED:

TOTAL Drainage Area	Acres	Project Drainage Area	Acres
Water Area	Acres	Average Depth of Water	Feet



(7) DESCRIPTION OF DRAIN:

Pumping Rate (if applicable)	gpm / cfs	Fill Volume (if applicable)	cubic yards	Bottom Width (B)	Feet
TOTAL Length of Drain	Feet	Length of Drain Project	Feet	Side Slopes (S)	:1 Foot
(8) Anticipated completion date:		(9) Assessment drain? ☐ YES ☐ NO		Maximum Cut (D)	Feet

(10) Do you own the land to be drained in fee? ☐ YES ☐ NO If NO, give the name and address of the legal landowner(s):

The filing of this application and its approval does not relieve the applicant and/or landowner(s) from any responsibility or liability for damages resulting from the construction, operation or failure of this drain.

APPLICANT'S CERTIFICATION

I understand that I must undertake and agree to pay the expense incurred in making an investigation. If the investigation discloses that the quantity of water to be drained will flood or adversely affect downstream lands, I will be required to obtain flowage easements and must file the easements in the office of the county recorder before a permit may be issued. My signature below acknowledges that I have read and agree to these statements, and will adhere to the conditions given on the back of this application.

NAME (PRINT OR TYPE):	DATE SUBMITTED:
ADDRESS:	PHONE NO:
CITY, STATE, ZIP CODE:	
SIGNATURE (Owner of the land on which the project is located or legal entity sponsoring project):	

North Dakota Geological Survey

Edward C. Murphy - State Geologist

Department of Mineral Resources

Lynn D. Helms - Director

North Dakota Industrial Commission

https://www.dmr.nd.gov/ndgs/

May 14, 2013

Tracey Dubuque
Tetra Tech
160 Federal Street, 3rd Floor
Boston, Massachusetts 02110

RE: Thunder Spirit Wind Energy Project in Adams County, ND

Dear Ms. Dubuque:

The surface of some of the area that you have identified is strewn with boulders of silcrete (hard, siliceous rock) which measure up to three feet wide, two feet thick, and four feet long. These chunks of silcrete will range in this area from absent to abundant and may prove a problem when attempting to auger holes (see attached photograph). In addition, we have been investigating kaolinite-rich claystones that potentially could be used in the manufacture of ceramic proppant in hydraulic fracturing. One of the two clays we are investigating is present in the area that you have outlined. We have a series of maps on our website that have been generated by this project that might find useful https://www.dmr.nd.gov/ndgs/Clay%20map/Clay%201%20.asp and https://www.dmr.nd.gov/ndgs/Clay%20map/mott_100k_al.pdf .

None of the permits that our agency issues would be required for this wind energy project. Please contact me if you have any questions.

Sincerely,

Edward C. Murphy
State Geologist

Encl.


SILICATE
WHITE KAOLINITE


SILCRETE

NORTH DAKOTA
DEPARTMENT of HEALTH

ENVIRONMENTAL HEALTH SECTION
Gold Seal Center, 918 E. Divide Ave.
Bismarck, ND 58501-1947
701.328.5200 (fax)
www.ndhealth.gov

May 3, 2013

Tracey Dubuque, P.E.
Senior Project Manager
Tetra Tech, Inc.
160 Federal Street, 3rd Floor
Boston, MA 02110

Re: Thunder Spirit Wind Energy Project, PSC Case No. PU-11-601
Adams County, North Dakota

Dear Ms. Dubuque:

This department has reviewed the information concerning the above-referenced project submitted under date of April 22, 2013, with respect to possible environmental impacts.

This department believes that environmental impacts from the proposed construction will be minor and can be controlled by proper construction methods. With respect to construction, we have the following comments:

1. All necessary measures must be taken to minimize fugitive dust emissions created during construction activities. Any complaints that may arise are to be dealt with in an efficient and effective manner.

2. Care is to be taken during construction activity near any water of the state to minimize adverse effects on a water body. This includes minimal disturbance of stream beds and banks to prevent excess siltation, and the replacement and revegetation of any disturbed area as soon as possible after work has been completed. Caution must also be taken to prevent spills of oil and grease that may reach the receiving water from equipment maintenance, and/or the handling of fuels on the site. Guidelines for minimizing degradation to waterways during construction are attached.

3. Projects disturbing one or more acres are required to have a permit to discharge storm water runoff until the site is stabilized by the reestablishment of vegetation or other permanent cover. Further information on the storm water permit may be obtained from the Department's website or by calling the Division of Water Quality (701-328-5210). Also, cities may impose additional requirements and/or specific best management practices for construction affecting their storm drainage system. Check with the local officials to be sure any local storm water management considerations are addressed.

NORTH DAKOTA
DEPARTMENT of HEALTH

ENVIRONMENTAL HEALTH SECTION
Gold Seal Center, 918 E. Divide Ave.
Bismarck, ND 58501-1947
701.328.5200 (fax)
www.ndhealth.gov

Construction and Environmental Disturbance Requirements

These represent the minimum requirements of the North Dakota Department of Health. They ensure that minimal environmental degradation occurs as a result of construction or related work which has the potential to affect the waters of the State of North Dakota. All projects will be designed and implemented to restrict the losses or disturbances of soil, vegetative cover, and pollutants (chemical or biological) from a site.

Soils

Prevent the erosion of exposed soil surfaces and trapping sediments being transported. Examples include, but are not restricted to, sediment dams or berms, diversion dikes, hay bales as erosion checks, riprap, mesh or burlap blankets to hold soil during construction, and immediately establishing vegetative cover on disturbed areas after construction is completed. Fragile and sensitive areas such as wetlands, riparian zones, delicate flora, or land resources will be protected against compaction, vegetation loss, and unnecessary damage.

Surface Waters

All construction which directly or indirectly impacts aquatic systems will be managed to minimize impacts. All attempts will be made to prevent the contamination of water at construction sites from fuel spillage, lubricants, and chemicals, by following safe storage and handling procedures. Stream bank and stream bed disturbances will be controlled to minimize and/or prevent silt movement, nutrient upsurges, plant dislocation, and any physical, chemical, or biological disruption. The use of pesticides or herbicides in or near these systems is forbidden without approval from this Department.

Fill Material

Any fill material placed below the high water mark must be free of top soils, decomposable materials, and persistent synthetic organic compounds (in toxic concentrations). This includes, but is not limited to, asphalt, tires, treated lumber, and construction debris. The Department may require testing of fill materials. All temporary fills must be removed. Debris and solid wastes will be removed from the site and the impacted areas restored as nearly as possible to the original condition.

4. Noise from construction activities may have adverse effects on persons who live near the construction area. Noise levels can be minimized by ensuring that construction equipment is equipped with a recommended muffler in good working order. Noise effects can also be minimized by ensuring that construction activities are not conducted during early morning or late evening hours.

The department owns no land in or adjacent to the proposed improvements, nor does it have any projects scheduled in the area. In addition, we believe the proposed activities are consistent with the State Implementation Plan for the Control of Air Pollution for the State of North Dakota.

These comments are based on the information provided about the project in the above-referenced submittal. The U.S. Army Corps of Engineers may require a water quality certification from this department for the project if the project is subject to their Section 404 permitting process. Any additional information which may be required by the U.S. Army Corps of Engineers under the process will be considered by this department in our determination regarding the issuance of such a certification.

If you have any questions regarding our comments, please feel free to contact this office.

Sincerely,

L. David Glatt, P.E., Chief
Environmental Health Section

LDG:cc
Attach.

Appendix C
Turbine Specifications

Vestas

Wind. It means the world to us.™

V100-1.8/2.0 MW™ IEC 3A/ IEC 2B

The V100-1.8 MW™ IEC 3A is ideal for low wind sites with high turbulence and the V100-2.0 MW™ IEC 2B is suited for medium wind sites with low turbulence. Both turbines are available for onshore wind sites.

Data

Operational data

Rated power: 1,800/2,000 kW
Cut-in wind speed: 3 m/s
Rated wind speed: 12 m/s
Cut-out wind speed: 20 m/s
Wind class: IEC 3A/ IEC 2B
Operating temperature: range standard range -20°C to 40°C, low temperature option -30°C to 40°C

Rotor

Rotor diameter: 100 m
Swept area: 7,854 m2
Air brake: full blade feathering with three-pitch cylinders

Electrical

Frequency: 50 Hz/60 Hz
Generator type: 4-pole (50 Hz)/6-pole (60 Hz) doubly fed generator, slip rings

Gearbox

Type: two helical stages and one planetary stage

Power regulation

Pitch regulated with variable speed

© Vestas 2013 all rights reserved Disclaimer Sitemap Vestas Wind Systems A/S Hedeager 44 8200 Aarhus N Denmark +45 97 30 00 00 Company reg. no. 10 40 37 82 This is a CO_2-neutral website

2009.02.27

Technical Specifications

SWT-2.3-108

Rotor

Type	3-bladed, horizontal axis
Position	Upwind
Diameter	108 m
Swept area	9144 m²
Speed range	6-16 rpm
Power regulation	Pitch regulation with variable speed
Rotor tilt	6 degrees

Blade

Type	Self-supporting
Blade length	53 m
Root chord	3.4 m
Aerodynamic profile	NACA63.xxx, FFAxxx, SWPxxx
Material	GRE
Surface gloss	Semi-gloss, <30 / ISO2813
Surface colour	Light grey, RAL 7035

Aerodynamic brake

Type	Full-span pitching
Activation	Active, hydraulic

Load-Supporting Parts

Hub	Nodular cast iron
Main bearing	Spherical roller bearing
Main shaft	Alloy steel
Nacelle bed plate	Steel

Transmission system

Coupling hub - shaft	Flange
Coupling shaft - gearbox	Shrink disc
Gearbox type	3-stage planetary/helical
Gearbox ratio	1:91
Gearbox lubrication	Splash/forced lubrication
Oil volume	Approx. 400 l
Gearbox oil filtering	Inline and offline
Gearbox cooling	Separate oil cooler
Gearbox designation	PEAB 4456 (Winergy) or EH851 (Hansen)
Coupling gear - generator	Double flexible coupling

Mechanical brake

Type	Hydraulic disc brake
Position	High speed shaft
Number of callipers	2

Canopy

Type	Totally enclosed
Material	Steel
Surface gloss	Semi-gloss, 25-45, ISO2813
Colour	Light grey, RAL 7035

Generator

Type	Asynchronous
Nominal power	2,300 kW
Protection	IP 54
Cooling	Integrated heat exchanger
Insulation class	F

Grid Terminals (LV)

Nominal power	2,300 kW
Voltage	690 V
Frequency	50 Hz or 60 Hz

Yaw system

Type	Active
Yaw bearing	Externally geared slew ring
Yaw brake	Passive friction brake
Yaw drive	Eight electric gear motors with frequency converter

Controller

Type	Microprocessor
SCADA system	WPS via modem
Controller designation	KK WTC 3.0
Controller manufacturer	KK Electronic A/S

Tower

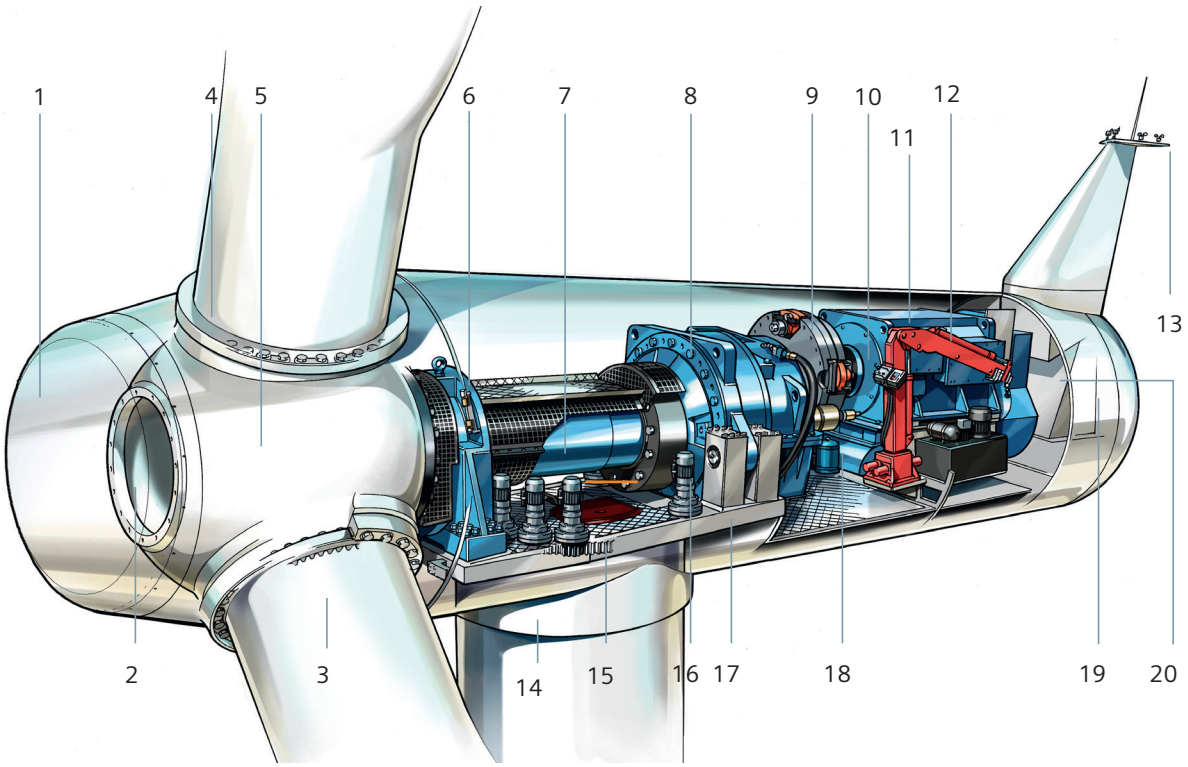
Type	Cylindrical and/or tapered tubular
Hub height	80 m or site-specific
Corrosion protection	Painted
Surface gloss	Semi-gloss, 25-45, ISO2813
Colour	Light grey, RAL 7035

Operational data

Cut-in wind speed	3-4 m/s
Rated power at	11-12 m/s
Cut-out wind speed	25 m/s
Maximum 3 s gust	59.5 m/s (IEC version)

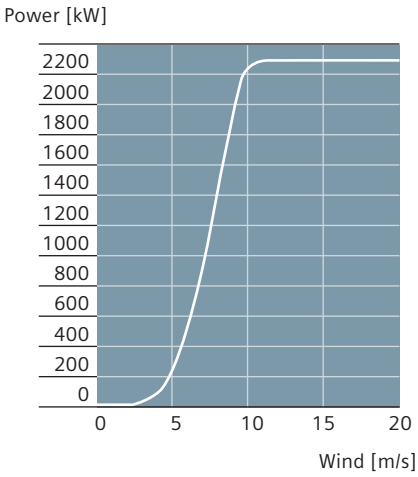
Weights (approximately)

Rotor	60,000 kg
Nacelle	82,000 kg



Sales power curve

The calculated power curve data are valid for standard conditions of 15 degrees Celsius air temperature, 1013 hPa air pressure and 1.225 kg/m³ air density, clean rotor blades and horizontal, undisturbed air flow. The calculated curve data are preliminary.



Nacelle arrangement

1. Spinner
2. Spinner bracket
3. Blade
4. Pitch bearing
5. Rotor hub
6. Main bearing
7. Main shaft
8. Gearbox
9. Brake disc
10. Coupling
11. Generator
12. Service crane
13. Meteorological sensors
14. Tower
15. Yaw ring
16. Yaw gear
17. Nacelle bedplate
18. Oil filter
19. Canopy
20. Generator fan

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Siemens AG
Energy Sector
Freyeslebenstrasse 1
91058 Erlangen, Germany

Siemens Wind Power A/S
Lindenplatz 2
20099 Hamburg, Germany
www.siemens.com/wind

For more information, please contact
our Customer Support Center.
Phone: +49 180 524 70 00
Fax: +49 180 524 24 71
(Charges depending on provider)
E-mail: support.energy@siemens.com

Wind Power Division
E50001-W310-A184-X-4A00

Printed in Germany
Dispo 34804 c4bs No. 7491
MCS 12.11.1
Printed on elementary chlorine-free
bleached paper.

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Subject to change without prior notice.
The information in this document contains
general descriptions of the technical options
available, which may not apply in all cases.
The required technical options should therefore
be specified in the contract.

ACCIONA Windpower

AW-3000



acciona
Windpower

AW-3000
WIND TURBINE

The AW-3000 is based on Acciona´s experience of operating thousands of megawatts of wind turbines worldwide in all types of conditions. Like its successful predecessor the AW-1500, it has been designed to optimize the life-cycle cost of a wind turbine, not merely the upfront capital cost.

The turbine is designed from an owner´s perspective. Features include two bearings to reduce the axial loads on the gear box, access to the inside of the hub from the nacelle, and a wider nacelle for easier serviceabilty.





Rotor

- Designed for three diameters, suitable for sites with different wind conditions: 100 m (class IEC Ia), 109 m (class IEC IIa) and 116 m (class IEC IIIa).
- Hub heights of 100 and 120 m with a concrete tower.
- Hub made of nodular cast iron. The hub contains the hydraulic pitch system capable of locking the blades in the event of an emergency stop.
- Designed for easy access to the interior of the hub from the nacelle. Eliminates the need to enter from outside.

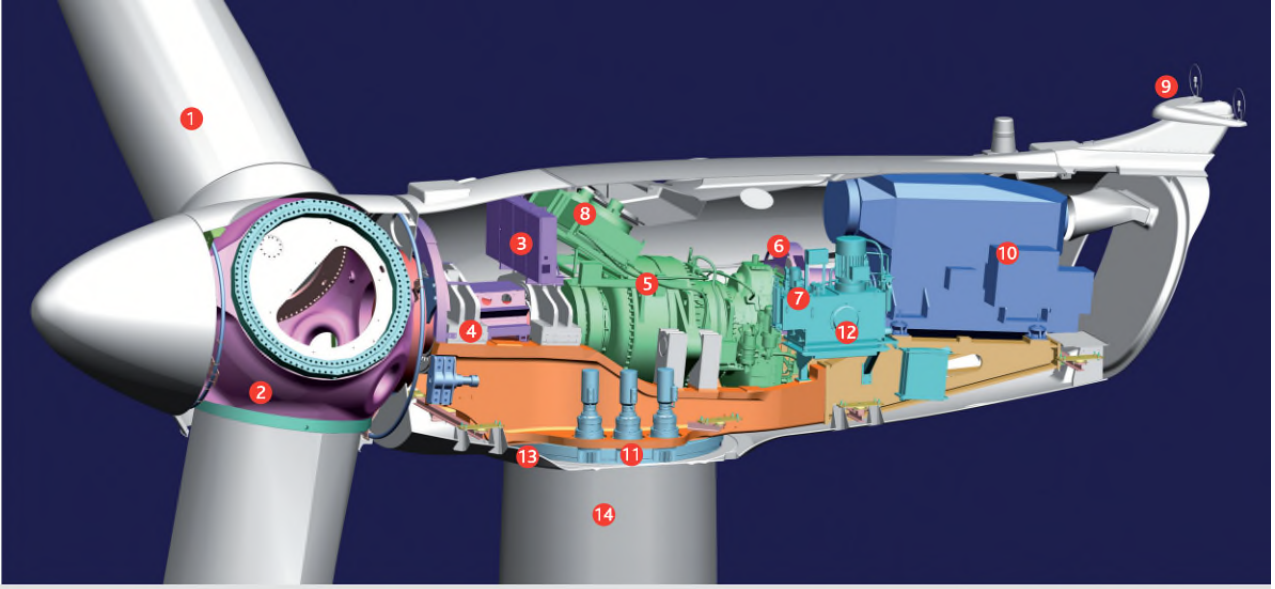
Blades

- Made of polyester-reinforced fiberglass and coated with a special surface protection.
- Available in three lengths depending on the rotor diameter: 48.7 m, 53.2 m and 56.7 m.
- Equiped with an independent pitch system that allows the pitch angle of each blade to turn on its horizontal axis, to optimize the regulation of capacity generated at high winds and increase the safety of the aerodynamic braking system.

Nacelle

- Innovatively designed cover made from fiberglass-reinforced polyester.
- Spacious interior with easy access to the hub and the exterior.
- Crane to hoist materials up to 500 kg (1100 pounds).
- Robust double frame that reduces the stress on the drive train.
- Double-fed, three-phase asynchronous induction generator with wound rotor and excitation by collector rings. Generates at medium voltage (12 kV), which reduces losses and avoids the need for a transformer in many cases.
- Yaw system uses a gear ring integrated into the tower and six geared motors integrated into the nacelle.





1 Rotor blades
2 Hub
3 Control system monitoring
4 Main shaft
5 Gearbox
6 Disk brake
7 Generator coupling
8 Cooling radiator
9 Wind measuring system
10 Generator
11 Yaw drive
12 Hydraulic system
13 Yaw bearing
14 Tower

Concrete tower

- Innovative concrete tower design to cost-effectively reach taller heights and take advantage of increased production.



12.000 Volt Output

- Medium voltage output to optimize collection system designs. Ideal for small to medium size projects.



Remote Operating Center

- State-of-the art 24/7 remote operating capabilities to maximize performance and project avilability.



Technical information

	AW-100/3000	AW-109/3000	AW-116/3000
Rotor diameter	100 m	109 m	116 m
Wind class (IEC)	IEC Ia	IEC IIa	IEC IIIa

OPERATING DATA

Cut-in wind speed	4 m/s	3,5 m/s	3 m/s
Nominal power wind speed	11.7 m/s	11.1 m/s	10.6 m/s
Cut-out wind speed	25 m/s		20 m/s
Nominal power	3,000 kW		

LOW TEMPERATURE KIT

Cold Weather Operational temperature range (optional)	- 30° C to +40 °C

COMPONENT DATA

Diameter	100 m	109 m	116 m
Swept area	7,864 m²	9,331 m²	10,568 m²
Nominal rotation speed	14.2 rpm	13.2 rpm	12.3 rpm
Power regulation Overspeed control	Full span blade pitch		
Nominal tip speed	74.3 m/s	74.7 m/s	74.7 m/s

PITCH SYSTEM

Pitch bearings	Double row four point contact
Actuation	Hydraulic
Failsafes	Accumulators on hub

DRIVE TRAIN

Gearbox	3 stages: 2 planetary/helical		
Gearbox nominal power	3,000 kW		
Gearbox ratio	1:77	1:83	1:89
Input nominal speed	14.2 rpm	13.1 rpm	12.3 rpm
Ouput nominal speed		1,100 rpm	
Lubrication	Pressure and splash with oil cooler/oil filter		
Condition Monitoring System	Optional		

ROTOR SHAFT

Support	2 bearings
Bearings	Double spherical roller bearings

YAW SYSTEM

Type	Four point ball bearing
Slewing ring	External
Braking system	Disk + callipers

YAW GEARS AND MOTORS

Type	5 planetary stages
Number of yaw gears	6

GENERATOR

Type	6 poles, double feeding
Insulation type (starto/rotor)	H/H
Rated power	3,000 kW
Frequency	50/60 Hz
Voltage	12,000 V
Speed range (50 Hz)	770 - 1,320 rpm 50 (Hz)/924 - 1,584 rpm 60 (Hz)

CONTROL SYSTEM

Type	Ingecon-W
Scada interface	OPMT

TOWER

Material	Concrete
Tower height (hub 100/120 m)	98.2 m/118.2 m
Access to tower	Door with lock system
Access to nacelle cabin	Ladder or lift
Weight (hub 100/120 m)	850 t/1,100 t
Foundation connection	Anchor bars embedded in the foundation and high quality grout

WEIGHT

Nacelle	118 t
Rotor (100 m)	66 t
Nacelle + hub	154 t

DIMENSIONS AND TRANSPORT

Nacelle + hub (L, W, H)	18 m, 4.5 m, 4 m
Nacelle + hub transport	Complete nacelle or w/out rotor shaft drivetrain
Blades	48.7 m, 53.2 m, 56.7 m

SERVICEBILITY

Automatic lubrication system	Pitch, yaw, main shaft and generator bearings
Service lift capacity	250 kg
Onboard crane	500 kg

AW-3000
Benefits



1 **Reliability**

Based on the same proven design concept that has made the AW-1500 one of the most reliable turbines in the market with a global fleet average availability of over 98%.

2 **Product flexibility**

Optimized design to maximize energy production in all wind classes. 12 kV output, which may eliminate the need for step up transformers under certain conditions, saving on collection system costs.

3 **Durability**

Double bearing support for the main shaft to reduce loads on the gearbox, robust main frame design, 6-pole generator, among other best-in-class design elements to extend the working life.

4 **Safety**

Safety features such as access to the hub from the nacelle, protection of rotating parts, anti-slip materials inside and outside the nacelle, and fireproof materials.

5 **Grid integration**

Double-fed asynchronous generator with IGBT pulses (PMW) that improves voltage and frequency stability. Power management capabilites that allow for the provision of reactive power without wind.



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The technical data included in this brochure may be subject to revision without prior notice. The technical data included in this brochure is not contractually binding.

Appendix D
Receptors Located Within ½ mile of a Turbine

All Receptors within 0.5 miles of a wind turbine (4/26 layout)

Receptor ID	Type	Signed Status	TwnRange	Section	Nearest Turbine	Distance (miles)	Distance (feet)
8	Residence	Signed Easement	T130N R95W	12	A5	0.39	2046.6
28	Residence - Not occupied full time	Signed Easement	T130N R95W	28	68	0.16	*822.6*
67	Residence - Abandoned	Signed Easement	T130N R95W	6	6	0.24	*1272.0*
60	Barn	Not Signed	T130N R95W	7	5	0.50	2628.7
158	Barn	Signed Easement	T130N R95W	28	A19	0.49	2609.4
97	Barn	Signed Easement	T130N R95W	15	62	0.49	2574.3
128	Barn	Not Signed	T130N R95W	19	34	0.48	2547.5
207	Barn	Not Signed	T130N R95W	24	A22	0.48	2522.9
129	Barn	Not Signed	T130N R95W	19	34	0.46	2439.2
90	Barn	Signed Easement	T130N R95W	14	A13	0.45	2388.3
61	Barn	Not Signed	T130N R95W	7	5	0.45	2373.1
209	Barn	Not Signed	T130N R95W	24	A22	0.45	2372.8
152	Barn	Signed Easement	T130N R95W	19	38	0.44	2314.6
63	Barn	Not Signed	T130N R95W	7	5	0.43	2261.6
130	Barn	Not Signed	T130N R95W	21	A10	0.41	2148.4
69	Barn	Signed Easement	T130N R95W	12	A5	0.39	2070.5
71	Barn	Signed Easement	T130N R95W	12	A5	0.38	1989.7
162	Barn	Not Signed	T130N R95W	27	68	0.38	1984.0
70	Barn	Signed Easement	T130N R95W	12	A5	0.37	1957.1
72	Barn	Signed Easement	T130N R95W	12	A5	0.36	1905.0
75	Barn	Signed Easement	T130N R95W	12	A5	0.35	1864.0
76	Barn	Signed Easement	T130N R95W	12	A5	0.33	1764.1
74	Barn	Signed Easement	T130N R95W	12	A5	0.33	1738.2
73	Barn	Signed Easement	T130N R95W	12	A5	0.29	1532.8
131	Barn	Signed Easement	T130N R95W	15	58	0.24	*1253.1*
163	Barn	Signed Easement	T130N R95W	28	68	0.23	*1191.8*
132	Barn	Signed Easement	T130N R95W	15	58	0.20	*1078.4*
66	Barn	Signed Easement	T130N R95W	7	6	0.19	*1023.4*
160	Shed	Signed Easement	T130N R95W	28	A28	0.49	2603.2
98	Shed	Signed Easement	T130N R95W	15	62	0.47	2505.3
208	Shed	Not Signed	T130N R95W	24	A22	0.46	2413.3
161	Shed	Signed Easement	T130N R95W	28	A19	0.43	2293.6
154	Shed	Signed Easement	T130N R95W	19	A16	0.42	2217.0
133	Shed	Signed Easement	T130N R95W	22	72	0.41	2185.2
78	Shed	Signed Easement	T130N R95W	12	A5	0.35	1862.5
79	Shed	Signed Easement	T130N R95W	12	A5	0.35	1853.8
80	Shed	Signed Easement	T130N R95W	12	A5	0.35	1842.0
77	Shed	Signed Easement	T130N R95W	12	A5	0.34	1807.0
65	Shed	Signed Easement	T130N R95W	7	6	0.20	*1054.9*
159	Silo	Signed Easement	T130N R95W	28	A19	0.49	2583.7
203	Silo	Signed Easement	T130N R95W	28	A19	0.48	2545.3
64	Silo	Not Signed	T130N R95W	7	5	0.47	2502.8
91	Silo	Signed Easement	T130N R95W	14	A13	0.44	2325.0
68	Silo	Signed Easement	T130N R95W	11	A5	0.44	2308.1
153	Silo	Signed Easement	T130N R95W	19	A16	0.38	2023.2
81	Silo	Signed Easement	T130N R95W	12	A5	0.37	1977.4
206	Silo	Not Signed	T130N R95W	27	68	0.33	1743.1
204	Silo	Signed Easement	T130N R95W	28	68	0.23	*1235.8*
202	Silo	Signed Easement	T130N R95W	15	58	0.22	*1138.3*
164	Silo	Signed Easement	T130N R95W	28	68	0.21	*1110.3*
205	Silo	Signed Easement	T130N R95W	28	68	0.20	*1051.8*
49	Silo	Signed Easement	T130N R95W	2	A2	0.17	*910.9*
48	Silo	Signed Easement	T130N R95W	2	A2	0.17	*892.4*